INDIAN SEED CONGRESS
Seeds for Global Unity
2-4 March, 2023 | New Delhi

nsa National Seed Association of India

Report on
INDIAN SEED CONGRESS 2023

2-4 March, 2023, New Delhi

WWW.NSAI.CO.IN

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 providing 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 zones. 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.

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Report Summary

INDIAN SEED CONGRESS 2023

The National Seed Association of India (NSAI) successfully organized the 11th Indian Seed Congress (ISC 2023) in New Delhi from 2-4 March, 2023 at JW Marriott, Aero City, New Delhi. ISC 2023 was attended by more than 400 delegates including professionals from the Indian and global seed industry, prominent scientists, agri-professionals and government officials. The congress was addressed by eminent personalities and professionals including Shri Narendra Singh Tomar Hon'ble Union Minister of Agriculture and Farmers' Welfare, , Shri Ashish Bahuguna, Former Secretary (Agriculture), Govt. of India, Dr. Trilochan Mohapatra, President NAAS, Former DG ICAR and former Secretary, DARE, Govt of India, Dr. S K Pattanayak, Former Secretary (Agriculture), Govt. of India, Shri Sanjay Agrawal,

The National Seed Association of India (NSAI) successfully organized the 11th Indian Seed Congress (ISC 2023) in New Delhi from 2-4 March, 2023 at JW Marriott, Aero City, New Delhi.

Former Secretary (Agriculture), Govt. of India, Shri R K Singh IAS, Secretary (Animal Husbandry), MoFAHD, Govt. of India, Shri Pankaj Yadav, Joint Secretary (Seeds), DAFW, Govt of India and Dr. Panjab Singh, Chancellor, Rani Lakshmi Bai Central Agriculture University, Jhansi.

On the first day of the ISC 2023 i.e., 2nd March, 2023, a CEO conclave was organized, which was addressed by spiritual guru Swami Gyanvatsal Ji, motivational speaker Shri Pramod Parkar and management expert Shri Bhupen Dubey. 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. 3rd and 4th March, 2023, the event involved the showcasing of industry products and services through exhibition stalls of various national and multinational companies, trading tables for Business to Business (B2B) meetings and more importantly the eight technical sessions spread over two days of ISC 2023,which witnessed high quality presentations/deliberations by renowned scientists, agri-professionals and seed industry experts.

Eight technical sessions were held on 3rd and 4th March 2023 as per the details given at Annexure II. The technical sessions were mainly focused on interaction, discussion, and debate for developing and strengthening the Indian seed sector. These were well appreciated by many delegates, especially scientists, researchers and technical professionals working in the industry. Various important topics were covered during the event such as Carbon Offsets in Agriculture Sector, Molecular Breeding of Oilseeds, CRISPR based Bioengineering for Novel Agriculture, New Approaches in Seed Technology, Novel Approaches for promoting Vegetable and Forage Seeds, Seed Quality Regulation, Global Seed Trade, IPR, Legal framework and Traceability in Seed Industry and a highly interactive Seed Industry Leaders Panel- Discussion on emerging Indian Seed Industry Issues.

This 11th ISC 2023 also witnessed an overwhelming presence of young seed entrepreneurs along with professionals of large, medium and small companies. The trading tables and the exhibition area were bustling with delegates and overall feedback confirmed that ISC 2023 generated substantial business. NSAI promised the delegates to have more trading tables and exhibition stalls during next editions of the Indian Seed Congress.

Shri Narendra Singh Tomar, Hon'ble Union Minister for Agriculture formally inaugurated the 11th Indian Seed Congress 2023 by lighting the lamp and unveiling of Seed wall. The ISC 2023 was widely covered through print and electronic media on agriculture like Krishi Jagran and Krishi Jagat.

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The Hon'ble Union Agriculture Minister Shri Narendra Singh Tomar announced that the government would soon launch seed traceability system to ensure the

availability of good quality seeds to the farmers. "This will curb the marketing of spurious seeds to the farmers. Hence, the farmers will benefit from the traceability system.

He further added that he is well aware about the difficulties of seed sector and the Government is taking steps to remove the difficulties

Taking into account the rising population and the challenge of climate change, he said everyone engaged in the farm sector should be ready to meet the future challenges and steps should be taken to mitigate the adverse impact of these challenges. He also called upon the stakeholders of the seed sector to contribute to make the country self-sufficient in production of seeds of oilseeds and cotton and reduce import burden. He urged the seed industry to prepare a roadmap in this regard.

https://planet.outlookindia.com/news/seed-traceability-to-enable-farmers-procure-quality-seeds-news-414891

CEO CONCLAVE

Indian Seed Congress 2023

CEO Conclave is a component of NSAI's mega global event, the Indian Seed Congress. This programme is aimed to bring together CEOs of prominent seed companies and other associated industries to explore a vision of developing a healthy, competitive and a strong corporate ecosystem in the seed industry. It also provides a multidisciplinary and vibrant forum for the Seed and Agri-input business top management to have an open interaction on wide range of issues concerning seed sector in the country. The CEO Conclave is aimed to explore current and future challenges in a fast-changing seed industry environment while satisfying the demands of ultimate consumer of seeds i.e., farmers.

To mark the start of the event, NSAI organized CEO Conclave on 2nd March, 2023 as a pre-conference activity to the Indian Seed Congress 2023. The CEO conclave was attended by the **top seed industry leaders from India and overseas, management experts, business strategists**. The conclave witnessed talks and presentations by eminent motivational speakers, management gurus and seed industry strategists.

The first Session was at 03.00 PM in virtual mode on the theme "How to remain calm and balanced under Stress situation" addressed by Swami Gyanvatsal Ji, who is a Motivational Speaker from Akshardham, BAPS Swaminarayan Sanstha. Swami Ji is a great social reform motivator, continuously working for spiritual wellness of youngsters, businessmen and

students by his deep knowledge of human social life and through his life changing talk and preaching. His motivational talks for business leaders are well acclaimed all over the world.

In his talk Swami ji explained the mantra of work life balance in a very effective manner with the help of many real-life situations with an active involvement of all the participants.

In his talk Swami ji explained the mantra of work life balance in a very effective manner with the help of many real-life situations with an active involvement of all the participants. Each of the participants had many good messages to carry home for managing stress at work and daily life. Participants were highly impressed by Swami Ji's talk and wished to have another opportunity to listen to his teachings face to face.

The Second Session at 04:45 PM was on "Effective communication and management of change at work place" taken by Shri Pramod Parkar, Director, Edify Consultants and an eminent Management Expert from Mumbai. Shri Pramod Parkar is an analytical, innovative & result-oriented Information Communication Technology Service Management professional with 18 plus years of experience in multiple sectors including Automobile, Banking, Healthcare, Insurance, Manufacturing & Information Technology industry verticals.

Shri Parkar made his session highly participatory and interactive with the help of management games, sharing of participants' own experiences and his own presentation. He was quite successful in conveying his message of effective communication and change management in business organizations through his well-designed presentation and activities.

The Third Session on "Globalizing the seed business" was taken by Shri Bhupen Dubey, Global CEO, Advanta Seeds (a UPL Group company), Dubai, UAE at 06:30 PM. During his 15 years tenure with the UPL Group, Shri Dubey has been a key player in managing and integrating companies within the UPL group such as Advanta, Golden Seeds, and Unicorn. With an engagement of over 30 years with the agriculture and food production industry he has been associated with a number of international companies like companies including Hoechst, OptimAgro, and Bayer, apart from UPL group, which highly enriched him with business expertise and market insights.

The talk of Shri Bhupen Dubey provided deep insights of the global seed trade, potential countries and regions for seed export and import, opportunity for Indian seed companies to do global seed business and a critical assessment of strengths and weaknesses of Indian seed companies to play a lead role in global seed market. It was well received by all the participants as his talk provided them with future vision for strategic growth of the industry.

The above speakers, who are masters in their own field, boosted the spirit of the delegates.


CEO CONCLAVE

Speech of the Chief Guest

Shri Narendra Singh Tomer

Hon'ble Union Minister for Agriculture and Farmers Welfare

Shri Narendra Singh Tomar, Hon'ble Union Agriculture Minister inaugurated the 11th Indian Seed Congress 2023. He also unveiled of the Seed Wall of India displaying wide diversity of seeds of crops grown in all the agro-climatic zones of India.

While recounting the steps taken by the Government towards creating an ecosystem of ease of doing business, the Hon'ble Minister mentioned that this is the first such government under the leadership of Hon'ble Prime Minister Shri Narendra Modi ji, which has abolished 1500 such laws which had become irrelevant during the 75 years of independence of the country. It was done with the objective that the trade-industry sector in the country should be able to function properly, while abiding with the law, and without any fear. The Government was also keen to set in an environment of mutual trust among all sections of the country to transform India as a developed nation in the coming time. If we had full trust and confidence on our private sector then the industry would also be encouraged not to resort to any unfair trade practices.

In his speech the Hon'ble Minister mentioned that the interest of farmers is of paramount importance for the Government of India under the leadership of Hon'ble Prime Minister Shri Narendra Modi ji. At the same time , the government is concerned about challenges faced by the seed sector. He stated that the Government would soon launch the Seed Traceability System to ensure availability of good quality seeds to farmers. Its launch will benefit the farmers as well as the seed industry. He also called upon all the stakeholders in making the country self-sufficient in production of oilseeds and cotton and reduce import burden. He urged upon the seed industry to prepare a roadmap in this regard.

In his talk Swami ji explained the mantra of work life balance in a very effective manner with the help of many real-life situations with an active involvement of all the participants.

He also stated that through "Make in India" programme, India has taken many steps in logistic sector through PM Gati Shakti program. It is the responsibility of all of us who are working in the field of agriculture to be ready to meet the expected needs of the country and the world, keeping in mind the increasing population by the year 2050. We should now, therefore, concentrate on seed research especially for improvement of new varieties by addressing various challenges like climate change, biotic and abiotic stresses, and quality enhancement apart from breaking the yield barriers. Thus, organizing this kind of Seed Congress and focusing on seeds for global unity are very appropriate and need of the hour.

He further informed that the Government is committed to provide all the support to ensure that seed sector of the country grows in a transparent manner and with a farmer centric approach. Government is always ready to address the problems of the seed industry and invited Shri Prabhakar Rao, President , NSAI to discuss the pending issues of the industry with Ministry officials before Lok Sabha session starts.

The Hon'ble Minister hoped that India will play an important role in shaping and strengthening global agriculture. He said that the Indian Seed Congress 2023, which is focusing on deliberations on new technologies, regulatory issues, trade barriers etc. concerning seed business, will certainly pave the way to achieve global unity and prosperity through seeds.

At the end he wished for success of the event and congratulated team NSAI for organizing the Indian Seed Congress 2023.

Highlights of the Address by

Shri M. Prabhakar Rao

President, NSAI

Shri M. Prabhakar Rao, President NSAI welcomed the Hon'ble Union Minister of Agriculture ,other dignitaries and delegates and said that the Indian Seed Congress is very important for the seed industry. He also asserted that if good seed is made available to the farmer, there is a possibility of maximum improvement in agricultural production and profitability of farmers, especially the full impact of fertilizer, crop protection and other agricultural resources would only be possible if seed is good.

Referring to the Azadi ka Amrit Mahotsav, he expressed confidence that in the coming 25 years, the country will grow tremendously and become the second largest economy of the world, for which the contribution of agriculture and seed industry under agriculture is essential. It is necessary that as the Government of India is implementing

Shri M. Prabhakar Rao, President NSAI welcomed the Hon'ble Union Minister of Agriculture ,other dignitaries and delegates and said that the Indian Seed Congress is very important for the seed industry.

a plan to strengthen other industries, such as textile, pharma, electronic, sugar etc. by giving PLI and export incentives, similarly adequate incentives should also be given to the seed sector. Mr. Rao stressed on setting up self-sufficient seed industry for self-reliant agriculture. He further mentioned that the private seed sector comprised of large, medium and small companies should be encouraged for research.

Mr. Rao stressed on setting up self-sufficient seed industry for self-reliant agriculture. He further mentioned that the private seed sector comprised of large, medium and small companies should be encouraged for research.

For this, research grants, similar to those available to the pharma and engineering industries, should be available to seed sector also by the Ministry of Science and Technology, Indian Council of Agricultural Research and the Department of Science and Technology so that seed sector investment in research may be encouraged and farmers can be benefited by the supply of improved varieties of seeds. At the same time, he proposed that it is necessary to promote the seed processing, seed testing and seed storage capacity of the seed industry, for which provision of capital incentive and capital grant can be made as is being given in other industries. In this direction, a proposal for production-based incentive has also been given by NSAI to the government in important crops like groundnut, sunflower, mustard, pulses etc., on which a positive action is expected.

NSAI President also mentioned some regulation related issues of the seed industry. He also talked about the proposal made earlier in this regard, under which it was requested that if it is likely to take a long time to come out with the new Seed Bill, then in such a situation some amendments should be made in the existing Seed (Control) Order, 1983. It is necessary to further facilitate the licensing of companies. Presently there is no difference between license of seed companies and seed sellers.

By making appropriate amendments in Seed (Control) Order, 1983 the license of the company should be made on the basis of the field of activity of the company, seed processing, research and development, capacity of plant breeding, availability of seed testing laboratory, etc. and on the basis of these criteria, the license of large and national seed trading companies should be issued at a single window like the Department of Agriculture and Farmers Welfare, Government of India. This will be a good step for the seed industry and will facilitate the seed trade.

Thanking the Hon'ble Agriculture Minister, Mr. Rao said that the government is going to implement the seed traceability system for certified seeds and truthfully labeled seeds from the coming Kharif for transparency in the seed sector. With the amendment of the current seed licensing system, the process will become easier because through this, complete information about varieties, characteristics of varieties, etc. will also be available.

On this occasion, he also talked about amendment in the income tax provisions for the seed industry. He suggested that there should be no tax on seed production and marketing as this is an agriculture related work which is a well-established policy of the government, this proposal had also sent to the Finance Ministry by the Ministry of Agriculture. It was proposed by NSAI that the provision of tax can be made only on 20% of the income received from the seed business because the other income is mainly agriculture based, which is free from income tax as per the rules. The criteria of taxing already exist for coffee and rubber. Action on this proposal is still pending.

Shri Rao also discussed on the dissemination of new technologies in agriculture & seed and said that it is very necessary for the benefit of the farmers.

Shri Rao also discussed on the dissemination of new technologies in agriculture & seed and said that it is very necessary for the benefit of the farmers. He pointed out that farmers' income can be tripled from the current high density planting system in cotton by increasing the number of plants per acre. To reduce the water consumption in paddy, direct sowing of paddy is a new technique to plant paddy with less water. In this direction the seed sector is also undertaking plant breeding work for suitable varieties.

At the end, Mr. Rao drew the attention of the Hon'ble Agriculture Minister to the above points and thanked him for gracing the Indian Seed Congress 2023 and addressing the gathering. He hoped that the Ministry of Agriculture will take positive action on these issues and will become an ally of the growth of seed sector.

Glimpse of Technical Sessions


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Delegate Section

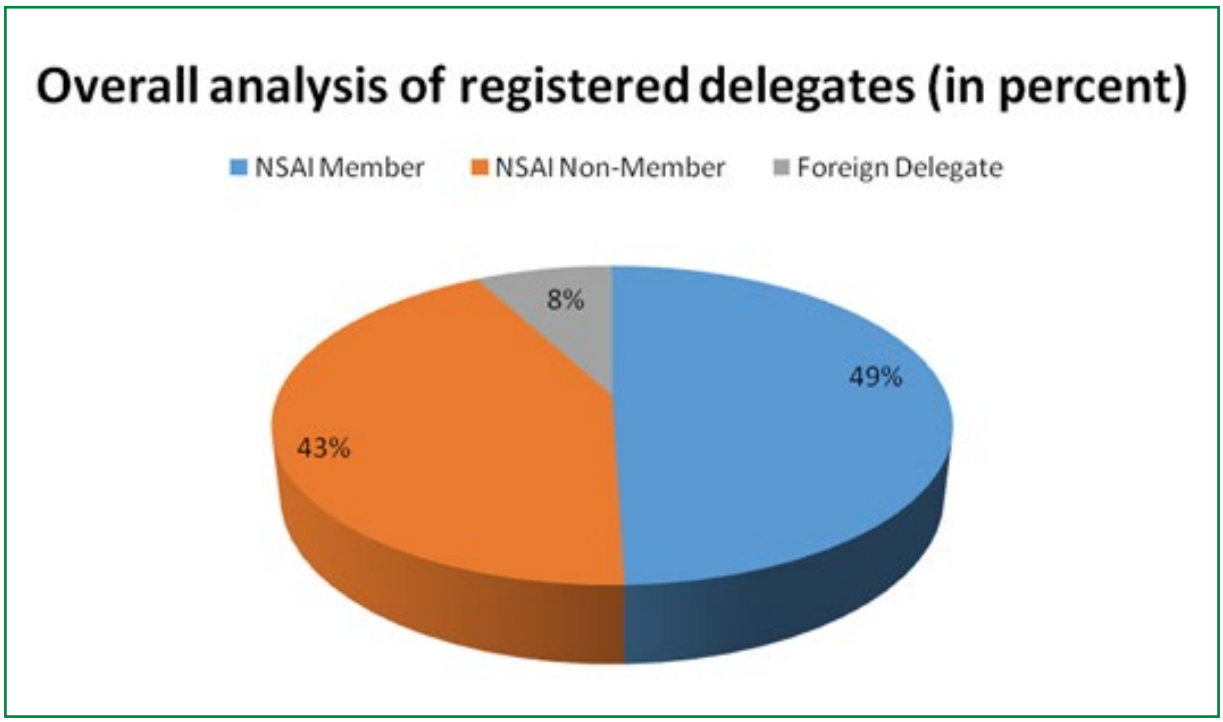
Indian Seed Congress 2023 witnessed encouraging participation of all stakeholders including scientists , government officials, delegates from public and private sector seed companies, input suppliers to the seed industry and overseas delegates.

The total number of registered delegates for Indian Seed Congress 2023 were 422, out of which Indian participants were 389 besides 33 overseas delegates from nine countries (USA, Italy, Sri Lanka, Bangladesh. Thailand, Japan, Nepal, Greece and Korea).

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

Among the total participation of 422 delegates, NSAI-member delegates participation was 49 % (209 delegates) as compared to 43% non-member delegates participation (180 delegates)and the overseas delegates participation was 8 % (33 delegates)(Fig 1).

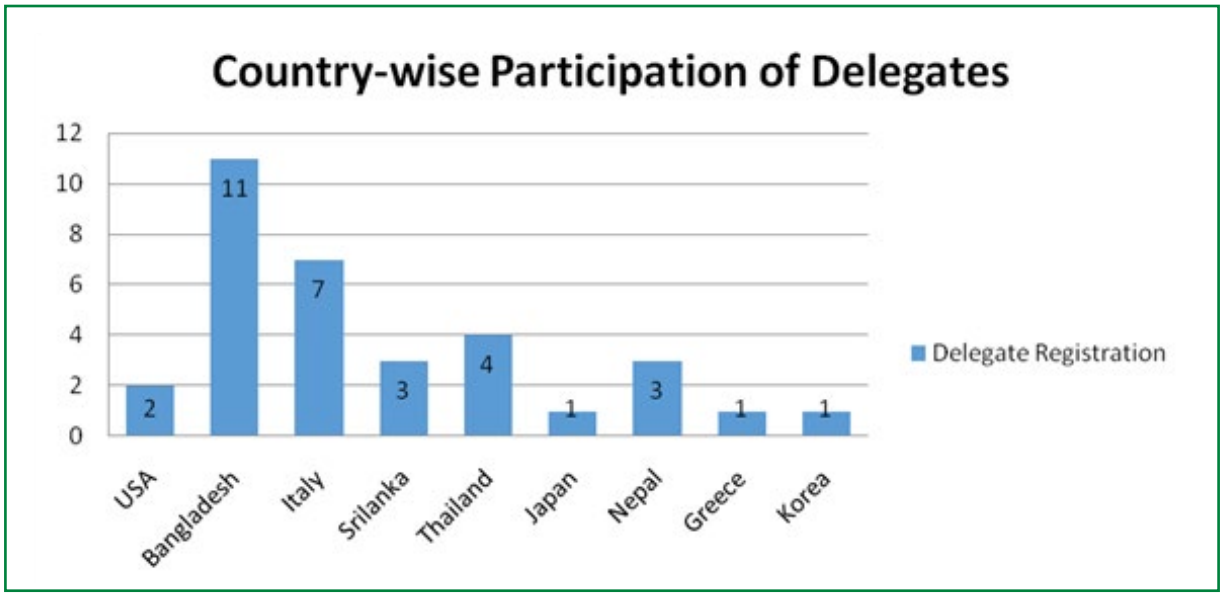
Fig 1: Overall analysis of registered delegates (in percent)



ii). Country wise participation of overseas delegates

The total numbers of registered delegates were 422 out of which 33 were overseas delegates. Among the overseas participants, Bangladesh (11) and Italy (7) had a high delegates participation followed by Thailand (4), Sri Lanka and Nepal (3 delegates from each country), USA (2), Japan, Greece and Korea (1 delegate from each country).

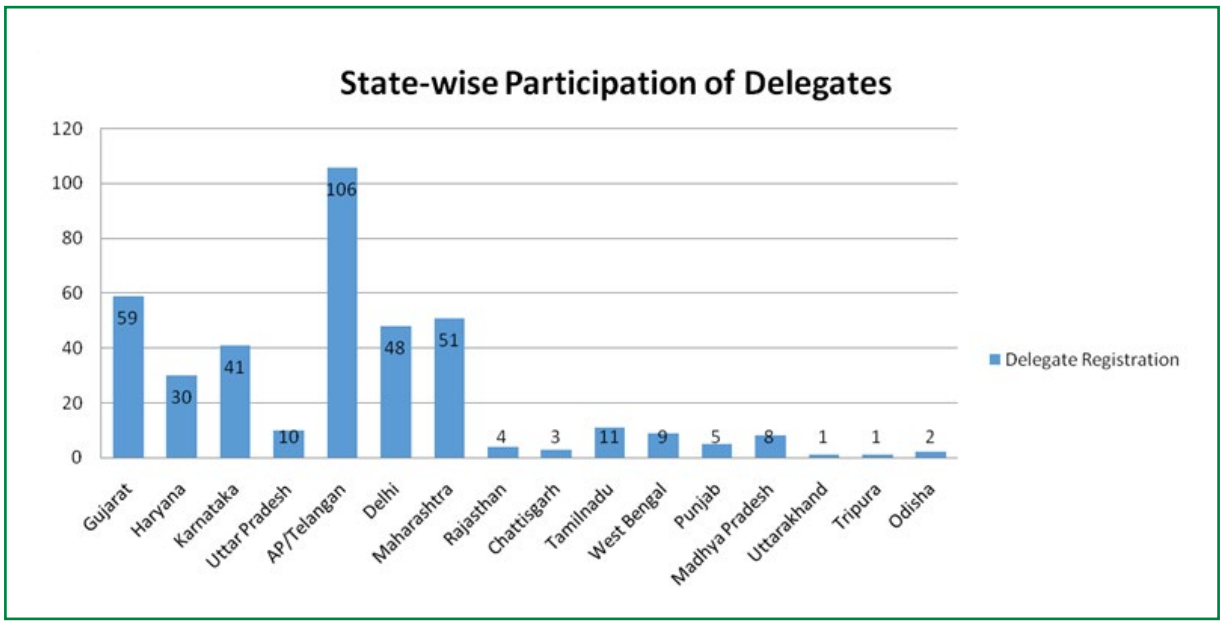
Fig 2: Country-wise participation of delegates



iii). State-wise participation of Indian delegates

Among the 389 Indian participants, Andhra Pradesh and Telangana had a highest delegates participation (106) followed by Gujarat (59), Maharashtra (51), Delhi (48), Karnataka (41), Haryana (30), Tamil Nādu (11), Uttar Pradesh (10), West Bengal (9), Madhya Pradesh (8), Punjab (5), Rajasthan (4), Chhattisgarh (3), Odisha (2), Uttarakhand (1) and Tripura (1).

Fig 3: State-wise participation of delegates



Trading Table and Exhibition Stall Section

To promote B2B activities in the region (National as well as Global), the National Organising Committee organized Exhibition Hall and Trading Table for the delegates.

- This year the participation in Exhibition Stall had an active involvement of industry with 24 stalls exhibited by major companies. The stalls were sold out much prior to the event.
- In total 23 trading tables were sold out. Out of which 22 were taken by Indian Companies and 1 by a company from Italy.


VERDESIAN
55%
11%


VERDESIAN
REDUCE YIELDS
65%
11%


SEED TRIALS
ACROSS ALL
STRATEGIC
LOCATIONS
OF INDIA
SCOPE OF
OPERATIONS:

PRESENTATIONS DELIBERATED AT EACH TECHNICAL SESSION

Global Competitive Advantage to India through integrated Millet value chains

Arvind Kumar
Deputy Director General- Research

Presented at Indian Seed Congress – 2023
Seeds for Global Unity

ICRISAT: Science of Discovery to Science of Delivery

- ICRISAT is a **non-profit, non-political international research organization** that conducts **agricultural research for development** in dryland areas of **Asia and Africa** with a wide array of partners throughout the world
- ICRISAT **was established in 1972** with support from Government of India
- ICRISAT has diplomatic status of international organization in India
- ICRISAT works to bring landscape level holistic solutions
- ICRISAT works for more than 2.1 billion people, 764 million of whom are poor, inhabiting in 55 countries in Asia and Sub-Saharan Africa

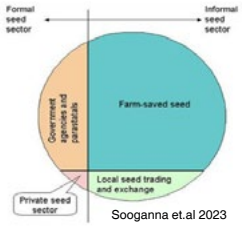
- **Ecology:** Drylands of Asia, Sub-Saharan Africa
- **Mandate Crops:**
  Millets: Pearl millet, Sorghum, Finger millet and other minor millets
  Legumes: Groundnut, Chickpea, Pigeon pea
- Our crops are grown beyond drylands
- Seed system- all crops-fit in the systems- Oilseed, vegetables, cereals, agro-forestry, livestock

India is the epicenter of global millets production

- Millets are climate resilient, nutritious
- 17 m ha area and 18 m tons production
- Pearl millet, sorghum and finger millet occupy 15 m ha area
- Minor millets are popular in many states
- Millet productivity increased by 40% in last 5 years
- Millets grown in drylands, compared with wheat rice grown with irrigation

Dual-purpose, nutritious and climate resilient

Millets seed system is traditional in dryland ecosystems

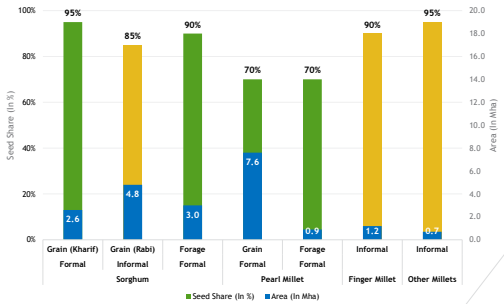


Sooganna et.al 2023

- Millets, pulses, Oilseeds- seed system not as developed as that for Rice, Wheat, Maize
- Informal Seed System models are not delivering with the efficiency and effectiveness needed in drylands
- Non-availability of seeds due to absence of adequate formal seed system
- Limited community participation in millet seed value chain
- Huge opportunities

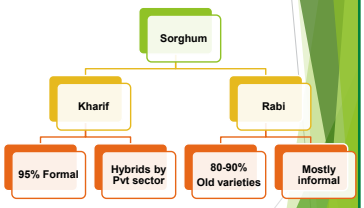
Hybrids dominate Asia, while OPVs are cultivars in ESA and WCA

Share of Seed Systems for Millets in India



Sorghum seed system in India is unique

- Local varieties popular among the farmers include M 35-1 (Maldandi) and Dagadi grown by 80–90% of farmers in India.
- M 35-1, a landrace selection from Maldandi was selected in 1938 and is still dominating the post-rainy season tracts (Maharashtra, Karnataka and Andhra Pradesh)
- **Interventions** required for accelerated varietal replacement in Rabi



Seed system is highly context-specific

- Two major goals in ICRISAT crop breeding
- 1. Develop market-preferred varieties with higher rate of genetic gain
- 2. Rapidly replace farmers' varieties with improved varieties
- For Rapid replacement of farmers' varieties
- Context-specific seed systems (to suit the product, country, policy, industry)
- Right partnerships (public, private, civil society, community)
- Rapid innovations needed to accommodate the changes dynamically

Hybrid Parents Research Consortium contd..

- Rapid increase in adoption rates together with public- private sector efforts
- Fastest way to transfer improved hybrids to farmers
- >500 hybrids commercialized till date, average life of hybrid 5 years. For mega hybrids 8-10 years
- Hybrid adoption rates increased to 90% in rainy season sorghum and 65-70% in pearl millet
- 65-70% of sorghum and pearl millet area under HPRC hybrids (productivity increased 3 folds in PM)
- Seed farmers get 30-50% price than market price
- Contributed nearly USD 10 m for ICRISAT's research

Licensing of released hybrids to companies

- Forage sorghum hybrid CSH 24 MF licensed to 15 companies
- Occupies 1/3rd area of forage sorghum (2.4 m ha)
- New hybrids for Rajasthan A1 dry zone developed and ready for sharing

Achievements in Tropical Legumes Project

- Between 2007 and 2019, ICRISAT led a collaboration of partners to deliver the Tropical Legumes Project
- Under this, developed 266 improved legume varieties and almost 0.5 million tons of seed of pigeon pea, chickpea, groundnut, cowpeas, common bean and soybean.
- These new varieties have helped over 25 million smallholder farmers become more resilient to climate change, as well as pest and disease outbreaks
- In addition, the project trained 52 scientists working in national research institutes across Africa
- **ICRISAT awarded the Africa Food Prize 2021**

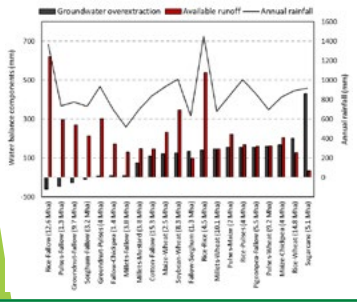
Achievements in sorghum and millets

- The HOPE Sorghum and Millets project, involved 50 partners led by ICRISAT
- 49 cultivars released by the project countries (25 sorghum; 13 pearl millet; and 11 finger millet)
- 183,421 farm households reached with new production technologies
- 8,579 tons of seed produced under the program (6,251 tons of sorghum; 2,084 tons of pearl millet; and 244 tons of finger millet)
- Sorghum and pearl millet productivity increased by 150%

Seed Revolving Fund in Malawi

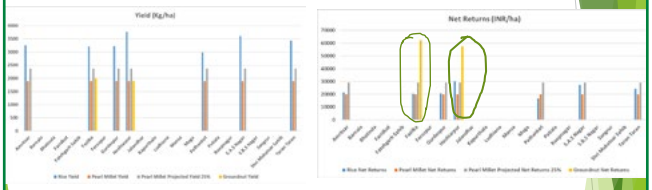
- Malawi Seed Alliance (MASA) is a unique public-private partnership
- Facilitated by SRF, there was an eight-fold increase in the supply of legume certified seed from 270 tons to 2,405 tons
- The groundnut productivity increased from 800 kg to 1560 kg/ha
- Several private companies worked with ICRISAT and have started exporting seed and grain to Europe from Malawi
- Seed Trade Association of Malawi (STAM) awarded a certificate and a trophy to ICRISAT for championing groundnut seed systems

Millets for sustainable crop intensification in India



- Rice fallows holds huge opportunities for sustainable crop intensification as generated runoff is greater than 600 mm/year and groundwater utilization is negligible
- Rice-wheat cropping system is developing negative water budget of about 75 mm/year
- Sugarcane based cropping system in low to medium rainfall zones have developed 400 mm water deficit and needs immediate attention

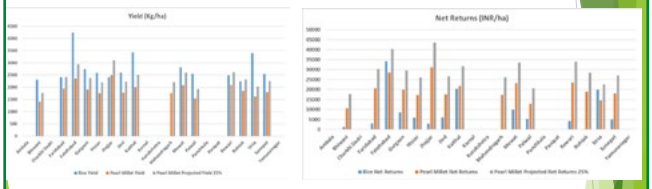
Millets in Punjab



These districts have good potential to replace paddy with millets and groundnut (in two districts only) about 20% area, if MSP price is available

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Millets in Haryana

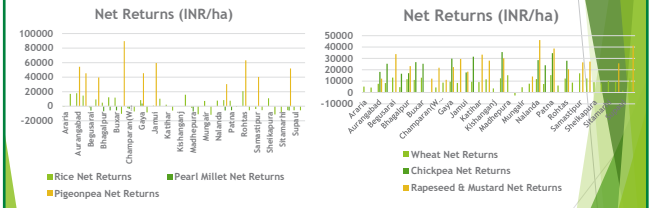


These districts have good potential to replace paddy with millets (about 20% area) if MSP price is available. That will be more profitable for farmers

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

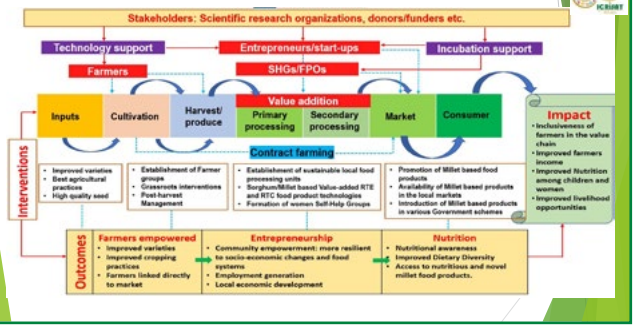
Millets, pulses and oilseeds in Bihar

Relative competitiveness of crops across districts



- Initial analysis shows pigeon pea, chickpea, rapeseed and mustard are more competitive in some districts
- Farming systems modelling to design most profitable diversification options (crop and livestock) in different districts / sub-regions

Millets- Supply, demand, value chain based dissemination



ICRISAT vision on millets seed systems

- Develop **innovative partnerships** with public & pvt. seed sector stakeholders for scaling the adoption of millets (hybrids & inbreds)
- Replicate **SRF model** in other countries of Eastern, Southern Africa- Kenya, Zimbabwe, Ethiopia, Mozambique; Central and West Africa- Mali, Niger, Nigeria in collaboration with **Pvt sector** in **India**
- **We have improved varieties of millets, strong relationship with Govt, public institutions as well as NGOs and farmers**

Opportunities for Indian Seed Industry in Millets seed supply in India, ESA and WCA

- Huge opportunities to expand in India, mechanism existing
- Large untapped sorghum and pearl millet seed market (>30 m ha) in ESA & WCA
- ICRISAT has demonstrated the potential of sorghum and pearl millet hybrids in both these regions
- Our Hybrid Parents Research Consortium in ESA and WCA can provide material needed for local adaptation
- We have excellent partnerships with African NARS, seed industry and AGRA which have significant influence on policy sphere
- ICRISAT can facilitate entry of Indian seed companies to African markets
- International Year of Millets (IYM 2023) provides ample opportunities to get support from various countries
- Together we can enhance millets production in India, SE Asian countries and Africa under South-South collaboration
- We can replicate the success of Millets Value Chains in India, in Africa through public-private partnerships

Opportunities for Indian Seed Industry in India, ESA and WCA beyond millets

- Pulses, Oilseed important crops for drylands
- Seed System for Pulses and Oilseed not fully developed
- High demand to increase production of Pulses- Pigeon pea, Chickpea and Oilseeds- Mustard, Rapeseed, Soybean, Sunflower, Sesame in India as well as for Oilseeds in Africa
- Early duration pigeon pea, machine harvestable Chickpea, high yielding varieties of Oilseed crops provide new opportunities
- Opportunities for Seed companies to work in consortium mode to ensure timely availability of quality seed of pulses and oilseed crops
- Our Hybrid Parents Research Consortium in India, ESA and WCA can provide material needed for local adaptation
- We can replicate the success of Millets Value Chains in India, in Africa through public-private partnerships

Come, let us work together to expand millet cultivation for sustainability, diversification of our food to have better nutrition and for our and future generations good health

Thank you

Seeds without Borders: An IRRI initiative on Regional Cooperation for Seed Sharing

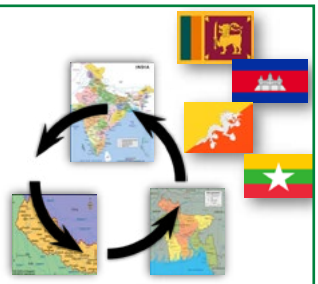
Dr. Sudhanshu Singh

Director , IRRI South Asia Regional Centre , Varanasi

Indian Seed Congress 2023

SWB : Context and Relevance

- **Originally signed by India, Bangladesh, and Nepal in 2014 for Rice**
- **Later expanded to other crops, in addition to rice, and included more countries**
- **Strengthen regional cooperation to bolster inter-region transfer of planting materials**
- **Reduce the time to market new rice varieties in similar ecologies in different countries**
- **Fast-paced delivery of genetic gain in the farmers' field**



Genesis of Seeds Without Borders (SWB)

- A variety performs based on agro-ecological conditions, knows no political boundary.
- Usually bordering states of countries share similarity in agro-ecological conditions
- If a variety is suitable and advantageous, it will move across borders, officially or unofficially!
- Swarna (MTU 7029), although never released in Bangladesh, was most popular variety (20% area coverage) in *Aman* season in Bangladesh
- Several rice varieties from Bangladesh are widely grown in India (e.g BR 11)
- Indian rice varieties, Swarna, Sarju 52, Samba Mahsuri and Ranjeet are popular in Nepal terai.
- A number of Indian rice varieties are being cultivated in Africa (Basmati 370, recently CSR 36)

Why regional cooperation is needed?

- Varietal development : **6 to 8 years**
- Varietal evaluation and release, initial awareness : **4 to 5 years**
- Seed multiplication: **2 to 3 years**

- Do we really need to duplicate the efforts and resources?
- Can we cooperate each other to take advantage of varietal research and development?

Policy catalyzation led by IRRI

- ✓ Fast-tracked varietal release, awareness creation, seed multiplication and varietal out scaling without sacrificing quality.
- ✓ Efficient use of research and resources.
- ✓ Supporting formal seed system.
- ✓ To promote SRR and varietal turn over.
- ✓ To encourage seed exchange/business.

Policy dialogues and Agreements (2013-2022)

Regional Workshop for Cooperation on Seed Issues
Dhaka Agreement
(16-17 February 2013)

Regional Workshop for Cooperation on Seed Issues
Kathmandu Agreement
(17-18 October 2014)

Regional Workshop On Seed Without Borders
Siem Reap Agreement
(9-10 June 2017)

Regional Workshop for Cooperation on Seed Issues
Thimphu Agreement
(22-23 November 2022)

IRRI

- Played a catalysing role
- Advocated the mutual benefits and cooperation
- Facilitated NARES institutes for cross border varietal release
- Delivered on seed scaling, varietal popularization

Dhaka Agreement (17.02.2013)

- Joint varietal evaluation and release.
- Reciprocal recognition of evaluation data for varietal release.
- Reducing time for the evaluation of varieties released in neighbouring countries for similar agro-ecologies.
- Reducing time for evaluation for MAS generated varieties.
- Pre-release seed multiplication & promotion.
- Encouraging private sector by providing level playing field.
- Harmonization of seed system.

Kathmandu Agreement (18.10.2014)

- Three countries agreed to share the evaluation data and varieties released in their respective countries for release and commercialization in other two countries for similar agro ecologies.
- Agreement signed by Bangladesh, India and IRRI extended to Nepal.

L to R : Md. Nazmul Islam, Secretary Agriculture, Bangladesh; Robert S. Zeigler, DG, IRRI; Jaya M. Khanal, Secretary Agriculture, Nepal; Ashish Bahuguna, Secretary Agriculture, India.

Siem Reap Agreement (10.06.2017)

- Signed by Bangladesh, Cambodia, India, Nepal, Sri Lanka and IRRI in Siem Reap.
- Later on joined by Myanmar and Bhutan.
- Agreement extended beyond rice to include other cereals, pulses, oil seeds, vegetables, sugarcane and fibre crops.
- Recognition of each other's seed certification system.

L to R : Additional Secretary Agriculture, Bangladesh; Secretary Agriculture, Cambodia; Secretary Agriculture, India; Director General, IRRI; Secretary Agriculture, Nepal and Secretary Agriculture, Sri Lanka.

Thimphu Agreement

- **Signatory Countries: Bangladesh, Bhutan, Cambodia, Fiji, India, Nepal, Philippines, Sri Lanka** and **Vietnam** & **IRRI** signed as facilitator.
- **Observer Countries: Indonesia, Lao PDR & 8 African countries (Burundi, Ethiopia, Kenya, Madagascar, Mozambique, Tanzania, Uganda & Zambia).**
- **Donors Participation: ACIAR, ADB, ADBI, BMGF, IFAD, JICA, KOIKA, World Bank**
- **Others: BIMSTEC, Syngenta Foundation, MAHYCO (FSII)**

Thimphu Agreement Outcomes

- Establishment of Nodal cell by each country for the coordination of the agreement.
- In addition to existing crops (i.e., rice and other cereals, pulses, oil seeds, vegetables, sugarcane and fibre crops), inclusion of roots and tuber crops and fruit crops.
- Inclusion of additional countries (Fiji, Philippines & Vietnam).
- Inclusion of varieties developed by private sector.
- Agreed to work towards implementation of other provisions of the Dhaka agreement, particularly on the joint varietal evaluation and release.
- Develop a database of varieties of different crops from signatory countries for sharing with the group.

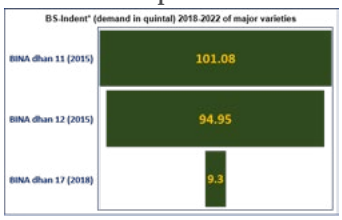
Thimphu Agreement Outcomes

- Expansion of the scope of the seed agreement to strengthen the seed system, varietal improvement and capacity building to support the food and nutritional securities in member countries.
- Mobilization of resources through proposals to secure funding from international donors to support the objectives of the agreement.
- Formation of a joint committees consisting of experts from the signatory countries & IRRI to suggest methods and modalities for implementing the different agenda items. IRRI acting as facilitator.
- Organize follow-up meetings at regular intervals to review the progress and take action to resolve the problems, if any.

CapDev under SWB

- During Siem Reap workshop IRRI facilitated Secretary level discussion between Cambodia and India. They agreed to cooperate on various aspects in the field of agriculture including seed.
- Ministry of Agriculture, Government of India and IRRI jointly organized a training for 20 seed experts, both from public & private sectors from Cambodia on 'Quality Seed Production, Certification and Quality monitoring' at National Seed Research & Training Centre, Varanasi, India.

Demand and spread of SWB varieties in India



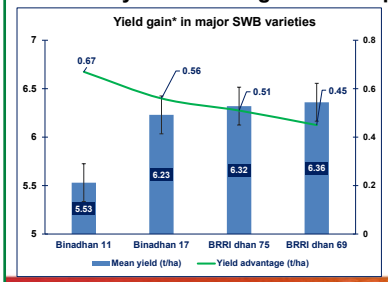
The release year of the variety is in the parentheses

*data compiled from seednet portal

- High indent originated from the states of Assam, Odisha, West Bengal (IRRI program).
- Significant quantity is also demanded by National Seed Corporation, Seed Association of India
- Non-availability of BS remains as an issue
- Increasing farmer-demand trend for BINA dhan 17, BRRI 75 and BRRI dhan 69 will lead to BS indent

Multiplying agency: Odisha State Seed Corporation, Assam State Seed Corporation, Private agencies

Observed yield advantages and adoption drivers



- **High yield advantage over long-grown varieties**
- **These varieties offer relatively more resistance to common diseases and pests**
- **Special market –smart qualities**

--High HRR and grain weight of BRRI 69

--Preferred grain size and mild aroma of BRRI 75

- **Submergence tolerance of Binadhan 11**
- **Appropriate positioning and on-farm trialling**
- **Coordinated on-farm validation with seed system stakeholders is crucial**
- **A survey showed 67% adoption by the farmers who had been given minkits of Binadhan 11**

*As observed in 4-year OFT in eastern India

Variety Replacement

- In Odisha, Binadhan 11 was observed to replace older varieties-Lalat, Naveen, MTU 1010 and many other local varieties
- Binadhan 11 makes up about **4%*** of total seed sales in Odisha
- In Assam, Binadhan 11 has picked up in the last couple of years
- In West Bengal Binadhan 11 is replacing MTU 1010, MTU 1001, and Sindhu (Privately bred variety)
- The other recent SWBVs (Bina dhan 17, BRRI dhan 75, and BRRI dhan 69) steadily getting accepted and disseminated

*Seed Sales data of DOA, GoO

How to accelerate the adoption?

- Integrated and participatory on-farm evaluation and validation
- Appropriate positioning of the product (Ecology, consumer preference, etc)
- Assured seed multiplication and supply
- Informal seed channels to foster the significant adoption of these varieties

VARIETAL PROMOTION FOR SWBVs BY IRRI

- Varietal need identification
- Product release through SWB

Research

- Varietal Cafeteria
- H2H/OFT Trials
- Cluster Demonstration
- Seed Production

Testing and delivery

SWBVs in farmers' field

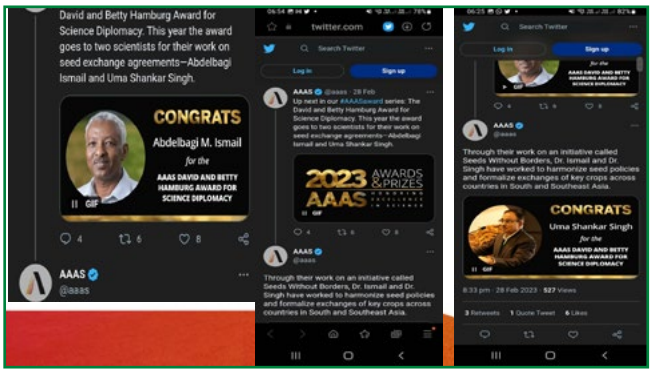
Photo Credit: Dr. Swati Nayak, IRRI

SWBVs in field (*Yusi Maap*)

Photo credit : Dr. Minhas, CIP

FUTURE FOCUS

- Working modalities for policy to practice
- Support signatory countries for varietal selection, basic seeds sourcing for release and seed increase
- Spilling the benefits beyond rice
- Fostering dialogues and idea exchange among member countries
- Impact documentation and share



Acknowledgements

ACIAR
ADBI
BMGF
IFAD
USAID
CIP
World Bank

Dr Swati Nayak, Seed Specialist of IRRI for South Asia and Seed team

Current status of global carbon market and possible opportunity in agriculture sector

Deputy Director
Climate and Energy Area

Kentaro TAKAHASHI

IGES

Keywords related to carbon market at COP27

Keywords	Issues	
High Quality Carbon Market / Environmental Integrity	Environmental Integrity (Quality of credit) Concerns related to human rights and Indigenous peoples were expressed by various stakeholders	
Implementation	• Detailed rules for implementation • Expansion of the bilateral cooperation	
Capacity Building	Capacity building for implementation • Art6 implementation partnership (established by Japanese government) https://a6partnership.org/ • Launch of Art6 online course by UNDP (IGES cooperates as a partner)	 (Photo：Ministry of the Environment Japan)

2

Carbon Credit Trend (1)

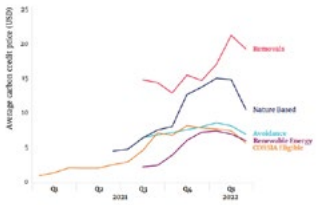
• Overall, Increase of credit issuance under carbon market up to 48% from 2020 to 2021 (327 million tons to 478 million tons). In particular, the amount of credits issued in the voluntary carbon market has increased.

Source：World Bank State and Trends of Carbon Pricing 2022, Figure9
https://openknowledge.worldbank.org/handle/10986/37455

3

Carbon Credit Trend (2)

More demands related Removal and Nature based solution (NbS) projects



- Nature based solution
- Agriculture
- SDGs
- Community based projects etc

Source：World Bank State and Trends of Carbon Pricing 2022, Figure 14
https://openknowledge.worldbank.org/handle/10986/37455

4

Future trends of Carbon Credit

POINT There are concerns about the operation of the credit system due to the strict standards affecting the supply of credits.


Achievement of carbon neutral by using carbon credit in the private sector

Concerns by environmental activists
- Use of low quality of carbon credit
- Greenwashing

Disclosure
IFRS SEC ISSB

High quality on carbon credit
IC-VCM
Article 6 of PA

Use of carbon credit
SBTi  Race to Zero

Report by UN's High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities

Abbreviations

IC-VCM	Integrity Council for the Voluntary Carbon Market
IFRS	International Financial Reporting Standards
ISSB	International Sustainability Standards Board
SBTi	Science Based Targets initiative
SEC	Securities and Exchange Commission

5

Strengthening the bilateral cooperation

POINT Accelerated the bilateral cooperation that allows each country to operate and manage the system under its own discretion. Singapore signed with a number of countries that were already operated under the existing bilateral cooperation.

Japan
Joint Crediting Mechanism (JCM)
25 countries
New 8 partner countries in 2022
Senegal, Tunisia, Azerbaijan, Moldova, Georgia, Sri Lanka, Uzbekistan, PNG

Singapore
Bilateral Cooperation
6 countries
6 countries signatures in 2022
Morocco, Colombia, Vietnam, Ghana, PNG, Peru, Thailand (under consultation)

Switzerland
Bilateral Mechanism (KliK)
11 countries
5 countries signatures in 2022
Thailand, Morocco, Malawi, Ukraine, Uruguay

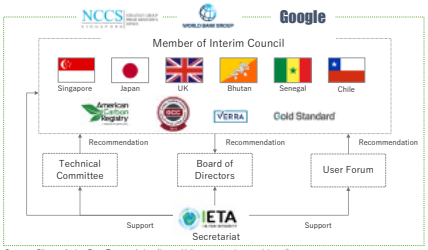
※JCM partner countries signed by 2021 (17 countries)
Mongolia, Bangladesh, Ethiopia, Kenya, Maldives, Vietnam, Lao ODR, Indonesia, Costa Rica, Palau, Cambodia Mexico, Saudi Arabia, Chile, Myanmar, Thailand, and Philippines

※ Countries signed by 2021 (6 countries)
Dominica, Georgia, Ghana, Peru, Senegal, and Vanuatu

6

Climate Action Data Trust

POINT Launched by Singapore government, World Bank and IETA on 7 Dec, 2022 to develop a platform for High Integrity Carbon Market



Keywords on CAD Trust

- ✓ High integrity carbon market
- ✓ Digital MRV
- ✓ Enhanced transparency
- ✓ Blockchain

Source : Climate Action Data Trust website (https://climateactiondata.org/about/)

7

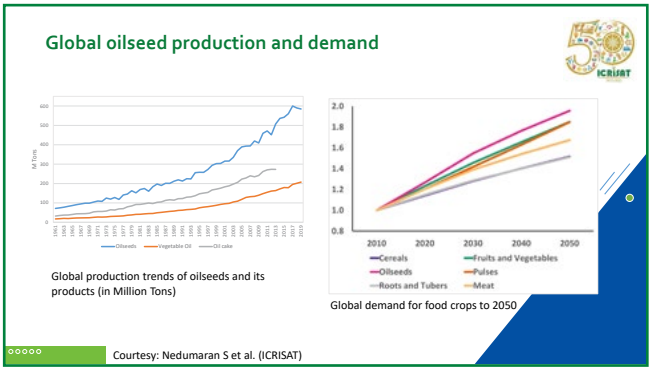
Future perspectives

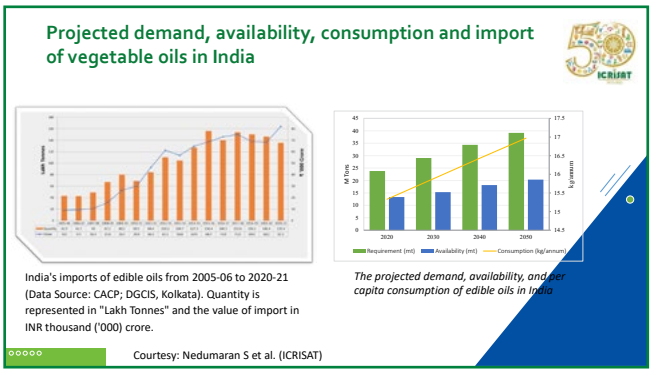
1. Continuation of demands for mechanisms such as bilateral cooperation and voluntary carbon markets, which can be implemented at their discretion
2. Bilateral cooperation will seek more opportunities to develop carbon credit in the agriculture sector.
3. To design the new carbon market, the capacity building for government official and private sector is important. Cooperation with various stakeholders is necessary to facilitate more arrangements.

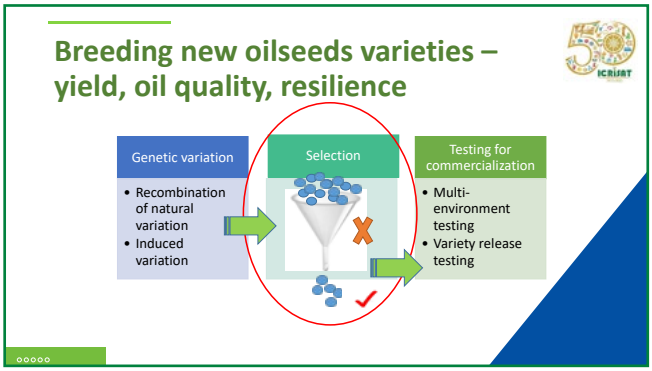
8

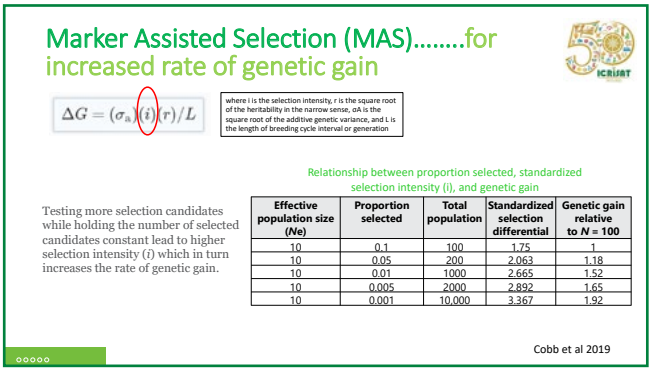
Thank you for your kind attention

IGES Institute for Global Environmental Strategies
公益財団法人 地球環境戦略研究機関









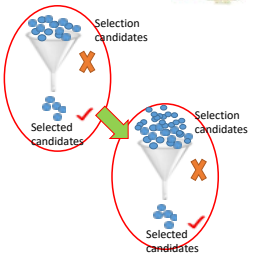
Effective population size (Ne)	Proportion selected	Total population	Standardized selection differential	Genetic gain relative to N = 100
10	0.1	100	1.75	1
10	0.05	200	2.063	1.18
10	0.01	1000	2.665	1.52
10	0.005	2000	2.892	1.65
10	0.001	10,000	3.367	1.92

MAS for increased rate of genetic gain

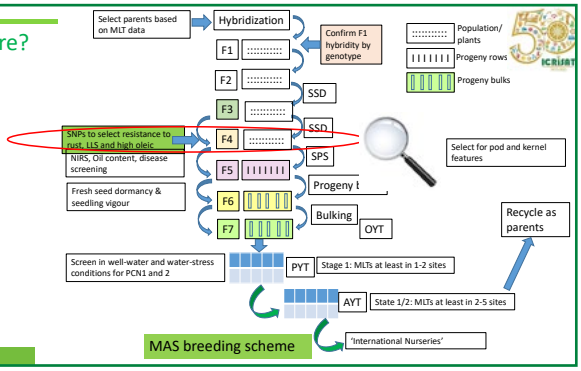
$$\Delta G = (\sigma_a)(i)(r)/L$$

where i is the selection intensity, r is the square root of the heritability in the narrow sense, σA is the square root of the additive genetic variance, and L is the length of breeding cycle interval or generation

- Testing more selection candidates while holding the number of selected candidates constant lead to higher selection intensity (*i*) which in turn increases the rate of genetic gain Increasing *i* by way of increasing population sizes requires increased budgets or reduction in the cost of testing each selection candidate.
- Options to reduce cost - GS, MAS, HTP

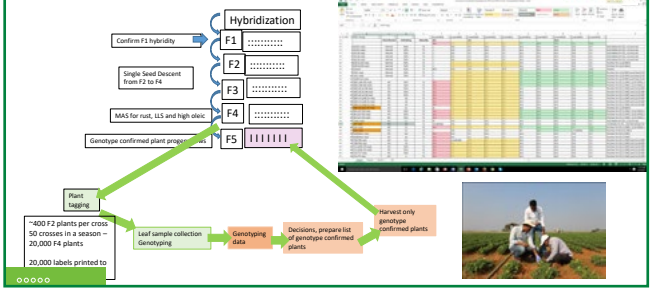


Where?



MAS breeding scheme

Steps in MAS and logistics

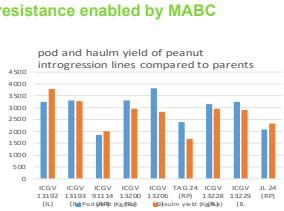


Sample of genotyping results in a F2 population

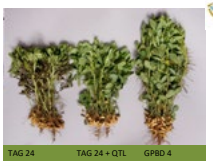
Cross identify	F2 seeds	Homozygous (A:A)	Heterozygous (A:-)	Wilde type (-:-)
ICGX 191003	656	138	340	162
ICGX 191004	470	93	207	160
ICGX 191005	374	103	174	88
ICGX 191006	564	96	209	258
ICGX 191007	575	85	227	256
ICGX 191008	361	78	170	104

Examples

Combine early maturity and foliar fungal diseases resistance enabled by MABC



Comparison of introgressed lines with local checks		
Percentage increase of pod yield		
	GPBD 4	G 2-52
Rainfed	29%	40%
Irrigated	26%	46%



MAS for foliar fungal disease resistance - agronomic traits of Introgression lines

	Pod yield (Kg/ha)	Shelling outturn (%)	HSW (g)	Haulm yield (Kg/ha)	Height of Primary branch (cm)	No. of primary branches	Leaf area (Sq cm)
IL of ICGV 91114 (6)	2641	69-73	26-39	2250-3333	8-12	5-7	18-30
ICGV 91114	1438	75	31	2500	14	6	24
IL of TAG 24 (7)	2598	68-74	31-37	1250-2000	6-8	4-7	10-16
TAG 24	1893	69	34	1083	7	5	10
IL of JL 24 (7)	3083	67-76	34-53	2250-3167	9-12	5-7	17-36
JL 24	2400	65	33	2583	10	7	25
GPBD 4	2683	73	36	2528	11	7	19

IL = Introgression lines; Data from the trials conducted at ICRISAT, Patancheru during 2013 Rainy and 2013-14 Post-rainy seasons

Marker-assisted selection in soybean

Pod shattering:

- The evaluation of pod shattering in the field was highly dependent on the environmental factor such as humidity and temperature conditions although pod shattering was a trait with 90% heritability (Parker et al. 2020).
- KSS-SNP5 TaqMan probe on Chromosoem 16 is tightly linked to pod shattering is effective to select a resistant line.

Soybean mosaic virus (SMV):

- Marker-assisted pyramiding of soybean resistance genes *RSC4*, *RSC8*, and *RSC14Q* to SMVusing SSR (simple sequence repeat) markers
- Three SMV resistance genes, R_{SC4}, R_{SC8}, and R_{SC14Q}, have been identified and mapped on soybean chromosomes 14, 2, and 13 from Dabaima, Kefeng 1, and Qihuang 1 cultivars, respectively.

Ji-Min Kim et al (2020) Euphytica; Da-gang WANG et al (2016) Journal of Integrative Agriculture

Marker assisted selection (MAS) in Soybean

- Define haplotypes of maturity genes E1–E4 and used in MAS
- Rust resistance gene genes *Rpp1*, *Rpp2*, *Rpp3*, *Rpp4*, and *Rpp5 pyramiding using SSRs*
- SoySNP50K, a high-density genotyping array for soybean - Illumina Infinium BeadChip that contained over 50,000 SNPs
- (http://www.illumina.com/).
- Soybean BARCSoySNP6K: An assay for soybean genetics and breeding research - chosen from the SoySNP50K assay based on their position in the soybean genome and haplotype block, polymorphism among accessions and genotyping quality.

Song et al (2013) PLoS One; Song et al (2020) The Plant Journal; Fang et al (2021) Front. Plant Sci

Marker assisted selection (MAS) in rape seed and mustard

- MAS of new high oleic and low linolenic oilseed rape (*Brassica napus* L.). Genotyping was done for the selection of homozygous high oleic and low linolenic lines using allele-specific CAPS markers and SNaPshot assay, respectively.
- Marker-assisted pyramiding of white rust resistance loci in Indian Mustard (*Brassica juncea* L.)

Spasibionek et al (2019) PLoS One; Singh et al (2015) Canadian Journal of Plant Science.

What is oleic acid?

Reduced risk of CVD

- Substitution of dietary saturated fat by oleic acid and/or polyunsaturated fatty acids (PUFA) has been described to reduce the cardiovascular diseases (CVD) risk by reducing blood lipids, mainly cholesterol.

Omega-9

- Oleic acid is most abundant Omega-9 fatty acid of vegetable oils
- Several health benefits when substituted with SFA, although it is non an essential fatty acid.

Mediterranean diets

- Olive oil that is rich in Oleic acid
- Significant benefits with regards to the markers of cardiovascular risks, insulin resistance, and incidence of type II diabetes
- Oleic acid, increased fatty acid binding proteins (FABP) in the small intestine.

Lopez-Huertas et al. (2010) Pharmacol Res.; Djuric et al 2011 Nutr Rev.,

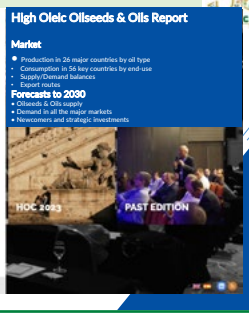
Potential health benefits of oleic acid rich foods

- Reduces the risk of Cardiovascular Diseases by reducing the levels of serum LDL cholesterol and maintaining the levels of (HDL) (Wang et al., 2009, Barbour et al., 2017)
- Suppresses tumorigenesis and amelioration of inflammatory diseases (Yamaki et al., 2005; Sales-Campos et al., 2013)
- Improves insulin sensitivity and helps in lower the risk of Type-2 diabetes (Shah et al., 2007)
- Improves gastrointestinal functions and increases uptake of nutrients (Lin et al., 2001)
- High oleic to linoleic acid ratio (O/L ratio) products have longer shelf life (Bolton & Sanders, 2002)
- Increases short-term memory, verbal fluency, processing speed and cognition therapy (Barbour et al., 2017)

High Oleic Congress (HOC)

What's HOC?

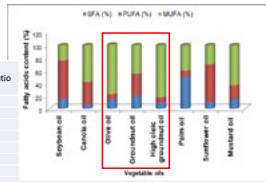
HOC 2023
7-8 September 2023
Italy, City of Florence.



http://higholeicmarket.com/hoc-congress-2/

High oleic groundnut

Genotype	Oleic Acid (%)	Linoleic Acid (%)	O/L ratio
ICGV 15006	82	3	27
ICGV 15016	82	2.8	29
ICGV 15017	84	2.6	32
ICGV 15035	83	2.6	32
ICGV 15052	82	2.9	28
ICGV 15064	84	2.6	32
ICGV 15065	83	2.5	33
ICGV 15070	80	5	16
ICGV 15073	82	2.3	36
ICGV 15074	83	2.6	32
ICGV 15080	82	2.6	32
ICGV 15083	83	2.7	31
ICGV 15090	83	2.8	30
ICGV 15095	83	2.6	32
ICGV 15105	82	2	41
ICGV 15106	80	2	40

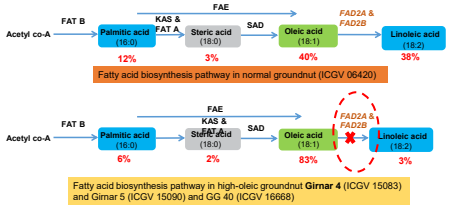


Janila Pasupuleti et al (2015) Plant Science.

Amounts of omega-9s in 100 grams of the following foods

1. Olive oil: 83 grams
2. Cashew nut oil: 73 grams
3. Almond oil: 70 grams
4. Avocado oil: 60 grams
5. Peanut oil: 47 grams
6. Almonds: 30 grams
7. Cashews: 24 grams
8. Walnuts: 9 gram

Fatty acid biosynthetic pathway in normal peanut and FAD mutants



FAT B- palmitoyl-ACP thioesterase
KAS- ketoacyl ACP synthetase
FAD2A& FAD2B - Fatty acid desaturase
FAT A- stearoyl-ACP thioesterase
SAD-stearoyl-ACP desaturase
FAE- Fatty acid elongase

- F435 - first high oleic mutant identified at University of Florida, USA
- Sun Oleic 95R - first HOA variety (Gorbet and Knauft, 1997)
- Tifguard High O/L generated through MABC (Chu et al 2011)

Girnar 4 (ICGV 15083) and Girnar 5 (ICGV 15090) – the first high oleic groundnut varieties of India

- The prime minister of India dedicated the first high oleic groundnut varieties of India to the nation (2020).
- Common goal of the team - 9-year of committed research, team work, collaboration and co-operation between research institutes
- Long-term funding support from NMOOP (now NFSM), DoAFW of GoI

Performance of Girnar 4 (ICGV 15083) and Girnar 5 (ICGV 15090)

Variety name	Pod yield (Kg/ha)	Shelling percent (%)	Oleic acid content (% of total fat)	Maturity duration (days) in Kharif	100-seed mass (grams)	% of sound mature kernels	oil content (% of kernel weight)	protein content (% of kernel weight)
Girnar 4 (ICGV 15083)	3218	67	79	110 to 115	42	90	53	27
Girnar 5 (ICGV 15090)	3124	67	78.5	110 to 115	41	90	53	27
GPBD 4	2046	65	48		39	85	50	27
TG 37 A	2276	69	46		39	88	51	26

Source: Release proposal and AICRP-G Report

Pod yield superiority of the three high oleic groundnut varieties released in India

Description	GG 40 (ICGV 16668)*	Girnar 4 (ICGV 15083)*	Girnar 5 (ICGV 15090)*
Pod Yield (kg/ha) in AICRP-G (Pooled mean of IVT I (2018) and IVT II (2019)		3218 (41% increase over TG 37A and 57% increase over GPBD 4)	3124 (53% increase over TG 37A and 37% increase over GPBD 4)
Pooled Pod Yield (Kg/ha) in AICRP-G (IVT-1 2018, IVT-2 2019, AVT Rainy 2021)	3321 (29% increase over GPBD 4 and TG 37A and at par with GJG 32, JL10BS and DH 256)*		
Kernel yield (kg/ha)	2103	2166	2133
Kernel size and shape	Medium and round	Medium and round	Medium and round
Shelling outturn (%)	63 (62-65))	67 (67-68)	67 (67)
Pod size	Medium	Medium	Medium
Sound Mature Kernel (%)	89%	90%	90%
Kernel grades (or kernel size distribution)	Not estimated in a large commercial sample	38% of grade-I (>7.5mm; 40-50 counts per ounce) & 18% of grade-II (>7.0mm; 50-60 counts per ounce) in a large commercial sample	26% of grade-I (>7.5mm; 40-50 counts per ounce) & 15% of grade-II (>7.0mm; 50-60 counts per ounce) in a large commercial sample
Presence Flower on main stem	Yes	No	No
Flower on primary branches	Sequential	Alternate	Alternate
Testa colour	Tan	Tan (Pinkish)	Tan (Pinkish)

Feedback from farmer's who cultivated Girnar 4 (2021)

Sl	Name of the farmer	Gram Panchayat and District	State	Area planted (ha)	Pod yield (kg/ha)	Check variety pod yield (kg/ha)	Feedback from the farmer on performance and other aspects	Source
1	Jentibhai Damjibhai Munjpara	Village: Bilkha, Taluk: Junagadh Dist.Junagadh	Gujarat	0.16	2625	875	Very good yield and performance	DGR-Junagadh
2	Nileshbhai Bhagvanjibhai Gorasiya	Village: Bilkha, Taluk: Junagadh Dist.Junagadh	Gujarat	0.16	2500	2125	Very good yield and performance	DGR-Junagadh
3	Dilipbhai Arjanbhai Umretiya	Village: Bilkha, Taluk: Junagadh Dist.Junagadh	Gujarat	0.16	2125	1750	Very good yield and performance	DGR-Junagadh
4	Maheshbhai Laljibhai Patoliya	Village:Toraniya Taluk:.Junagadh Dist.Junagadh	Gujarat	0.16	3333	3125	Very good yield and performance	DGR-Junagadh
5	Rameshbhai Kanjibhai Patoliya	Village:Toraniya Taluk:.Junagadh Dist.Junagadh	Gujarat	0.16	3166	3125	Very good yield and performance	DGR-Junagadh
6	Raysingbhai Laxmanbhai parmar	Village: Gotana Taluk:.Maliya (hatina) Dist.Junagadh	Gujarat	0.16	2250	1000	Very good yield and performance	DGR-Junagadh
7	Jitendrabhai Meramanbhai Parmar	Village: Gotana Taluk:.Maliya (hatina) Dist.Junagadh	Gujarat	0.16	1500	1200		DGR-Junagadh
8	Haresh Bhai Vallabhbhai Thummar	Rajkot	Gujarat	0.65	1850 from 0.65 ha		High Yielding as compared to other variety And Disease Resistance Less Effected by Heavy Rain Fall	Mr Baxi, Bombay Super Hybrid Seeds Ltd
9	Kantilal Jadavbhai Pansara	Sandhvaya and Rajkot	Gujarat	1.6 Acre	3570		Perfomance of this variety is much better than other varieties	Jagdish Patel Vishwas Agri Seeds, Rajkot
10	Mr Ashutosh V Patel	Goila, Banas Kantha	Gujarat	0.48	1750 from 0.48 ha			Kartikeya Shah, Aarneea Foods LLP

Progress in high oleic groundnut breeding

SunOliec 95R registered line in the US, high oleic (FAD2A and FAD2B); runner type, long duration)

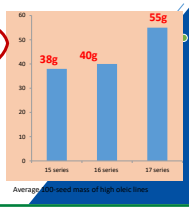
Parent X SunOleic 95R → Lines had large variability for → 100-160 days duration; spreading, Large proportion of runner, semi-spreading, 100 seed mass of 20-45 g

Parent X F5 elite progenies

Recycling of elite line in crossing to accumulate favourable alleles for yield, shelling outturn & seed size

ICGV 15, 16 series high oleic lines — 100-seed mass of 35-45g, Duration of 120-140 days

ICGV 17 series high oleic lines — 100-seed mass of 55-70 g, Duration of 105-125 days



Average 100-seed mass of high oleic lines

Speed breeding

- A protocol that uses harvesting of immature seeds and drying was standardized
- 65 days for early maturing genotypes
- 75 days for medium duration genotypes

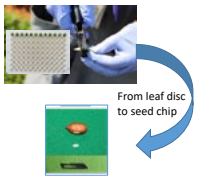
Short duration varieties of groundnut

Days to 50% flowering	Pegging	Pod filling	Harvest	Drying	Seed to seed
25-28 days	8-10 days	22-27 days	60th day	5 days	65 days

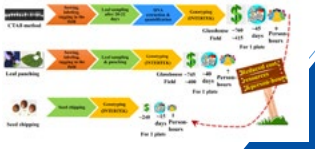
Medium duration varieties of groundnut

30 days	8-10 days	27-32 days	70th day	5 days	75 days

Seed chip for SNP genotyping to select the 2 mutant alleles



From leaf disc to seed chip



Comparative assessment for cost-effectiveness and time saving among DNA-based, leaf-punching and single seed-chipping based genotyping

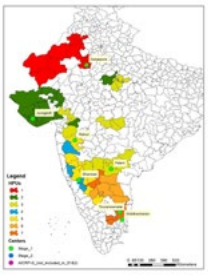
After seed-chipping, seeds are stored in fridge in a 96-well seed plate which is replica of DNA plate

Sejal ..... Janila Pasupuleti*, Manish (2021) Agronomy

Multi environment testing guided by homogenous production units (HPU) in India

HPU	State(s)	Area	Trials
HPU1	Rajasthan	250,000	PCN 3 SB, PCN 3 VB, PCN 2VB
HPU2	Gujarat	1,900,000	PCN 3 SB, PCN 3 VB, PCN 2VB, PCN 2 SB
HPU3	Many states	350,000	PCN 1 SB
HPU4	Coastal Karnataka and Maharashtra	150,000	PCN 1 SB
HPU5	Maharashtra	500,000	PCN 2 SB, PCN 2 VB, PCN 1 SB
HPU6	South India	1,500,000	PCN 2 SB, PCN 1 SB
HPU7	Tamil Nadu and Karnataka	350,000	PCN 2 SB, PCN 2 VB, PCN 1 SB

Hajjarpoor et al 2021, Fields Crops Research

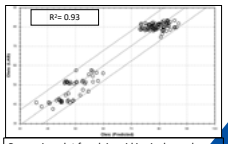


Single seed NIRS – estimating fatty acid content of peanut kernels

Statistical parameters used to calibrate Near-Infrared Reflectance Spectroscopy (NIRS) equation for fatty acids in single seed

Fatty acid	N*	Range (%)	SD*	Maths treatment	R^2	SEC
Palmitic acid	120	5-17	3	2,4,4,1	0.85	1.3
Oleic acid	131	38-83	15	2,4,4,1	0.93	7.3
Linoleic acid	123	2-41	13	2,4,4,1	0.93	1.3

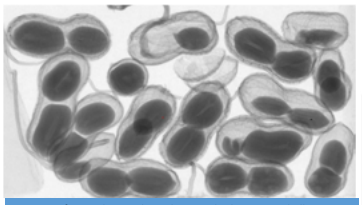
*N-number of samples, *SD-standard deviation, R^2- Coefficient of determination of calibration; SEC- Standard error of calibration



Regression plot for oleic acid in single seed determined by standard biochemical method (GC) and NIRS prediction

Deshmukh D.... Janila Pasupuleti (2021) Indian J of Gen. Pl Br.

Kernel grades, blanchability, shelling outturn



CT image of groundnut pods – robust method to assess shelling outturn, kernel grade, 100-kernel mass

Blanchability is an important industry trait – we are validating SNPs to select this trait

(Domhoefer et al 2022)

Cost-effectiveness is the key to deploy MAS in crop breeding

- Marker assisted selection is used for three traits
  1. resistance to rust (major effect QTL explaining >80% PV, on A03)
  2. resistance to late leaf spot (major effect QTL explaining 65% PV, on A02)
  3. high oleic trait
- 4 for rust resistance – IPAHM103 (dominant marker), GM1536, GM2079, GM2301 (SSRs)
- 3 for LLS resistance – SEQ8DO7, GM032, GM1009 (SSRs)
- High oleic- FAD2 mutant alleles on A- and B-genome using allele specific and CAPS
- Cost for high oleic trait – 4 USD per sample
- Cost for rust and LLS markers - 9 USD per sample (2USD for DNA isolation, 1 USD per data point)

- 10 SNPs @ 2 USD including DNA sampling – service provide is Intertek (Sweden based, with labs in Hyderabad-India and Australia)

Take home message

- Why MAS? MAS can be used to enhance cost-effectiveness of selection of target traits so that a large number of selection candidates can be tested, thus enhance the selection intensity and consequently increase the genetic gain.
- Simultaneous selection of several desirable traits is possible
- Delay MAS to F4 or later generation where higher proportion of desirable homozygotes are produces
- Early generation selection prior to phenotyping for yield actually reduces gain for yield due to unfavorable genetic correlations between traits evaluated in early generations and traits evaluated subsequently.
- Logistics, leaf/seed, turn-over time, platform, decision support tools
- Seed chip genotyping is efficient as it does not require planting of F4 in the field, tagging or plant
- Current impact of MAS on products delivered to farmers seems small, there are also obstacles to its use, particularly in developing countries, nonetheless, the future possibilities and potential impacts of MAS are considerable.

A high oleic groundnut variety developed using MAS, released in 2020 in India

Thank YOU

CRISPR based Bioengineering for novel Agriculture and food product development relevant to seed industries'

Anindya Bandyopadhyay
(Anindya.b@ril.com)

R&D
SynBio-Biofuel-Genome Editing

Reliance Has Built Three New Mega-Growth Engines in a Single Decade

1. Connecting Indians digitally with **unprecedented reach** at **affordable prices** with superior customer experience
   - Reached **398.3 million subscribers** (1Q FY21) in less than four years since inception
2. Serving the entire spectrum of Indian society **with 640 million footfalls** (FY20)
   - Supplying a **diversified product portfolio** of groceries, fashion & lifestyle, consumer electronics and connectivity through **11,800+ stores across 28.7 million sq. feet** (1Q FY21)
3. Connecting people and businesses by **providing transportation fuels** in **one of the fastest growing energy markets**
   - Supplying petrochemicals to diversified end-use industries **manufacturing essential industrial and consumer goods** using polymers and polyesters

RIL caters to a significant portion of consumer spending through its digital and physical presence

3

RIL Biofuel – Synthetic Biology

Reliance
Industries Limited

Discovery and Excitement

Chronology of CRISPR genome editing discovery

1987: Ishino *et al.*
First observation of CRISPR repeats in bacterial genomes

2002: Jansen *et al.*
Identification of Cas genes

2006: Makarova *et al.*
Proposal of CRISPR as part of the bacterial adaptive immune system

2007: Barrangou *et al.*
Discovery that CRISPR sequences in combination with Cas genes impart selective phage resistance determined by spacer sequences in between CRISPR repeats

2010: Garneau *et al.*
Confirmation of CRISPR/Cas as part of the bacterial immune system

2012: Jinek *et al.*
Use of crRNA and tracrRNA for directed DNA double-stranded breaks by CRISPR/Cas9

2013: Cong *et al.*
CRISPR/Cas9 system first used for targeted gene editing in human and mouse cells with designed crRNA sequences.

2015: Shmakov *et al.*
Shmakov et al. characterizes Cas12a and Cas13a as class 2 CRISPR systems

2017: East-Seletsky *et al.*
Use of orthogonal Cas13a homologs to detect multiple distinct RNA species

Abudayyeh *et al.*
Creation of catalytically dead Cas13a as a RNA-binding protein

Gootenberg *et al.*
CRISPR/Cas13a used for nucleic acid detection through SHERLOCK

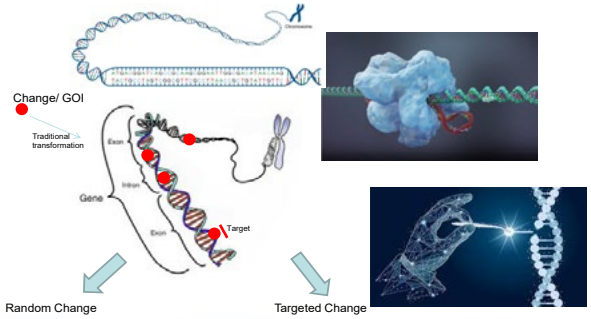
Lee *et al.*
Creation of the CUT-PCR

Moritz et al 2018

Pictures taken from Science

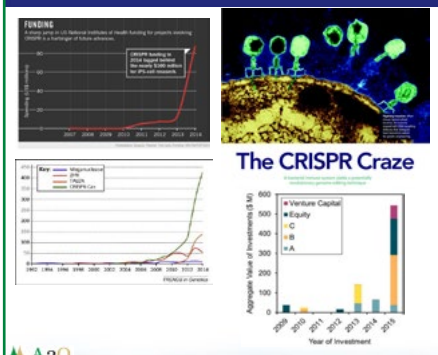
6

Paradigm Shift : Targeted editing by CRISPR



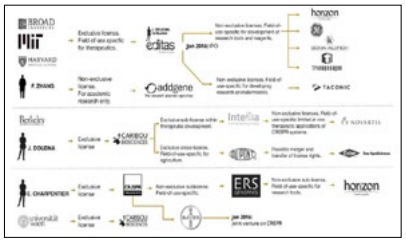
(From Google image)

CRISPR craze



Ledford Nature 2015
(Pennisi Science 2013)

CRISPR patent licensing and sub licensing among global players

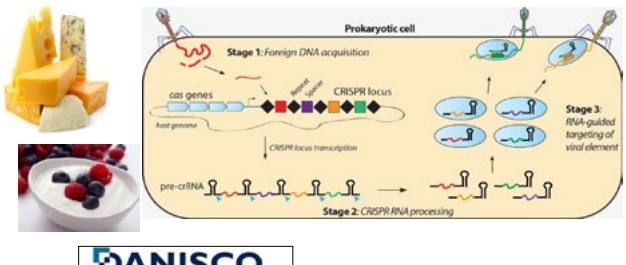


(Egile et al Nature Biotech 2016)

Bloomberg
Business
Global CRISPR and CAS Gene Market to Surpass US$ 7,603.8 million by 2026

Science Behind CRISPR

CRISPR : Bacterial Adaptive/ memory dependent Immune System

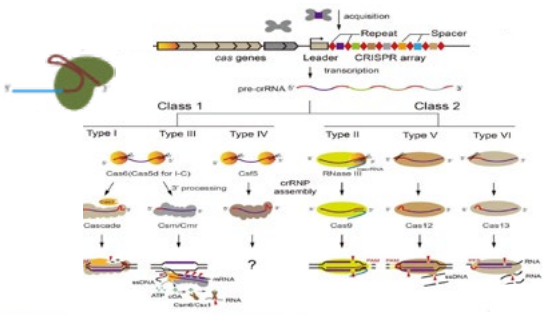


DANISCO
First you add knowledge...

S. Thermophilus strain CHOOZIT SWIFT
in Duponts pizza cheese and yogurt making strains

(Doudna Lab 2015)

Types of CRISPR System

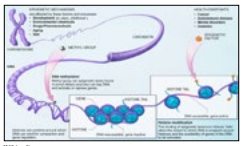


(Li et al, Frontiers in Microbiology 2019)

Protein and gRNA

(Addgen.org /Public domain data)

epi-CRISPR, CRISPRi, CRISPRa

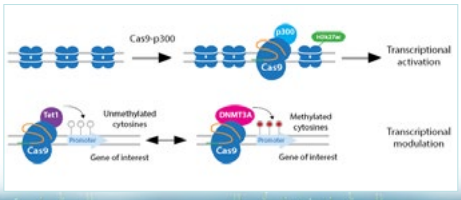


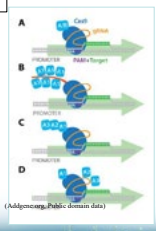
Wikipedia

- P300, LSD1,MQ1, TET1 type epigenetic modifiers could be fused with dCas9

to develop programmable epigenome engineering tool

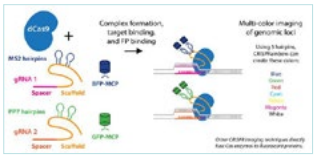
- Methylation state change/inducing histone acetylation or demethylation
- Inheritable targeted epigenetic modifications

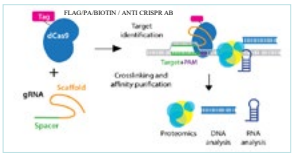




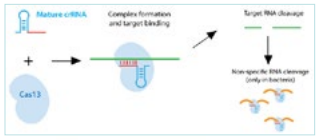
(Addgene.org, Public domain data)

Visualization , Purification and RNA editing





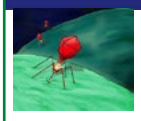
- gRNA fused to protein interacting aptamer, which recruits specific RNA binding proteins tagged with fluorescent proteins
- Programmable
- Multiple colour in multi-loci

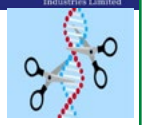


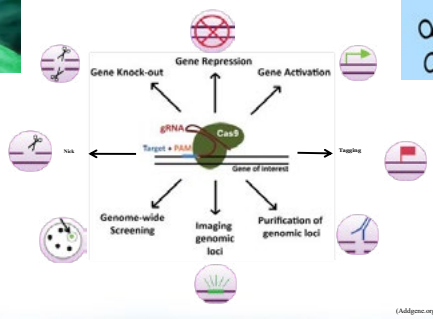
enCHIP(Engineered DNA binding molecule mediated CHIP)

(Addgene.org, Public domain data)

Molecular Applications of CRISPR system



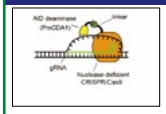


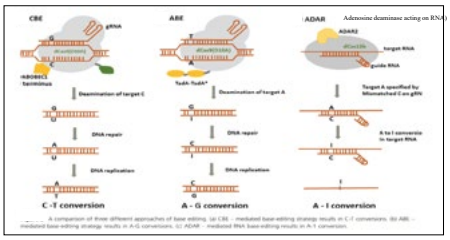


(Addgene.org)

Updates and Technology progress

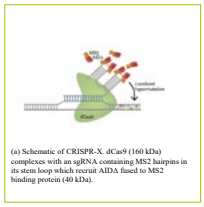
Base Editing





Mishra et al, Plant Biotechnology Journal, 2020)

CRISPR-X generates targeted point mutations.



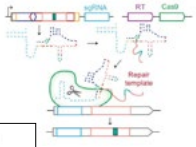
(a) Schematic of CRISPR-X. dCas9 (160 kDa) complexes with an sgRNA containing MS2 hairpins in its stem loop which recruit AIDA fused to MS2 binding protein (40 kDa).

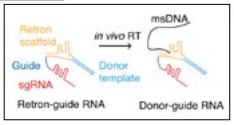
- **CRISPR-X** *[Hess et al., Nature Methods (2016): Vol13(12):1036]*
  - MS2 trap system to tether Cytidine deaminase (AID) and dCas9 with sgRNA
  - Mutagenesis within a much wider window (100bp from PAM) in comparison with Cas9-CdA in covalent fusions (5bp window); +20 to +40 from the PAM displayed the highest median percentage of possible variants.
  - Generation of diverse libraries of localized point mutations
  - Capable of targeting multiple genomic locations simultaneously
  - Mutation rate: up to ~1/500–1/1,000 per bp overall and 20% within the hotspot region.

CRISPEY – Retron RT

- **Very high efficiency of SDN2 and SDN3 in *S. cerevisiae*:** Retron RNA as the template of ssDNA HDR donor
- Multiple copies of donor generated by *in vivo* RT. covalentlv tethered to the Cas9-seRNA complex

Retrons are natural DNA elements coding for a reverse transcriptase (RT), as well as a template on which the RT acts, to create a multi-copy single-stranded DNA (msDNA) product





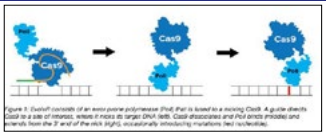
Cas9 Retron precISe Parallel Editing via homologY, e.g. 'CRISPEY' .

A retron msr/msd sequence containing homology and a desired edit to a targeted gene is expressed as a fusion to a sgRNA (light blue) targeting the gene of interest. The retron RT (purple) and Cas9 (green) are expressed in trans. Cas9 generates a DNA break and the RT-generated DNA is used as a template by the host's DNA repair machinery

(Sharon et al cell 2018)
(Simon, Nucleic acid research 2019)

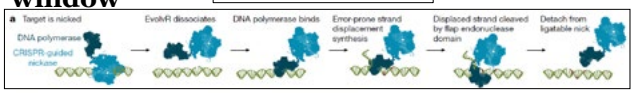
EvolvR

EvolvR Technology: enable diversification of all nucleotides in a tunable window



- The Dueber Lab used EvolvR to discover novel genotypes that result in a spectinomycin resistant phenotype in bacteria. While there are many known spectinomycin resistance mutations, several new mutations were identified by targeting EvolvR to five dispersed regions of the target gene of spectinomycin, rpsE. These results not only uncovered novel resistance genotypes, but also provide a better understanding of the key residues responsible for this protein-drug interaction.
- multiplexing of guides allows EvolvR to target more than one genomic site for mutagenesis

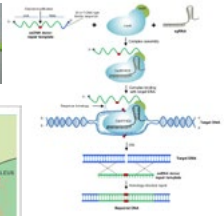
- EvolvR could also be used to map protein-protein interactions, investigate non-coding segments of the genome, or engineer microbes to perform tasks.
- EvolvR could also be a tool for lineage tracing cells that do not tolerate double-strand DNA breaks by introducing a unique tag into a genomic site of choice via the mutational abilities of PolIIm.

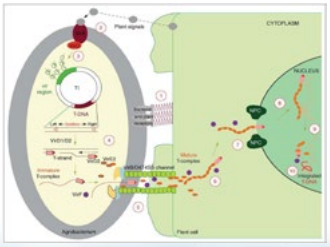


EvolvR [Halperin et ., Nature (2018)]

Vir Gene aided HDR

Agrobacterium Vir gene aided HDR





Cas9 and VirD2 DNA binding activities can be used for Plant genome editing
VirD2 protein in the chimeric Cas9-VirD2 fusion will process and covalently bind with RB-Edged ssDNA repair templates.
Avialability of the repair templates in the proximity of the DNA DSBs created by the sgRNA-guide Cas9 may enhance the rate of precise repair via HDR

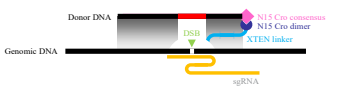
(Ali et al Communications biology 2020)

(Tzfira and Citovsky, 2006)

Cro-Cas9 fusion to recruit the donor DNA to the double strand break site

N15 Cro
All α-helical fold
TTATAGCTGGCTATAA

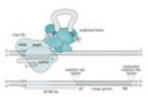
λ Cro
Mixed α+β fold
TATCACCGCGGGTGATA



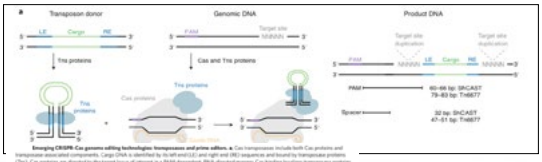
- To achieve efficient HDR, a donor DNA molecule has to be in immediate proximity to the DSB site when the SDN generates the DSB.
- Numerous donor-tethering strategies have been proposed for improving HDR efficiency, in which a tether molecule is fused to the editing machinery and recruit the donor DNA by specifically interacting with a moiety in the donor.
- Bacteriophage Cro repressors specifically bind to 14-19bp symmetric consensus DNA sequences, and thus are good candidates of the tether.

RNA guided DNA insertions by CRISPR associated transposes

Feng Zheng's lab found a compact CRISPR-associated transposon (CAST) in the cyanobacterium *Scytonema crispum*. The researchers characterized the system and modified it to make it programmable. They were able to insert DNA sequences of various lengths into different loci of *E. coli*. The reported efficiency reached 80%, as compared to 1% of typical Cas9-mediated insertions.



Model for RNA-guided DNA transposition.
The SHCAST complex that consists of Cas12k, TniB, TniC, and TniQ mediates insertion of DNA 60 to 66 bp downstream of the PAM. Transposon LE and RE sequences, along with any additional cargo genes, are inserted into DNA resulting in the duplication of 5-bp insertion sites.



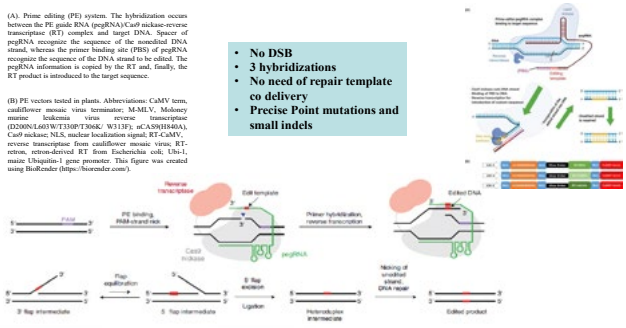
(Liu et al Nature Biotech 2020)

Prime Editing

(A). Prime editing (PE) system. The hybridization occurs between the PE guide RNA (pegRNA)/Cas9 nickase-reverse transcriptase (RT) complex and target DNA. Spacer of pegRNA recognize the sequence of the nonedited DNA strand, whereas the primer binding site (PBS) of pegRNA recognize the sequence of the DNA strand to be edited. The pegRNA information is copied by the RT and, finally, the RT product is introduced to the target sequence.

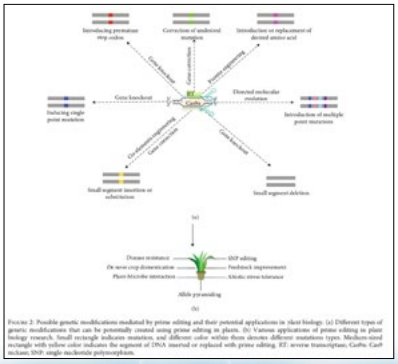
(B) PE vectors tested in plants. Abbreviations: CaMV term, cauliflower mosaic virus terminator; M-MLV, Moloney murine leukemia virus reverse transcriptase (D200N/L603W/T330P/T306K/ W313F); nCAS9(H840A), Cas9 nickase; NLS, nuclear localization signal; RT-CaMV, reverse transcriptase from cauliflower mosaic virus; RT-retron, retron-derived RT from Escherichia coli; Ubi-1, maize Ubiquitin-1 gene promoter. This figure was created using BioRender (https://biorender.com/).

- No DSB
- 3 hybridizations
- No need of repair template co delivery
- Precise Point mutations and small indels



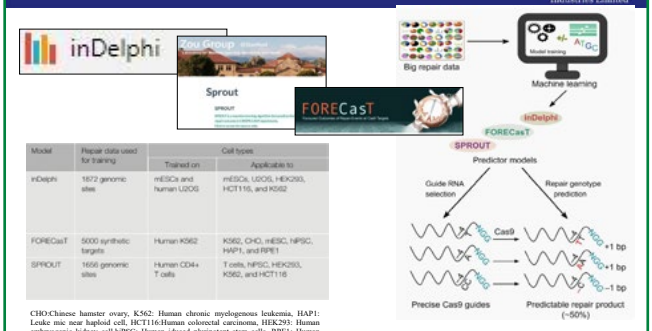
(Liu et al Nature Biotech 2020)

Prime Editing (Contd.)



(Hassan et al Biodesign research 2020)

Machine Learning for CRISPR edit prediction



Model	Repair data used for training	Cell types	
		Trained on	Applicable to
inDelphi	1872 genomic sites	mESCs and human U2OS	mESCs, U2OS, HEK293, HCT116, and K562
FORECasT	5000 synthetic targets	Human K562	K562, CHO, mESC, NPSC, HAP1, and RPE1
SPROUT	1656 genomic sites	Human CD4+ T cells	T cells, NPSC, HEK293, K562, and HCT116

CHO:Chinese hamster ovary, K562: Human chronic myelogenous leukemia, HAP1: Leuke mic near haploid cell, HCT116:Human colorectal carcinoma, HEK293: Human embryogenic kidney cell,hiPSC: Human iduced pluripotent stem cells, RPE1: Human retinal epithelial immortalized cells, U2OS: Human osteocarcoma cell

(Molla et al Trends in Biotechnology 2019)

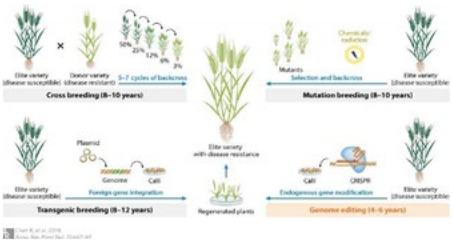
OFF Targets

Off-targets and analysis tools

- **Computational predictions (Biased)**
  - *Cas-OFFinder: Bae et al., 2014. Bioinformatics 30, 1473-1475.*
    - Supports a wide selection of PAM types including SpCas9 and LbCpf1.
    - Supports 76 plant genomes (Maize B73).
    - DNA and RNA bulges can be considered.
  - *CSAT: Braselton et al. 2015., GM Crops & Food 6:4, 266-276*
    - Developed by Carolyn Dill's group at ISU
    - Design sgRNAs for CRISPR-Cas9
    - Supports 6 plant genomes: maize, rice, barley, soybean and peanuts
  - *CHOPCHOP v2: Labun et al., 2017. Nucleic Acids Research 44 (W1), W272-W276.*
    - Design sgRNAs for CRISPR-Cas9, Cas9 nickase and Cpf1
    - Designs PCR primers for mutation analysis
- **Genome-wide *in vitro* and *in vivo* analysis (Non-biased)**
  - *Digenome-seq: Kim et al., 2015. Nature Methods 12, 237-243.*
    - Identifies in vitro DSBs
    - Yields sequence reads with the identical 5′ ends at cleavage sites
    - Requires high read depth
  - *GUIDE-seq: Tsai et al., 2015. Nature Biotechnology 33, 187-197*
    - Relys on dsODN tag integration in live cells
    - Identifies in vivo DSBs
  - *CIRCLE-seq: Tsai et al., 2017. Nature Methods 1 17-614.*
    - Identifies in vitro DSBs
    - CRISPR-Cas induced DSBs are highly enriched
    - More sensitive than Digenome-seq
  - *SITE-seq: Cameron et al., 2017. Nature Method. . . . .10-606.*
    - Identifies in vitro DSBs
    - Cleavage fragments are enriched.

-- InVIVO: Akcakaya etc al.,2018, Nature LetterDoi.Org/10.1038/s41586-018-0500-9
- *CIRCLE Seq followed by targeted resequencing inVivo*

Agriculture : plant breeding



Novel trait development

Quality: amino acids, sugar, starch, oil, protein, digestibility, pigments, flavonoids, therapeutic compounds

Biotic stress resistance: resistance to viral, bacterial and fungal pathogens

Abiotic stress resistance: drought, cold, heat and herbicide

Yield enhancement

Functional genomics research

-Gene discovery

-and function validation

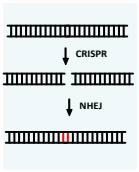
Breeding and seed production tools

Doubled haploid production

Hybrid seed production

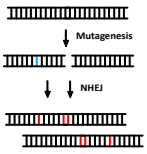
Site Directed Nuclease Activity Type 1: SDN-1

SDN-1:
Random repair via Non-Homologous End Joining (NHEJ)



=> Mismatch (SNP) or small INDEL at specific site

Breeding Equivalent:
Mutational Breeding



=> Mismatches (SNPs) or small INDELs at random sites

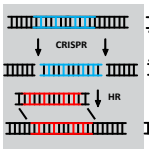
Breeding Applications:

Fast (~1 year) introgression of "loss-of-gene-function"-conferred traits
e.g.: sd1, non-shattering, Rc frg1, waxy, Xa13 Male sterility

Gene validation studies for diagnostic marker design and editing target discovery

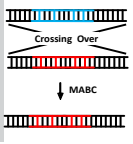
Site Directed Nuclease Activity Type 2: SDN-2

SDN-2:
Insertion of orthologue via homologous recombination (HR)



=> Allele replacement

Breeding Equivalent:
Variety upgrading by MABC
Wide Hybridization



=> Near Isogenic Lines (NILs)

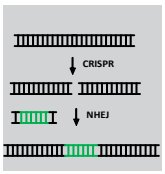
Breeding Applications:

Fast (~1 year) introgression of "gene-validated" traits e.g.:
Sub1, Pup1, Saltol, AG1 … Xa genes Pi genes

Fast (~1 year) introgression of know "wild-rice" genes free of species barriers and linkage drag e.g.:
biotic stress resistance, abiotic stress resistance,

Site Directed Nuclease Activity Type 3: SDN-3

SDN-3:
Insertion of foreign DNA via NHEJ or HR



=> Targeted insertion of cis- or transgenes

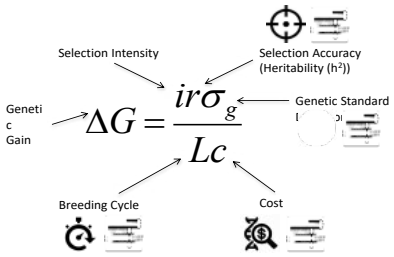
Breeding Equivalent:
None;
Except for GMO

Breeding Applications:

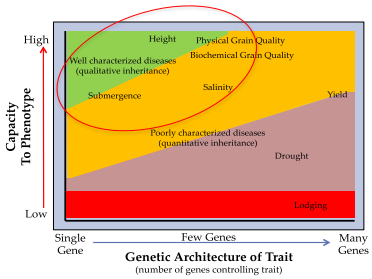
Fast (~1 year) generation of traditional GMO crops with known integration sites and without any traces of bacterial DNA or resistance markers
e.g.: roundup-ready, Bt-resistance

Artificial gene duplications
e.g.: resistance genes

"Editing" the breeder's equation



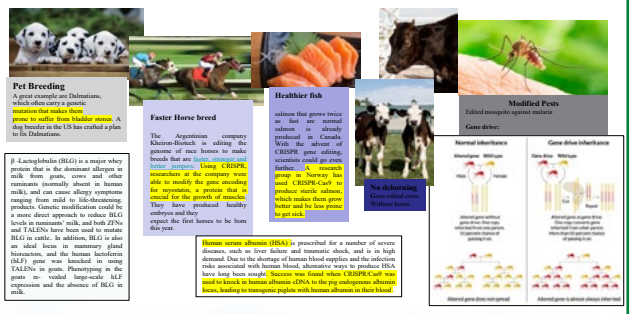
Traits amenable for genome editing



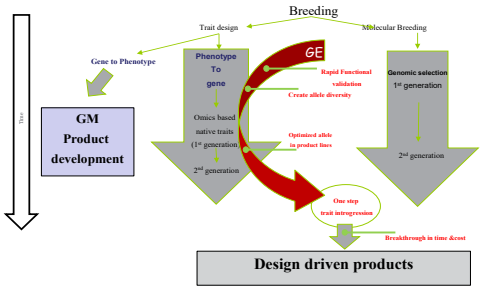
CRISPR Application in Agriculture

(Fernandez , Labbiotech.ed, 2020)
(Bio.org, 2018)

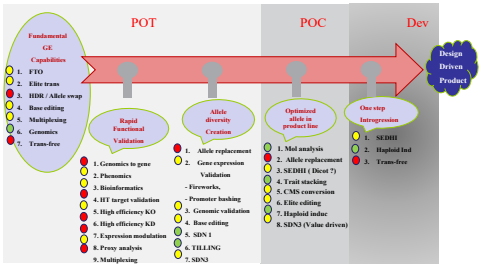
CRISPR application in Animals / Livestock



Vision on application of GE in the design driven product strategy

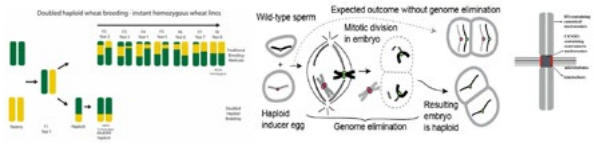


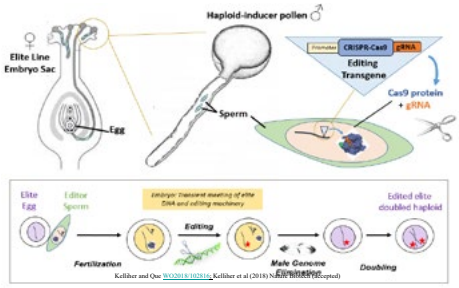
GE Pathway to design driven product



- *Agrobacterium* and direct delivery methods limited to selected varieties
- In most crops the most elite materials are not easily transformable
- Delivery of protein, RNA and Cas9 ribonucleoprotein complex into intact plant cells difficult due to the cell wall barrier
- In corn transform and introgression by backcrosses: 6-7 generations; 2-3 years

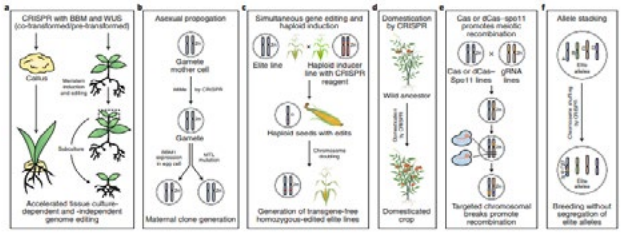
- Chromosomes with mutant CENH3 at the centromere do not compete well during early zygotic divisions resulting in haploid embryos.



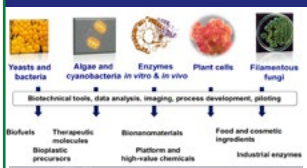


Kelliher and Que WO2018/102818; Kelliher et al (2018) Nature (Accepted)

CRISPR + FOR BREEDING



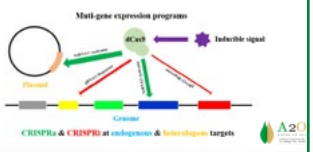
CRISPR in Industrial Biotech



"Bioproduction" and "industrial fermentation" – cells manufacture a product

EG. detergent enzymes, ethanol, pharmaceutical drugs, and vaccines

CRISPR systems can be used to make production cells better factories



(Slidcahre.net/ Edward perello)

SEED to Product / Cell based food

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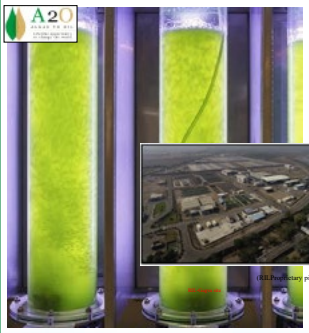
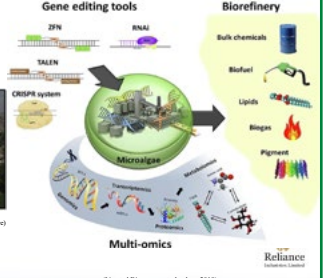
CRISPR Application for algae based product development



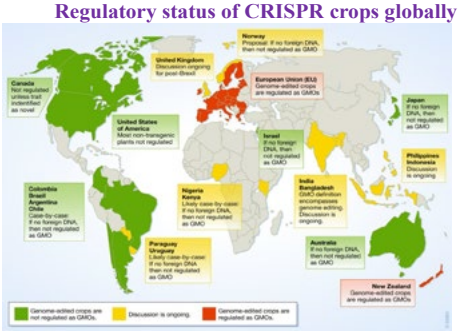
(R&L Proprietary picture)



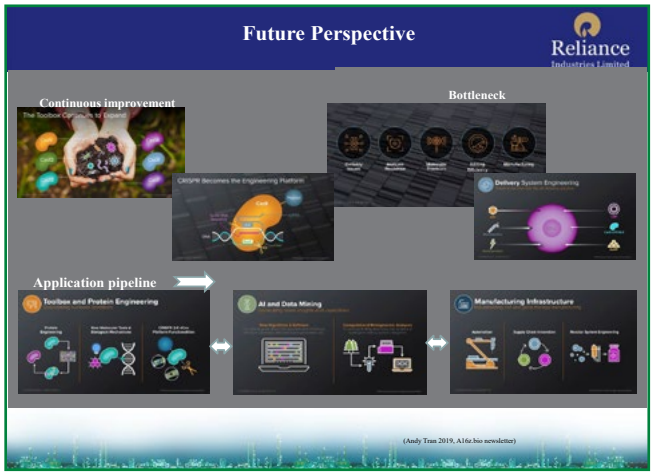
Fernandez, Labbiotech.eu, 2020)

(Lin et al Bioresource technology 2019)

Regulatory status of CRISPR crops globally



Future Perspective



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Combining Acquired Tolerance mechanisms with constitutive traits is the most appropriate physiological breeding strategy to improve water productivity in Rice.

Role of physiology-based breeding to evolve stress adaptive varieties in various crops

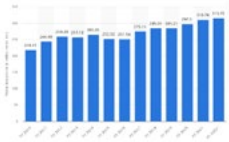
Lekshmi VS; Pushpa D; Prathibha MD; Preethi NV; and Sheshshayee MS

Department of Crop Physiology,
University of Agricultural Sciences, Bangalore

Good news first

Food grain production may be 1.6% higher in 2021-22

We may produce 316 mil tons of Food grains



With the total domestic consumption of 220 mt, we have good surplus

Not so good news

India's rice production may fall 6% to 104.99 million tonnes in kharif season of 2022-23

PTI / Sep 21, 2022, 13:06 IST

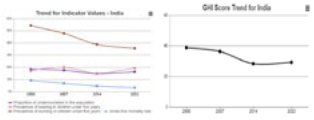
Wheat production down, but many crops set for record

Updated: August 16, 2022 7:44:46 am

To remain food secure, India must produce 377 mil tons of food grains by 2050!

The Bad news

Large populations in India do not have access to food



In the 2022 Global Hunger Index, India ranks 107th out of the 121 countries

India has a level of hunger that is serious.

The Worst news

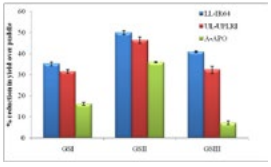
The challenges therefore, are…

- Water availability and high temperature will affect yields
- How do we achieve food production targets with less resources?
- Is there a strategic plan?

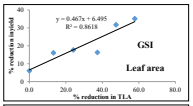
Of the fresh water used in Agriculture, more than 50% is used for irrigating rice.

We need to avoid this by adopting "semi-irrigated" aerobic cultiovation

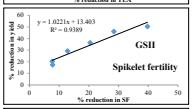
Yield loss is inevitable due to water limitation



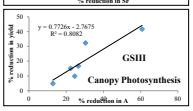
What causes yield loss in Rice under water limitation?



Leaf expansion



Spikelet fertility



Canopy photosynthesis

Preethi et al., (2020)- Rice Science

Possible strategies to Cope with these challenges

Better management

Conservation Agriculture

- Reducing cost of cultivation
- Conserves soil & environment

Precision Agriculture

- Precise inputs as required
- Significant resource saving

Superior varieties

Breeding by Design

Feasible and Most required

- Physiological traits
- Identification of QTL

Despite the fantastic progress made in CA and PA, a seed based technology has greater acceptability in India

Breeding strategy has been

↓

Select for higher absolute yield under stress

Rapid progress, but

Low variability
High G x E
Less stability

Further yield enhancement may not be remunerative

Alternatively

↓

Improve specific drought adaptive Traits

Slow progress, but

Low G x E
Higher stability

Excellent opportunity

Analytical Trait based approach is preferable

But choosing traits has always been the challenge!

All mechanisms point towards maintenance of metabolism and water relations

Morphological	Physiological
Leaf area	WUE
Leaf thickness	NUE
Root traits	NAR
Stomatal characters	MTR
Canopy architecture	ATT

These are Constitutive traits

Acquired Tolerance Traits

Propensity to respond
Upregulate specific mechanisms

Sheshshayee et al., 2018 frontiers in Chemistry

We strategically assessed these traits in Rice germplasm/Mutants

Root and canopy architecture → EMS induced mutants N22

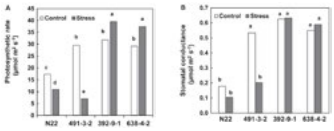
Water use efficiency → 3K RG panel of rice from IRRI

Acquired tolerance → 3K RG panel of rice from IRRI

Several experiments were carried out to screen and capture variability in these traits

Water mining through superior root system is undoubtedly important for maintaining water relations

We analyzed EMS induced Mutants of Nagina 22 and Germplasm



Root traits improved water relations.

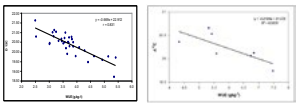
But can exhaust water resources early

Physiologia Plantarum 2019

Sowmya et al., 2020

Thus, the emphasis was to improve Water Use Efficiency

Stable isotopes is an accurate and high throughput approach



Impa et al., 2005; Sheshshayee et al., 2005

Combining Root traits with WUE will have greater relevance

Thanu x IET 15963

↓

450 F_2 progeny analyzed

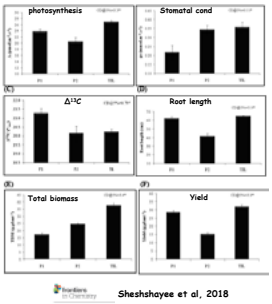
Genotyping | Phenotyping

↓

SSD

Advanced to generate RIL

The trait introgressed lines performed better



Sheshshayee et al, 2018

DHAKSHA: Requires 50% water

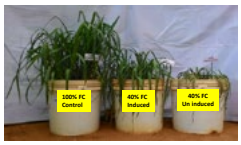
Has been nominated for Aerobic cultivation

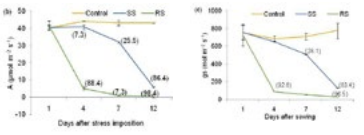
But can be still improved by enhancing Spikelet sterility

Requires tolerance at Cellular level

When stress is progressive, certain traits are "induced" referred to as Acquired Tolerance traits.

These Acquired Tolerance traits provide higher levels of tolerance when stress becomes severe.



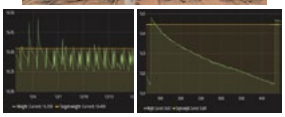


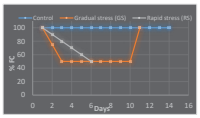
We hypothesised

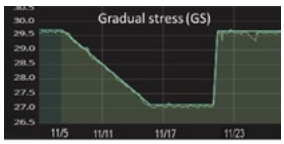
When combined with Constitutive traits, these Acquired Tolerance traits provide a comprehensive improvement in stress adaptation

Phenotyping for acquired tolerance traits requires a mechanism to impose stress "gradually"

We established a "drought simulator" phenomics platform at UASB

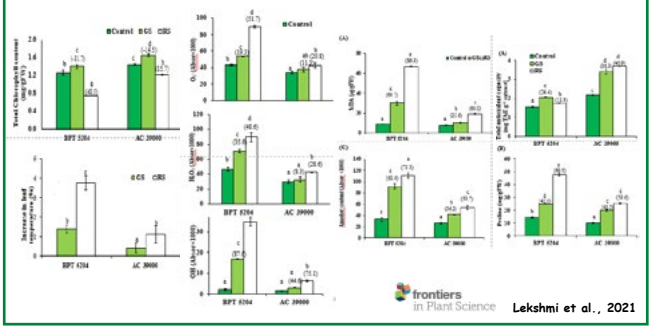






Preethi et al., 2020: Plant Phenomics

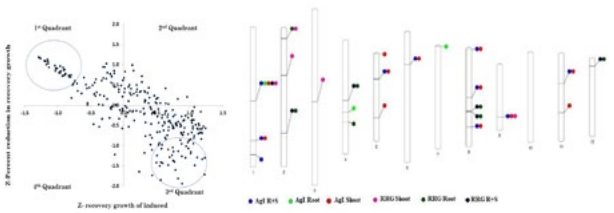
Standardised a protocol to assess genetic variability in ATT



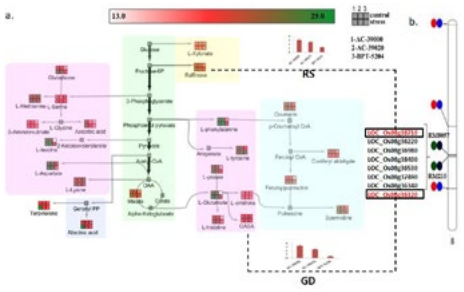
frontiers in Plant Science Lekshmi et al., 2021

A systematic effort was made to map the QTL for ATT genomic and metabolomics approach

A set of 150 germplasm accessions was phenotyped



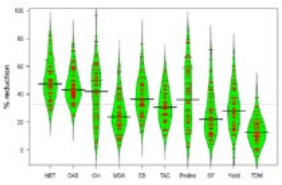
Pushpa et al., 2023: Physiol Plant



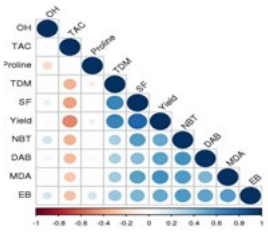
Raffinose and GABA emerged as potential regulators of ATT

Pushpa et al., 2023: Physiol Plant

A diversity panel of 90 germplasm from the 3K RG collection has been phenotyped



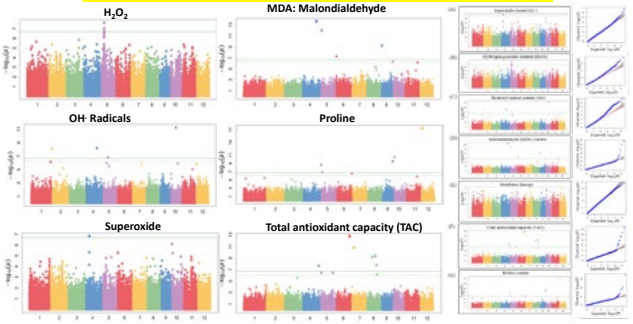
Significant genetic variability was found in 90 genotypes



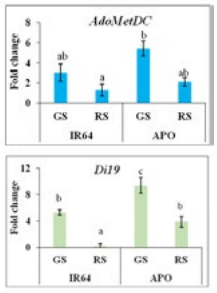
Spikelet fertility showed a strong association with ATT traits

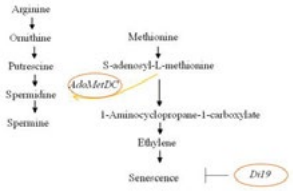
frontiers in Plant Science Lekshmi et al., 2021

We identified robust QTL using >2 lakh SNP by GWAS



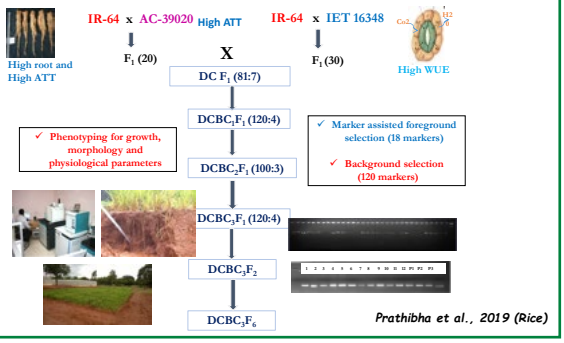
Based on transcriptome and metabolomic profiling, we a possible mechanism of Acquired tolerance



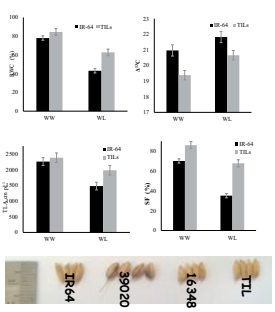


An interaction between Ethylene and Polyamine biosynthesis appear to trigger ATT

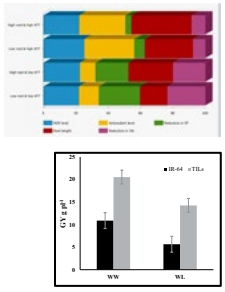
We adopted a Marker Assisted Backcross breeding strategy



Prathibha et al., 2019 (Rice)



Background genome recovery >98%



TILs performed significantly better than IR64

Prathibha et al., 2019

Summary

- Acquired Tolerance Traits are extremely important to sustain reproductive growth under stress
- Introgression of ATT with constitutive traits provided a greater yield advantage under stress
- Molecular breeding helps improve Physiological traits and hence drought adaptation
- Understanding the mechanisms that regulate ATT will be highly rewarding.

I thank various funding agencies of Govt of India

ISCB WorldVeg

My wonderful team of graduate students/post-Docs

Collaborators (National):
TNAU: Raveendran
NIPB: Amitha, Rohini, Prashanth
IARI: Viswanathan AK Singh, Gopalkrishnan,
NRRI: Padmini Swain, Meera Kar
IIRR: Seshu Madhav
IIOR: Sarla, Lakshmi Prayaga

International collaborations
WUR: Xinyou, Paul Struik
ETH: Kentaro Shimizy, Masaomi
ANU: Graham Farquhar, Richard Richards
ICRISAT: Rajeev Varshney

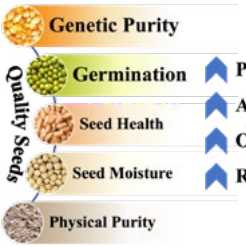
Thank you

Indian Seed Congress
Seeds for Global Unity
2-4 March 2023

New Technology Trends in Seed Quality Assessment and Certification

Arun Kumar M.B.
Division of Seed Science and Technology
ICAR-Indian Agricultural Research Institute
New Delhi
Email: akmbsst@gmail.com

Quality Seed - A Means to Enhance Agricultural Production and Productivity

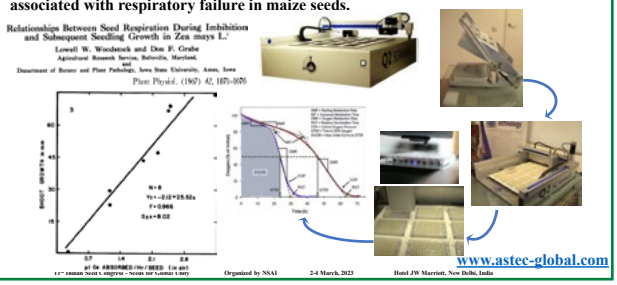


- Performance potential of the variety
- Additional dividends to the added inputs
- Optimum and uniform plant population
- Reduces the cost of cultivation

Seed Quality Regulation

Q2 Technology

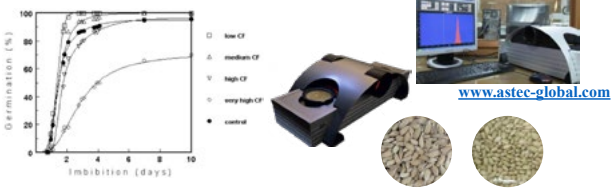
- Throneberry and Smith (1955) established that the loss of seed viability is associated with respiratory failure in maize seeds.



www.astec-global.com

CF analyzer

- This technology is based on the concept that chlorophyll content of the seeds decreases as seeds move towards harvestable maturity and that the seeds with lower chlorophyll content will have higher seed quality parameters like germination, speed of germination and vigour.

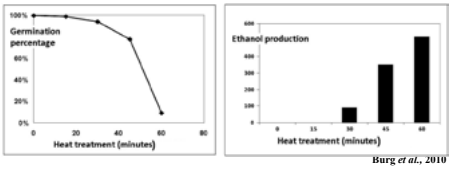


www.astec-global.com

Jalink *et al.*, 1998

Ethanol assay

- Partially imbibed immature and aged seeds produce ethanol, that is negatively correlated with seed quality parameters like germination, seed vigour and storability.

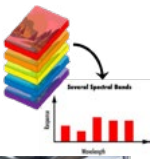


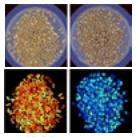
Burg *et al.*, 2010

Groot, 2023

Videometer

- When seeds receive light of different wavelength, depending on the chemical composition, light reflectance and transmission changes giving possibilities for multispectral imaging and, further processing of those images gives the relevant required information about the seeds.

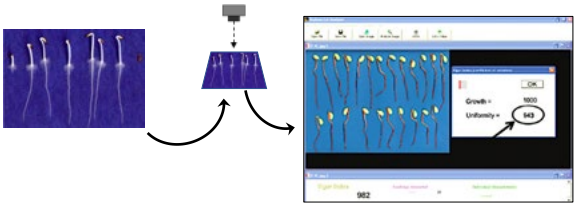




https://videometer.com

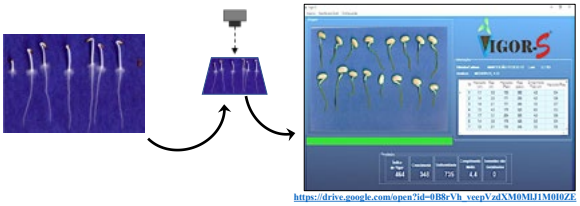
Seed Vigour Imaging System (SVIS®)

- It is a software interface used for quick observation and analysis of germination test results.



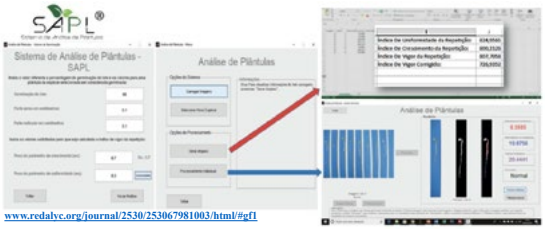
Vigor-S®

- It is a software interface used for quick observation and analysis of germination test results.



https://drive.google.com/open?id=0B8rVh_veepVzdXM0MlJ1M010ZE

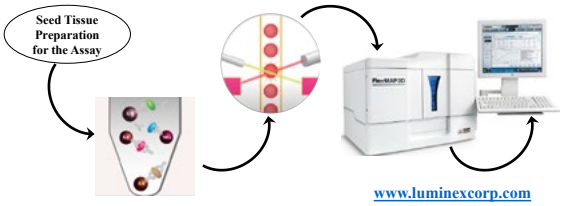
SAPL® - Seedling Analysis System



www.redalyc.org/journal/2530/253067981003/html/#gf1

Luminex® xMAP technology

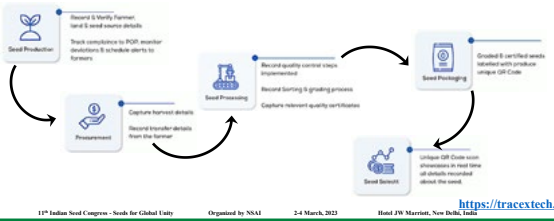
- The Luminex® xMAP technology is based on the principle of the antigen-antibody reaction, similar to that of the DAS-ELISA method.



www.luminexcorp.com

Tracex Blockchain Technology

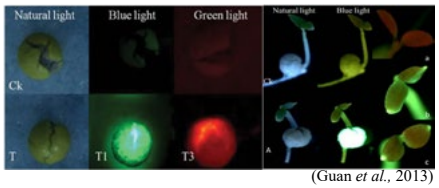
- A step against the entry of spurious and illegal seeds into the market
- A step towards the better traceability of seed information back to the source
- A step towards establishing a trustworthy among the stakeholders of the seed supply chain by facilitating the transparency in seed supply chain



https://tracextech.com

Division of Seed Science and Technology - ICAR-IARI

Seed-pelleting as Anti-Counterfeit Technology

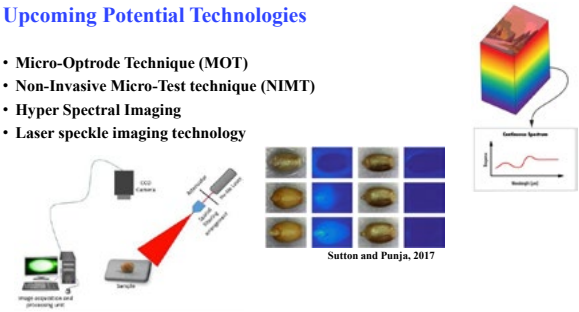


(Guan *et al.*, 2013)

Division of Seed Science and Technology - ICAR-IARI

Upcoming Potential Technologies

- Micro-Optrode Technique (MOT)
- Non-Invasive Micro-Test technique (NIMT)
- Hyper Spectral Imaging
- Laser speckle imaging technology



Sutton and Punja, 2017

11th Indian Seed Congress - Seeds for Global Unity Organized by NSAI 2-4 March, 2023 Hotel JW Marriott, New Delhi, India

THANK YOU ALL FOR
YOUR KIND ATTENTION

Prospects for development of high value vegetable seed industry in India

Ramakrishnan Madhavan Nair[1*], Sandhya S. Kumar[1], Pepijn Schreinemachers[2], Mandy Lin[3], and Roland Schafleitner[3]

[1]World Vegetable Center, South Asia/Central Asia, Telangana 502324, India
[2]World Vegetable Center P.O. Box 1010 (Kasetsart), Bangkok 10903, Thailand
[3]World Vegetable Center, P.O. Box 42, Shanhua, Tainan, 74199, Taiwan
*corresponding author: ramakrishnan.nair@worldveg.org

World Vegetable Center

. The prospects for the vegetable seed industry in India:

highly encouraging, with a projected growth of 4.5% per year

Seed market

- breeding technology (hybrids, open pollinated varieties & hybrid derivatives)
- cultivation mechanism (open field, protected cultivation)
- crop family (brassicas, cucurbits, roots & bulbs, solanaceae, unclassified vegetables).

Hybrids: largest and fastest growing segment.
Major companies are developing new hybrids.
Higher adoption: disease-resistance, increased shelf life, high yield, and wider adaptability.

Roots and bulbs: fastest-growing segment.

India is the leading producer of garlic, onion, and potatoes.

Public vs Private

Public sector: National Seeds Corporation, State Seed Corporations, ICAR institutes and state agricultural universities.

Private sector: The top five companies occupy 27.5% of the total seed market value in India.

Major players: Advanta Seeds - UPL, BASF SE, Maharashtra Hybrid Seeds Co. (Mahyco), Syngenta Group and VNR Seeds

Private companies are mainly concentrating on vegetables like tomato, cabbage, eggplant, chili, okra and cucurbits.

Source: Modor Intelligence, 2023

Vegetable seed production in India

Factors promoting:

- ever-increasing demand
- varied agro-climatic conditions
- cheap labour
- vast domestic and international markets

Challenges:

- high cost and vague demand
- perishable nature of seed
- problems linked with contract farming
- climate
- pest and disease-related problems
- stringent seed policies and laws

Source: Walia and Lalotra (2021)

Ongoing study by WorldVeg

Many seed companies report:

- Lack of protection of their research and intellectual property is a major barrier for the introduction of improved varieties.
- Differing protocols from state to state for the release of seeds create bottlenecks and additional costs for getting quality seed to farmers.
- Need to assess the relationship and roles of the public and private sectors in the research, development and dissemination of improved vegetable seeds for the benefit of farmers.

Role of WorldVeg

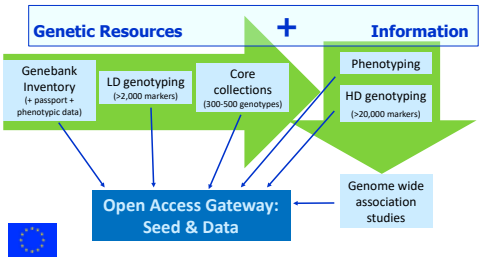
Schreinemachers et al (2017) explored whether crop breeding research by international agricultural research centers like World Vegetable Center, which traditionally served public sector crop breeding, still has a role when research and development have shifted to the private sector.

Tomato and Chili pepper in India:

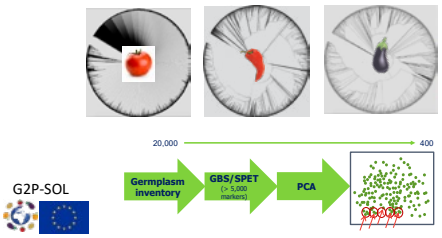
- International breeding needs to focus on pre-breeding research,
- Capacity strengthening of smaller seed companies, and
- Delivery of open-pollinated varieties for marginal environments.

G2P-SOL
Linking genetic resources, genomes and phenotypes of Solanaceae crops

The G2P-SOL approach

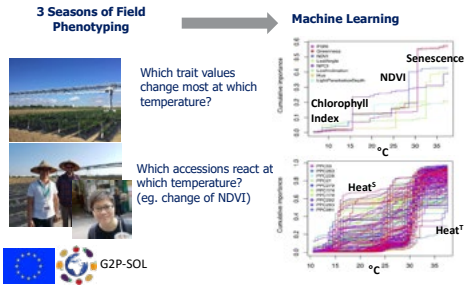


Diversity analysis - Core Collections



Field phenotyping of a *Capsicum* core collection under heat stress

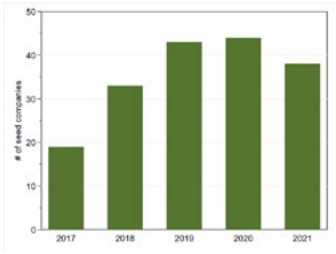
Heat stress responses of pepper



APSA-WorldVeg Vegetable Breeding Consortium

Join and benefit from:
- 15 free lines/year
- 24-month lead access
- Annual workshop
- Demonstration trials
- Discussion meetings
- Participate special projects
- Consortium newsletter
- 20% Disc. for training

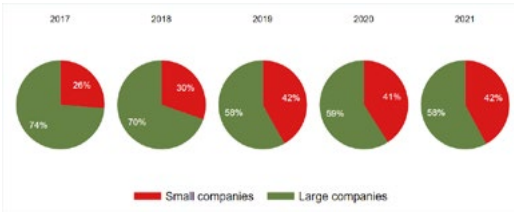
Consortium membership



Consortium membership 2017-2021

World Vegetable Center

Consortium membership



Share of large and small companies in the consortium

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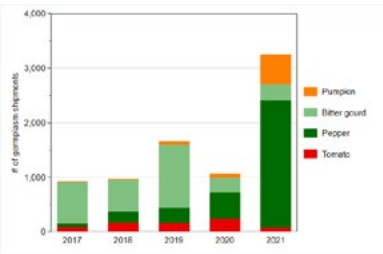
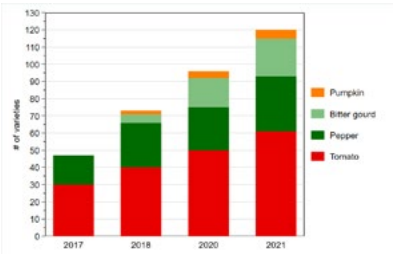
Germplasm shipments



Germplasm shipments by the WorldVeg genebank to consortium members

World Vegetable Center

Varieties containing WorldVeg germplasm



Vegetable varieties sold in Asia that contain WorldVeg-developed germplasm

World Vegetable Center

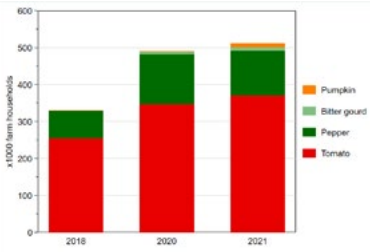
Use of WorldVeg lines in F1 hybrids

WorldVeg material used as:	Tomato	Pepper	Bitter gourd
One parental line of a hybrid	26%	41%	57%
Both parental lines	0%	3%	29%
Other uses	74%	56%	14%

Based on 2021 data

World Vegetable Center

Farmer Adoption



Farm households potentially reached by WorldVeg-related vegetable varieties in Asia, 2018-2021.

World Vegetable Center

List of current consortium and future projects

Consortium Companies are eligible to participate in special collaborative projects with WorldVeg and jointly fund the project.

Project name	Project duration	# of Co.**
ChiVMV project	Jul 2020 – Jun 2024	8
ChiLCD project	Jul 2020 – Jun 2024	17
Pumpkin breeding project	Jul 2020 – Jun 2023	11
Heat stress tolerance of tomato & pepper	Aug 2021 – Jul 2024	14
Bitter gourd breeding project (phase 4)	Feb 2023 – Jan 2025	35
Loofah breeding project*	Jan 2024 – Dec 2025	-
Chili thrips resistance project*	2023 – 2025/2026	-

*Projects in the pipeline
** Number of companies jointly funded the project

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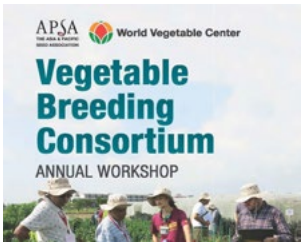
APSA-WorldVeg Vegetable Breeding Consortium



9-10 MAY 2023

WORLD VEGETABLE CENTER

TAIWAN

Registration is open

World Vegetable Center

Seed Potato: An opportunity for Indian Seed Industry

Dr. Brajesh Singh
Director, ICAR-Central Potato Research Institute, Shimla

Seed Potato: Status & Gap

Potato area	2.18 m ha
Seed rate	2.5 t/ha
Total Seed requirement	~54 lakh ton
Breeder seed (through Conventional system)	
Production	2520 - 3300 ton
Supply	2000 - 2600 ton
Certified seed (projected)	4.32-5.62 lakh ton (8-10%) (@ Seed multiplication rate: 1:6)
Gap	~49 lakh ton (=54-5)
Seed supply by private sectors	~12 lakh ton (22%)
Total seed supply (public + private)	30-32%

Remaining seed requirement: 37 lakh ton (68-70%)

ICAR-CPRI: A nodal agency for Potato Breeder seed production

1. Conventional system
2. Hi-tech system

1. Conventional System:

✓Conventional seed potato production technology based on "seed plot technique" is successfully going on since last four decades.

✓It comprises of tuber indexing against all major viruses and clonal multiplication in four cycles for breeder seed.

✓The limitation of low multiplication rate, repeated exposure of initial disease free seed stocks to soil and insect pests results into accumulation of pathogens accompanied by deterioration in quality of produce by the time it reaches to the end user.

2. Hi-tech system: Incorporation of hi-tech seed production system coupled with advance virus detection techniques is the only way out in fulfilling the huge demand of quality seed potatoes in the country.

Stages of Conventional Seed Production

Stage –I (1st year)	Nucleus seed
Stage –II (2nd year)	Pre-Breeder seed
Stage –III (3rd year)	
Stage –IV (4th year)	Breeder seed
FS-I (5th year)	Foundation seed
FS-II (6th year)	
Certified (7th year)	Certified

*However, the current status of breeder seed multiplication by the majority of the agencies is not as per the desired seed multiplication chain.

Why new innovations in Seed Production System?????

- ✓ For countries where no isolated and virus free potato growing areas.
- ✓ Early supply of pre nucleus/nucleus seed to commercial growers by reducing the field exposure time.
- ✓ Improved tuber quality.
- ✓ Reducing the load of degenerative diseases.
- ✓ Utilize the resources and trained manpower year the round.
- ✓ Vertical growth and reduce pressure on land.

Tissue culture seed production system

- Tissue culture based hi-tech seed system has led to the opening of > 25-30 tissue culture labs across the country, which has allowed supply of healthy mother stock (in vitro plants) to different seed producing organizations/agencies for seed production in the country.
- During 2010-2020, 1296 culture tubes had been supplied to 64 firms included in seed production programme.

Fig 1: Impact of healthy microplants supply to 64 firms

*This has resulted in covering the 12.5% of the total potato area of the country

Aeroponic seed production system: A boon to potato seed industry

- ICAR-CPRI has developed a programmed air mist based potato culturing technique based on aeroponics technology.
- Just to shorten the span of almost 2 years in the potato breeder seed production and production of clean material are the major advantages of Aeroponic system which in fact is revolutionizing the potato seed industry in the country.
- Aeroponic has been commercialized to 17 firms. Each firm was licensed to produce one million minitubers. If these firms operate at its capacity, it might have covered 1.47 million ha area with 352050.9 thousand tonnes of certified seed. This has led to a total monetary gain of Rs.70412 million crores to the agricultural GDP assuming that the seed potato was sold @ Rs. 20000/ton (Fig.).

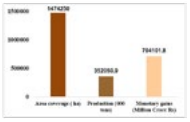


Fig : Impact of Hi-tech seed production through licensing of aeroponic system to 17 firms

Details of aeroponics technology commercialized (non-exclusive licensed) by ICAR-CPRI, Shimla to 17 firms in India & their future projections for quality seed production

Entrepreneur's	Licensing year	Expected minitubers (in millions) produced till date & area coverage*						
		G0	G1	G2	G3	G4	G5	Million hectares
M/s Rajdeep Agri. Product. Pvt. Ltd., New Delhi	2013	7	35	175	875	4375	21875	0.21875
M/s Sekhon Biotech Pvt. Ltd., Rupnagar, Punjab	2013	7	35	175	875	4375	21875	0.21875
M/s Siddhivinayak Agri processing Pvt. Ltd. Pune	2014	6	30	150	750	3750	18750	0.1875
M/s Bhatti Tissue Tech, Jalandhar – 144 022	2014	6	30	150	750	3750	18750	0.1875
M/s Goliwala Foods, Ahemdabad	2014	6	30	150	750	3750	18750	0.1875
M/s Director Horticulture, Punjab	2015	5	25	125	625	3125	15625	0.15625
M/s Sandhu Farms, Jalandhar	2015	5	25	125	625	3125	15625	0.15625
M/s Raghuvansh Agro. Farms Ltd., UP	2016	4	20	100	500	2500	-	0.025
M/s Handa Bio Agritech. Kurukshetra, Haryana	2016	4	20	100	500	2500	-	0.025
M/s. TchGreenz, Jalandhar	2016	4	20	100	500	2500	-	0.025
M/s. Sheel Biotech, New Delhi	2016	4	20	100	500	2500	-	0.025
M/s. GMS Agri. tech. Pvt. Ltd. West Bengal	2016	4	20	100	500	2500	-	0.025
M/s Shri Guru Hargobind Biotech, Jalandhar.	2016	4	20	100	500	2500	-	0.025
M/s Swastik Agri. Solution	2017	3	15	75	375	-	-	0.00375
M/s Sungro Seed. Pvt. Ltd, Maharashtra	2017	3	15	75	375	-	-	0.00375
M/s JPG Agri tech.	2017	3	15	75	375	-	-	0.00375
M/s. Deputy Director Horticulture, Karnal	2018	2	10	50		-	-	0.0005
		Total			385	9375	41250	131250	1.47425

**The multiplication rate is five times. Each aeroponic unit expected to produce ~1 million mini-tubers per year*

Success story

Novel Apical Rooted Cutting (ARC) LOW COST technology: Integration in breeder seed production & quality seed production

- Apical Root cutting is a low cost technology for small & marginal farmers.
- Easy to deal with & Alternative to minitubers in current production seed systems for potato.
- High multiplication rate (ONLY 3-4 cuttings are recommended).
- Strict health standards are MANDATORY.

1500 healthy microplants as motherstock at 5x5cm

⇩

In 6 weeks, 6-8 cuttings micro-plant

⇩

ARC seedlings @10000 at 30x10 cm R P

⇩

Production 100000 tubers@ enough for one ha

Commercialization of technology through MoU

1. M/s. Sekhon Biotech Pvt. Ltd, Rupnagar- Punjab
2. M/s. Bhatti Tissue Tech, Jalandhar
3. M/s. Sandhu Farms, Jalandhar
4. Uttar Bnga Krishi Vishwavidyalya, Cooch Behar, WB

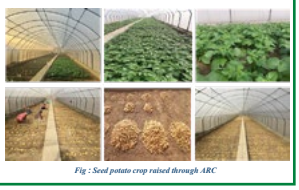


Fig : Seed potato crop raised through ARC

Opportunities for Seed Industry

- Adaptation studies of the exotic varieties in India and taking Indian varieties to the international markets with the interested stakeholders.
- To hasten the seed supply
  - Early generation
  - Disease free
- Opportunity to increase production
  - Better seed
  - Quality Inputs
  - Improved Agronomy Practices

Challenges

- Shortening of the growing window in reference to virus vector appearance
- No certification standards for hi-tech seed production
- Introduction of new exotic viruses
- Widening of vector profile (whitefly, thrips, new aphid spp.)
- Cross contamination from non potato viruses
- High virus load/degeneration
- No physical separation between table and seed crop
- Introduction & spread of quarantine diseases

Future Strategies

- Revisiting SPT and to develop revised dates of planting and management schedules for different regions.
- Redesigning plant protection schedules in reference to virus- vector behavior.
- Develop seed system based on PTCMT by developing seed health standards independent of the conventional seed system based on BREEDERS SEED.
- Integration of low cost technology @apical rooted cutting technology for the breeder seed production by following strict health standards.
- Standards for seed exports needs to be framed.
- Large scale integration of conventional and innovative techniques.
- Seed Village concept.
- Engaging progressive farmers and private parties.
- Discontinuation of seed production in sick state farms.

Possible Solutions

- Seed sector needs to be reformed/ structured by pooling the land holdings of small and marginal farmers and creating FPOs to make potato a profitable venture especially to small and marginal farmers.
- Involvement of SAUs, KVKs, Private sector companies, Growers associations, Cooperative societies and Progressive growers for multiplication of breeder seed in three assured multiplication cycles by Govt. of India.

OR

- Involvement of above agencies by the State Govts. for multiplication of Foundation-I in two multiplication cycles.

THANK YOU

Building sustainable growth in vegetables- A perspective from breeding to market

Tusar Kanti Behera
Director, ICAR-IIVR, Varanasi
Director.iivr@icar.gov.in

Vegetables as protective food

- Vegetables are bulky source of micronutrients and their 'compound matrix' is effective in supply of diverse elements to the body
- They contribute functionally active secondary metabolites which have preventive role against various health ailments.
- The **5 a Day** campaign is based on advice from the **World Health Organization** (WHO), which recommends eating a minimum of **400g** of fruit and vegetables a **day** to lower the risk of **malnutrition** & **health** problems

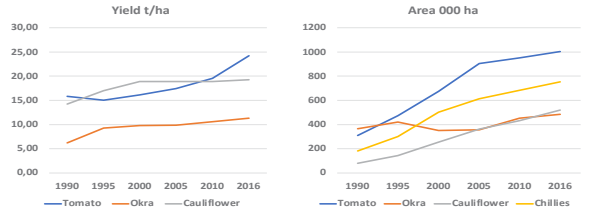
- ✓ The 2019 EAT-Lancet report: The planetary health plate should consist by volume of approximately half a plate of vegetables and fruits.
- ✓ To optimize the diversity of microbial species in the human gut requires consumption of greater range of vegetables and fruits

State-wise vegetable production

Uttar Pradesh	15.3%
West Bengal	15.0%
Madhya Pradesh	9.7%
Bihar	8.5%
Gujarat	6.6%
Maharashtra	6.2%
Others	38.7%

More than 60% vegetable production is concentrated in 6 states of India.

Production gains but also through increased area



- Yield gains over three decades less than doubled but area grew three times
- Large Gap between best farmers yields vs average farmers in all crops

Low productivity in Vegetable crops

- Shrinking resources and degraded production environment
- Inadequate and delayed availability of planting/seed materials
- Post-harvest losses and quality vegetable production
- Lack of climate resilient technologies
- Limited use of modern biotechnological approaches
- Lack of real time production information and market linkage
- Lack of Plant health management and bio-security

The end users and drivers of the vegetable value chain

A crucial element to build sustainability in vegetable value chain through plant breeding is to ensure that farmers and others stakeholder like processors and consumers, who will adopt and make use of new improved varieties/hybrids

1. Farmer

- ❑ Yield, fruit quality suitable for market & stress tolerance (biotic & abiotic)
- ❑ Off season production (protected cultivation)

2. Industry

- ❑ Seed industry - Economised seed production
- ❑ Food & processing industry
- ❑ Pharmaceutical industry

3. Consumer

- ❑ Consumers have their say in assessing preferred quality traits of vegetables and implications for breeding

Product development and market driven plant breeding

- Product development is an essential activity in market-driven plant breeding.
  - Identify products (Varieties/hybrids) most suitable for the targeted market/s, by testing potential new hybrids/varieties in multiple environments
  - A agronomy platform that restrict wrong or poor product to enter into the market.
  - Links the breeding and marketing activities, where breeders can observe how the hybrids/varieties perform in an actual farm environment, and the marketing team gets to know the new products and uses the testing sites for visits by potential customers (distributors, dealers, and farmers).
- Product Profiles were designed by breeders for the development of products that will replace established varieties on the market, taking into account market knowledge.
- Product Profile describes a variety with the necessary characteristics to replace the older varieties that still dominate a particular market.

Product Development: High Temperature tolerant CMS-based Radish hybrid

Maturity period:
Summer season (mid-May to mid-June)

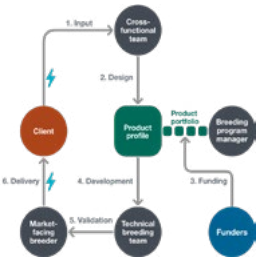
Tolerance
Temp max 38-45˚C

Yield potential
350-400 q/ha
15-20% higher than next best F_1 (Somani Seeds)

VRRAD-201×VRRAD-200

Product profile: A blue print for breeding with impact

- Market segment: A geographic area or a group of people having a relatively homogeneous demand for a commodity (crop varieties).
- Product profile: A set of targeted attributes that a new plant variety is expected to meet in order to be successfully released onto a market segment. For instance, a product profile may list fruit yield, tolerance to disease pest.
- Breeding priorities: Set of attributes/criteria to be considered during the breeding process, in view of existing knowledge, experience, and germplasm. For each attribute, a quantified description of the desired outcome and a rank or priority are assigned.



https://excellenceinbreeding.org

Market mapping and value segments

CROP	Season	SEGMENT	MARKET SIZE (MT)	KEY HYBRID 2-3
Tomato	Summer	SQR	13	Abhinav, TO 1057, JK 811, NS 229, NS 629, Shakthiman, NS 5002, Ansal
Tomato	Kharif	SQR	11	NS 2535, Megadoot, TO 1389, Alankar, US 3383, Utsav, Rishika
Tomato	Summer	RND	21	Lakshmi, Sahoo, US 3140, US 440, Hard Rock, Prabhav,
Tomato	Kharif	RND	36	Abhilash, US 440, US 3140, Lakshmi, JK Desi, NS 585, Rasam, Sagar
Tomato	Kharif & Rabi	RND GS	13	Shivam, US 618, Abhilash
Tomato	Kharif & Rabi	IND	5	HeemShona, HeemShikar, US 2853, NS 4266, Avtar
Tomato	Kharif / Rabi / Summer	Cherry (Indoor)	0,10	Nowara, Heemshikar, Avishkar
Total			99	

Needed separate breeding teams
Same has happened in other crops

Innovative techniques for vegetable breeding

- Traditional breeding approaches are generally slow & labor-intensive. Recent progress in genetics and genomics, accompanied by the deployment of novel tools, techniques, and approaches could enhance plant breeding programs.
- Molecular markers, genetic linkage maps, marker assays, and whole-genome sequence have been developed and published for several vegetables
- Mapping of traits of interest: Linkage mapping (Tanksley, 1993), genome-wide association mapping (GWAS) (Thornsberry et al., 2001), nested association mapping (NAM) (Tian et al., 2011), and multi-parent advanced generation inter-cross (MAGIC) populations (Cavanagh et al., 2008) have been developed for the detection and mapping of genes and QTLs.
- Marker-assisted selection (MAS) (Collard and Mackill, 2008), marker-assisted backcrossing (MABC) (Collard and Mackill, 2008), marker-assisted recurrent selection (MARS) (Charmet et al., 1999), and genomic selection (GS) (Heffner et al., 2009)

CRITICAL REVIEWS IN PLANT SCIENCES
2022, VOL. 41, NO. 5, 321–350
https://doi.org/10.1080/07352689.2022.2130361

Taylor & Francis

Progress in Marker-Assisted Selection to Genomics-Assisted Breeding in Tomato

Jagesh Kumar Tiwari, Suresh Reddy Yerasu, Nagendra Rai, Dhananjaya P. Singh, Achuit K. Singh, Suhas G. Karkute, Prabhakar M. Singh, and Tusar K. Behera

ICAR-Indian Institute of Vegetable Research, Varanasi, India

ABSTRACT
Tomato is an important vegetable crop for fresh and processed products. In the past decades, conventional breeding cum marker-assisted selection (MAS) has been deployed widely to develop modern tomato cultivars with desirable agronomic traits, market classes, and consumer preferences. The rapid developments in sequencing technologies with the reduced costs per sample, high-throughput single nucleotide polymorphism (SNP) genotyping platforms, and bioinformatics tools have revolutionized crop improvement programs, and deciphered the tomato genome sequence in 2012. Since then thousands of cultivated, its close relatives, and wild species have been genome resequenced to analyze structural variants population structure, genetic diversity, high-density map construction so on. Further, tomato pan-genomes have been constructed to search genomics regions associated with agronomic traits to expedite the breeding process. Importantly, genomics-assisted research has begun in tomatoes with the identification of genes, and SNP markers associated with phenotypic variation by applying genome resequencing, genome-wide association studies (GWAS) using SNP array, and genotyping-by-sequencing techniques. Further, the genomic selection (GS) method is expected to increase breeding efficiency and genetic gain rapidly. This review provides the latest information on progress in MAS to genome resequencing, pan-genomes, SNP genotyping, GWAS, and GS for genomics-assisted breeding in tomatoes.

KEYWORDS
Breeding; genome sequencing; genomics-assisted breeding; marker-assisted selection; SNP; tomato

Exploiting untapped plant genetic resources (PGRs)

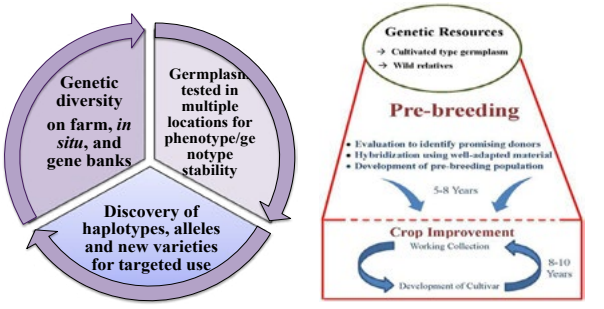


Photo source: www.nature.com

Identification of new traits: Sponge gourd Aromatic line

- A **special aroma like 'Basmati Rice'** has been noticed in leaves, vines, flower and fruits.
- The aroma test analysis of leaves and fruits justify that the whole fruit VRSG-7-17 showed the presence of high concentration of Hexenol and 3 Octanone, which is either absent or found in very low concentration in the control sample 'Kashi Shreya' (VRSG-194).
- Other common volatile identified using GCMS were cis-3 hexenol, 1-octane-3-ol, 1-hexenol and Limonene etc.

Marker assisted selection

- ❑ The genes with **major QTL effects**
- ❑ The major success is only achieved with the **qualitative traits**
- ❑ The biparental mapping populations used in most QTL studies do not readily translate to breeding applications

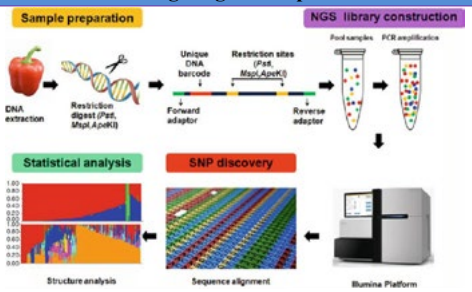
Marker assisted pyramiding of triple disease resistance in tomato

56 resistant varieties through AICRP-VC has been recommended in brinjal, tomato, okra, muskmelon, pea

Arka Samrat and Arka Rakshak
BW+EB+ToLCV
Kashi Aman and Kashi Abhiman
ToLCV

Genotyping by sequencing

- ✓GBS accesses regulatory regions and sequence tag mapping
- ✓Flexibility and low cost.
- ✓GBS markers led to **higher genomic prediction** accuracies



(Shamsad and Sharma , 2017)

Speed Breeding

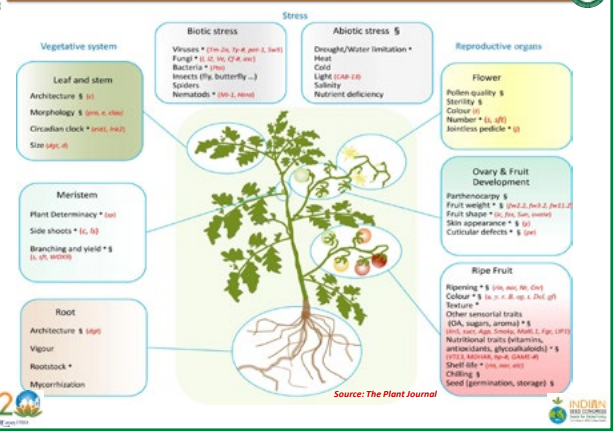
LIGHT
- ✓ PAR region (400-700nm). Red, far-red and blue range
- ✓ LEDs or LEDs + halogen lamps
- ✓ PPFD of ~450-500 μ mol/m²/s

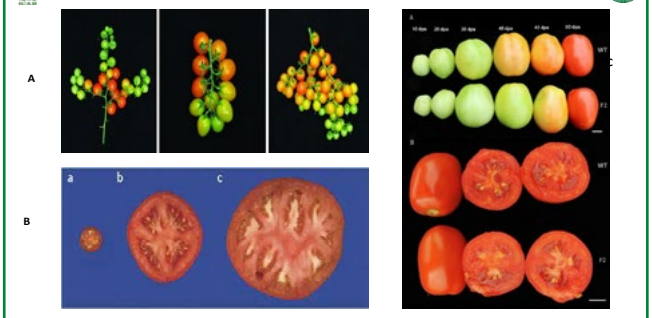
TEMPERATURE
- ✓ 22 °C day temperature
- ✓ 17 °C night temperature

PHOTOPERIOD
- ✓ 22 hr light and 2 hr darkness Proved to be useful for speed breeding

Humidity
- ✓ 60-70% RH is ideal for crop growth

Feasibility of genome editing for major traits in tomato

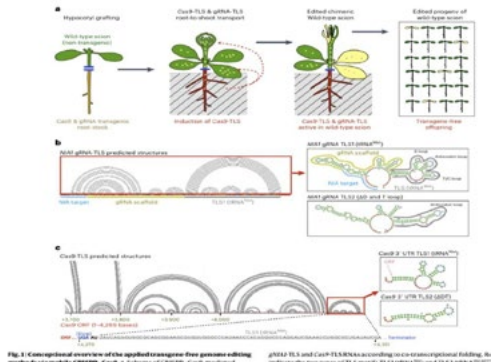




The CRISPR gene editing tool box to:
A. Alter the number and branching pattern of flowers that become tomato fruit;
B. Increase in tomato fruit size;
C. Change of fruit color and soluble sugar content in tomato.

source:
www.frontiersin.org;
www.nature.com

Heritable transgene-free genome editing in plants by grafting of wild-type shoots to transgenic donor rootstocks



New initiatives in genome editing research initiated at ICAR-IIVR Varanasi

Crop	Trait(s)	Gene(s)	Current Status	Transgene free or not
Tomato	ToLCV Resistance	Pelota (Host susceptible gene)	Plant Transformation	SDN1
Tomato	ToLCV Resistance	Nac1(Host susceptible gene)	Plant Transformation	SDN1
Tomato	Male sterility	SlCRK1 (Host gene)	Plant transformation	SDN1
Tomato	ToLCV Resistance	TolCV genomic regions (Rep, Coat protein and Movement gene)	Plant Transformation	SDN3
Tomato	Total soluble solid (TSS) (Processing)	SlINVINH1and SlVPE5	Construct is ready	SDN1
Tomato	Multiple disease resistance	DMR6 and Pectate Lyase	Plant transformation	SDN1
Okra	OELCV Resistance	OELCV genomic regions (Rep and Coat protein)	Plant Transformation	SDN3

Seed Industry

Methods to economize F_1 hybrid seed production cost

Use of Male Sterile Systems

a) Genic male sterility (GMS)
b) Cytoplasmic-genic male sterility (CGMS)
c) Gynoecism

How the male sterility is useful in hybrid seed production?

- **Reduced Seed Cost** – as it reduces 50% of the F_1 hybrid seed production (emasculation) cost
- **Protection** of female parent
- **Purity of F_1s**

Processing Industry

- Nearly 99% of the tomatoes are consumed as fresh, with only about 150,000 tons (less than 1%) of tomatoes being processed annually.
- India imported processed tomato products (canned tomato, sauce and paste) worth 20.64 Million US Dollars in 2019
- The current varieties/ hybrids, which cover over 90% of the area, are not specifically bred for processing qualities
- There is a need to breed and promote tomato hybrids also suitable for processing, which are not only high yielding and firm but have high Brix (>5.5%), high lycopene levels (> 14 mg/100g FW), low acidity (0.35 to 0.40%), and high viscosity (12-14 Botswick cm/30 sec).


Figure 4. Arka Apeksha


Figure 5. Arka Vishesh

Industrial Use of Bioactive active compounds of *Capsicum* sp.

Oleoresins

Natural oily organic resin extracted from fruits. It contains: capsaicinoids, carotenoids and also contains calcium, iron, zinc, vitamin A, B complex and vitamin C

Capsaicinoids

- ✓ **Capsaicin**
- ✓ Dihydrocapsaicin
- ✓ Nordihydrocapsaicin

Capsinoids

- ✓ **Capsiate**
- ✓ Dihydrocapsiate
- ✓ Nordihydrocapsiate

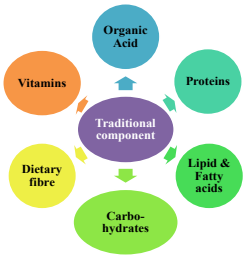
Carotenoids

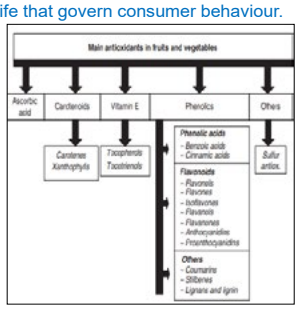
- ✓ **Capsanthin**
- ✓ Capsorubin
- ✓ Crytocapsin

- ✓ ß-cryptoxanthin
- ✓ ß-carotene
- ✓ Violaxanthin
- ✓ Lutein
- ✓ Zeaxanthin
- ✓ Antheraxanthin

Breeding vegetables Nutritional Quality and Nutraceutical properties

Nutritional quality describes the inherent biological or health value of produce including the ratio of beneficial to harmful substances, taste, fragrance, freshness, and shelf-life that govern consumer behaviour.





Carrot breeding

Promising genotypes

Red colour (350-375 q/ha):
VRCAR-186, AVT-II
VRCAR-201
VRCAR-109
VRCAR-185 , AVT-II

Black colour:
VRCAR-126 (Kashi Krishna)
VRCAR-89-1,
VRCAR-124

Orange colour:
VRCAR-91-1,
VRCAR-91-2

Purple-red colour:
VRCAR-107-1,
VRCAR-107-2,
VRCAR-171-1

Yellow colour:
VRCAR-153
VRCAR-178
VRCAR- 127

Breeding of nutraceutical rich Vegetables

Chemical compounds	Plant source	Properties
Allicin (organosulfur compound)	Garlic, onion, parsnip	Antifungal; antibacterial; antioxidant; used to treat arteriosclerosis
Apigenin	Cabbage, celery, lettuce	4',5,7-trihydroxyflavone is a flavone that is the aglycone of several glycosides
Beta carotene	Carrots, pumpkins, sweet potatoes, winter squash, broccoli, spinach and kale	Anti aging; anti cancerous; improve lung function; reduce complications associated with diabetes
Betanin	Beets, chard	Natural colourant used in ice creams
Capsaicin or trans-8-methyl-N-vanillyl-5 Nonenamide	Red chilli	Used for pain relief topically and as a digestive aid when taken internally; antioxidant; antiallergic
Caffeic acids	Carrot	Inhibitor of the lipoxygenase enzyme that forms leukotrienes from arachidonic acid
Tocopherol	Broccoli, carrot, celery, onion	It is a fat-soluble antioxidant that stops the production of reactive oxygen species formed when fat undergoes oxidation
Plant Glucosamine	Lettuce, peas, cabbage	Chondroitin and glucosamine are part of normal cartilage and act as a cushion between the joints

Plant Glucosamine	Lettuce, peas, cabbage	Chondroitin and glucosamine are part of normal cartilage and act as a cushion between the joints
Luteoline	Cauliflower, celery , sweet pepper	A carotenoid which shows eye benefits
Sulphoraphane	Broccoli	Used against breast cancer
Phytosterol	Germinated corn	Lower cholesterol absorption in the digestive tract thereby lowering overall cholesterol level in the bloodstream
Proanthocyanin	Red cabbage, egg plant	Help in urinary tract infections by inhibiting adhesion of microorganisms like E. coli to the urinary tract wall
Zeaxanthin	Carrot , celery, kale, lettuce	Used for eye health and in age related muscular degeneration

Breeding varieties of minor Vegetables

Chenopods	Capsicum
Basella	Long melon
Amaranths	Water melon
Kale	Kakrol
Water chestnut	Kartoli
Lotus	Ivy gourd
Water spinach	Round melon
Vegetable Soybean	Summer squash
Winged bean	Snake gourd
Lima bean	Baby Corn
Faba bean	Sweet Corn

At present ICAR-IIVR has programs on 42 vegetables

Focus Areas for Future breeding in vegetable crops

- Fertilizer Use Efficient Genetic materials and Use of Biologicals
- Water use efficiency
- Carbon sequestration & Global warming
- Postharvest losses
- Improving Nutritional Quality & Crop Diversity Research
- Genetic Engineering and genome editing
- Speed to Deliver Traits
- Farm automation for small farmers

Future crop with sustainable production through efficient utilization of inputs

Pomato: Harness benefits of both tomato and potato

Brimato: brinjal and tomato

❖Potato tuber yield: 500-750 g; *Tomato (Indet.) fruit yield: 2.5-3.6 kg/ plant
❖Effect of late blight resistant rootstock of potato on susceptible tomato scion

Rootstock: IC 354557; Scion 1: Brinjal (Kashi Sandesh);Scion 2: Tomato (Kashi Aman)
Yield: Brinjal- 3-4 kg; Tomato- 2.5-3.0 kg/ plant

Thank You

Fodder, feed and dairy industry – New paradigms and approaches for sustainable livestock productivity




Dr. Amaresh Chandra, FNAAS
Director
ICAR-Indian Grassland and Fodder Research Institute, Jhansi – 284003 (UP)

Agriculture V/s Livestock

- Livestock production is backbone of Indian agriculture.
- It contributes 4% to national GDP and gives employment to 70% population of rural areas.
- India has 56.7% of world's buffaloes, 12.5% cattle, 20.4% small ruminants, 2.4% camel, 1.4% equine, 1.5% pigs and 3.1% poultry.
- Indian livestock productivity is 20 to 60 % lower than the global average.

Reasons of low productivity of livestock are

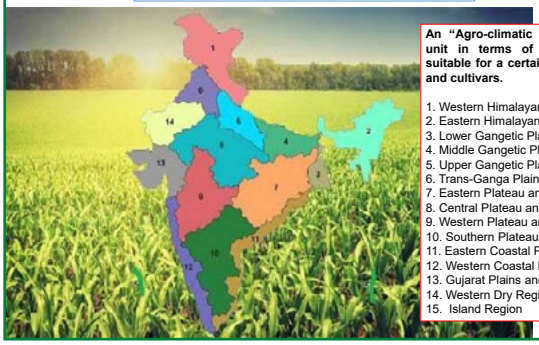
-Deficit in green fodder (11.24%), dry fodder (23.4%) (Roy et al 2019) and feeds (28.9%)

-Breeding and reproduction (21.1%)

- Diseases (17.9%) and management (10.5%)



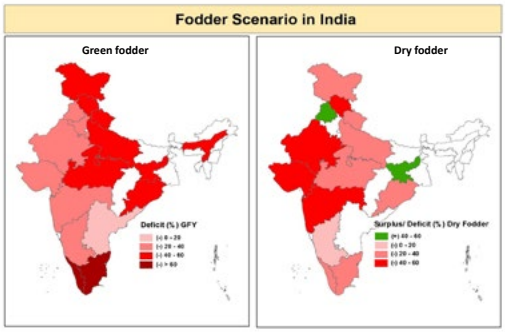
Agro-Climatic Zone of India (15)



An "Agro-climatic zone" is a land unit in terms of major climates, suitable for a certain range of crops and cultivars.

1. Western Himalayan Region
2. Eastern Himalayan Region
3. Lower Gangetic Plain Region
4. Middle Gangetic Plain Region
5. Upper Gangetic Plains Region
6. Trans-Ganga Plains Region
7. Eastern Plateau and Hills
8. Central Plateau and Hills
9. Western Plateau and Hills
10. Southern Plateau and Hills
11. Eastern Coastal Plains and Hills
12. Western Coastal Plains and Ghats
13. Gujarat Plains and Hills
14. Western Dry Region
15. Island Region

Fodder Scenario in India



Regional imbalances in fodder availability

➢**The green fodder availability;**

i. **> 60% availability:** In Western Himalayan (1), Upper Gangetic Plains (5) and Eastern Plateau and Hilly Zones (7)
ii. **40-60 % availability:** in Trans Gangetic Plains (6)
iii. **< 40 % availability:** in the remaining zones,

➢**Dry fodder availability;**

i. **> 60% availability:** In the Eastern Himalayan (2), Middle Gangetic Plains (4), Upper Gangetic Plains (5), East Coast Plains and Hilly Zones (11)
ii. **40-60 % availability:** In Trans Gangetic Plains (6), Eastern Plateau and Hills (7) and Central Plateau and Hills (8)
iii. **< 40 % availability:** in the remaining zones of the country


Fodder Production Technologies

Technologies at hand

Arable

1.Rainfed situation
- Perennial based fodder production
- Seasonal based fodder production

2. Irrigated situation
- Perennial based fodder production
- Seasonal based fodder production

Non-Arable

1. Arid
   - Hortipasture based fodder production
   - Silvipasture based fodder production
   - Fodder Trees
2. Semi Arid
   - Hortipasture based fodder production
   - Silvipasture based fodder production
   - Fodder Trees

Alternative fodder resources: opportunities

Non-conventional

1. Azolla as fodder
2. Lathyrus as fodder
3. Cactus as fodder
4. Fodder sugarcane

Non competitive land uses

1. Fodder from plantation crops/ orchards
2. Fodder on field boundaries
3. Hydroponics

Fodder production from arable lands

Potential intensive forage crop rotations under irrigated conditions for semi arid region of India

Crop rotations	Green fodder yield (t/ha/year)	Dry matter yield (t/ha/year)
NB hybrid + (Cowpea - Berseem + Mustard)	273.1	44.3
Sorghum (multi cut) - Turnip - Oat	190.1	37.4
Sorghum + Cowpea - Berseem + Mustard - Maize + Cowpea	180.5	33.3
Sorghum (multi cut) + Cowpea - Berseem + Mustard	172.0	32.3

Crop and its variety should be selected according to soil type, area and situation

i. For irrigated and arable land conditions: Bajra × Napier hybrids, guinea grass, rye grass, setaria, maize, sorghum, oat, cowpea, berseem, lucerne, etc.

ii. For rainfed and non-arable land:

Perennial grasses like Tall fescue, Orchard grass, *Brachiaria* spp., *Paspalam* spp., *Chrysopogon* spp., *Bothriocloa* spp., *Setaria* spp., Guinea grass, etc and

Perennial legumes like red clover, white clover and *Stylosanthes etc.*

Intensive forage crop rotations for different agro-climate zones of India

Crop rotation / climate & soil	Green fodder yield (t/ha/year)
Hill and Northern Region	
Sub-temperate, Moist, Red soil	
1. Maize + Cowpea – Lucerne + Oats - Mustard	85
2. NB Hybrid + Velvet bean – Berseem + Mustard	123
Tarai, Red & yellow soil	
1. Maize + Cowpea – Toria - Oats	177
2. NB Hybrid + Berseem – Cowpea	121
Semi-arid, Sandy loam soil	
1. NB hybrid + Berseem	212
2. NB hybrid + Lucerne	176
Central and Western Region	
Semi-arid, Red soil	
1. NB hybrid + Cowpea - Berseem + Mustard	255
2. Sorghum + Cowpea – Berseem + Mustard – Maize + Cowpea	176
Sub-humid, Black soil	
1. NB hybrid + Cowpea - Berseem	176
2. Sorghum + Cowpea – Berseem + Mustard – Sorghum + Cowpea	169
Semi-arid, Black soil	
1. NB hybrid + Cowpea - Lucerne	253

Fodder production systems in irrigated arable lands

Intensive fodder production systems

Model - I: Annual based fodder production system

Sorghum(multi-cut)+ Cowpea – Berseem + Japanese rape – Maize + Cowpea)

Production potential: 197 t/ha/year green fodder

Cereal : legume : 67:33

Adoption area: Whole India

Clientele group: Periurban and milkshed areas

Water requirement: 1820 mm

Livestocks support: 5-6 ACU

Fodder production systems in irrigated arable lands

Model - II: Perennial grass based fodder production system
N-B hybrid + (cowpea - berseem + mustard)

Production potential: 273 t/ha/year green fodder (44.3 t/DM)

Cereal : legume : 67:33

Adoption area: Whole India except tropical region

Clientele group: Periurban and milkshed areas

Water requirement: 1090 mm

Livestock support: 7-8 ACU

Fodder production systems in Rainfed arable lands

Model-I: Seasonal based fodder - food production System
Sorghum (Grain) + cowpea (Fodder)

Production potential: Grain- 2.5 t/ha, Green fodder – 17 t/ha

Cereal : legume: 67 : 33

Adoption area: Semi arid region

Clientele group: Small and medium farmers

Water requirement: areas up to 500 mm rainfall

Livestock support: 2-3 milch animals

Fodder production in Rainfed arable lands

Model-II: Perennial based fodder - food production System
Subabul + Trispecific hybrid (*Pennisitum purpureum X P. squamulatum X P. glaucum*) - sorghum (fodder) + pigeonpea (grain)

Production potential: 53.3 t/ha green fodder grain -0.4 t/ha, sticks – 0.8 t/ha

Cereal : legume : 80 : 20

Clientele group: Small and medium farmers

Water requirement: areas up to 500 mm rainfall

Livestock's support: 2-3 milch animals

Fodder production from non arable lands

Before interventions

After interventions

Fodder production from non arable lands

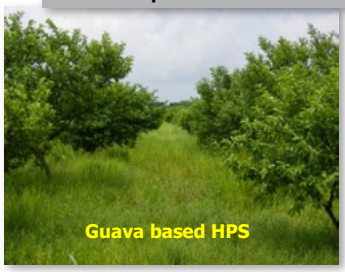
Horti-pasture System
Aonla + Anjan Grass avg. of 10 years

Replicated in Adarsh chara gaon

Zone : Arid to semi arid
Fruit : 8-10 t fruit
Forage : 7.9 t DM/ha
ACU : 1.4 - 1.6/ha
B:C ratio: 1:3.7

Contour Staggered trenches : 63% reduction in soil loss and 51% runoff loss

Fodder production from non arable lands



Horti-pasture System
Guava + Anjan Grass avg. of 10 years

Zone : Semi arid
Fruit : 6.8 t and
Forage : 7.9 t DM/ha
ACU : 1- 1.2/ha
B:C ratio: 1:4.9

Model suitable for 700-800 mm rainfall with staggered trenches

Fodder production from non arable lands

Silvi - Pasture System
Pakar + Guinea grass & Stylo

Zone : Semi arid
Forage : 12.3 t/ha DM/ha
ACU : 3 – 4/ha

Fodder production from non arable lands

Hardwickia binata + Anjan based Silvipasture system

Rainfall	:	300-400 mm
Productivity	:	5-7 t DM/ha
SWC measure	:	Staggered trenches
Carrying capacity	:	2.0 ACU/ha
Grazing period	:	Aug to Jan
B:C	:	1: 1.5

Fodder production from non arable lands
Model grassland development on degraded land

Original site
Loam to sandy in texture, Very low in OC content

Productivity- Fresh wt. 5 t/ha

Carrying capacity - 0.55 ACU/ha

Range grasses and legumes:
Anjan, Dhaman, Dhawalu, Sen, Lampa, Phulkara, Stylo, Clitoria, Siratro

Productivity- Fresh wt. 17 t/ha(1st year) 29t/ha (2nd year)

Carrying capacity - 2 ACU/ha

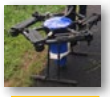
Utilizing Drone For Degraded Land Restoration And Grassland Development

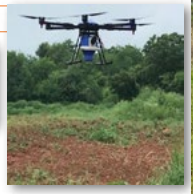
Grasses: Seed pellets of *Cenchrus ciliaris*, *Megathyrsus maximus* and *Pennisetum pedicellatum* were sown.

HEXACOPTER DRONE-Mediated sowing carried out.

Area covered: 1.5- 2 hectare at CR FARM GSM Division and Animal Husbandry Dharwad site


SEED PELLETS


HEXACOPTER DRONE



Best for inaccessible degraded areas

Time saving

DRONE IN ACTION: sowing seeds

Improved Grassland through community approach

Total Area: 70 ha

Tree Species: Neem, Sisau, Subabul

Pasture species: Cenchrus, Stylo

Production:

Earlier: 3.4 t/ha

After improvement: 4.3t/ha

Involved Institutes:

IGFRI

IIRD

Jal Grahan Samithi

Cenchrus grass in Soda village, Avikanagar, Rajasthan

Fodder Trees: Opportunities

Important fodder trees and productivity

Area	Name of tree	Fresh leaves per tree (kg)	Area	Species name	Fresh leaves per tree (kg)
Semi Arid region	*Acacia spp*	14-16	Arid region	*Ailanthus excelsa*	18-22
	Albizia spp	15-17		*Azadirachta indica*	18-20
	Azadiracta indica	18-20		*Bauhinia variegate*	20-22
	Dalbergia sissoo	15-18		*Hardwickia binate*	14-16
	Ficus spp	15-20		*Leucaena leucocephala*	15-20
	Lucaena leucocephala	15-20		*Prosopis cineraria*	18-20
	Moringa oleifera	20-22		*Ziziphus nummularia*	14-16

❖**Protein content in leaves: 14 - 28%**

Fodder tree species for arid zone

Fodder Tree: Ardu (*Ailanthus excelsa*)

States: Rajasthan, UP, Gujrat, M.P., Haryana, T.N.

Fodder from Non competitive land use system: Forage cultivation on field boundaries/bunds

In Farmers field under Adarsh Chara Gaon project

NB Hybrid in IFS mode in farmers' field

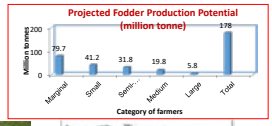
In Farmers field under Adarsh Chara Gaon project

Prospects of Fodder Production on field boundary

➢Introducing perennial cultivated grasses on farm bunds along irrigation channels involves by growing of 2 rows of Bajra × Napier hybrids, guinea grass, setaria, etc along with field boundary can supply 7-11 q green fodder per 100 m length of boundary per year.

Total bund length available in India

Category of farmers	No. of holdings (million)	Total bunds length (million meter)
Marginal	92.4	11391
Small	24.7	5886
Semi-medium	13.8	4543
Medium	5.9	2832
Large	1.0	834



If 10 % Farm Bunds utilized: Additionally 17.8 mt green fodder production/year

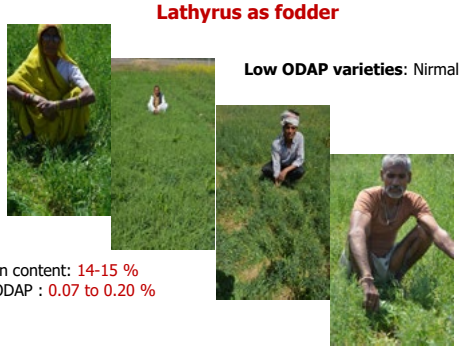
Non-conventional fodder sources

Azolla cultivation

Azolla spp.	Biomass (g) (fresh wt.)	Doubling time (days)
A. filiculoides	4.65	6.3
A. microphylla	5.86	5.4
A. pinnata	2.41	11.1
A. rubra	4.93	6.1
A. mexicana	4.29	6.6
A. caroliniana	4.89	6.1

- Good source of green fodder during lean period
- Good source of protein: 20-22 %
- Fat: 3.0 %
- Carbohydrate: 50 %
- Production cost: Rs. 1 - 1.5 per kg
- Production potential: 400 g/sq.m/day
- Suitability: Round the year in southern states
  Summer &monsoon in northern states

Lathyrus as fodder



Low ODAP varieties: Nirmal & Ratan

- Protein content: 14-15 %
- Low ODAP : 0.07 to 0.20 %

Alternate forage resource – Thorn less Cactus

- Promotion in farm boundaries
- Regular/Alternate hedge rows in degraded land
- Protein content: 4.5-5.5 %
- Fodder potential – 30-35 t/ha

Fodder Sugarcane

Component	Value
Crude Protein	10.95%
NDF	64.96%
ADF	37.07%
Ash	9.66%
Dry matter digestibility	65.69%

Feed Technology

Complete Feed Block Technology

- The CFB mainly consist of crop residue 60-70 parts and concentrate mixture30-40 parts. Molasses and guar gum could be used as binder.
- Such type of CFB had CP content of 10-12 % .
- For example a composition of wheat straw 40%, berseem hay 20%, molasses 20%, conc. mixture 20% and mineral & vitamin 1% had CP of 9.7%
- This can be used as sole feed or as supplements during natural calamities or at high altitudes.

Complete feed block of Straw storage and Transport

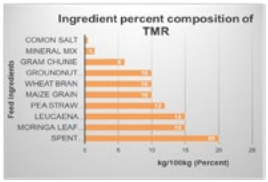
Intake of feed block

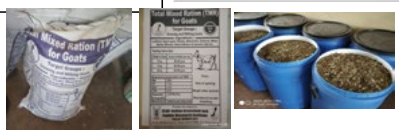
Nutritional Quality of CFB (% DM basis)

OM	Ash	CP	NDF	ADF	HC	ADL	DM Digestibility
88.31	11.69	9.72	44.02	31.11	12.91	3.27	58.94

Spent Grain Mixed TMR for Goats

- Brewers' spent grain mixed balanced TMR developed for growing goats.
- 7 days metabolic trial carried out for developed ration indicates higher feed intake of TMR fed group (3.82 kg/100kg body weight) as compared to the control group (3.11kg/100kg body weight).
- Dry matter digestibility in TMR fed group 69%.
- Product is also being commercialized through ABI Centre of IGFRI, Jhansi.





Feed Pellet Technology

Feed ingredients:

Fine chaffed stover, wheat bhusa, leguminous fodder/tree leaves, cake, wheat bran, mineral mixture and salt etc.

Economic Ration for Livestock Production

Ingredient	Control CM	Treatment CM.
Mustard cake	40	16
Barley	50	-
Maize	7	26
Berseem hay meal	_	48
Wheat flour	_	6.25
Urea	_	0.75
Salt	1	1
Mineral mix.	2	2

CM-Concentrate Mixture

Replacement of mustard cake protein(60%) with berseem hay meal protein and addition of NPN @.75% in concentrate mixture reduce the feed cost per kg milk production by 17.53% in crossbred milch cows and 16.25% in lactating bhadawari buffaloes.

Forage Seed

- Seed is one of the main obstacles in green fodder production.
- In India only 25–30% cultivated fodder and <10% in range grasses and legumes quality seed is available .

Forage seed production challenges

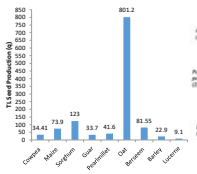
- Poor seed setting
- Seed shattering
- Non-synchronization maturity
- Low seed multiplication ratio
- Presence of empty seeds
- Non availability of suitable seed production technology and land
- Fewer varieties
- Lack of hybrids
- Poor resource allocation

Estimation of seed requirement of major cultivated fodder

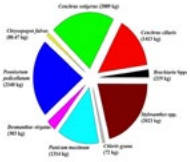
Crop	Area (m ha)	Average Seed Rate (kg/ha)	SMR	Breeder Seed (t)	Foundation seed (t)	Certified Seed (t)
Maize	0.9	20	100	1.8	180	18000
Jowar	2.6	10	100	2.6	260	26000
Bajra	0.9	10	80	1.4	112	9000
Oats	0.25	75	20	46.9	938	18700
Berseem	2.0	20	25	64.0	1600	40000
Lucerne	1.0	15	26	21.6	561	14600
Cowpea	0.3	20	30	6.7	200	6000
Guar	0.2	20	45	2.0	90	4000
Total	8.15	-	-	147	3941	136700

Source: Hand Book of Agriculture & IGFRI Vision 2030 document

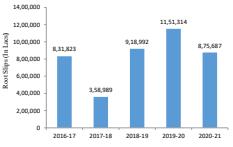
Quality Seed Production



Range legumes and grass seed production (kg) in last 3 yrs



Production of root slips of grasses (in lacs)



Total root slips 41.36 lacs

Forage Seed Production at IGFRI

Year	Breeder (q)	Truthfully labelled (q)	Grasses & legumes(q)
2014-15	208.14	384.89	9.14
2015-16	101.86	70.37	20.79
2016-17	363.3	117.93	20.95
2017-18	183.6	342.86	57.49
2018-19	83.86	211.17	24.29
2019-20	146.68	368.12	14.97
2020-21	210.61	224.39	12
2021-22	228.51	242.42	4.25
Total	1526.56	1962.15	163.88

Developed seed standards in range grasses and legumes

Crop	Submitted sample size (g)	Working sample size (g)
Lasiurus scindicus	200	20
Clitoria ternatea	1000	110
Stylosanthes hamata	220	22
Desmanthus virgatus	170	17

Crop	Germination test duration		Recommended Temperature	Substratum/ method of test	Dormancy breaking treatment if any
	First count	Final count			
Lasiurus scindicus	12	22	20-30 °C	TP	17 h soaking in 500 ppm GA_3
Clitoria ternatea	7	10	20-30 °C	BP	Nicking/ Sand paper scarification
Stylosanthes hamata	7	21	25-30 °C	TP/BP	Mechanical scarification
Desmanthus virgatus	7	21	20-30 °C	TP	H_2SO_4 for 1 minute

Seed standards in temperate grasses and legume under development

Developing seed standards in five temperate grasses and legume species *Bromus, Datylis, Rye grass, Tall fescue* and Red clover.

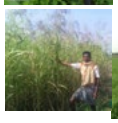
Seed pelleting in Dinanath grass

Weed control in berseem and cowpea seed production through application of imazethapyr @ 0.1 kg a.i./ha

ICAR-IGFRI Technologies (crop cultivars) available for commercialization

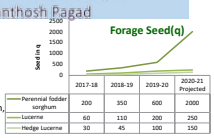
Crop	No.	Name of cultivar
Berseem (*Trifolium alexandrinum*)	05	Bundel Berseem-5 (JHB-17-2), Bundel Berseem-6 (JHB-17-1), Bundel Berseem-7 (JHB-18-1), Bundel Berseem-8 (JHB-18-2) and JBSC-1)
Oat (*Avena sativa*)	03	Bundel Jai - 2009-1 (JHO -2009-1), Bundel Jai 2012-2 (JHO 2012-2), Bundel Jai 2015-1 (JHO-2015-1)
Fodder Cowpea	01	IGFRI-DC-215
Guinea grass	01	DGG-1

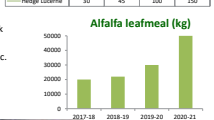
Impact and success story



Krishika Agro Farm Developers
Prop: Santhosh Pagad

Commodities:
- Seed
- leaf meal
- **Area:** 110 acres
- **Location:** Karnataka
- **Crops:** Perennial fodder sorghum, Hedge Lucerne and Lucerne
- **Client base**
  - more than 2000 farmers
  - AHVS department and Milk federations
  - Stud farms in Mumbai, Ahmadabad, Mangalore etc.
- **Total turnover: Rs.140 lakhs**





Fodder plan

Mini fodder plan by Assam
>10 Cr BN hybrid root supply etc

Success Story of utilizing Inter-spaces of fruit orchards

Districts covered: Shopian, Kulgam, Ganderbal, Ananatnag, Budgam

Area covered: 55 acres

Number of farmers: 352

Method: Participatory selection

https://www.youtube.com/watch?v=_37iQhIW8t4
https://m.facebook.com/watch/?v=312616349093854 1&paipv=0&eav=AfZG4HglaxnmBLZIM7hjsp70guKaSXecQhXGQy6afJgmctAqwPh7VIHTUu3NrFDoZKA&_rdr

Conclusion

- Prioritized research for trait specific varieties including bio-fortified and extensive use of millets as fodder.
- Promoting adoption of fodder crops through fodder based FLDs.
- Promotion/ participation opportunities in commercial venture for fodder quality seed production and entrepreneurship development for post- harvest conservation and utilization.
- Rejuvenation of grassland and pasturelands through new tools including Drone and involvement of state govt in its development.

Thanks .....

11th Indian Seed Congress-2023

"Seeds for Global Unity"

March 2-4, 2023, New Delhi

Seed Regulations harmonization for Globally Competitive Industry

Dr. K. Keshavulu
President, ISTA, Switzerland &
Managing Director, Telangana State Seed Organisations
Government of Telangana, Hyderabad, India

Introduction

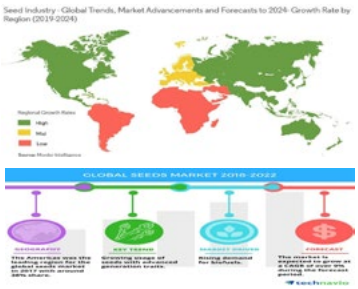
- Food and nutritional security for the ever-growing global population is the major challenge!
- Access to good-quality seed: fundamental and most vital in crop production systems
- Seed is not only a biological product, it is an unique industrial commodity
- Seed - primary input for agriculture and allied industry
- Yields & productivity depends on the quality of seeds used by farmers
- Seed trade beyond borders: supporting global agriculture

Global Seed Scenario

- Global seed market: Expected to register USD **86.8 billion by 2026**
- Growing demand for grains, oils, and vegetables is a significant driver for the seeds market
- Other reasons are the shift in farming practices, adoption of commercially produced seeds by farmers
- High yield, improved nutritional quality, reduced crop damage, disease resistance, etc. motivated farmers in investing in commercial seeds

Global Seed Trade: Factors

- ***Seed Policies/ Regulations***
- ***Enabling environments***
- Technologies (Products)
- Production costs of HYVs
- Transport /Logistic Costs
- Infrastructure, communication and information availabilities
- Seed Quality Assurance Systems
- Acquisitions and Mergers
- Access to Quality Seed !!!!



Seed Regulations: Importance

- To strengthen the seed sector through adherence to policies that guarantee quality standards and regulatory features
- To oversee the interests of breeders, seed producers, and farmers
- Appropriate Seed Regulatory framework promotes;
  - Competitive seed markets
  - Promotes seed sector growth and innovations
  - Ensure quality seed access to the farmers
  - Lowers trade barriers
  - Diverse seed systems

Global Seed Regulatory Regime

OECD — AOSCA — Seed Certification Schemes

ISTA — Rules for Seed Sampling & Testing

IPPC — Phytosanitary measures

UPOV — Plant Variety Protection

The International Treaty on Plant Genetic Resources for Food and Agriculture — Laws on Plant Genetic Resources

FAO — Effective Seed Systems & Quality Declared Seeds

National laws of the respective countries also plays a greater role

Seed Certification Systems

Indian Seed Congress-2023
March 2-4, 2023, New Delhi

- Seed is controlled & inspected to guarantee consistent high quality for consumers;
  - ➢Controlling the seed in previous generations;
  - ➢Administrative check over seed source;
  - ➢Field inspections to ensure varietal purity and identity;
- Seed Conditioning and treatments
- Growing samples in control plots
- Seed quality assessments in laboratories

Certification process varies between countries and parts of the world

Seed Certification Bodies

Indian Seed Congress-2023
March 2-4, 2023, New Delhi

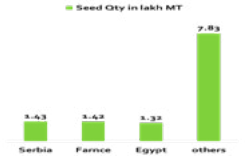
- International
  - The OECD Seed Schemes
  - Association of Official Seed Certifying Agencies (AOSCA)
  - EU Directives on Seed
- National
  - National/ Regional Seed Certification Agencies (as per the national laws / standards)
- Others
  - Latin American Seed Certification Mechanism
  - Southern African Development Community (SADC),
  - Economic Community of West African States (ECOWAS)

Seed Control Approach	Countries	Key Features
Mandatory Certification	EU, some African countries & Asian countries like Republic of Korea, Philippines & Indonesia	• Mandatory certification is contingent on variety and firm registration (regulatory gateway / preconditions) • Based on OECD Seed Schemes and ISTA Standards • Advanced regulatory environment and appropriate infrastructure needed
Voluntary Certification with Compulsory Labelling	USA and few Asian countries, like India, Nepal, China, Japan, Thailand, Vietnam, Myanmar etc.	• Truthful labeling relies on self-declaration of seed producers • Produces provide information based on minimum quality standards
Quality Declared Seed (QDS)	Some African countries like, Madagascar, Uganda, Guatemala, Peru & Zambia	• More flexible alternative for quality assurance than mandatory seed certification, especially for local and farmer's varieties • Adopted to address inefficiencies and capacity gaps in formal seed certification mechanisms • Limited to specific regions or crops

Global Seed Trade under OECD Seed Schemes

Indian Seed Congress-2023
March 2-4, 2023, New Delhi

- 8 Seed Schemes – facilitate seed trade
- A total of 12 lakh tonnes of seed was certified in the year 2019-20
- The largest producer is Serbia (1.43 lakh tones) followed by France (1.42 lakh tonnes) and Egypt (1.32 lakh tonnes)
- By continent Europe is the leading one followed by Africa, South and North America while the Asia is least producer
- The leading crop species: Maize, Wheat, Sun flower, Barley, Sorghum etc.



EU Directives on Seeds

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- 12 Directives on seeds and propagating materials (agriculture, vegetables, vine, forestry, ornamentals, fruit)
- Free marketing of seed within the EU with the aim to ensure the quality of seed to farmers
- Member States have the right to implement additional measures
- Key elements: **compulsory registration of varieties** and **mandatory seed certification**

Seed produced in countries other than EU may be marketed within the EU if the seed affords the same assurances as seed officially certified within the EU (EU seed equivalence)

Africa, North & South America: Seed Certification

Indian Seed Congress-2023
March 2-4, 2023, New Delhi

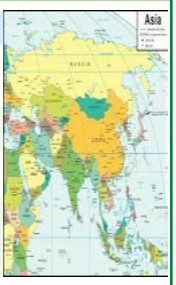
- No mandatory Seed Certification in US (AOSCA rules)
- In Latin Americas seed laws vary between nations
- During 2000, in Latin America, governments to updated plant variety legislation that included seed certification and variety registration: compulsory Certification.
- **African continent: R**egional harmonization of seed rules and regulations has been undertaken in various regional economic communities of SADC, the ECOWAS and the CEMAC.

ECOWAS, for example, introduced a new regulation on the harmonisation of rules governing quality control, certification and marketing of plant seeds and agricultural plants in 2008.

Asian: Seed Certification Systems

Indian Seed Congress-2023
March 2-4, 2023, New Delhi

Country	Certification process
India, Nepal, China, Thailand & Cambodia	Voluntary seed certification & compulsory labelling, no pre & post control tests
Pakistan & Bangladesh	Mandatory certification for few crops (wheat, paddy, corn, etc.)
Japan	Voluntary seed certification but seed health testing is mandatory
Republic of Korea, Philippines & Indonesia	Compulsory seed certification & varietal registration and also pre & post control tests



Seed Testing

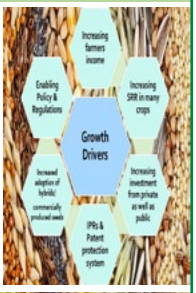
- Majority of the countries (83) across the globe including India are following ISTA rules for seed sampling & testing
- Majority of Asian countries have laws on seed testing and quality assurance except a few like Laos, Cambodia, Malaysia, etc.
- Seeds are subjected to mandatory testing for P, G, & M (seed health in only a few countries like Japan)
- No regulatory mechanism to ensure seed health and vigor in many countries including India
- Need to focus on seed health and vigour tests

Phytosanitary Measures

- To regulate, restrict or prevent the import and marketing of certain plant species or plant products
- To prevent the introduction and spread of plant pests across international boundaries or to limit the economic impact of regulated non-quarantine pests
- International Level:
  - Agreement on the Application of Sanitary and Phytosanitary Measures (WTO-SPS Agreement) of the World Trade Organization (WTO)
  - International Plant Protection Convention (IPPC)
  - are seeds pathway or pests themselves?
  - Has your NPPO completed any pest risk analyses for imported seeds?
  - Do you use different sources of information to set import requirements for seeds (ISHI , ISTA)?

Seed Regulations: India

- 5th Largest seed industry- about USD 5.5 Billion
- Seed Regulations: 1966, 1968 and 1983
- ICAR, 70+ SAUs, NSC, 15 SSCs, 26 SSCAs, >500 seed companies, 160 public laboratories, and many private labs
- Fragmented Seed Sector- > 500 public & private seed companies of varying sizes without proper coordination
- Hormonisation of seed law enforcement procedures across the country
- Voluntary certification & mandatory testing of PMG
- Need to emphasize seed health testing and vigour
- Need to build capabilities and capacities



Harmonisation of seed regulations

- To facilitate the movement of seed or plant products in the local, regional and international markets and also to promote scientific research
- Like European Seed Association, African Seed Association, Asia- Pacific Seed Association, American Seed Association etc.
- Absence of seed association in South-East Asia to harmonise the seed regulations and to promote seed movement in the region
- Regional associations need to work towards harmonising standards, regulations, procedures, and policies to expedite the movement of seeds within the region
- Bilateral and subregional agreements !!!
- EU regulations & procedures are similar to OECD Seed Schemes rules, in the future similar kind of regulations & procedures at the regional level may be necessary for seed quality assurance including filed inspections and control plot tests for all crops!!!!

Summary

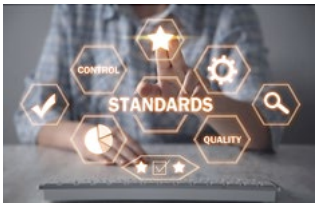
- Good seed for better crops, all farmers need good seeds
- A strategy is needed for the alignment of seed sector policies with better productivity and production
- Support for innovation in the public-private seed industry
- Strengthening of quality control system
- Emphasis on seed health tests / phytosanitary requirements
- Uniformity in certification / labelling system
- Uniformity seed law enforcement
- Comprehensive strategy for seed exports & international trade
- Harmonization of seed regulations at Regional level !
- Seed Exports: Huge Scope

ISTA ANNUAL MEETING
29 MAY-01 JUNE, 2023
VERONA, IT

ISTA ANNUAL MEETING
01-04 JULY 2024
CAMBRIDGE, UNITED KINGDOM

Thank you.....

Capability/Infrastructure of Seed Testing Laboratories and NABL Accreditation



By
Mr. N. Venkateswaran
CEO, NABL

NATIONAL ACCREDITATION BOARD FOR TESTING & CALIBRATION LABORATORIES

About NABL

- NABL operates accreditation program in accordance with the requirements of ISO/IEC 17011 "Conformity Assessment - General requirements for accreditation bodies accrediting conformity assessment bodies" and has Asia Pacific Accreditation Cooperation (APAC)/ International Laboratory Accreditation Cooperation (ILAC) MRA since 2000.
- The CABs are accredited as per the following standards:

Discipline/Area	Standards
Testing Laboratories	ISO/IEC 17025 : 2017
Calibration Laboratories	ISO/IEC 17025 : 2017
Medical Laboratories	ISO 15189 : 2012
Proficiency Testing Provider (PTP)	ISO/IEC 17043 : 2010
Reference Material Producers (RMP)	ISO 17034 : 2016

NATIONAL ACCREDITATION BOARD FOR TESTING & CALIBRATION LABORATORIES

Scope of NABL Accreditation

Testing Laboratories
Chemical
Electrical
Mechanical
Non-Destructive Testing & so on...

Calibration Laboratories
Electro-Technical
Mechanical
Radiological & so on.....

Medical Laboratories
Clinical Biochemistry
Clinical Pathology
Molecular Testing & so on....

Biological Discipline
Seed Testing (Biological)
- Germination
- GM Testing
- Purity
- Others

Tests
- Seed Germination test
- Seed Moisture Content test
- Physical Purity test
- Seed Viability Test
- Seed Vigor test
- Seed Health test

NATIONAL ACCREDITATION BOARD FOR TESTING & CALIBRATION LABORATORIES

Need of Seed testing

Seed Testing Laboratories are important to assess the seed quality

Enabling the farming community to get quality seeds and ensure the quality of planting material

Serve the seed industries by providing information of seed quality & suitability for planting.

For sustainable growth of Indian Agriculture and for valuable contribution to food security to facilitate the trade.

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Quality Assurance for Seed Testing Laboratories

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Functional Check/Intermediate Check of Equipment

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Retesting of Samples

Retesting

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Replicate Testing/Intra-laboratory Comparison

Replicate Testing/Intra-laboratory Comparison

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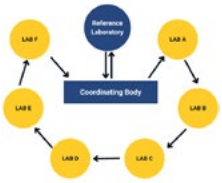
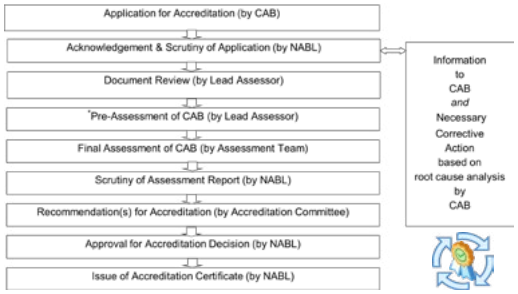
Proficiency Testing and Inter-laboratory Comparison



Proficiency Testing and Inter-laboratory Comparison

NATIONAL ACCREDITATION BOARD FOR TESTING & CALIBRATION LABORATORIES

Accreditation Process



* Optional for labs (Testing/Calibration/Medical Testing

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Benefits of Accreditation

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An Overview: Seed Testing Labs in India

Government Seed Testing Laboratories

State Seed Testing Laboratories -105
(under sub-section (2) of section 4 for that State (as per seed act 1966)

Central Seed Testing Laboratories -02 under section 4 (1) - sub-section (1) of section 4 (as per seed act 1966)

NABL Accredited Seed Testing Laboratories

State Seed Testing Lab - 01

Private Seed Testing Labs - 13

NATIONAL ACCREDITATION BOARD FOR TESTING & CALIBRATION LABORATORIES

Contact Us

National Accreditation Board for Testing and Calibration Laboratories (NABL)

NABL House, Plot No. 45, Sector 44,
Gurugram - 122003, Haryana

Email
info@nabl.qcin.org

Website
www.nabl-india.org

Phone
91-124-4679700 (30 lines)

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Harmonization of Seed Regulatory System and need for Amendment of Seed (Control) Order, 1983

Dr B B Pattanaik,
General Secretary
National Seed Association of India

Background

- Seed is the basic and most critical input for sustainable agriculture
- Growth of Indian agriculture has largely been driven by revolution in seed sector over the past 60 years.
- Seed policy reforms by the government also contributed greatly to the growth of Indian seed sector.
- These efforts are supplemented by public and private R&D system making available new and improved varieties and hybrids in various crops to the farmers.
- Indian seed industry has grown in size and performance becoming the 5th largest seed sector globally
- Rich agri-biodiversity and diverse agro climatic zones, exhibit a great potential in the country to become a global seed hub.

2

Growth of Private Seed Industry

- National Seed Policy of 1988 aimed at boosting availability of quality seeds to farmers and increase seed trade.
- **The liberalized policy created environment for promoting seed production and distribution in private sector.**
- With the credit support under NSP, Indian seed companies have created state of the art facility in R&D for development of new varieties, hybrids and genetically modified seeds to address various issues of agriculture .
- **New Industrial Policy 1991 liberalized the policy for entry of MNCs and foreign collaborations in seed sector.**

3

Seed Regulatory System in India

- The Seeds Act, 1966 (Act 54 of 1966) provides for regulating the quality of various seeds, notification of seed varieties, etc.
- **The Seeds (Control) Order, 1983 notified under Section 3 of the Essential Commodities Act, 1955 regulates the marketing of different types of seeds in the country through the process of licencing.**
- Presently license for seed manufacturers and dealers is issued by States after following the system prescribed under Seed (Control) Order, 1983.
- **Bringing in Clause 8A under the Seed Control Order has clarified that the non notified kind or varieties of seeds may also be traded provided they meet the prescribed quality standards.**
- Different States have mandated varying requirements regarding licensing for sale and distribution of seeds particularly - non-notified kind or varieties and hybrids developed by private sector.

4

Challenges concerning distribution of non notified varieties/hybrids

- Different States prescribe varying requirements w.r.t. performance evaluation data of the private proprietary/research varieties for granting licence for sale/distribution of these seeds.
- **Private seed companies have developed sizeable capacity for production, processing and distribution of seeds crossing State barriers. However, for interstate seed business, they have to take licence in each state which is a cumbersome process.**
- Reforms are required in the existing seed licensing system for a harmonized growth of Indian seed industry.

5

Difficulties faced by the Seed Industry in adopting to the existing Seed Licencing System

- Many States carry a misconception that there is a difference in the quality of certified seed and TL seeds. However, the Seeds Act, 1966 together with Seed (Control) Order 1983 regulates the quality of both certified and TL seeds and standards for Certified and TL seeds are the same.
- **Many States are also adding the name of varieties/hybrids to be marketed in the seed licence, though there is no such provision under the Seed (Control) Order, 1983.**
- Different States are also coming up with different performance evaluation criteria / data with respect to proprietary/research hybrids
- **The format of application for seed license under Seed (Control) Order, 1983 does not have the provision of registration of a variety for inclusion in the license.**
- State licencing authorities requiring to submit detailed information about the characteristics of the variety, the performance data along with required reports etc. with the application for licence.
- **This causes delay in bringing private research varieties into market thereby restricting ease of doing business in seed sector.**

6

Some Specific cases of misinterpretation of seed licencing legislation

- Arbitrary declaration of rectifiable and non-rectifiable contraventions contrary to the provisions of the Seeds Act, 1966 and the Seeds (Control) Order, 1983 by Andhra Pradesh.
- **Seizing of seed stocks of varieties which are being processed and packed for other States under the plea that the variety is not permitted for sale in Andhra Pradesh.**
- Restrictions against sale of Research Varieties in Bihar.
- **Inclusion of varieties in the licence contrary to the licence format (Form 'B'), which requires only inclusion of place for storage and place for sale in States like Maharashtra, Andhra Pradesh etc.**
- Complex procedure being followed for inclusion of varieties in the seed license in these States causing inordinate delay in issue of licence.
- **Restrictions against sale of labeled seed, contrary to the provisions of the Seeds Act and Seeds (Control) Order, under a false impression that quality standards of certified seeds are higher compared to labeled seeds.**
- Even for certified seed , responsibility for quality of the seeds, lies with the seed company and not with the Certification Agency.

7

Amendment of Seed Act 1965 Badly Delayed

- The extra-ordinary time taken in Seed Legislation as listed below is a matter of serious concern for Indian agriculture, particularly, the Seed Sector
  - **First draft Seed Bill by Prof AS Carter- 1957 to 1961;**
  - **Passing of the Indian Seeds Act- December, 1966 [after 5 years];**
  - **First and only one Amendment in the Act in 1972.**
  - **First Revised Seed Bill – 2004 [after 38 years] ; and**
- Second Revised Seed Bill- 2019 [after 14 years].
- The Seed Bill (2004) was proposed to replace the Seed Act (1966).However , owing to several shortcomings it was not passed. The 2019 draft version tries to overcome the drawbacks of the 2004 Bill. Still the Revised Seeds Act is in the ' Consideration Stage ' only
- On the other hand, the vibrant Indian seed industry is making significant progress in various spheres related to any 'well developed seed program'.

8

Suggested Initiatives through Amendment of the Seed (Control) Order, 1983

- Prescribing a uniform procedure to be followed for issue of seed licence to facilitate production, processing and distribution of different types of seeds dealt by the seeds companies
- **Including a provision for a license to a seed producing company apart from dealers. Hence, adding Seed Company in all the places where dealer is appearing**
- Adding definition of new words like, Seed Company, Seed Processing Plant, Seed Testing Laboratory etc. for sake of inclusiveness.
- **Bringing in a provision of Central Licencing Authority also apart from State Licencing Authority in the SCO**
- A specific license for seed companies by putting in place a system of their classification
  - **Companies with or without R&D operating in one State, or**
  - **Companies with or without R&D operating in more than one States**

9

Suggested Initiatives through Amendment of the Seed (Control) Order, 1983

- Bring in a System of Central licencing for companies operating in more than States and continuing with State licencing for companies operating within the State.
- **Including other activities of the seed company viz. seed testing, seed processing, Seed R&D, seed storage godowns etc. in the licence.**
- Provision of committees at Central and State level to recommend approval for inclusion of Seed Testing, seed processing, Seed R&D, seed storage godowns of a seed company operating in multiple States or single State.
- **Providing for inclusion of proprietary/research v arieties/hybrids developed by a Seed Company's own R&D System or approved varieties/hybrids obtained under a license agreement from other Seed Companies having approved R&D units, in the application for licence as well as in the licence.**

10

Suggested Initiatives through Amendment of the Seed (Control) Order, 1983

- The inclusion of the hybrids/varieties to be based on the performance evaluation data of in-house R&D or two years trial data in specific format used by Indian Council of Agricultural Research or any SAUs of the respective states.
- **Prescribing separate application form, seed licence format and seed licence renewal application formats for companies operating in one State or Multiple States.**
- Revising the fee for application licence, renewal of licence and also prescribing additional fee for including other activities like seed testing, seed processing, Seed R&D, seed storage godowns.
- **Seed traceability norms as stipulated by the Central Government to be complied by all the seed companies.**
- Reducing the time limit for testing and sending the report of the seed samples referred by the Seed Inspectors to a Seed Testing Laboratory from 60 days to 30 days.

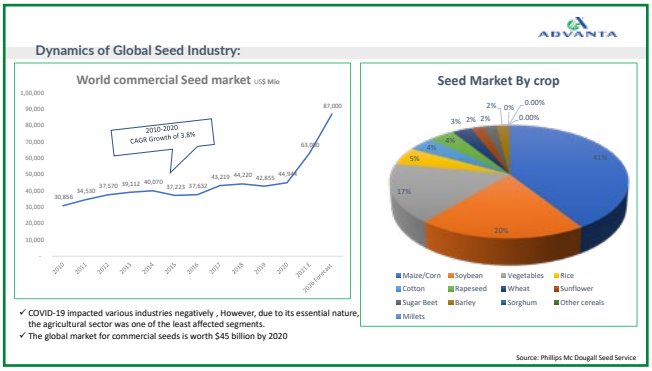
11

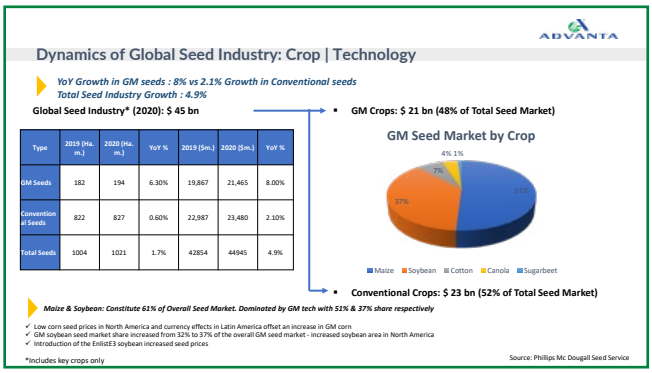
Way Forward

- Seed sector in the country has proved its credence over the years putting the Indian seed industry in the fore front globally.
- Seed industry has made substantial investment in seed research and development, processing, quality testing and seed value addition.
- India has also exhibited its potential to grow many kind of seeds produced in any part of world, with trained and skilled workforce and low cost of production, thus
  - creating greater interest for Indian seeds
  - identifying India as a hub for undertaking custom seed production for a good number of interested countries
- Making Indian seed industry globally competitive will require policy reforms in the seed regulation in the country to create ecosystem for ease of doing business and enable seed sector to exhibit its full potential.

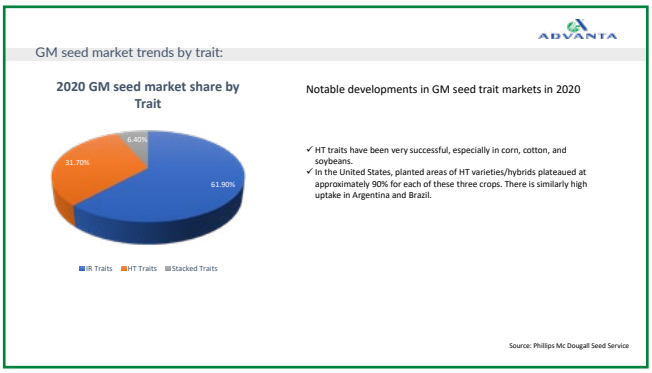
12

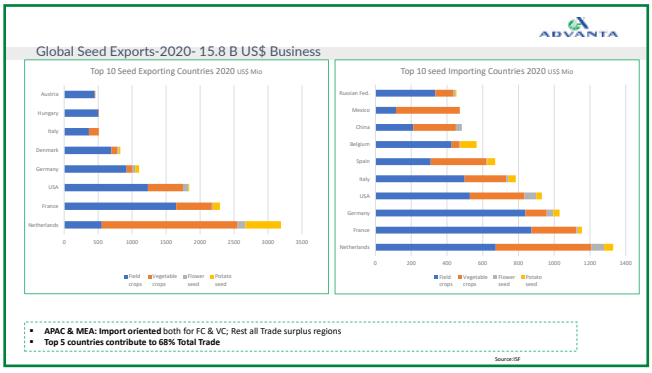
THANK YOU

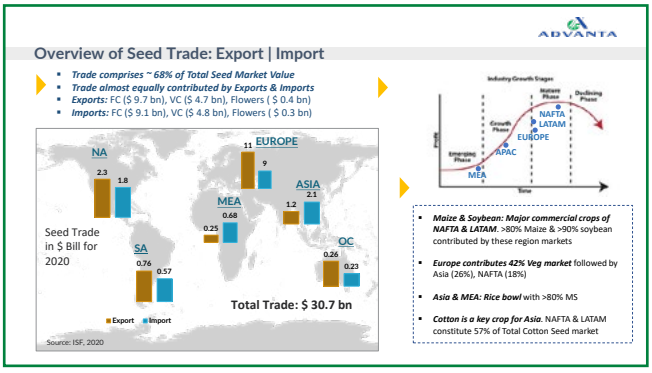




Type	2019 (Ha. m.)	2020 (Ha. m.)	YoY %	2019 ($m.)	2020 ($m.)	YoY %
GM Seeds	182	194	6.30%	19,867	21,465	8.00%
Conventional Seeds	822	827	0.60%	22,987	23,480	2.10%
Total Seeds	1004	1021	1.7%	42854	44945	4.9%







France Seed Industry

Major production country of Europe & leading seed supplier to world

Country Statistics:
Seed Market: $ 2.2 Bn (Main crops: Wheat, Fodder crops, Maize, Rapeseed)
FC Export: $ 1.2 Bn: Driven by cereals & forage seeds and exporting to 150 countries
VC Export: $ 0.4 Bn
FC Import: $ 0.5 Bn | VC Import: $ 0.16 Bn

Non- GMO Market

- Agroclimatic & soil for farming ✓
- R&D by Seed Companies: 15% of Turnover ✓
- IP Protection: Sound legal system ✓
- Regulation: OECD, UPOV All seeds should be certified ✓
- Seed Quality: Supervision & Control: Strict Vigilance ✓
- Focuses on Treated Seeds ✓
- Very well integrated system b/w Govt., Pvt & Farmers: ✓
  - **AFSIS**: Training, Expertise & Consultancy to Seed structure (Alike KVK Structure, India)
  - **GNIS**: Privately funded to bring together all entities *(No alike body in India)*
  - **FNAMS**: Federation of Seed Growers Focuses on R&D of seed crop protection *(No alike body in India)*
  - **UFS**: Dedicated national seed trade association (Alike NSAI, India)

Netherlands Seed Industry

Leading Exporter & Importer of Veg Seeds

Country Statistics:
Seed Market: $ 0.59 Bn
Exports: $ 1.8 Bn
Small densely populated country with not much of endowment of natural resources
Involved in trading seeds: Imports and re-export of seeds

Non- GMO Market

- Agroclimatic & soil for farming ✗
- Strong support for agri education R&D: Wageninger Univ ✓
- Access to Genetic Resources & Seed storage for future (Svalbard Global Seed Vault) ✓
- Regulation: One of the first countries to launch Plant Breeders Right with Breeder's Exemption ✓
- Innovative & advanced in using technology for seed processing ✓
- Ranked No 1 in Enabling Business of Agriculture (EBA)* by World Bank ✓
- Exemplary Integrated Models of Innovation & Knowledge: ✓
  - **PPPs:** 40 PPPs exists in Life Sciences
  - **Collaborative Research Progs:** Ex. Keygene, plant biotech company.
  - **Consortiums:** Ex. CBSG (Centre for Biosystems Genomics) for Potato/ Tomato & Brassica

**Evaluated the efficiency of country's agribusiness policies & regulations*

Quick Overview of Enabling the Business of Agriculture (EBA), 2017 for Seeds

Report developed by World Bank indexing 62 countries

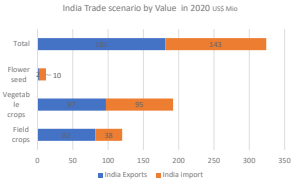
Index **examines and monitors regulations** that impact how markets function in the agriculture and agribusiness sectors.

Promotes smart regulations that ensure safety, quality control & supports business

Economy	Seed Ranking	Seed DTF (0- 100)	Plant breeding index (0-10)	Variety registration index (0-8)	Seed quality control index (0-12)	Time to register new variety (days)	Cost to register new variety (% income per capita)
Netherlands	1	88.00	9.0	7.0	12.0	556	13.7
Spain	2	86.65	10.0	6.0	12.0	598	9.3
Denmark	3	85.32	9.0	7.0	12.0	690	7.4
Italy	4	81.55	10.0	5.5	10.5	624	5.6
Poland	5	81.52	10.0	5.5	11.5	699	15.2
Romania	6	81.11	10.0	5.5	11.0	654	23.2
Kenya	7	79.24	10.0	7.0	6.0	322	123.2
Korea, Rep.	8	77.46	9.0	5.0	5.3	298	2.0
Uruguay	9	76.46	10.0	4.0	8.3	305	5.0
Peru	10	72.49	7.0	5.0	8.0	357	21.3
Philippines	11	72.28	10.0	6.5	5.3	570	1.5
Turkey	12	72.07	6.0	6.5	10.0	646	28.8
Georgia	13	71.42	9.0	7.0	4.0	581	0.0
Greece	14	70.43	8.0	5.0	9.5	729	8.7
Zimbabwe	15	69.65	10.0	4.0	8.5	607	41.2
Zambia	16	69.36	8.0	5.5	8.0	544	70.1
Tanzania	17	68.91	9.0	4.0	6.5	333	65.1
Russia	18	68.41	9.0	7.0	4.0	716	0.0
Serbia	19	68.38	8.0	5.0	7.0	604	0.4
Morocco	20	67.87	10.0	4.5	6.5	584	18.1
India	21	66.60	8.0	6.0	4.5	397	98.7

India's current position in Seed Trade

Leading crops of India (by production) do not feature in Exports;
Cotton restricted by Bt regulations of destination country & Wheat/ OP Paddy restricted for exports



✓ India Ranks 30th in over all seed Exporting countries

✓ India Ranks 46th in over all seed Importing countries

- ✓ Asian countries primary customers for India's Corn, Sorghum & Rice
- ✓ Tropical veg like Okra, Gourds, Solanaceous crops exported worldwide

Potential Crops for boosting India's Export: 1/2

India: Can be a Potential Export Hub
- ✓ Diverse agro-ecological zones
- ✓ Availability of techno-commercial talent
- ✓ Capacity & capability for seed production

Regions with Tropical/ Sub-Tropical climate conditions alike India: SAARC & AFRICA

1 Vegetables
- Increasing demand, one of the fastest growing seed type
- Market driven by value added traits
- Comparative advantage of growing tropical veg

Gap: Quality certified seed for aggressive market expansion

2 Hybrid Rice
- Staple food, demand influenced by population growth & low productivity
- Compete with Chinese hybrids which has MS%
- Subject to erratic hurdles of regulatory & quarantine

Gap: Tapping market thru tie-up with local companies

3 Hybrid Maize
- Growing industrial demand
- Competition in South Asia with Thailand or USA imports due to assured superior quality products
- Mature market with MNCs and several other players

Gap: Quality seed production in India

Potential Crops for boosting India's Export: 2/2

4 Forages
- Market at a nascent stage, oligopolistic
- Potential to develop India brand for Animal Nutrition Specialist

Gap: Efforts required to create market demand for quality seeds
Invest in R&D to supply quality seeds

5 Pulses
- Identified by UN as Food security & Nutrition Crop
- India largest producer, consumer & importer of pulses
- Target to boost domestic production for self sufficiency and export

Gap: Lack of HYV & Research by private sector
GoI policy initiative for incentivizing pulse production

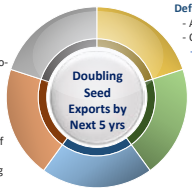
6 Bt Cotton
- Current exports limited to Myanmar, Korea & trial permits for Pakistan
- Potential to revolutionize seed market of other countries like India

Gap: Subject to GM regulation of destination country

Strategy for Boosting Exports from India:

"Make in India"	1	• Ramp up production vol to boost exports • Applicable for veg, maize seeds (less restriction on movement) • Hub & Spoke model • Scope to tap SAARC countries with Quality seed with competitive price
Globalizing Indian Companies	2	• Enter into partnership /inorganic expansion for tapping overseas markets • Operate with worldwide network for breeding, multiplication and distribution • Applicable with destination market is attractive but Indian germplasm is not adequate or cost to serve is high
Hybrid Model of Custom Production	3	• Outsourcing seed production to other countries where factors of production is an advantage • Adapting Netherlands Model of import & re-export

Modus Operandi :



AEZ/ Seed Clusters:
- Tie-up/ Backward integration with Destination country Govt
- Suitable for Indian states with same agro-ecological zones as Destination country

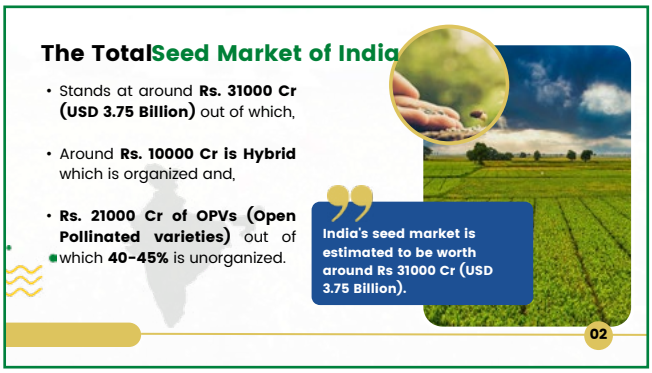
Defining Vision Statement for Exports:
- Alike Doubling Farmers' Income
- Concerted approach

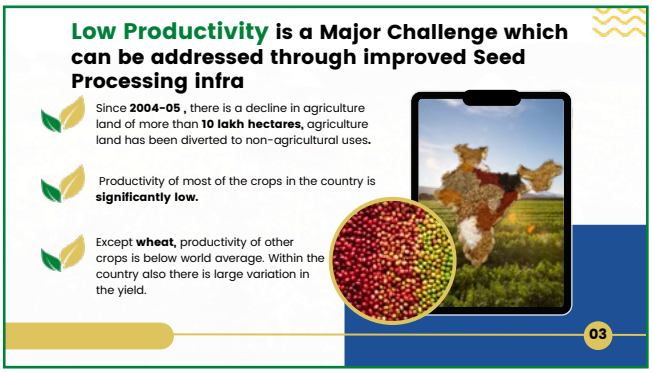
Upgrading Infrastructure:
- For Quality Products an lowering cost of production
- Cold Storage, advanced seed processing units, digitalization in seed production

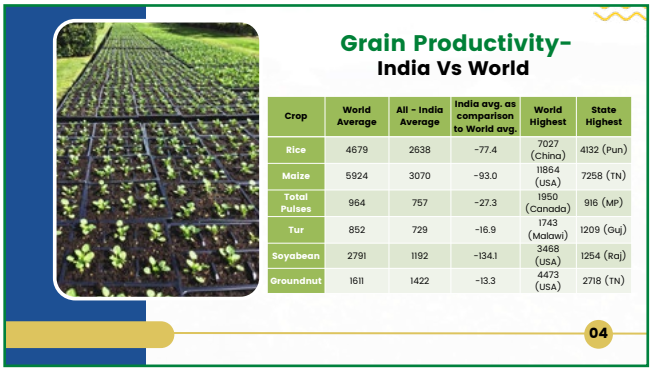
Enforcing IP/ PVP Rights:
- Delayed prosecution and grant of PVP causing disappointment for private sector companies
- To improve the EBA index –Reforms must be brought in for robust timebound approval/grant process.

Investing in R& D:
- Companies in India invest ~8-9% of TO
- Govt. should propose innovative models of co-investment e.g. Outsourcing lab & land of ICAR to private sector etc.
- Specific breeding prog for developing varieties for export

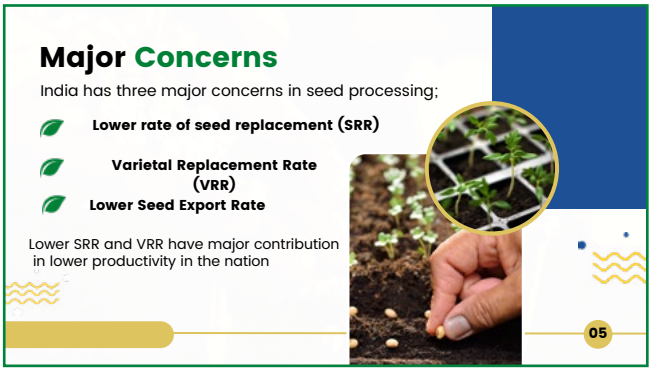
Thank you

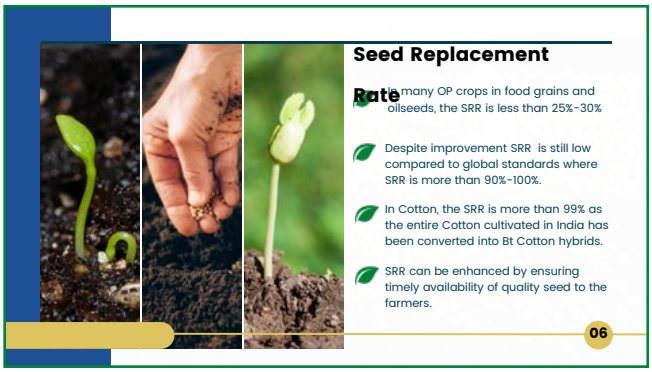






Crop	World Average	All - India Average	India avg. as comparison to World avg.	World Highest	State Highest
Rice	4679	2638	-77.4	7027 (China)	4132 (Pun)
Maize	5924	3070	-93.0	11864 (USA)	7258 (TN)
Total Pulses	964	757	-27.3	1950 (Canada)	916 (MP)
Tur	852	729	-16.9	1743 (Malawi)	1209 (Guj)
Soyabean	2791	1192	-134.1	3468 (USA)	1254 (Raj)
Groundnut	1611	1422	-13.3	4473 (USA)	2718 (TN)





Seed Replacement Rate

- In many OP crops in food grains and oilseeds, the SRR is less than 25%-30%
- Despite improvement SRR is still low compared to global standards where SRR is more than 90%-100%.
- In Cotton, the SRR is more than 99% as the entire Cotton cultivated in India has been converted into Bt Cotton hybrids.
- SRR can be enhanced by ensuring timely availability of quality seed to the farmers.

06

Varietal Replacement Rate

- Varietal Replacement Rate (VRR) of the highly adopted varieties is low
- old varieties released in the past 3-5 decades in both private and public sector are still under cultivation in many States
- Productivity of the most of these old varieties has reached a plateau or stagnated

07

Seed Exports

- The global seed industry market size is currently estimated to be at USD 52 Bn.
- The market is growing at a CAGR of 5%.
- While India is the 5th largest seed industry globally, it has a miniscule share in global seed trade.
- The total global seed exports are valued at USD 13.8 Bn market size of seed.
- India exports USD 137 million worth seeds per year, which accounts to approximately 1% of the total global exports.

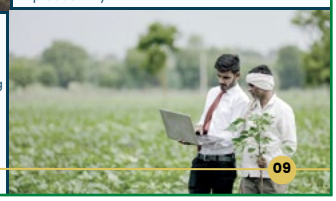
08

Scope for Seed Processing

- India needs entrepreneurs in the field of seed production and processing.
- Increased supply of seeds can reduce price of seeds and results in higher adoption by farmers and ultimately leads to higher productivity.

Financial Assistance through government schemes

- Various schemes available by state and central government, where financial assistance is being provided for production of seeds and also seeds are procured at a higher price through several government schemes.



09

Agri Infra Fund (AIF)

- Agri Infra Fund provides financial assistance for medium to long term debt **Post-harvest management infra and community farming assets**
- Agri Infra Fund was launched under Aatmanirbhar Bharat Package.
- **seed processing, tissue culture and nursery units** are eligible under AIF
- The Fund of **Rs. 1 lakh crore** under the scheme will be disbursed from **FY 2020-21 to FY2025-26**

10

Eligible beneficiaries under Agri Infra Fund

- Farmers
- Agri-entrepreneurs
- Start-ups
- FPOs
- Self Help Groups
- APMC (Mandis)
- Pvt. entities
  - Central sponsored Public-Private Partnership Project
  - Local Body sponsored Public-Private Partnership Project
  - State sponsored Public-Private Partnership Project
- Others
  - Joint Liability Groups
  - Marketing Cooperative Society
  - Multipurpose Cooperative Society
  - National Federations of Cooperatives
  - State Federations of Cooperatives
- PACS

11

Key Features of Agri Infra Fund

- Cheaper Rate of Interest: RoI Cap- 9%, **Interest Subvention-3%** Effective RoI for PACS- 1%
- **Credit guarantee** coverage under CGTMSE for loans up to Rs. 2 Crores.
- Each entity is eligible to get the benefit of the scheme for **up to 25 projects** located in different LGD codes.
- All the process of loan sanction starting from registration, application, sanction and disbursement happens seamlessly through the scheme portal.
- Agri Infra Fund can be dovetailed with any available government schemes including state government scheme.

12

Govt. Support for Seed Processing

Scheme: SUB-MISSION ON SEEDS AND PLANTING MATERIAL (SMSP) UNDER Krishonnati Yojana

Eligible
Private companies, individual entrepreneurs, self-help groups, seed co-operatives and partnership firms

Nodal
Seed Division, MoA&FW

Eligible activities:
Seed cleaning, grading, processing, seed treating, packaging and storage units as well as for seed testing facilities including R&D.

Support
40% of the capital subsidy in general areas and 50% in case of hilly and scheduled areas subject to an upper limit of Rs 150 lakhs per project.

13

Govt. Support for Seed Production & Processing for Vegetables and Spices

Scheme: Mission for Integrated Development of Horticulture (MIDH)

SN	Activity	Available Support
1	Open pollinated crops	• Rs 35,000/ha • For public sector 100%, • For private sector 35% in general areas and 50% in NE & Himalayan States, Tribal Sub Plans (TSP) areas, Andaman & Nicobar & Lakshadweep Islands, limited to 5 ha.
2	Hybrid Seeds	• Rs 1.5 lakh/ha . Other condition same
3	Seed infrastructure (for handling, processing, packing, storage etc. of seeds meant for use as seed material for cultivation of horticulture crops)	• Rs 200 lakh • 100% to public sector limited • For private sector, credit linked back ended subsidy @ 50% of cost of project

Govt. Support for Nursery

Scheme: Mission for Integrated development of Horticulture (MIDH)

SN	Activity	Available Support
1	Hi-tech nursery (4 ha)	• Rs 25 lakh /ha. 100% to public sector limited to Rs 100 lakh/unit •For private sector, 40% credit-linked back ended subsidy subject to a maximum of Rs. 40 lakh/unit, for a maximum of 4 ha on pro-rata basis.
2	Small Nursery (1 ha)	• Rs 15 lakh/ha 100% to public sector . •For private sector, credit linked back-ended subsidy of cost, subject to a maximum of Rs. 7.50 lakh/unit

15

Govt. Support for Tissue Culture Unit

Scheme: Mission for Integrated development of Horticulture (MIDH)

SN	Activity	Available Support
1	Setting up of new TC Units.	• Rs 250 lakh/unit 100% to public sector •For private sector, credit linked back ended subsidy @ 40% of cost
2	Strengthening of existing Tissue Culture (TC) units	•Rs 20 lakh/Unit 100% to public sector •For private sector, credit linked back ended subsidy @ 50% of cost

16

MINISTRY OF AGRICULTURE & FARMERS WELFARE
GOVERNMENT OF INDIA

Plant Quarantine Regulation and PRA for hassle free export-import of Seeds

Dr. J. P. Singh
Plant Protection Adviser

GOVERNMENT OF INDIA
Ministry of Agriculture & Farmers Welfare
Department of Agriculture & Farmers Welfare
Directorate of Plant Protection, Quarantine & Storage

Plant Quarantine Regulations

WTO-SPS members agree to:

Article 2
- Basic Rights and Obligations
- Right to take SPS measures
- Protection of human, animal or plant life or health.
- Measures are not inconsistent with the provisions of this Agreement.

Article 5
- Assessment of Risk and Determination of the Appropriate Level of SPS Protection.
- SPS measures are based on an assessment, as appropriate to the circumstances, of the risks to human, animal or plant life or health
- Risk assessment techniques developed by the relevant international organizations.

Annex A: Definitions
- Sanitary or phytosanitary measures include all relevant laws, decrees, regulations, requirements and procedures including, inter alia, end product criteria; processes and production methods; testing, inspection, certification and approval procedures; quarantine treatments, sampling procedures and methods of risk assessment

Plant Quarantine Regulations

IPPC contracting parties agree to:

ARTICLE I (1)
- Purpose and responsibility.
- to prevent the spread and introduction of pests of plants and plant products,
- to promote appropriate measures for their control, the contracting parties undertake to adopt the legislative, technical and administrative measures specified in this Convention.

Article 2
- "Pest risk analysis" - the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it.

ARTICLE IV
- General provisions relating to the organizational arrangements for national plant protection
- Each contracting party shall make provision, to the best of its ability, for an official national plant protection organization with the main responsibilities set out in this Article

Plant Quarantine (Regulation of Import into India) Order, 2003

Pest Risk Analysis

Schedule IV	Schedule V	Schedule VI	Schedule VII	Schedule VIII	Processed
• Prohibited • 15 No.	• Restricted • 17 No.	• PSC • AD & Spl. Condition • 701 No.	• PSC • Treatment • 519 No.	• Quarantine Weeds • 57 No.	• 34 No.

Point of Entries

(Schedule I, II & III)

PQS	**73**
Airports	25
Sea ports	47
Land Frontiers	**24**
ICDs/ CFSs	**80**
Post Offices	11

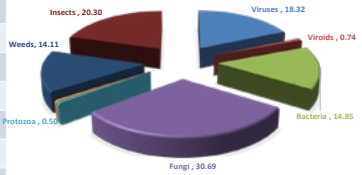
Propagative Materials: New Delhi, Kolkata, Mumbai, Bengaluru, Chennai, Amritsar

Commodity categories

Consumption	Propagation	Others
• Wood and wood products • Fruits and vegetables • Cut flowers • Cereals and Pulses • Processed/canned, etc.	• Seeds • seed sprouts • live plants/TC • cuttings (rooted or un-rooted) • bulbs • tubers • rhizomes • Bud wood • scions • setts • Suckers, etc.	• Germplasm, Transgenic or Genetically Modified Organisms • live insects and other arthropods/nematodes/ microbial cultures including algae/biocontrol agents • soil, sand and similar material and stone, etc.

Pest of Concern in seeds

Pests	Number
Viruses	74
Viroids	03
Bacteria	60
Fungi	124
Protozoa	2
Weeds	57
Insects	84



Pest Intercepted in the past five years

	2018-19	2019-20	2020-21	2021-22	2022-23
QP	05	12	09	20	46
NQP	210	150	516	490	15
Total	215	162	525	510	61

Revision of PQ Order, 2003

- Total amendments : 98 times
- Latest amendment: 28th July 2022

Year	# times
2004	03
2005	03
2006	04
2007	02
2008	02
2009	04
2010	06

Year	# times
2011	02
2012	02
2013	04
2014	06
2015	02
2016	07

Year	# times
2017	10
2018	11
2019	11
2020	07
2021	06
2022	06
Total	**98**

PP & PPP Model

PP & PPP	No.
PSC issuing authorities (DPPQS) ICAR/State/UT	68 130 198
DIAs of ICAR & SAUs	43+3
NBPGR	1+1
MBR Fumigation (NSPM-12)	766
ALP Fumigation (NSPM-22)	687
FHAT (NSPM-09)	646
Irradiation (NSPM-21)	4
Heat Treatment (NSPM-18)	2
EXIM committee	

Human Resource Development

- In house Hands on Training Programs
- Training at National Institutes *viz*., NIPHM, Hyderabad & NBPGR, New Delhi
- National Academy of Customs, Indirect taxes & Narcotics (NACIN): Newly recruited CUSTOMS officers

Interactions

- Stake Holders Meetings
- Permanent Trade Facilitation Committee Meetings (PTFC)
- Customs Clearance Facilitation Committee Meetings (CCFC)
- National Time Release Study (NTRS)

Post Entry Quarantine

Open field	Closed
• Germplasm • Seed crops • Bulbs/tubers of flowers • Oil palm nurseries • **Section 3A (1) of SOP for PEQ Inspection**	• Glass houses/screen houses/poly houses • High risk ornamental plants • Fruit plant species including tissue culture plants

Closed PEQ facility for Ornamentals

Closed PEQ facility for Oil Palm Plants

Industry's concern

- Import requirements for same pest differ from country to country, and for each country of origin (production)
- Seed for planting under restricted conditions
- Frequent re-exports due to processing and packing facilities in limited countries
- same seed lot, multiple destinations, over many years
- Removal of pest which is not in seed pathway
- Harmonization of testing protocol

Issues with re-exports

- Countries of export won't add Additional Declarations on phytos for countries other than first country of import (processing).
- Importing countries insist that all their phytosanitary requirements be met in the country of production and be on original phyto certificate.
- Because of different testing protocols, seed companies can be testing the same lot several times for the same pathogen (cost and increased chance of false positives).
- Current e-phyto model does not capture re-export situations – difficult for seed companies to engage.

Way forward

- Requirements imposed by any countries are based on PRA mutually agreed by two countries NPPO, it can be resolved only through bilateral technical discussion.
- PRA is conducted based on risk involved in origin country so that fulfillment of PS requirement at country of origin is scientifically justified. However, based on risk associated, mitigation measures applied certain measures and declarations can be allowed at country of re-export such as fungicidal treatment, some pathogen testing based on factual evaluation of the process. Commodity and country base decision to be taken.
- With respect to issue of increased cost and false positive due to different testing protocol, effort should be made for harmonizing protocol through the IPPC/ Regional NPPO platform

Way forward

India's positive insurance

- phytosanitary regulations which are necessary and based on scientific evaluation (PRA) & have minimum impact on trade.
- possibility of evaluation of seed processing & packing facilities in third country. Testing protocol, facilities, accountability of re-exporting country's Government and all other aspects that ensure appropriate level of protection.
- periodical review of seeds PRA based on scientific developments and risk mitigation

New Initiatives

- PQMS Mobile App
- ePhyto
- NSPM-23
- Molecular Diagnostics
- Capacity Building
- Addition of PSC issuing authorities and DIAs

Relaxation of condition of Chapter III, Clause 10(2) of PQ Order 2003 & Implementation of ISPM 38.

No. 8-35/2021-PP II (e-94561)
Government of India
Ministry of Agriculture and Farmers Welfare
Department of Agriculture and Farmers Welfare

Krishi Bhawan, New Delhi
Dated: the 17th December, 2021

To

The Plant Protection Advisor,
Directorate of Plant Protection, Quarantine & Storage,
NH-IV, Faridabad, Haryana.

(Kind Attention: Dr P.E. Naik, Joint Director (PQ))

Subject: Request for relaxation of conditions of PQ Order, 2003 relating to requirements of re-export PSC for cases of seed re-export for two years – reg.

Sir,

Please refer to DPPQ&S letter No.99-113/2019/PQO (Pt.I) dated 08.12.2021 on the above mentioned subject.

2. In this regard, the competent authority in DA&FW has approved the proposal to grant relaxation of conditions mentioned in Chapter- III, Clause 10 (2) of PQ Order, 2003 relating to requirements of re-export PSC for cases of seed imports (re-export) for two years.

3. However, the competent authority in DA&FW has also directed DPPQ&S to further study the case of seed imports (re-exports) in light of various existing ISPM's (ISPM 38, ISPM 12 etc.) and also on how other countries deal with the same and then if necessary propose for amendments to PQ Order, 2003 so that the issue is resolved suitably and as per the international standards/guidelines set out by IPPC.

Yours faithfully,
(Kamini Tandekar)
Deputy Director
Telephone No. 011-23386618
Email: kamini.tandekar@nic.in

Thank you

Indo-German Cooperation on Seed Sector Development

Official Release

Exposure Visit to Germany and The Netherlands of the Members from Indian Seed Industry
(December 04-11, 2022)

Indo-German Cooperation on Seed Sector Development

Outcomes of the Exposure Visit of Members from Indian Seed Industry to Germany and The Netherlands
(December 04-11, 2022)

Prepared by the consortium of

in collaboration with

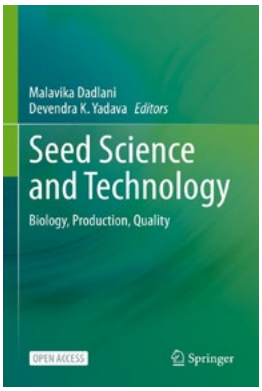
Presented By
Dr. Raghavendra Kavali,
National Project Coordinator,
Indo-German Seed Project

Objective of the Project

The overall goal of the project is to make a contribution to **promoting Indian farmers' access to high quality seeds**, to **strengthening the competitiveness** of the Indian seed sector and to improving the conditions for International Cooperation.

In the fields of

- "political & regulative framework of the seed sector",
- "harmonization of DUS testing and VCU testing of new plant varieties" as well as on
- "production, storage, processing, certification and marketing of high quality of seed"
- Exposure visits to Europe for academia, institutes, Govt and private seed industry members



Background and Aim of the Exposure Visit

Under the aegis of the Indo-German Project on Seed Sector Development (IGPSSD) a study tour was organized by the German partners during **4-11 Dec 2022** on seed production and processing technologies for a team of **8 Indian seed professionals** representing the academia and the seed industry (NSAI, FSII members).

The aim was to provide information on latest technologies and trends to the advancements in seed technology happening in Europe.

Characteristics of European Seed Sector

- Commercial Seed Market Value about 10 bn EUR
- More than 1000 breeding companies are active in Europe (more than 90% of which are small and medium-sized enterprises)
- These breeding companies develop and register a substantial number of new varieties every year (approx. 3500 to 4000 in agric. and vegetable species alone)
- High percentage of turnover of breeding companies in R&D

List of Companies Visited in Germany & Netherlands

The one-week exposure visit comprised the visits to several big, medium, and specialized seed technology, innovation, and service providing partners.

1. PETKUS Technology Center in Wutha-Farnroda (Germany)
2. NORDSAAT Saatzucht GmbH in Langenstein (Germany)
3. KWS SAAT SE & Co. KGaA in Einbeck (Germany)
4. Meiners Saaten GmbH in Dünsen (Germany)
5. Bayer AG Crop Science Division in Monheim (Germany)
6. BASF Seed Company Nunhems BV (the Netherlands)
7. De Bolster Organic Seeds in Oude Oenerweg (the Netherlands)
8. Incotec Headquarters in Enkhuizen (the Netherlands)
9. Seed Valley in the Northwest of the Netherlands

1. PETKUS Technology Center in Wutha-Farnroda (Germany)

PETKUS is a group of Technology, Innovation, Engineering and Service (TIES) companies. PETKUS is a medium-sized company with over 360 employees from more than 20 nations.

PETKUS has established

3 Business Divisions,

5 Manufacturing Companies,

6 Regional Headquarters,

20 Sales & Service Centres,

1 R&D Competence Centre and

1 PETKUS Academy.

Key Takeaways:

The range of Petkus technologies were presented by **Burghard Petersen**. Their concern for highest performnace of every seed by applying precision in Processing was explained in every machine – small and big.
Some best examples are:

- **Optical sorters**, developed during 2016 to 2023. Seed sorters **OS F3** (for fine seeds) and **OS P** (sorter with AI) can do sorting of seeds having 25,000 – 30,000 seeds per sec.
- **Seed Cleaners** from 2.5t to 30t/h which can use upto 36 screens and uses recycled air flow can enhance the precision at lower energy cost.
- Mobile and Movable seed processing plants (1-4t/h), where coating facility can also be added.
- **Steam Hygination** (may also be combined with herbal treatment) for integrated seed treatment.

2. NORDSAAT Saatzucht GmbH in Langenstein (Germany)

NORDSAAT with headquarter office in Langenstein is one of the **leading cereal breeding companies** in Europe. The core focus of NORDSAAT's business is on **the development of cereal varieties** like winter wheat, winter barley, winter triticale, spring barley and oats. Three breeding stations are located on approximately 150 ha of plant breeding garden are used for the further development of high-yield varieties of winter wheat, hybrid wheat, triticale, winter and spring barley and oats.

NORDSAAT is the only breeding company in Europe that has been working on the **hybrid breeding of winter wheat** since the beginning of the 1980s. Today, ASUR Plant Breeding SAS (France) and Nordsaat Saatzucht GmbH are working together to breed new hybrid varieties.



Seed production includes all cultivation types that are bred by NORDSAAT. The core focus of seed production is on the production of preliminary stage and base seed. In the course of one year, breeding is done on approximately 3.000 ha in our own agricultural holdings.


3. KWS SAAT SE & Co. KGaA in Einbeck (Germany)

KWS is one of the world's leading **growers and seed producers**. More than 5,000 employees working in 70 countries with core markets in Germany, Europe, North & South America and China, generated sales about 1.54 billion euros in 2021-22 fiscal year.

KWS SAAT SE & Co. KGaA is the parent company of the KWS Group. It is a strategic leader and manages the propagation and distribution of **sugarbeet** and corn seed, along with cereals, oil seeds & protein plants, vegetable seeds, special crops and organic seed etc. The R&D led company invests **18-19%** of their net sales and 25% of KWS varieties are **bred for low input** conditions.



4. Meiners Saaten GmbH in Dünsen (Germany)

Seed Service Company Meiners Saaten GmbH offers **services** related to seed growing management & contracting, seed cleaning, seed treatment, field trials, advice, quality assurance, seed marketing etc.

Crops: pulses, forage grasses, fodder, rapeseed, and grass mix etc.

Focus areas are:
- Propagation and processing of seeds
- Production of agricultural mixtures and their trade to agricultural resellers
- Advising farmers in cooperation with our customers
- Services in the field of seed processing and logistics for leading seed breeding companies.

They have state-of-the-art technical facilities for cleaning, processing, seed treatment and treatment, mixing, packaging and storage of seeds. Since 2005, the company has been ISO 9001 certified. **Their forage mix seed packets along with minerals is their USP in forage grasses.**

From the very beginning, Meiners Saaten has relied on high quality and testing standards, also in seed dressing. The company is a SeedGuard certified pickling plant for rapeseed and maize crops and is listed with the renowned Julius Kühn Institute (JKI). Compliance with the requirements is also checked annually by DEKRA.



In their Heubach laboratory, they examine treated seed lots for dust content to ensure the highest quality and safety for their customers. The laboratory is one of the few certified laboratories in Germany that meets the strict test criteria of the checklist of the EU guideline for monitoring the release of particulate matter from treated seed. Regular certification and monitoring is carried out by SGS Group, the global leader in inspection, testing, verification and certification.

5. Bayer AG Crop Science Division in Monheim (Germany)

Bayer's Crop Science Division is the **third largest innovative agricultural input company** in the world and has businesses in high value seeds, crop protection and non- agricultural pest control. Headquartered in Monheim, Germany, Bayer Crop Science division has a **global footprint** that spans nearly every country.

Across more than 35 research sites and over 175 breeding sites, they had invested more in research and development than any other company in the industry.

Key Takeaways :

- At their SGR centre a presentation made focused on their seed treatment and training programmes. The **seed treatment products using synthetics and biological** were presented and the importance of stewardship in achieving best results was emphasized keeping a clean environment by using **Dust-free protocols and BayGAP** (in place of Global GAP).
- They also talked about many pilot programmes in India, eg., Regenerative agriculture; Indian grape initiative with Greenyard (a cooperative), and Solidariad (an NGO).
- Bayer's initiatives in supporting Biodiversity through Global Biodiversity Framework (GBF) were presented by Dr. Laura Korte.

6. BASF Seed Company Nunhems BV (the Netherlands)

BASF is a leading company in **developing vegetable seeds** for the professional vegetable production industry. Their aim to develop for market oriented vegetable varieties and hybrids with desirable vegetable traits, ranging from high yield, great taste and good looks, to long shelf-life, disease resistance and drought-tolerance.

With over 1,200 seed varieties in ~25 vegetable crops, BASF Nunhems BV is a **world-renowned brand in the hybrid seed industry**. As a leader, BASF has also established a high performing supply chain for seed production, processing, packaging and quality assurance to ensure our seeds reach vegetable growers with the highest standards in terms of purity and vitality.

Key Takeaways :

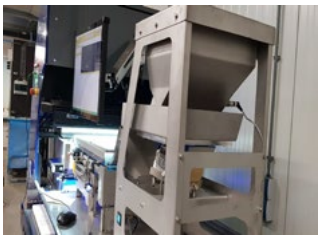
- **The breeding programmes** in partnership with universities, research institutes and start-ups is a successful model.
- Some specially bred branded vegetable varieties are Sunions onion, Finstar lettuce etc.
- Besides the routine treatments it included dry heat treatments, bleach, osmo priming, organic seed treatment and highly specialized pelleting technology that include BASF polymers, pesticides as well as biological separately or in combination.
- The facilities of Seed testing / Vigour testing were sophisticated and scientific.
- Their CSR programmes with Syngenta on minimum wages and child labour act compliance strictly implementing.

7. De Bolster Organic Seeds in Oude Oenerweg (The Netherlands)

(Equipped with PETKUS Selecta line)

De Bolster anticipates a world where organic, nutritious crops, grown sustainably, are available to everyone. That is why De Bolster is committed to **supporting organic farming** by providing growers with high quality organic seed of the best varieties. **Second Largest producers of Biological seeds.**

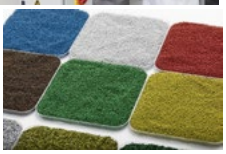
De Bolster supports seed companies worldwide with organic seeds. De Bolster produces more than 370 varieties of vegetables, herbs and flowers, **all certified organic and 100 % GMO-free**. De Bolster opposes the use of genetic modification. In their company, they only use traditional breeding techniques.



8. Incotec Headquarters in Enkhuizen (The Netherlands)

Incotec is a global company. Incotec is the **seed enhancement specialist**. They specialise in improving the quality of seed through seed technology. They have innovation centres, sales offices and manufacturing sites all around the world making seed enhancement accessible to customers in every region. Incotec is one of **Croda**'s three agricultural businesses. Each of these businesses is known for its use of smart science to maximise land productivity.

The seed enhancement work they do, contributes significantly to the development of sustainable agriculture. Their seed enhancement techniques improve germination, stimulate the healthy development of seeds and seedlings and increase crop yield. With research and production facilities worldwide, their solutions support the huge efforts of seed companies, breeders, growers and farmers around the globe.



Key Takeaways :

- They are focusing on developing **microplastic-free coating technology** for vegetables, aiming to be totally microplastic-free by 2025.
- The advantage of using encrusting technology in sunflower was presented.
- Pelleting could be useful in **increasing seed size specially in very small seeds (~500%)**.
- Their treatment and coating programmes are focused on **Abiotic stress mitigation, Regenerative agriculture and Intrinsic sustainability**.
- Seed coating and pelleting treatments for organic seeds was interesting.

9. Seed Valley in the Northwest of the Netherlands

Seed Valley in the northwest of the Netherlands is **the international center of plant breeding and seed technology**. It is home to dozens of innovative companies that develop high-quality vegetable and flower varieties for the horticulture sector.

Seed Valley plays a significant role in the development of plant varieties and seed technology similar to the role of Silicon Valley in IT and software. Seed Valley is where 'green software' is developed, the genetic programming that determines how vegetables taste, the color and size of a flower, and a plant's level of resistance to diseases.

Summary

To summarize, the visits of 3-4 plant breeding/seed companies in Germany/ The Netherlands, the German Plant Breeders' Association (BDP e.V.), the PETKUS Seed Technology Centre in Germany, a seed growing partner and other actors of the seed sector had enlightened the entire Indian delegation with the new technologies available and effective management and handling strategies. The topics of exchange were majorly focussed on seed processing technologies for high quality seed production, management of seed production, certification, processing, marketing aspects which is the need of the hour for Indian seed industry. **This exposure visit was not only helped in facilitation of future co-operations/colloborations between Indian and European Seed companies but also enhance the abilities of the NSAI & FSII participants to effectively manage their businesses.**

List of Participants

S.No.	Name of the Seed Company	Name of the Participant	Designation
1	Pokar Agrotech Pvt Ltd www.pokarseeds.com	Pankajkumar Arvindbhai Patel	CEO
2	Indo American Hybrid Seeds (India) Pvt. Ltd. www.indamseeds.com	Sridhar Hegde	General Manager (Supply chain-VC)
3	Ananya Seeds Pvt. Ltd. www.ananyaseeds.com	Lakshmikanth Pandey	Managing Director
4	Ganga Kaveri Seeds Pvt. Ltd www.gangakaveri.in	Gantla Venkata Ramana Rao	Chief Technology Office
5	Kohinoor Seed Fields India Pvt Ltd. www.kohinoorseeds.com	Sudhir Kansal	Director
6	Federaton of Seed Industry of India., www.fsii.in	Malavika Dadlani	Consultant
7	Federaton of Seed Industry of India., www.fsii.in	Narendra Kumar Dadlani	Consultant
8	Indo German Seed Sector Development, www.indogermanseedproject.com	Raghavendra Kavali	National Project Coordinator

Plant Variety IPR Protection in India: *Implementation & Road Ahead*

Raj Ganesh, Arun Kumar, D S Pilania, A K Singh, D R Chowdhury, T K Nagarathna, D K Agarwal and K V Prabhu

Presented at

National Seed Congress 2023

"Seeds for Global Unity"

J W Marriott Hotel, Aero City, New Delhi
March 4, 2023

IPR on Plant Variety - the MOST PIVOTAL ENTITY of Global Trade (*Not only Agriculture!!*),

As vital as the **Ball** in a **Football** Game

- The WTO Agreement on **Trade-Related Aspects of Intellectual Property Rights (TRIPS)** is the most comprehensive multilateral agreement on intellectual property (IP)
- **TRIPS made it compulsory that Plant Breeders be granted PBR on plant varieties and no country can retain WTO membership without PBR!!!**
- Since plant variety is the "***Ball in the game***" in the field of agriculture and farmers the players, creation of varieties becomes the most critical play valid agriculture, and hence the ball maker, the Plant Breeder is the pivot. PBR becomes as important as the IPR on OS or IoT.

Legislation on PBR *via* TRIPS compliance is the ONLY Gateway to WTO for any country

- All signatories to **Marrakesh Agreement on Agriculture** that established WTO to be compliant to TRIPS within 5-30 years of their becoming members of WTO
- Art 27 of TRIPS Directly connects Plant Variety Rights with WTO where the county is given an option either to have a legislation that allows
  (a) direct patenting of plant varieties or
  (b) have Plant Breeders' Rights without patenting through joining UPOV or *sui generis* legislation to facilitate the rights on plant varieties
- As a Member nation to enable itself to be in global market and compete globally, India had to establish within 10 years a PVP Authority, through an Act
- India took ONE ADVANCED STEP by adding PPV with FR in its Act PPVFR Act in 2001 and setting up PPVFR Authority in 2005

A Global Challenge

PBR and Compliance to ITPGRFA (2004) : The **Forerunner** for PPVFRA (2001)

- Initial voluntary agreement, the **International Undertaking on Plant Genetic Resources for Food and Agriculture** (IUPGRFA)1983 on the principle that PGR are common heritage of humanity.
- CBD a necessary binding for sustainable agriculture and environment, the IUPGRFA was renegotiated in harmony with the CBD for making it a TREATY in 1994
- ITPGRFA was opened for signature among member countries till November 4, 2002 by which time only 77 members + 1 (28 by EU) signed.
- The treaty, a binding agreement after ratification, acceptance, approval or accession entered into force on 29 June 2004.

FAO's ITPGRFA 2001

Preamble

*".....the rights recognized in this Treaty **to save, use, exchange and sell farm-saved seed and other propagating material**, and **to participate in decision-making** regarding, and **in the fair and equitable sharing of the benefits** arising from, the use of plant genetic resources for food and agriculture, **are fundamental to the realization of Farmers' Rights**, as well as the promotion of Farmers' Rights at national and international levels".*

A Major Headway Achieved on Implementation of Farmer Rights

by Members in Compliance to ITPGRFA at the GB9 held in Delhi September 2022

- **India led** the development of a set of options for encouraging, guiding, and promoting the realization of farmers' rights.
- GB9 adopted the full resolution including the opinion of co-chairs that suggests looking into national laws to consider farmers' rights, as co-chairs view
- Practically a sound achievement with the state of implementation report to be commissioned by GB 11

Farmer's variety

Traditionally cultivated variety (maintained as a heritage for generations by an individual or community), landrace and/or evolved through selection by the farmers "in their fields"

A wild relative or land race or a variety about which the farmers possess the common knowledge

- Any other variety bred from a non-traditional variety does not qualify under "Farmer's Variety"
- *Neither novelty of 12 months (new variety) nor <15/18 yrs in trade/use (VCK) conditions is applicable in the case of Farmer's variety* as it takes decades of continued seed to seed propagation cycles to become **Traditional** and through generations in communities, to a **landrace** even as new and agronomically superior varieties keep replacing and pushing the traditional/landrace out

Farmers' Rights under Indian Legislation

A farmer is entitled

- to save,
- to use
- to sow
- to re-sow
- to exchange
- to share
- to sell

his farm produce including seed of a variety protected, but without branding

- to seek compensation in the event of variety not productive as claimed by the right holder
- to seek relief under "**innocence against infringement charge**" if he has evidence to the effect that he is ignorant of existence of any PBR on the specific variety

Farmers right as Plant Breeder

- A farmer who has bred or developed a new variety shall be entitled for registration in the like manner as a breeder of a variety
- If it is a selection in traditional variety it will be Farmers' Variety
- If it is by plant breeding process involving selection, hybridization and handling of breeding materials, it will be New Variety

The Extent of Farmers' Rights

A farmer will be violating Farmer's Rights or infringing the Breeder's Rights on a variety if

- He sells seed in branded form (packs, labels)
- He adopts any practice that can be described as processing or beyond what is described as "farm produce"
- Produced on contract on behalf of any agency
- Multiplies seedlings, propagules under protected cultivation systems, nurseries, *etc.,* for selling
- He claims rights of 39(2) on "illegitimately obtained unbranded/unauthenticated seed"
- He sells the seed with variety denomination using 39 (1)(iv) from his farm produce if the seed is not true to type
- There can be no claims on compensation by any farmers under 39(2) who procure seed from a farmer who used his 39(1) iv to sell

Power to Revoke or Cancel a Registration on a scientific reasoning

- Revocation of registration on evidence provided by anybody for
  - incorrect information in the application for registration (commercial hybrid produced with 2 line system without involving male sterility)
  - Failure to comply with the directions issued by the Authority (genetic purity not less than 95%)
  - Registration not in public interest (a variety registered becomes susceptible to an evolved pathogen endangering the crop by spreading to endemic scale with epidemic potential in future)
  - not meeting any conditions imposed while registering such as sale of a particular wheat variety in an area restricted to grow the variety due to its yellow rust susceptibility

Scientific evidence based support in deciding applications

- Use of DNA based evidence for donor of EDV (Bolgard I *vs* II)
- DNA homology/polymorphism employed to detect denomination infringements
- Non-segregation of the progeny of an alleged "hybrid" as an evidence for decision that allegation is dismissal worthy as hybrid status itself is incorrect

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Genetic/breeding principles adopted in DUS Testing

- DUS testing at two centres as per DUS guidelines and use of National checks and regional checks for correction in case of local errors or G X E
- Hybrids can be only ensured through parents, it is mandatory to protect parents as a package irrespective of new or EDV involving parent line DUS and hybrid parentage verification
- In the case of hybrids, PARENTAL LINES (2 or 3 lines), shall be DUS characterized ***by the AUTHORITY, ONLY AT ITS BRANCH OFFICE*** under strict security under CCTV watch powered physical security (24X7 vigil)
- If in the first season, an essential trait expresses distinctive variation with reference variety within/between locations, then Registrar arranges for visit of the applicant to the sites for consensus recording of the trait/traits during the current or next season (as per the situation)

Seed Production of parents and hybrid by PPVFRA

- Seed for use in the 2nd year shall be produced by PPVFRA at its branch locations under high security by observing all isolation standards and reproductive systems requirements of the species
- In the case of hybrids, both parents & hybrid seed shall be produced
- Additional information on synchronization/staggering, etc shall be sought from the applicant in the case of hybrids during the **Step 3** above
- Decision on purity/uniformity shall be kept consistent with the DUS centres on the variety/hybrid concerned (seed production of variety to be carried out in one of the centres in first year)

Non-compliance to genetic stability and population homogeneity maintenance of certain species : NO PROTECTION POSSIBLE till exemptions are made or Apomixis enabled

- No registration of Composites or Synthetics as there is no possibility of Uniformity standards to be met and regeneration of the identical population that defies population homogeneity as both composites and synthetics are neither homogeneous plant grouping nor represent "one genotype". There are no robust breeding tools available to enable that every cycle of sexual reproduction of the composite will remain unchanged genotypically!!
- No registration of 3-way hybrids as no breeding principles can generate two identical populations to pass DUS testing for Uniformity and Genetic stability
- Where selfing/sib-mating are not possible, vegetative propagation protocols do not exist, and there is 100% cross pollination, no amount of plant breeding techniques can ensure DUS (e.g., Sandalwood)

Acceptable level of variants/Off type in the candidate variety

- Determination of acceptable no. of *off types/variants* by visual assessment & measuring of "population standard" and "acceptance probability"
  - ✓Tomato : 2/75 plants.
  - ✓Rice : 4/1500
  - ✓Millets : 2/100
  - ✓…….
- If more than the above observed, the company representative to be called to the site immediately by the Registrar for self-assessment and consensus on uniformity of the material (independent of monitoring team's visit)

Monitoring of DUS Trial

- No applicant will be allowed in DUS experimental plots for maintenance of confidentiality. When an applicant is required to be shown a plot of the concerned candidate variety, only that plot shall be shown, others will be coded
- DUS monitoring team will consist of Director of Research and Vice Chancellor of concerned SAU/Director /Programme coordinator of ICAR Institutions or their nominee not lower than Professor cadre, a crop expert if necessary

SAUs/ICAR to Establish Authenticity of Farmers' Variety

Applications of farmers' varieties shall be forwarded by the concerned Panchayat Officers to SAU/ICAR institute before submitting the application for registration

↓

Crop specific breeder of SAU's/ICAR Institutions shall certify the seed material for its authenticity, purity and uniformity by conducting one year testing

↓

Further, the application shall be counter signed and forwarded to Authority by Director of Research of SAU/Director or Principal Coordinators of ICAR Institutions before the onset of next season as described in protocol for receiving applications.

Genomics to Complement Classical Plant Breeding

- Modern plant breeding has been made precise and specific to target through genomics tools for selection and varietal development (MARS)
- New products can be developed using an Marker Assisted Selection (MAS) or Genomic Selection or edited genome containing introgression or involving such different parents either as recombination or hybrid products

Special Tests with DNA/genomics tools

- Detection the genetic introgression, GE event or Editing through gene (genome)-specific markers or Targeted Genotyping by Sequencing (tGBS) as special Tests within the provisions of the PPVFRA
- Supplemented with DUS test under specific condition enabling expression of the Gene/Introgressed/Edited region

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Legal Directions Issued in Implementation

Public Notice	Subject	Context
1 of 2019	A) Compound Registration B) Hybridization C) Linking of Hybrid protection period to earliest parent	Hybrids and its parents together constitute a unity for suitability of being propagated within the meaning of variety. Hybrid has no existence without parents.
12 of 2019	Required seeds of parents and Hybrids must be submitted along with application	Comply with the Act, seeds of parents and hybrids must be submitted along with the application
14 of 2019	Distinction between breeder and farmer- a person creating genetic variability using non-traditional crop variety would be a breeder	A person breeding non-traditional crop varieties cannot be a breeder of farmer's variety. That former will also be like any other plant breeder
20 of 2019	Criteria of DUS for ENV	DUS criteria of Extant Notified Varieties to be collected at least from one location where VCU data is collected

Legal Directions Issued in Implementation

Public Notice	Subject	Context
4 of 2020	Submission of root stock as per DUS Test guidelines	In view of epigenetic expression and genotype X genotype interaction between rootstock and scion in the expression of scion in the grafted plant, submission of root stock is a mandatory requirement in case of grafted trees and vines varieties with all details as given for the scion in the same application
11 of 2020	Mandatory certificate of farmers variety for registration by SAUs/ CAUs/ICAR or CSIR	To ensure genetic purity in case of farmers variety after verified one season's data by the concerned public institution
12 of 2020	Facilitation of certification of farmers variety for registration by SAUs/ CAUs/ICAR or CSIR in case were DUS test guidelines or yet to be framed	Farmers variety or community varieties will be registered irrespective of the notification of the species or availability of DUS test guidelines for the species

Public Notice	Subject	Context
14 of 2020	Submission of hybrid and parent along with application form	This is because a hybrid can be produced ONLY by crossing the specific parental pair, there is no viable option in seed propagated hybrids to establish the genetic stability, uniformity without the parents being established as unform and stable and homozygous, as well as the fact that the claimed parents indeed produce the hybrid seed applied for protection.
2 of 2021	Farmers right in case of failure of expected performance of registered variety as per the source of the seeds	Compensation by farmers in case of registered varieties will be based only if the planted seed is sourced from legitimate agency as primary seed, and not from saved farm produce of the same or other farmers as genetic deterioration would invariably be integral with the latter sourced seed
8 of 2021	Minimum seeds quality standard and pest and diseases certification from National agency	Follow same minimum seed quality standards and pest & disease resistance levels as certified by the national agency, where it is a mandatory requirement prior to notification under Seed Act. All such agencies issued directions to entertain disease testing requests, cost of which to be met by the applicant

Public Notice	Subject	Context
8 of 2021	Minimum seeds quality standard and pest and diseases certification from National agency	Follow same minimum seed quality standards and pest & disease resistance levels as certified by the national agency, where it is a mandatory requirement prior to notification under Seed Act. All such agencies issued directions to entertain disease testing requests, cost of which to be met by the applicant
5 of 2022	Submission of plant quarantine clearance in case of exotic varieties	In case of varieties from abroad PQ clearance is mandatory, along with regeneration protocols, availability of plant population as prescribed in the guidelines
6 of 2022 (Pre-approval Draft)	EDV with targeted trait associated inseparably (linkage or pleiotropy) with one or more traits	EDV through BC, MABB, Mutation, Transgenic, Genome Editing leading to linkage or pleiotropic multi-trait distinctiveness shall be registered as an EDV without being limited to a single distinctive trait from the initial variety.

Commercializing Through Agent or Licensee

- An Agent or Licensee has to be registered with the Authority for each variety (every title deed)
- The Agent and Licensee shall be liable to be responsible for all compensatory charges in the event of failure of the variety
- The Agent and Licensee therefore, will have to mention the denomination of the variety as registered and trade name of the variety will have to be separately maintained
- Each Agent or Licensee needs to register with the PPVFRA (apply in PV-9) with a fees of Rs.15,000/-
- The Agent or Licensee shall be responsible only for the particular right as authorized by the Registered Breeder in the Form 1A of PPV&FR Regulations, 2006 or other such documentation

Commercializing Through Authorised Person

- The Registered Breeder has to inform the Authority about each Authorized person whose details shall have to be provided in Form 1A
- In the case of exercise of any rights through an Authorized Person, the Registered Breeder shall be liable to pay compensatory charges in the event of failure of the variety sold/marketed by Authorized Person in the farmers field
- The Authorised Person has to mention the denomination of the variety as registered while executing any right as per Form 1A
- The details of the Registered Breeder of the variety has to be mentioned on the packet in case the authorization is for selling/marketing/distribution, etc., of the variety

Thanks to audience and organizers

COMMERCIALISATION OF TECHNOLOGIES FOR SEED DEVELOPMENT

Agrinnovate India Approach

Dr. Praveen Malik
ceo@agrinnovate.co.in

Agrinnovate India Limited (AgIn): A Government of India Enterprise

Incorporated under the Companies Act, 1956 (No.1 of 1956) on 19th October, 2011.

Agrinnovate India

Commercial Arm of National Agricultural Research System

ICAR

Apex body for coordinating, guiding and managing research and education in agriculture in the entire country.

NARS

To be a centre of excellence in teaching, research and extension education in the field of agriculture and allied sectors in North East India

AgIn is a Company owned by Government of India, under the administrative control of DARE, MoA & FW, GOI

AgIn is governed by:

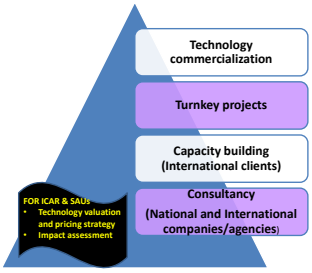
- Secretary (DARE) & DG (ICAR) - Chairman
- Addl Secretary (DARE) & Secy (ICAR) - Vice Chairman
- Addl Secretary & Financial Advisor (DARE/ICAR) - Director

Other Directors
- CEO, National Rainfed Area Authority (NRAA)
- Asst Director General (IP & TM)
- Joint Secretary (Fisheries)
- Two nominated non-governmental Directors

Agrinnovate services and strategies:

Services offered

- One stop shop for market ready agri-technologies
- Facilitate strategic collaborations and turnkey projects (domestic and foreign)
- Capacity building on IP & technology management
- Impact assessment
- Technology valuation & pricing



Priority Area

- Seed & Planting material (Field crops, horticulture)
- Bio based agri-inputs (bio pesticides, bio-fertilizers, Nano inputs with regulatory compliance)
- Animal husbandry, dairy and fisheries (diagnostics, vaccines, feed and dairy products)
- Post-harvest value added products (horticulture, meat, dairy & fisheries)
- Small & marginal farmer-friendly agricultural tools, implements and machinery
- Biotechnological products (protocols, GMO detection, molecular markers etc

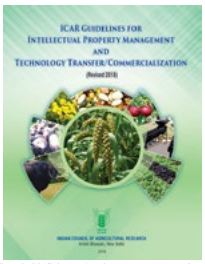
Range of products/technologies to bank on

- Improved crop varieties/Hybrids/elite germplasm lines types useful for the industry
  - Gluten free types or gluten enrichment of grains, Low fat, protein rich...
  - Fortified, nutritionally rich grains, millets
  - Dual purpose varieties of fruits/vegetables
- Bioformulation
- Nutritious animal/dairy/fish based products/Aqua technologies
- Machinery/tools/equipments suitable for industry
- Value added products, health and hygiene products
- Specialty products

Technology Commercialization

Technology Commercialization

A process of Technology transfer from an inventor(Licensor) to an interested client (Licensee) for purely **commercial scale production** under Mutually Agreed Terms and conditions for a **specified period** in a **given geographic territory** on a **exclusive/non-exclusive basis** (as per ICAR guidelines)



Institutionalized by ICAR in 2018

All technologies generated by ICAR to be commercialized through Agrinnovate

- Rules and procedures to be adopted include 'Techno-feasibility assessment'
- Finalizing the Terms of Reference
- Publicity
  - Posting on the website
  - Advertisement
  - Contacting clients directly
- Due diligence and finalizing ToT
- Preparing MoU
- Getting legal vetting
- Finalizing the MoU and the commercial licensing with tripartite agreement

Agrinnovate's Technology Transfer process

Submission of Technology and Disclosure Form and Costing Sheet

- Basis for arriving at Licensing terms
- Drafting ToT

Techno-Commercial Assessment Committee Meeting Standard Terms finalized

Uploading of Standard Terms

Advertisement and Business Development activities/Presentations, correspondence etc

Expression of Interest

Due Diligence of the Client

- Discussion, seek information, personal meeting, document verifications etc.

Agrinnovate's Technology Transfer process

Document drafting and Approvals:

- Terms of Trade drafting & Approval
- Agreement Drafting, Approval, Legal Vetting and its signing/execution

Post licensing Monitoring

- Meeting out Training and consultancy requirements in regard to tech transfer.
- Royalty payment collection

Revenue sharing 70:20:10 (Institute/SAU: AgIn: ICAR)

A License Agreement

Define parties, Effective date & What is agreed upon

- inclusion of technology details; logo etc, Licensees own brand name
- Improvements agreed/not included
- License fee (upfront value+ applicable taxes) Royalty clause
- Permissible exemptions
- Termination, Indemnity, Arbitration etc.
- Conflict resolution clause

Modalities of access to products

Licensing of technologies: Exclusive/Non-exclusive through an MoU

- Up front license fee
- Benefit of reduced license fee for MSMEs

Sourcing of required quantity of products from

- Institute's or licensees
- Incubatees producing through Institutes support
- Through 'start ups' working with the Incubation facilities

Research Institutes also assist through contract research or consultancy/collaborative programmes

Public-private partnership/collaboration

Challenges in seed development technologies

- The Vegetable seed production system is susceptible to the uncertainty of weather resulting in poor-quality seeds production.
- Lack of realistic data on the actual area under vegetable and the requirements of vegetable seeds is inappropriate.
- No system of maintenance of isolation distance in a particular crop.
- Unavailability of guidelines for planting any particular vegetable crops in any specific area.
- The quality seeds is the main drivers of crop production system and seed replacement rate is very less
- Gap between problem/demand and supply and Research development due to non-availability of the genetically pure seed
- Lack of robust mechanism or monitoring for new varietal characterisation/denomination.
- Development and commercialization of Open Pollinated Varieties (OPV) hybrids are rarely adopted so far.
- Refinement of Market strategy and planning strategies are not well placed
- Lack of effective mechanism to study intellectual property rights on various seed technologies developed by institutes/university and for exchange of knowledge nationally or globally by developing public-private partnership collaborations

AgIn strength

- **Well-developed and knitted seed multiplication and distribution system available with several ICAR institutes/SAUs.**
- **Well-equipped and established labs/infrastructure or farm facility with public funds are available with every research institute which can be utilised for public good.**
- **A large number of improved crop varieties/hybrids including vegetables with enhanced productivity suited to varied agro-climatic conditions are available for licensing.**
- **Availability of genetic information in gene bank for R&D, elite Germplasm and Breeder seed availability of different crops. Industry can also take the advantages of following services from NARS:**

For Processing of Seeds
- Seed processing units
- Quality testing laboratory
- Subsidized Open Pollinated Varieties (OPV) varieties

For Marketing of seeds
- Certified seed labels
- Subsidized programs
- Staff at different levels
- Distribution of seeds through various agricultural centres

Future prospective: A way forward:

- **In our country there is a frequent demand for high-volume and low-value crops, seeds with identified sources (breeder seed or foundation seed) and its easy accessibility along with testing facility at different agro climatic regions.**
- **To meet out the requirement, a continuous support from research institutes/stations with genetically pure seed having high germination and meeting all the quality standards as per the Seed Act is required along with the testing facility.**
- **Seed certification agencies must be promoted and there must be a provision of subsidy under various schemes offered by state or central governments.**
- **Promotion of seed technology parks is required to improve the seed processing facilities in line with MNCs.**
- **Development of model villages at different agroclimatic zones of the country must be adopted.**
- **Scope for public-private partnerships (PPP) need to be explored to cater the demand for improved varieties/seeds/hybrids.**
- **Requirement of policy intervention in regard to seed development based on market feedback.**
- **Involvement of relevant private sector in the designing the policy proposals leads to better policies.**

Visit our website (www.Agrinnovate.com)

Digital Ecosystem for Seed Traceability

Pratibha Lokhande
Dy. Director General
National Informatics Centre
Ministry of Electronics and Information Technology
Government of India

INTRODUCTION

Seed is the most critical input for agriculture. Farmers can increase the production by using high-quality seeds and earn more income. It is always endeavor of the government to ensure timely availability of quality seeds in sufficient quantity.

Though country produces surplus amount of seeds, there is need to ensure quality and bring transparency in its dealing by providing adequate information about the origin of seed, processing, packaging and its distribution.

However, there are numerous challenges being faced in seed production and distribution chain such as inadequate information, lack of transparency and visibility. Seed production and distribution chain is a complex ecosystem involving various stakeholders. The lack of transparency and visibility leads to possibility of the malicious mixing of quality seeds with spurious ones which results in losses in production to farmers.

To overcome various challenges, there is need of digital traceability solutions in the seed sector. Digital Interventions will help in achieving seamless information flow across the chain. It will ensure real time traceability.

For effective monitoring, efficiency and transparency in seed production and distribution chain, Department of Agriculture & Farmers Welfare (DA&FW), Ministry of Agriculture & Farmers Welfare (MoA&FW) has proposed the Digital Ecosystem for Seed Traceability. It will be a software enabled system where with the help of QR codes, one will be able to trace quality and purity of seeds. NIC has been entrusted with design and development of this **Digital Ecosystem - "Seed Authentication, Traceability & Holistic Inventory" (SATHI)**.

VISION

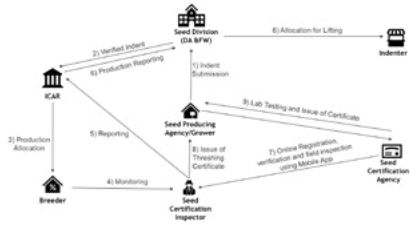
"To build a Digital Ecosystem, to effectively trace and monitor the seed production and distribution chain to ensure the quality and ingenuity of seeds from point of origin till sale"

STAKEHOLDERS

INTEGRATED SIX VERICALS OF THE SEED CHAIN

About the system

"Seed Authentication, Traceability & Holistic Inventory" (SATHI) provides a holistic approach to cover the complete seed life cycle over multiple seed generations. It will be achieved through computerization of the entire seed supply chain, starting from seed production to certification, traceability, licensing, seed inventory, seed sale by certified dealers.



SATHI Ecosystem – System enabled Processes

- Total Number of Crops: 176
- Total Number of Notified Varieties (Less than 20 years): 4989
- Total Number of Indenters: 60
- ICAR Institutes: 80
- State Agricultural Universities/Institutes: 70
- Seed Producing Agency: 3500
- Breeder Production Center: 650

PHASES

Phase – I

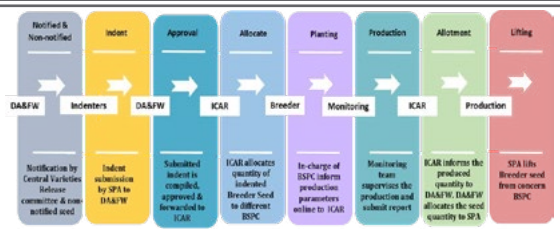
- **Nuclear to breeder seed management –** It will include Breeder seed indent generation, Registration of Breeder Seed Production Centre, Allocation of breeder seed, Issuing Breeder Seed Labels, lifting of allocated breeder seed by indenters.
- **Breeder to Certified Seed Management –** It will cover Online registration of Seed Growers, Seed Producing Agencies (SPAs) and Seed Processing Plants (SPPs), Inspection and Verification of seed source, class and other details and reporting through the mobile app by seed certification inspectors (SCIs), sampling, testing, issuing of certificates and tags with QR codes, seed traceability, billing and accounts, interstate permissions. Seed traceability system will use tags with QR (Quick Response) code having tag number embedded in it. By scanning this QR code user will be able to authenticate seed bag and get trace and track details. Fifteen digit (15) unique Tag number consisting of Certifying Agency code, Year of issuance, Class of seed(F/C/T) and serial number is being proposed. Information to be captured includes origin and class of the seed, crop, variety, lot, date of manufacturing, manufacturer details, location, certificate number, date of issue, Details of issuer, date of test results, date of expiry and movement tracking.

PHASES

Phase – II

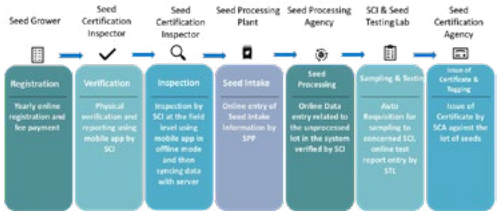
- **Seed Inventory Module** – Stock management, real time stock position and reports, accounting and reconciliation.
- **Seed Dealership** - Issuance, return, rejection and amendments of licenses for seed dealers, suspension, revocation, and cancellation of seed dealer licenses, mobile app for field inspectors, Geo-tagging of sale points, linkages between the state-level dealer and district-level dealer, issuing of source certificate to the district-level dealers.

Process Flows



Nucleus to Breeder Seed

Seed Certification



ENVISAGED BENEFITS

- ✓ End to end visibility of seeds throughout lifecycle
- ✓ Verifiable Seed quality and quantity availability
- ✓ Real time monitoring of demand, allocation and supply of breeder seeds
- ✓ QR based tags for traceability
- ✓ Trust, transparency and accountability in the Seed production and distribution chain
- ✓ Choice for farmers to check and buy quality seeds to increase the production. QR code can be scanned by them using mobile phone to access information
- ✓ Increased credibility of manufacturers
- ✓ Helpful in seed export

Contd/-

ENVISAGED BENEFITS

- ✓ Improved on-field efficiency of Seed Certifying Inspectors by use of mobile app. Reduced transactional time for registration, approval, access to field inspection reports, lab testing reports, and certification for officers
- ✓ Generation of GIS-based MIS reports powered by Bharat Map Interface for monitoring
- ✓ Inventory management to help in building visibility in the system with reduction of wastage and losses.
- ✓ Uniformity and adoption of best practices across the States

PROJECT STATUS

Department of Agriculture and Farmers Welfare has undertaken development of Digital Ecosystem for Seed Traceability and has assigned NIC to computerize the complete workflow in Seed Ecosystem. Accordingly, NIC is developing "Seed Authentication, Traceability & Holistic Inventory" (SATHI)

The detail system study was undertaken by NIC. Interactions with various stakeholders are being held. External linkages are being established. The system is in the last leg of completion. Process for on-boarding of States is in progress and it will be officially launched soon.

Thanks

KEY OBSERVATIONS AND RECOMMENDATIONS

Day 1: 03-03-2023

Technical Session 1

Seeds for Global Unity - Perspectives for growth

Presentation on Promoting Millets- Road Map for Indian Seed Industry

Dr. Arvind Kumar, DDG- Research, ICRISAT, Patancheru, Telangana

Highlights of the presentation

- India is the first country to set up nutritional standards for iron content in the grains of pearl millet. The release of 'Dhanashakti', first biofortified variety of pearl millet in India was from ICRISAT and Indian NARS partnership programme, which significantly helped in putting forward the policy of having nutritional standards under variety release.
- The millets market is set to grow from its current market value of more than USD 9 billion to over USD 12 billion by 2025.
- Partnership with the Hybrid Parents Research Consortium (HPRC) (the most successful public-private partnerships in CGIAR system, in operation since 2000) may provide better opportunities for millet varietal development. .
- Seed industry may adopt potential millet varieties/hybrids developed through the ICRISAT-NARS partnership and nationally released and notified, as these can be licensed to private/public sector seed companies with a license fee. Forage sorghum hybrid CSH 24 MF is a most successful example under this mechanism.
- ICRISAT vision on millets seed system is to develop innovative partnerships with public & private seed sector stakeholders for scaling the adoption of millets (hybrids & inbreds). and replicate in other countries of Eastern, Southern Africa- Kenya, Zimbabwe, Ethiopia, Mozambique; Central and West Africa- Mali, Niger, Nigeria in collaboration with private sector in India.
- There is a need for development and adoption of improved varieties/ hybrids of millets along with improved crop management system for these crops.
- ICRISAT could facilitate entry of Indian seed companies to African markets through its Seed Revolving Fund (SRF) model.

The millets market is set to grow from its current market value of more than USD 9 billion to over USD 12 billion by 2025.

- There is a greater potential of sustainable use of available natural resources by growing millets in the fallow and marginal land.

Presentation on Carbon offsets in Agriculture sector - Mechanism and Monetization in Agriculture Sector

Ms. Rajasree Ray, Department of Economic Affairs, Ministry of Finance, New Delhi

Highlights of the presentation

- Emphasis was given on climate stress mitigation and sustainable agriculture practices and their impact on productivity and concerns about the climate change and its impact on agriculture and the economy.
- She mentioned about the importance of adaptation measures which are very important and carbon credit is new source of income through market-based mechanism.
- She also discussed about green credit program, water use efficiency in agriculture for sustainability of domestic agriculture as a path of work and mentioned that post 2020 is not under Kyoto protocol, but under UNCCC as per Paris Agreement.
- Joint carbon crediting mechanism has been initiated by Japan, based on bilateral system.
- Agriculture as sector doesn't have qualitative target for India under Paris Agreement, however, India can have a domestic market in order to generate demand for Carbon Credit .
- This year union budget also mentioned about Green Growth Credit, Climate Finance issues and various kinds of grants for sustainable agriculture. Different stakeholders need to look at Green Credit Fund Guidelines for further details on these provisions.
- She emphasized on future projection on Carbon Credit and suggested the road map to meet out the future demand in her comprehensive presentation highlighting global competitive advantage of India in this field.

Emphasis was given on climate stress mitigation and sustainable agriculture practices and their impact on productivity and concerns about the climate change and its impact on agriculture and the economy.

Presentation on Current status of global carbon market and possible opportunity in agriculture sector

Mr. Kentaro Takahashi, Deputy Director Climate and Energy Area, Institute of Global Environmental Strategies (IGES) Japan

Highlights of the presentation

- The demand for carbon credit has been significantly increasing in industry because of its future plan to achieve carbon neutrality by 2050.
- When one looks at the issuance of carbon credit, the amount of issuance in total has been increased up to 48% between 2020 and 2021.

The demand for carbon credit has been significantly increasing in industry because of its future plan to achieve carbon neutrality by 2050.

- Although the carbon credit demand has increased, the international bodies more concerned about the quality of carbon credit.
- There are greater demands and expectations from the agriculture sector as it has potential to contribute Sustainable Development Goals.
- Since the demand for carbon credit is going to increase, there are several opportunities to be sought in the bilateral cooperations as well as in the voluntary carbon market.
- To facilitate design of the new carbon market in the agriculture sector, the capacity building programmes in this area for the government and private sector need to be organised.

Presentation on Seed without borders- IRRI initiatives on global and regional cooperation for seed sharing

Dr. Sudhanshu Singh, Director, IRRI -South Regional Centre, Varanasi UP

Highlights of the presentation

- Since bordering states of countries share similarity in agro-ecological conditions, if a variety is suitable and advantageous for a given agro ecology, it will move across borders, officially or unofficially
- Adoption of popular rice varieties across countries is commonly observed with respect to Swarna (MTU 7029) of India in Bangladesh, BR 11 of Bangladesh in India, Swarna, Sarju 52, Samba Mahsuri and Ranjeet of India in Nepal and Basmati 370 and CSR 36 of India in Africa.

- Policy innovation led by IRRI are concerning fast-tracked varietal release, awareness creation, seed multiplication and varietal out scaling, efficient use of research and other resources, supporting formal seed systems, promoting SRR and VRR and encouraging seed exchange/business.
- Important strategic initiatives promoted by IRRI towards regional cooperation on seeds include:
  - **Dhaka Agreement:** (i) Joint varietal evaluation and release (ii) Reciprocal recognition of evaluation data for varietal release (iii) Reducing time for the evaluation of varieties released in neighbouring countries for similar agro-ecologies (iv) Reducing time for evaluation for MAS generated varieties (v) Pre-release seed multiplication & promotion (vi) Encouraging private sector by providing level playing field (vii) Harmonization of seed system
  - **Kathmandu Agreement:** (i) Three countries namely, Bangladesh, India and Nepal agreed to share the evaluation data and varieties released in their respective countries for release and commercialization in other two countries for similar agro ecologies.
  - **Siem Reap Agreement:** (i) Signed by Bangladesh, Cambodia, India, Nepal, Sri Lanka and IRRI in Siem Reap, later joined by Myanmar and Bhutan. It has been extended beyond rice to include other cereals, pulses, oil seeds, vegetables, sugarcane and fibre crops.
  - **Thimphu Agreement:** Signed by Bangladesh, Bhutan, Cambodia, Fiji, India, Nepal, Philippines, Sri Lanka and Vietnam. (ii) Observer Countries: Indonesia, Lao PDR & 8 African countries (Burundi, Ethiopia, Kenya, Madagascar, Mozambique, Tanzania, Uganda & Zambia) (iii) Donors organizations for this agreement are ACIAR, ADB, ADBI, BMGF, IFAD, JICA, KOIKA, World Bank, BIMSTEC, Syngenta Foundation and MAHYCO.
- Support to be extended to signatory countries under IRRI initiated seed agreements for varietal selection, basic seeds sourcing for release and seed multiplication.
- Spilling the benefits of IRRI initiatives beyond rice.

Day 1: 03-03-2023

Technical session 2

Precision Approaches for Enhancing Breeding Value & Seed Technology

Presentation on Molecular Breeding of oilseeds to address quality and key challenges of productivity

Dr. Janila Pasupuleti, Principal Scientist (Groundnut Breeding) & Cluster Leader- Crop Breeding, ICRISAT

Highlights of the presentation

- Oilseed crops in India are grown under sub-optimal agro-ecological situations. The climate change effects further exacerbate the stresses in the sub-optimal agro-ecologies affecting the oilseed production.

Oilseed crops in India are grown under sub-optimal agro-ecological situations. The climate change effects further exacerbate the stresses in the sub-optimal agro-ecologies affecting the oilseed production.

- Modern crop breeding technologies offer opportunities to enhance the rate of genetic gain and are of high priority for use in the oilseeds breeding program to achieve the productivity gains and improve the oil content and quality.
- In groundnut breeding program at ICRISAT, Marker Assisted Breeding (MAB) is used for the selection of three traits, viz., high oleic acid content of kernels (~80% oleic acid), and two major QTLs on A02 and A03 governing resistance to rust and late leaf spot diseases.
- Following groundnut varieties were developed using MAB from two mutant alleles FAD 2A and FAD 2B:
  - High oleic variety Girnar 4 (ICGV 15083) and Girnar 5 (ICGV 15090).
  - Spanish type of high oleic groundnut variety , GG 40 (ICGV 16668).
- Marker assisted selection is used in soybean for selection of resistance to rust and soybean cyst nematode, flowering time alleles, pod shattering resistance, high oleic acid content, salt tolerance, seed protein content and other traits.

- In sunflower, molecular markers for fertility restoration, high oleic acid content, herbicide tolerance and resistance to Plasmopara halstedii, Puccinia helianthi, or Orobanche cumana have been successfully used in MAB.
- In rapeseed and safflower MAB is used to develop high oleic acid cultivars.
- The future possibilities and potential impacts of Marker Assisted Selection (MAS) are immense in oilseed crops.
- Modern Crop Breeding Technology needs to be included in breeding program of different research institutions and their collaboration with private seed sector and technology transfer to the industry is the need of hour for the growth of Indian Seed Sector.

Presentation on CRISPR based Bioengineering for novel Agriculture and Food Product Development Relevant to seed Industries

Dr. Anindya Bandyopadhyay, Vice President, Bioengineering R & D, Reliance Industries Ltd., India

Highlights of the presentation

- The ability of CRISPER Cas 9 to precisely modify genome in a non-transgenic route has opened up enormous possibilities in different fields of biotechnology including Agriculture.
- This technology not only targets gene-based product development but also for increasing speed of plant breeding, precise elite line editing, faster development of haploids using CRISPR etc. are taking the Agricultural product development to a new height.
- CRISPR-aided asexual propagation by creating genotype MiMe (mitosis instead of meiosis) shows significant prospect in this area of stable inheritance without the risk of segregation of elite lines.
- Many other new ideas while merge with CRISPR becomes beneficial for plant breeding such as SPO11 could be introduced along with dead Cas9

The ability of CRISPER Cas 9 to precisely modify genome in a non-transgenic route has opened up enormous possibilities in different fields of biotechnology including Agriculture.

- Focus should be given on reducing the breeding cycle by use of advance genome editing tools like CRISPR technology.

Presentation on Genetic Gains in Corn- From Labs to Market

Dr. B. M. Prasanna, Director Global Maize Program, CIMMYT

Highlights of the presentation

- CIMMYT's centralized platform has been offering maize DH (Double Hybrid) development services to CIMMYT breeders as well as NARES and SME Seed companies in Africa, Latin America and Asia. Over 80% of lines used in CIMMYT's maize breeding pipeline are DH lines.
- Since 2017, CIMMYT's formal product licensing models have enabled 275 unique maize hybrids and improved OPVs to be licensed to 197 distinct partners for varietal registration & commercialization across 70 countries.
- Double Hybrid maize is a productivity enhancing and welfare improving innovation, increase yield by 15% and reduced the probability of crop failure by 30%.
- 21 unique climate resilient (drought-tolerant/heat + drought tolerant) yellow maize hybrids are being commercialized by 27 SME seed companies in India, Nepal, Bangladesh and Pakistan.
- Significant progress is achieved in genetic gain in cereal crops and appreciable outcome in Pearl millet, maize and rice under CIMMYT's crop breeding programmes.
- There is a greater thrust on reducing breeding cycles through development of second-generation haploid inducer lines through MAS by CIMMYT.
- Breeder ready markers shall directly be realized for specific traits
- To shorten breeding cycle, recycling of elite lines in breeding pipelines can be utilized.
- Genomic selection is required to harness the potential of genotypic data for increasing genetic gains.
- Product licensing models, climate resilient maize hybrids and development of efficient collaboration with the private seed sector are need of hour.

Day 1: 03-03-2023

Technical Session 3

New approaches in seed technology for enhancing seed value

Presentation on Role of physiology-based breeding to evolve stress adaptive varieties in various crops

Dr. M.S. Settee, Professor and Head, Dept. of Physiology, UAS, GKVK, Bangalore

Highlights of the presentation

- Larger population in India do not have access to food. In the 2022 Global Hunger Index, India ranks 107th out of the 121 countries. India has a level of hunger that is serious.
- There is a scope for exploring the possibility of increasing the yield by following proper management in the field through precision agriculture.
- The use of breeding based upon combination of proper phenotyping through amalgamation of physiological traits, good agronomical practices and machine harvesting have to be looked into, as the studies based, only, on morphological traits have come to a plateau.

Oilseed crops in India are grown under sub-optimal agro-ecological situations. The climate change effects further exacerbate the stresses in the sub-optimal agro-ecologies affecting the oilseed production.

- When stress is progressive, certain traits are "induced" referred to as "Acquired Tolerance Traits" which provide higher levels of tolerance when stress becomes severe.
- Acquired Tolerance Traits (ATTs) are extremely important to sustain reproductive growth under stress. Their introgression with constitutive traits provides a greater yield advantage under stress.
- Significant variability is existing in various crops, e.g.: in paddy it can be harnessed through the combination of both phenotyping, genotyping and sequencing through molecular breeding and modern biotechnological tools.
- Understanding the mechanisms that regulate ATT will be highly rewarding.

Presentation on Breaking yield barriers in pulses productivity enhancement through Molecular approaches

Dr. Rajiv Varshney, Director, State Agricultural Biotechnology Center, Murdoch University (Australia)

Highlights of the presentation

Oilseed crops in India are grown under sub-optimal agro-ecological situations. The climate change effects further exacerbate the stresses in the sub-optimal agro-ecologies affecting the oilseed production.

- Research is being carried out in wheat, chickpea and horticulture crops on abiotic stress tolerant traits like heat, drought, herbicide tolerance and other biotic stresses at State Agricultural Biotechnology Center, Murdoch University (Australia).
- Notable research work has been done by ICRISAT on molecular approaches like efficient phenotyping and genotyping using techniques of Pan genomics, SSRs, DART, Genotype by Sequencing (GBS) etc. on chickpea, pigeon pea and ground nut which has resulted in the release of drought tolerant chickpea varieties like Pusa JG 16, Pusa 10216, IPC 14-14 and Fusarium wilt tolerant chickpea variety Pusa Manav, Super Annigeri 1.
- Also, variety GL18046 in ground nut tolerant to Ascochyta blight has been released in PAU, Ludhiana.
- Further Pigeon pea variety, Bheema (GRG 152) was also released in Ghana by using the marker assisted breeding methods.
- There is also an urgent need of capacity building programme of the scientists, scientific staff and association between several international, national and local Government and other agencies for an integrated approach in use of molecular approached for productivity enhancement.

Presentation on New technology trends in seed quality assessment and certification

Dr. Arun Kumar M S, Principal Scientist, IARI, New Delhi

Highlights of the Presentation

- Several new technologies for seed quality assessment, seed traceability and anti-counterfeiting measures like Q2 technology, CF technology, Ethanol assay, Videometer, Luminex® xMAP, Tracex blockchain technology, QR code, seed coating, etc. are now available to provide more accurate information on the quality of seeds tested.

- 2 new approaches by the ASTEC- Global have been developed to measure the Oxygen uptake called Q2 2 technology or Seed Respiration Analyzer or Q2 scanner.
- The Q2 technology uses Elisa plates with individual wells where seeds are placed, and each well is covered with a specially coated foil, which, when excited with a laser, produces fluorescence (that is influenced by the oxygen content of the cell), providing a measure of the oxygen consumption of the seed.
- CF Analyzer technology is based on the concept that chlorophyll content of the seeds decreases as seeds move towards harvestable maturity having higher seed quality parameters like germination, speed of germination and vigour.
- Ethanol Essay is widely used to compare the seed deterioration status of seed lots and to take necessary corrective measure at right time.
- Videometer is a patented technology and utilized for the assessment of seed quality parameters like physical purity, seed health and germination. It could also be used to assess genetic purity of the seed as parameters like seed shape, seed length, seed colour and surface texture can be very clearly and precisely differentiated.
- Luminex XMAP Technology is an advanced technology designed for the assessment of seed health by detecting seed-borne viruses and bacteria. Seed Vigour Imaging System (SVIS) is a software interface used to scan seedling images and generate vigor, growth and uniformity indexes for various crops.
- TRACEX Blockchain Technology is aimed at countering the entry of spurious and illegal seeds into the market by storing all relevant information on the seed history as a QR Code.
- Use of latest commercially available techniques is needed to improve seed quality assessment system, as they provide precise and authentic results as compared to conventional methods.

Day 1: 03-03-2023

Technical session 4

Adding value- Novel approaches for promoting vegetable and forage seed

Presentation on Prospects for development of High value vegetable seed industry in India

Dr. Ramakrishnan M. Nair, Regional Director, South & Central Asia, World Vegetable Centre

Highlights of the Presentation

- The top five companies namely, Advanta Seeds - UPL, BASF SE, Maharashtra Hybrid Seeds Co. (Mahyco), Syngenta Group and VNR Seeds occupy 27.5% of the total vegetable seed market value in India, mostly concentrating on vegetables like tomato, cabbage, eggplant, chili, okra and cucurbits.
- India offers an ideal ecosystem for vegetable seed production due to ever-increasing demand, varied agro-climatic conditions, cheap labour and vast domestic and international market.

India offers an ideal ecosystem for vegetable seed production due to ever-increasing demand, varied agro-climatic conditions, cheap labour and vast domestic and international market.

- However, there are some challenges concerning high cost and uncertainty of demand, the perishable nature of vegetable seed, problems linked with contract farming, climate, pest and disease-related problems and stringent seed policies and laws.
- In an ongoing study by WorldVeg, lack of protection of research and intellectual property of the private seed sector and varying regulatory protocols amongst states was a major barrier for the introduction of improved varieties of vegetables.
- "Linking genetic resources, genomes and phenotypes of Solanaceous crops (G2P-SOL)" is one of the projects from European Union driving the innovations for the development of improved varieties of Solanaceae crops.

- The APSA-WorldVeg Vegetable Breeding Consortium is a collaborative effort of international agricultural research, with private sector partners, which provides the consortium companies an early and exclusive access to WorldVeg improved breeding lines against a fee and are eligible to participate in special collaborative projects jointly funded by several seed companies.
- Quality Seed of Vegetables should be available at the right time and at reasonable prices for the farmers to utilize them for improved vegetable production.
- Collaboration of international agricultural research with private sector partners is needed for increased availability of improved varieties of vegetable seeds.

Presentation on Potato Seed and Opportunity for Indian Seed Industry

Dr. Brajesh Singh, Director, ICAR- CPRI, Shimla

Highlights of the presentation

- Low multiplication rate of potato seed, repeated exposure of initial disease-free seed stocks to soil and insect pests and accumulation of pathogens leads to deterioration in quality of produce.
- Incorporation of hi-tech seed production system coupled with advance virus detection techniques is the only way out in fulfilling the huge demand of quality seed potatoes in the country.
- Tissue culture based hi-tech seed system allows supply of healthy mother stock (in vitro plants) for seed production in the country.
- ICAR-CPRI has developed a programmed air mist-based potato culturing technique based on aeroponics technology, which is capable of shortening the span of almost 2 years in the potato breeder seed production and production of clean material.
- Apical Root cutting is a low-cost technology for small & marginal farmers, easy to deal with & is also an alternative to Mini tubers in current seed production systems for potato with a high multiplication rate.
- Involvement of SAUs, KVKs, Private sector companies, Growers associations, Cooperative societies and Progressive growers needs to be encouraged for multiplication of breeder seed in three assured multiplication cycles by Govt. of India.

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Presentation on Building sustainable growth in Vegetable value chain- A perspective from breeding to market

Dr. T. K. Behera, Director, ICAR- IIVR, Varanasi

Highlights of the presentation

- India is second largest producer of vegetables contributing 13.60% of the global vegetable production next to China in both area and production followed by USA, Russia and Turkey.
- The core element to build sustainability in vegetable value chain through plant breeding is to ensure that farmers and others stakeholder like producers, processors and consumers, adopt and make the use of new improved varieties/hybrids.
- There is need for linking the vegetable breeding with marketing activities to identify the changing market demands in order to develop need-based vegetable varieties.
- Traditional breeding approaches are generally slow & labor-intensive. Recent progress in genetics and genomics, accompanied by the deployment of novel tools, techniques, and approaches could enhance the outcome of plant breeding programs.

India is second largest producer of vegetables contributing 13.60% of the global vegetable production next to China in both area and production followed by USA, Russia and Turkey.

- Molecular markers, genetic linkage maps, marker assays, and whole-genome sequence have been developed and published for several vegetables
- A special aroma like 'Basmati Rice' has been noticed in leaves, vines, flower and fruits in sponge guard aromatic line. This kind of attributes also need attention of plant breeders for developing consumer targeted vegetable varieties.
- Advance breeding technologies like speed breeding, MAS, transgenic, genome editing needs to be essentially integrated in the vegetable improvement programme.
- Market and processing industry-oriented vegetable varieties may be key objective of varietal improvement in vegetables.
- Nutritional and neutraceutical properties of vegetables are also emerging as one of the key parameters for developing varieties.

Presentation on Fodder, Feed and Dairy Industry- New paradigms and approaches for sustainable growth

Dr. Amaresh Chandra, Director, ICAR- IGFRI, Jhansi (U.P.)

Highlights of the presentation

- Livestock production contributes 4% to national GDP and gives employment to 70% population of rural areas
- Low productivity of livestock is mainly on account of deficit in green fodder (11.24%), dry fodder (23.4%) and feeds (28.9%), breeding and reproduction (21.1%), diseases (17.9%) and challenges in livestock management (10.5%).
- Cultivated fodders and gathered grasses are two important sources of green fodder and each account for about half of the green fodder consumption.
- In states like Haryana, Punjab, Gujarat and some parts of Rajasthan, area under green fodder is comparatively higher resulting into higher livestock productivity in these states.
- Concentrate is a feed mixture which supplies protein, carbohydrates and fat at higher level but contains less than 18% crude fibre.

Cultivated fodders and gathered grasses are two important sources of green fodder and each account for about half of the green fodder consumption.

- Processed feed like hay, silage, TMR, leaf meal are some of the best alternative feed resources which should be promoted to improve livestock productivity.
- Limited availability of quality fodder seeds (only 25-30%) is the major factor adversely impacting the green fodder production/availability.
- Major constraints of fodder seed production are, poor seed setting; extreme climatic conditions; seed shattering; non synchronization in maturity; low seed multiplication ratio and the presence of empty seeds.
- Non availability of suitable seed production technology and land; fewer improved varieties, lack of hybrids and poor resource allocation towards fodder are also important impediments in cultivation of fodder crops.
- In case of fodder seed development/multiplication there is no government support like minimum support price or adequate number of frontline demonstration schemes. Moreover, there is less preference for fodder crops amongst farmers due to lack of market.

- There is a need to formulate strategies to enhance quality seed production of fodders and its timely availability to the farmers and other stakeholders.
- Promoting adoption of high performing fodder crops through fodder based FLDs is needed.
- The Government should encourage opportunities for participation of SME seed sector in commercial venture for fodder quality seed production.

Day 1: 03-03-2023

Technical Session 5

Seed Industry Leaders Panel-Discussion on Indian Seed Industry Issues

Highlights of Deliberations & Decisions:

1) At the outset **Dr K. Keshavulu**, the co-chair and moderator of the session, set the context for discussions in the session.

2) **Shri Prabhakar Rao**, President, NSAI, outlined the following important issues, challenges and needed policy level changes for the growth of the seed industry.

   a) Growth oriented development schemes available to sector like, Electronics, Pharma, Textiles, etc., should also be made available to the seed industry.

   b) Grants-in-aid, soft loans and funding support may be extended to the small and medium seed enterprises in Indian seed industry for upscaling their R&D investments.

   c) Government support in the form of PLI, interest subvention or capital grant for building the capacity of seed industry in terms of varietal testing, seed quality testing, seed processing infrastructure, common use infrastructure & services, etc. are needed.

Growth oriented development schemes available to sector like, Electronics, Pharma, Textiles, etc., should also be made available to the seed industry.

   d) India with varied agro-climatic zones can become a hub of seed production for not only meeting the needs of domestic industry but also for South and South East Asia and Africa.

   e) Indian seed sector needs to get unshackled from too much of regulation which limits its growth potential. Further, "One nation, one license" principle should be adopted with enough safeguards within the Governance structure as proposed by NSAI to the Government.

   f) Instead of Nil-GST, the Government should rephrase the term as zero % GST for the seed sector.

3) **Shri Ram Kaundinya**, Director General, Federation of Seed Industry of India (FFSII) made following remarks:

a) Currently Indian seed industry is spending less than 3% on R&D. The seed industry across the board need to increase R&D spend, for which investible surplus through profits aided by better price regulation or tax sops and funding support from the Government are essential.

b) IPR protection and mutual respect for IPR is essential for the growth of the industry.

c) For strengthening the access and benefit sharing mechanisms, the 64 crops designated under ITPGRFA need to be transferred under the purview of Ministry of Agriculture to enable an efficient governance structure for IP enforcement.

National level PPP project implementation needs to be in a mission mode by joint investments and collaborations.

d) National level PPP project implementation needs to be in a mission mode by joint investments and collaborations.

e) Cotton yields have hit a plateau. New Agronomic practices aligned with mechanized picking and coupled with provision of regulatory clearance for inputs such as Growth regulators and Defoliants is essential for breaking the yield barriers in this crop.

f) There is also a need to facilitate investment on pre-cleaners for establishing a demand driven Cotton value chain.

g) There is a need for 'Technology Mission on Cotton 2.0' designed based on multi-stakeholder approach. Further a "Cotton Board" similar to Plantation crops is the need of the hour to solve issues of various stakeholders.

h) Government is presently supporting ELS Cotton. There is a need to support non-ELS Cotton also to boost the profitability of the farmers.

i) Regulation should aid progress, rather than hinder it. Science based regulation should be designed for both GM and GE Technologies.

j) Enhancement of capacity of seed companies to produce high quality seeds will further improve our global competitiveness.

4) **Dr. Rajvir Rathi**, Director (Govt Affairs), Bayer mentioned that Indian seed industry has a great potential to grow in the next coming decade both domestically and internationally. The key suggestions made by him are as under:

IPR protection should be a critical enabler for global competitiveness for attracting global investments in Indian seed sector.

a) A "Seed Export Promotion Council" should be created, which will facilitate single window clearance for all exports including SPS compliances and clearances.

b) IPR protection should be a critical enabler for global competitiveness for attracting global investments in Indian seed sector.

c) The New Seed Bill should consider relevant solutions to the challenges faced by the industry before being enacted.

d) For being a global seed production hub, there is a need for institutionalization of germplasm movement not only for R&D but also for commercial purposes.

5) **Shri Dineshbhai Patel**, Vice President of NSAI made the following suggestions.

a) There should uniform rules and regulations under Seed Act, 1966 and Seeds (Control) Order, 1983 across the country with VCU based on SAU trials/AICRPs for registration and license of plant varieties.

b) Most of the State Governments are asking to add varieties/hybrids in the seed license for marketing of seeds, which is not laid down in Seeds (Control) Order, 1983 or Seed Act, 1966. Although this requirement is fulfilled by seed companies, different states are coming up with different requirements with respect to VCU/ variety performance evaluation data. Uniform guidelines to recognize the internal R&D trial data of the company may be issued by the Government to reduce the cumbersome process and also for timely release of seeds of new plant varieties into market.

c) The new guidelines by Go for revalidation of certified seeds are causing an additional cost burden to seed companies. The old system which was in use since 1989 should be continued.

d) Private sector companies should also be provided with seed distribution subsidy on certified seeds as provided to the public sector seed companies. Further seed subsidy should be given to only those crops where cost of seeds is more than 10% of cost of cultivation.

e) Availability of good land is essential for R&D and product evaluation for seed companies. Since, the present laws do not permit private seed companies to hold such lands, provisions of Land Ceiling Act need to be amended for this purpose.

f) The seed certification charges of certain certification agencies such as GSCCA are exorbitant and need to be rationalized.

Seed Production Research (SPR) technology is essential to improve seed quality and reduce failure of seed lots.

g) Seed Production Research (SPR) technology is essential to improve seed quality and reduce failure of seed lots.

h) Multiplication of Bt version of public sector Cotton hybrids need to be provided to seed growers for faster scale-up and adoption.

i) Some State Governments such as Gujarat are buying seeds of various crops by specifically mentioning the variety name through tender system. Specifications of such varieties should be given with an opportunity for more companies to supply such seeds and encourage competitive bidding.

j) Private sector should be encouraged to store seed buffer stock by facilitating suitable air conditioned/ambient warehousing systems.

k) Biotechnology services for quality assurance and fast-tracking breeding programs to be made available by Government to small and medium enterprises.

l) Interest rate on working capital loans to the seed industry need to be reduced.

m) Special SEZ should be created for Seed industry similar to the policy developed for other industries.

n) NOC should not be imposed by PPVFR authority for registration of GM variety which has already been cleared by GEAC in line with its scope under environmental risk.

o) Use of deregulated and royalty free events should be provided to all breeders and seed companies to develop new varieties.

p) While fixing Bt Cotton seed price, the Seed value needs to be significantly improved keeping in view the high seed production costs.

q) A protocol for standardization of parameters for the presence of HT Cotton trait and its testing protocols need to be published to prevent penalizing seed companies where HT trait contamination is detected.

r) The high cost of breeder seeds creates a burden on certified seed producers which will increase the overall price of certified seeds.

s) Despite following all precautions and procedures, there are cases of failures in germination of Groundnut and Soybean both in public and private sector. Government needs to investigate the issue scientifically and solve the problem by standardizing quality testing protocols.

6) **Shri Krushna Chandra Sahoo**, Director (Commercial), NSC, mentioned that NSC has 22000 ha of land under seed production, with 600 varieties in 80 crops and is committed to supply quality seeds to meet the needs of the farmers in the country.

7) **Shri Vaibhav Kashikar**, Director , Ankur seeds made the following recommendations.

a) Authorize private sector seed testing laboratories to test seed quality for seed certification.

b) Recognition of the Seed industry for its role in the Indian economy and growth of agricultural sector.

c) Income Tax exemptions for seed sector

8) **Shri K. Subba Rao**, Ex-President of NSAI made the following recommendations.

a) Governments have to take steps to put in place enabling policies relating to seeds.

b) There is a need to look at an end-to-end approach with a value chain perspective, including harmonization of the processes such as Plant quarantine for a competitive export-oriented seed industry.

c) Industry should invest in R&D for significant value addition in its programs.

d) Government policy support for Seed Production Research (SPR) and easing out large scale varietal evaluations for accelerating the speed of commercialization of products to the market.

e) R&D in some crops like Sorghum/SSG has stagnated and is not moving forward and there needs to be focus by the Government on such crops and millets.

Government policy support for Seed Production Research (SPR) and easing out large scale varietal evaluations for accelerating the speed of commercialization of products to the market.

9) **The Co-Chair Dr K. Keshavulu**, President ISTA while summing up the deliberation of this session highlighted the following key issues to be addressed on priority.

   a) India has got a robust seeds system in the country. All the support may be provided by the government to help it emerging as a world leader in the seed sector.

   b) There has to be support for small and medium seed enterprises to strengthen their R&D system as well as seed testing/processing infrastructure.

   c) R&D based seed companies may also be supported for strengthening and upscaling their R&D system through government support in the form of a capital grant or interest subvention.

   d) Too much of regulation hinders the growth of seed industry hence the regulatory process should facilitate ease of doing seed business.

   e) Putting in place One Nation One License system in the country.

   f) A system of Seed Traceability in the country is the need of the hour. Its implementation may be fast tracked.

   g) Creating a Cotton Board similar to other commercial crop like tea, coffee and rubber to be implemented in the country for boosting cotton productivity.

10) **The Chairman Dr Panjab Singh**, summarized by saying that excellent deliberations and recommendations were made during the session and remarked that presently Government is keen in providing support to FPOs in seed production. With respect to regulatory hurdles, the Government needs to engage with the industry and resolve most of the issues keeping in view the interests of the farmers and industry.

Day 2: 04-03-2023

Technical Session 6

Seed Quality Regulation

Presentation on Seed Quality Standards, Regulation and enforcement and their harmonization for a globally competitive industry

Dr. K. Keshavulu, President-ISTA, MD, TSSDC and Director, TSSOCA

Highlights of the presentation

- Global seed market is expected to reach to USD 86.8 billion by 2026 and vegetables are a significant driver for the seeds market.
- Global Seed Regulatory Regime includes OECD and AOSCA for Seed Certification Schemes, ISTA for Seed Sampling and Testing, IPPC for Phytosanitary Measures, UPOV for Plant Variety Protection, ITPGRFA for Laws on Plant Genetic Resources and FAO for effective seed systems and availability of quality seeds to farmers are being implemented in the country.

Global seed market is expected to reach to USD 86.8 billion by 2026 and vegetables are a significant driver for the seeds market.

- In seed certification system, seed is controlled and inspected to guarantee consistent high quality for consumers. Certification process varies between countries and parts of the world.
- Seed produced in countries other than EU can be marketed within the EU if the seed affords the same assurances as seed officially certified within the EU (EU seed equivalence).
- Majority of the countries (83) across the globe including India are following ISTA rules for seed sampling & testing.
- Majority of Asian countries have laws on seed testing and quality assurance except a few like Laos, Cambodia, Malaysia, etc.
- Regional associations need to work towards

- harmonising standards, regulations, procedures, and policies to expedite the movement of seeds within the region.
- Seed health testing and vigour assessment need to be included in the quality regulations.
- There is need of uniformity in certification and labelling system and need to develop strategy for seed export.

Presentation on Capability/Infrastructure of Seed Testing Laboratories and NABL accreditation

Mr. N. Venkateswaran, CEO, NABL

Highlights of the presentation

- NABL operates accreditation program in accordance with the requirements of ISO/IEC 17011 "Conformity Assessment - General requirements for accreditation bodies accrediting conformity assessment bodies" and has Asia Pacific Accreditation Cooperation (APAC)/ International Laboratory Accreditation Cooperation (ILAC) MRA since 2000.
- Testing Laboratories, Calibration Laboratories and Medical Laboratories are accredited by NABL.
- Seed Testing Laboratories are important to assess the seed quality. It enables the farming community to get quality seeds and ensure the quality of planting material and serve the seed industries by providing information of seed quality & suitability for planting.

Among all the seed testing laboratories in the country only 1 state seed testing laboratory and 13 private seed testing laboratories are accredited by NABL.

- Accreditation of laboratories provides international recognition, access to global market, time and money efficiency, enhanced customer confidence and satisfaction, robust quality management system, cost reduction and better operational control.
- Among all the seed testing laboratories in the country only 1 state seed testing laboratory and 13 private seed testing laboratories are accredited by NABL.
- Seed Testing Laboratories also need to be accredited by NABL to achieve a robust quality management system and better operational control.

Presentation on Harmonization of seed regulatory system and need for amendment of Seed (Control) order, 1983

Dr. B. B. Pattanaik, General Secretary, NSAI

Highlights of the presentation

- Private seed companies have developed sizeable capacity for production, processing and distribution of seeds crossing State barriers. However, for inter-state seed business, they have to take licence in each state which is a cumbersome process.
- Many States carry a misconception that there is a difference in the quality of certified seed and TL seeds. However, the Seeds Act, 1966 together with Seed (Control) Order 1983 regulates the quality of both certified and TL seeds and standards for Certified and TL seeds are the same.
- The States have also put their own conditions for regulation though not provided in the relevant law as under:
  - Many States are also adding the name of varieties/hybrids, to be marketed, in the seed licence, though there is no such provision under the Seed (Control) Order, 1983 (Maharashtra and AP).
  - Different States are also coming up with different performance evaluation criteria/ data with respect to proprietary/research hybrids which causes delay in bringing private research varieties into market thereby restricting ease of doing business for the seed sector.
  - Arbitrary declaration of rectifiable and non-rectifiable contraventions contrary to the provisions under law (Andhra Pradesh).
  - Seizing of seed stocks of varieties which are being processed and packed for other States on the grounds that the particular variety is not recommended for the State (AP).
  - Restrictions against sale of Research Varieties in (Bihar).
- Bring in a System of Central licencing for companies operating in more than one State and continuing with State licencing for companies operating within the State.

Private seed companies have developed sizeable capacity for production, processing and distribution of seeds crossing State barriers. However, for inter-state seed business, they have to take licence in each state which is a cumbersome process.

- There is a need for including other activities of the seed company viz. seed production, seed processing, seed testing, seed R&D, seed storage godowns etc. in the licence.
- Provision of committees at Central and State level for verification and recommendation for approval for inclusion of seed Production, seed Testing, seed processing, seed R&D, seed storage godowns of a seed company in the Seed Licence.
- The inclusion of the hybrids/varieties to be based on the performance evaluation data of in-house R&D or two years trial data in specific format used by Indian Council of Agricultural Research or any SAUs of the respective states.
- Reducing the time limit for testing and sending the report of the seed samples referred by the Seed Inspectors to a Seed Testing Laboratory to avoid hardship to the industry.
- There should be amendments in existing Seed (Control) Order, 1983 for incorporating the above provisions and also for smooth functioning of seed industry.
- "One nation, one license" principle should be adopted with enough safeguards within the Governance structure.

Day 2: 04-03-2023

Technical Session 7

India in Global Seed Trade: Opportunities and Challenges

Presentation on Indian Seed Industry in global seed trade: Challenges, Present status and future strategies

Mr. Soumen Sarkar, Business Lead – Europe & Global Oilseeds Crop Asset Lead, Advanta Seeds, UPL

Highlights of the presentation

- Soybean covers the maximum seed market share globally. GM crops and conventional crops share almost equal market share of 21 billion USD and 23 billion USD respectively.
- France and Netherlands, despite their small population and area, are having exports of 2.2 billion USD and 1.8 billion USD. France is having system of AFSIS and GNSIS where private companies are working together with public partners.

Soybean covers the maximum seed market share globally. GM crops and conventional crops share almost equal market share of 21 billion USD and 23 billion USD respectively.

- In Netherlands, collaborative Research is going on despite less endowment of natural resources.
- With respect to enabling policies for the business of agriculture India ranks 21st whereas Netherland is at 1st position. Therefore, we need to work over it for harnessing the strength of Public Private Partnership with enabling policies for seed sector to ensure ease of doing seed business in the country.
- Greater focus is required to the seed development work on potential crops of vegetables, hybrid rice, hybrid maize, forages, pulses and Bt Cotton by using HYV and strengthening seed research by the private sector.
- For boosting exports, we need to adopt Make in India approach, globalizing Indian companies and hybrid model of custom production of seeds need to be encouraged.
- Upgrading infrastructure, setting up AEZ/SEED CLUSTERS, investing in research and development, enforcing IP/PVP rights are some of the key initiatives which may boost seed export.

Presentation on Improving Seed Replacement Rate (SRR), Varietal Replacement Rate (VRR) and Seed Export through Agri Infra Fund

Mr. Samuel P. Kumar, Joint Secretary (AIF), DA&FW

Highlights of the presentation

- In many OP crops in food grains and oilseeds, the SRR is less than 25%-30%. Despite marginal improvement the SRR is still low compared to global standards where SRR is more than 90%-100%. In Cotton, the SRR is more than 99% as the entire Cotton cultivated in India has been converted into Bt Cotton hybrids.
- Varietal Replacement Rate (VRR) of the highly adopted varieties is low. Old varieties released in the past 3-5 decades in both private and public sector are still under cultivation in many States. Productivity of the most of these old varieties has reached a plateau or stagnated.
- As against, the total global seed exports valued at USD 13.8 Bn, India exports only USD 137 million worth seeds per year, which accounts to approximately 1% of the total global exports.
- Agri Infra Fund provides financial assistance for medium to long term debt on post-harvest management infra and community farming assets. Agri Infra Fund was launched under Aatmanirbhar Bharat Package. Seed processing, tissue culture and nursery units are eligible under AIF. The Fund of Rs. 1 lakh crore under the scheme will be disbursed from FY 2020-21 to FY2025-26.
- Eligible beneficiaries under Agri Infra Fund are farmers, Agri-entrepreneur, Start-ups, FPOs, Self Help Groups, APMCs, Private companies etc.
- Key Features of Agri Infra Fund:
  - 3% Interest Subvention for loan up to Rs. 2 Cr. and for 7 years
  - Credit guarantee coverage under CGTMSE for loans up to Rs. 2 Crores
  - Each entity is eligible to get the benefit of the scheme for up to 25 projects located in different LGD codes.
  - Agri Infra Fund can be dovetailed with any available government scheme including state government schemes.

Each entity is eligible to get the benefit of the scheme for up to 25 projects located in different LGD codes.

- Govt support for seed sector are also available under the scheme SUB-MISSION ON SEEDS AND PLANTING MATERIAL (SMSP) under Krishonnati Yojana, Support for Seed Production & Processing for Vegetables and Spices and for nursery and Tissue Culture Unit is available under the scheme Mission for Integrated Development of Horticulture (MIDH).
- Provisions under the AIF may be used by seed professionals/entrepreneurs for setting up seed production,/processing/storage infrastructure in the country and augmenting quality seed availability to farmers.

Presentation on Plant Quarantine Regulation and PRA for hassle free export-import of Seeds

Dr. J.P. Singh, Plant Protection Adviser, DPPQS

Highlights of the presentation

- Plant Quarantine system in India is regulated under The Destructive Insects & Pests Act, 1914 (DIP Act). Plant Quarantine (Regulation of Import into India) Order, 2003 commonly known as PQ Order, 2003.
- As per the current EXIM Policy, 2009-2014, exports of all seeds are free, except breeder or foundation seeds or wild plants. Further, the export of some seeds viz., onion, berseem, cashew, Nux vomica, rubber, pepper cuttings, sandalwood, saffron, neem, forestry species, red sanders, Russa Grass and tufts and Seeds of tufts is restricted and is only allowed on case-to-case basis under license issued by Directorate General of Foreign Trade (DGFT) on the basis of the recommendations of EXIM Committee of Department of Agriculture & Farmers Welfare.

Plant Quarantine system in India is regulated under The Destructive Insects & Pests Act, 1914 (DIP Act). Plant Quarantine (Regulation of Import into India) Order, 2003 commonly known as PQ Order, 2003.

- Inspection, sampling and laboratory testing for pathogens are carried out by designated officials of Plant Quarantine, State Agriculture/Horticulture Department or ICAR as per Export Inspection and Phytosanitary Certification protocol of Plants/ Plant Products & other Regulated Articles or as specified by the importing country. If required, growing season inspection will also be carried out by officials of Plant Quarantine Stations, notified officials from the State Agriculture/ Horticulture Dept, ICAR Institutes etc.

- Major concerns of seed industry include (i) import requirements for same pest differ from country to country (ii) difficulties in exporting/ importing seeds for planting under restricted conditions, (iii) challenges in managing frequent re-exports of seeds due to availability processing and packing facilities for some seeds in limited countries, (iv) difficulties faced in exporting same seed lot to multiple destinations, (v) need for harmonization of testing protocol.

The aim was to provide information on latest technologies and trends to the advancements in seed technology happening in Europe.

- There is an urgent need for standardization and harmonization of laboratory testing protocols to detect and diagnose the exotic pests associated with seed import pathway through the IPPC/ Regional NPPO platform.
- There is also a need for Capacity building of all associated stakeholders.

Presentation on Outcome of exposure visit to Germany and the Netherlands of Members from Indian Seed Industry

Dr. Raghavendra Kavali, National Project Coordinator, Indo-German Seed Project

Highlights of the presentation

- Under the aegis of the Indo-German Project on Seed Sector Development (IGPSSD) a study tour was organized by the German partners during 4-11 Dec 2022 on seed production and processing technologies for a team of 8 Indian seed professionals representing the academia and the seed industry (NSAI, FSII members).
- The aim was to provide information on latest technologies and trends to the advancements in seed technology happening in Europe.
- Visits were undertaken in several companies like Petkus Technology Centre, NORDSAAT SAAT WEHT, KWS SAAT SE and Co., Meiner SAATN GmBH Dunsen, BAYER AG Crop science division, BASF in Germany, De BOLSTER ORGANIC SEED, INCOTEC in Netherland.
- All the companies were working on different crops of cereals, oilseeds, pulses and vegetables in coordination with public sector and demand of the farmers by using all the Hitech equipment like color sorter.
- Similar kind of study visits need to be organized in India for the seed industry and other stakeholders from Germany also to understand Indian Seed System and work for future collaboration.

Day 2: 04-03-2023

Technical Session 8

IPR, Legal framework and Traceability in Seed industry

Presentation on IPR for Plant Varieties- Implementation challenges and Road ahead

Dr. K. V. Prabhu, Former Chairperson PPV&FRA, New Delhi

Highlights of the presentation

PPVFRA is the only Authority in the world that grants rights to farmers as breeders as well as conservers of traditional plant varieties as their heritage.

- In compliance to WTO/TRIPS Agreements of 1995, as a signatory, the Government of India established the Statutory Authority by passing an Act, The Protection of Plant Varieties and Farmers Rights Act (2001).
- PPVFRA is the only Authority in the world that grants rights to farmers as breeders as well as conservers of traditional plant varieties as their heritage.
- Once a plant variety (all forms such as new, extant (varieties in common knowledge, varieties notified under Seed Act of 1966) and farmers' varieties is registered with a unique designation by the Authority, it allows no one other than the registered plant breeder to sell, export, import or produce the seed or propagating materials of such protected (registered) plant variety with its denomination, without the registered breeder's (owner's) permission. Any or all of these activities can be permitted to be carried out through authorized breeders, agents or licensees by the Registered Plant Breeder, variety by variety.
- The registered plant breeder (who could be an individual, farmer, community of farmers, institution or a government) exercises his right over the variety (along with designation of the notified plant species), as the said variety's owner, who is entitled to plant breeders' rights on the variety with the exception of farmers' rights on the variety as provided in the Act that can be exercised without any labeling of the variety or without making it a formal seed production followed by formal seed selling.
- The protection of a variety with the IP right to the breeder is independent of the release or national notification, that is, only DUS is good enough and VCU is not a requirement under PPVFRA (2001).

- UPOV 1991 exemptions to allow self-saved seed would not have enabled more than 70% of seed-deprived farmers to plant seeds, as even less than 30% of farmers have any facility for saving their seed.
- Extant plant varieties in trade beyond 15 years of their release or notification or development make up for lion's share among seed trade in India.

Extant plant varieties in trade beyond 15 years of their release or notification or development make up for lion's share among seed trade in India.

- Emphasis should be given to DUS monitoring, IPR issues to seed production of parental line and hybrid.
- PPV&FRA guideline and registration process of farmers variety must be circulated to the seed industry to keep them update with the various provisions.

Presentation on Commercialization of Technologies for Seed Development – Agrinnovate India Approach

Dr. Praveen Malik, CEO Agrinnovate India

Highlights of the presentation

- There is a need for a well-defined mechanism for the transfer of the R&D technologies of ICAR to the end users for regulating the access, transfer, and dissemination of innovative technologies.
- Agrinnovate India Ltd. (AgIn) is the commercial arm of DARE/ICAR which acts as an effective interface between the research outcome of NARS and various public/private stakeholders for the successful transmission of the technologies to domestic as well as global markets.
- AgIn facilitates the dissemination of new technologies by creating a vibrant platform for stakeholders in agriculture and the allied sector. It also creates awareness through regular events and programs, as well as facilitates partnerships with producers and processors through backward and forward linkages, thereby ensuring the continuous promotion of technologies.
- AgIn is also mandated to collaborate with industry at national and international levels for Sponsored Contract Research, Consultancy, and Capacity building.
- AgIn aims to work with a wide spectrum of organizations from industry, research, and academia that have an interest in NARS technologies to gain competitive advantages of mutual benefits.

- There is a well-developed and well knitted seed multiplication and distribution system available with several ICAR institutes/SAUs. A large number of improved crop varieties/ hybrids including vegetables with enhanced productivity suited to varied agro-climatic conditions are available for licensing.
- More emphasis on the promotion of Seed Technology Parks is required to improve the seed processing facilities in line with MNCs.

The scope for public-private partnerships (PPP) needs to be explored because there is a huge demand for improved varieties/seeds/hybrids.

Presentation on Status of implementation of National Seed Traceability System

Ms. Pratibha R. Lokhande, DDG, NIC

Highlights of the presentation

- Seed is the most critical input for agriculture. It is always endeavor of the Government to ensure timely availability of quality seeds in sufficient quantity to farmers.
- For effective monitoring, efficiency and transparency in seed production and distribution chain, Department of Agriculture & Farmers Welfare , Ministry of Agriculture & Farmers Welfare has proposed the Digital Ecosystem for Seed Traceability. It will be a software enabled system where with the help of QR codes, one will be able to trace quality and purity of seeds.
- NIC has been entrusted with design and development of this Digital Ecosystem - "Seed Authentication, Traceability & Holistic Inventory" (SATHI).
- SATHI provides a holistic approach to cover the complete seed life cycle over multiple seed generations. It will be achieved through computerization of the entire seed supply chain, starting from seed production to certification, traceability, licensing, seed inventory, seed sale by certified dealers etc.
- Under present development phase of the SATHI only nucleus to certified seed will be under traceability and Truthful label seed will not be covered under present system but later on T/L seed will also be covered.
- Several benefits are associated with the application such as end to end seed visibility, real time monitoring of the seed, QR based tags, increased credibility of production, inventory management and seed export etc.
- Awareness and Capacity building of different stakeholders on Seed Traceability Module will need to be organized in a mission mode.

SUMMARY OF KEY RECOMMENDATIONS

Summary of Key Recommendations

- In the 75th year of independence when India is moving towards USD 5 trillion economy and the period of Amritkal, Government of India should set up growth targets for the seed industry, which plays a catalytic role in agriculture and nation's economy.
- Bilateral cooperation will seek more opportunities to develop carbon credit in the agriculture sector. Capacity building is needed for implementation of carbon credit trend, nature-based solutions for future trend of carbon credit. To design the new carbon market, the capacity building for government sector and private sector is important.

Collaboration of international agricultural research with private seed sector and technology transfer is need of hour for the growth of Indian Seed Sector.

- There is a need of enhancing millet productivity and nutrient value through focused varietal improvement initiatives through participation of domestic and international research institutions.
- Advance breeding technologies like speed breeding, MAS, transgenic, advance genome editing tools like CRISPR technology need to be essentially integrated in the crop improvement programmes.
- Collaboration of international agricultural research with private seed sector and technology transfer is need of hour for the growth of Indian Seed Sector.
- There is a need for development and adoption of improved varieties/ hybrids along with improved crop management for the growth of Indian seed sector.
- Involvement of SAUs, KVKs, Private seed companies, Growers associations, Cooperative societies and Progressive growers for multiplication of breeder seed in three assured multiplication cycles needs to be promoted by Govt. of India.
- Promotion/ participation opportunities in commercial venture for fodder quality seed production and entrepreneurship development for post- harvest conservation and utilization.
- Growth oriented development schemes available to Electronics, Pharma, Textiles, Agrochemical sector etc., should also be made available to seed industry.
- Grants-in-aid, soft loans and funding support should be provided to the small and medium seed enterprises in Indian seed industry for upscaling their R&D investments.

- For strengthening the capacity of seed industry in terms of varietal testing, seed quality testing, seed processing infrastructure, common use infrastructure & services, etc., they should be provided support either through PLI, interest subvention or capital grants.
- Strengthening of R&D infrastructure is required to the growth of seed industry.

Private sector companies should also be considered for seed production/ distribution subsidy on certified seeds. This will improve VRR and SRR and aid in doubling of farmer's income.

- There is a need for 'Technology Mission on Cotton 2.0' designed based on multi-stakeholder approach. Further a "Cotton Board" similar to Plantation crops is also the need of the hour to solve issues of various stakeholders associated with this important crop.
- There should be uniform application of rules and regulations under Seed Act, 1966 and Seeds (Control) Order, 1983 across the country with VCU based on SAU trials/AICRPs/ In-house trials for registration and license of plant varieties. No State Government should be allowed to make new rules in deviation of the above. "One nation, one license" principle should be adopted with enough safeguards within the Governance structure.
- Private sector companies should also be considered for seed production/distribution subsidy on certified seeds. This will improve VRR and SRR and aid in doubling of farmer's income.
- While fixing the Bt Cotton seed price, the Seed value needs to be significantly increased keeping in view the high seed production costs in order to incentivize the cotton seed marketing companies to invest in R&D in plant breeding.
- A protocol for standardization of parameters for the presence of Ht Cotton trait and its testing protocols need to be published by the Government to prevent penalizing seed companies where Ht trait contamination is detected without having any role in this.
- Regional associations need to work towards harmonising standards, regulations, procedures, and policies to expedite the movement of seeds within the region.
- There is need of uniformity in certification and labelling system across the country.
- Seed Testing Laboratories needs to be accredited by NABL to put in place a robust quality management system and better operational control.

- There is an urgent need for amendments in existing Seed (Control) Order, 1983 for smooth functioning of seed industry in the country.
- More focused efforts are required on varietal improvement of potential crops of vegetables, hybrid rice, hybrid maize, forages, pulses and Bt Cotton.
- There is an urgent need to develop strategy for seed export.
- For effective monitoring, efficiency and transparency in seed production and distribution chain Seed Traceability tools are required to be implemented on fast track.

LIST OF DELEGATES

List of Registered Delegate ISC-2023

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
1	Dr	Pranjivan	Zaveri	Managing Director	Farm Tech Biogene Pvt. Ltd.	Ahmedabad	Gujarat	India	9824258961	biogenepz@gmail.com
2	Mr	S P	Singh	Managing Director	Indian Farm Forestry Development Coperative Ltd. (IFFDC)	Gurgaon	Haryana	India	9910057238	sp.singh@iffco.in
3	Mr	Mange	Ram	Dy. General Manager	Indian Farm Forestry Development Coperative Ltd. (IFFDC)	Gurgaon	Haryana	India	8130901093	mange.ram@iffco.in
4	Mr	C P	Yadav	Asst. Manager	Indian Farm Forestry Development Coperative Ltd. (IFFDC)	Gurgaon	Haryana	India	7290071052	cpyadav72@rediffmail.com
5	Mr	K S	Sandhu	Chief Project Manager	Indian Farm Forestry Development Coperative Ltd. (IFFDC)	Gurgaon	Haryana	India	9417500958	sandhu58ks@gmail.com
6	Mr	R K	Dwivedi	Dy. Project Manager	Indian Farm Forestry Development Coperative Ltd. (IFFDC)	Gurgaon	Haryana	India	9555666778	rkdwivedi.iffdc@gmail.com
7	Mr	Ashish	Kumar	State Coordinator	Indian Farm Forestry Development Coperative Ltd. (IFFDC)	Gurgaon	Haryana	India	8295988417	rarashish@gmail.com
8	Mr	Pramod	Jadhav	Manager Corporate Sales & Marketing	Integrated Coating and Seed Technology India Pvt. Ltd.	Ahmedabad	Gujarat	India	9601549629	pramod.jadhav@incotec.com
9	Mr	Arshad	Amir	Manager Corporate Sales & Marketing	Integrated Coating and Seed Technology India Pvt. Ltd.	Ahmedabad	Gujarat	India	9998244108	arshad.amir@incotec.com
10	Mr	Hiren	Patel	Sales Executive	Integrated Coating and Seed Technology India Pvt. Ltd.	Ahmedabad	Gujarat	India	9601549650	hiren.patel@incotec.com
11	Mr	V S	Agarwal	Managing Director	Swarup Chemicals (P) Ltd.	Lucknow	Uttar Pradesh	India	9839013405	info@swarupchemicals.com
12	Mr	S	Verma	Marketing Head	Swarup Chemicals (P) Ltd.	Lucknow	Uttar Pradesh	India	9820771812	swarupchemicalsmumbai@gmail.com,
13	Dr	P	Chandrasekhar	Managing Director	Veda Seed Sciences Pvt. Ltd.	Guntur	AP/Telangana	India	8179633999	ceo@vedaseeds.com
14	Mr	Lakshmi	N M	Managing Director	Noble Seeds Pvt. Ltd.	Delhi	Delhi	India	9350042525	md@nobleseeds.org
15	Mr	Anoop Kumar	Dwivedi	Chief Marketing Officer	Noble Seeds Pvt. Ltd.	Delhi	Delhi	India	7496969427	cmo@nobleseeds.org
16	Mr	Partha	Sarathi	Manager	Noble Seeds Pvt. Ltd.	Delhi	Delhi	India	9350342520	exim@nobleseeds.org
17	Mr	Ashwani Kumar	Garg		Super Seeds (P) Ltd.	Hisar	Haryana	India	9896061571	akg@superseedsonline.com
18	Mr	Dhruv	Patel	Director	Swarnim Farms India Private Limited	Ahmedabad	Gujarat	India	9909199096	dhruv@swarnimfarms.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
19	Mr	Mohammed	Abrar	Director	Abrar Brothers and Company	Aurangabad	Maharashtra	India	9370556562	abco.india@hotmail.com
20	Mr	Gajanan	Jadhao	Managing Director	Booster Plant Genetics Private Limited	Aurangabad	Maharashtra	India	9850687888	rajejadhao7888@gmail.com
21	Mr	Shantanu	Mogal	Director	Booster Plant Genetics Private Limited	Aurangabad	Maharashtra	India	9765307888	shantanu@boosterparis.com
22	Mr	Prashant	Pawar		Booster Plant Genetics Private Limited	Aurangabad	Maharashtra	India	9136216494	pawarprashant1986@gmail.com
23	Mr	Kishor T	Veer	Managing Director	Ellora Natural Seeds Pvt. Ltd.	Aurangabad	Maharashtra	India	9158425271	mdelloraseed@gmail.com
24	Mr	Pratikshit	Pawar	Production Coordinato Manager	Ellora Natural Seeds Pvt. Ltd.	Aurangabad	Maharashtra	India	9595812555	elloraproseed@gmail.com
25	Mr	Sachin Madhukar	Bhalinge	Managing Director	Namdeo Umaji Agritech (I) Pvt. Ltd.	Pune	Maharashtra	India	9822034517	sachin@namdeoumaji.com
26	Mr	Shlok	Bhalinge	Director	Namdeo Umaji Agritech (I) Pvt. Ltd.	Pune	Maharashtra	India	8605010999	shlok@namdeoumaji.com
27	Mr	Ganesh	Ladkat	Director	Namdeo Umaji Agritech (I) Pvt. Ltd.	Pune	Maharashtra	India	9822110432	ganesh@namdeoumaji.com
28	Mr	J A	Earanna	Managing Partner	Ashoka Farm Aids	Bangalore	Karnataka	India	9341956265	earanna@ashokaseeds.com
29	Mr	Nitin	Earanna	Managing Partner	Ashoka Farm Aids	Bangalore	Karnataka	India	9980870915	nitinearanna@ashokaseeds.com
30	Dr	Jai	Singh	MD & CEO	Sakata Seed (I) Pvt. Ltd.	Gurgaon	Haryana	India	9818384531	jaisingh@sakata.in
31	Mr	Sibotosh	Dash		Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/Telangana	India	7337052626	ishika@gubbagroup.com
32	Mr	Shaikh	Firdous		Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/Telangana	India	7337052626	ishika@gubbagroup.com
33	Mr	Manoj	Saxena		Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/Telangana	India	7337052626	ishika@gubbagroup.com
34	Mr	Santosh	Manohar		Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/Telangana	India		
35	Mr	Sandeep	Kulkarni	ViceGeneral Manager	Known You Seed (I) Pvt. Ltd.	Pune	Maharashtra	India	9011076174	kyi_kulkarni@knownyou.com
36	Mr	Agasti	Govardhan	Manager Marketing	Known You Seed (I) Pvt. Ltd.	Pune	Maharashtra	India	9970300112	kyi_agasti@knownyou.com
37	Mr	Cheng De	Siao	Asst. Maager Prod. & Product Management	Known You Seed (I) Pvt. Ltd.	Pune	Maharashtra	India	9175073590	chingyou@knownyou.com
38	Mr	Chi Yeh	Hsieh	Supervisor	Known You Seed (I) Pvt. Ltd.	Pune	Maharashtra	India	8956568428	wl02388638@knownyou.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
39	Mr	Rehan	Ahmed	Asst. Manager Marketing	Known You Seed (I) Pvt. Ltd.	Pune	Maharashtra	India	9996924414	rehan78642367@gmail.com
40	Mr	Elavarasan		Proprietor	Pooja Agritech Corporation	Salem	Tamilnadu	India	9443345987	poojaagritech@gmail.com
41	Mr	K V	Somani	CMD	Somani Kanak Seedz Pvt. Ltd.	Delhi	Delhi	India	9999499392	kvsomani25@gmail.com
42	Dr	Arjun	Singh	Director	Somani Kanak Seedz Pvt. Ltd.	Delhi	Delhi	India	9466238197	gmrnd.somaniseedz@gmail.com
43	Mr	Kantilal C	Patel	Managing Director	Dinkar Seeds Pvt. Ltd.	Himatnagar	Gujarat	India	9624085276	dsplhmt@gmail.com
44	Mr	Dhruv K	Patel	Director	Dinkar Seeds Pvt. Ltd.	Himatnagar	Gujarat	India	9723826736	dsplhmt@gmail.com
45	Mr	Sunil	Kumar	Director	Star Agri Seeds Pvt. Ltd.	Sriganganagar	Rajasthan	India	9414093228	sunil@staragriseeds.com
46	Mr	Shubham	Goyal	Director	Star Agri Seeds Pvt. Ltd.	Sriganganagar	Rajasthan	India	6378768406	shubhammundawala@staragri-seeds.com
47	Mr	Raghav	Goyal	Director	Star Agri Seeds Pvt. Ltd.	Sriganganagar	Rajasthan	India	9549776963	raghav@staragriseeds.com
48	Mr	N Chandu		Director	Surya Seeds Ltd.	Guntur	AP/Telan-gana	India	7680965251	narasingu.chandu@gmail.com
49	Mr	Dineshbhai	Patel	Managing Director	Mahalaxmi Crop SciencePvt. Ltd.	Idar	Gujarat	India	9925920082	mahalaxmi212003@yahoo.co.in
50	Mr	Jatin	Chaud-hary	Director	Mahalaxmi Crop SciencePvt. Ltd.	Idar	Gujarat	India	9979840948	jatinp0948@gmail.com
51	Mr	Laxmanbhai	Patel	Director	Mahalaxmi Crop SciencePvt. Ltd.	Idar	Gujarat	India	9925920082	mahalaxmi212003@yahoo.co.in
52	Mr	Pankaj	Taneja	Managing Director	Garnier Seeds India Pvt. Ltd.	Delhi	Delhi	India	9871677777	ptaneja@garnierseeds.com,
53	Mr	V Sudarshan	Reddy	Managing Director	Palamoor Seeds Pvt. Ltd.	Mahabub-nagar	AP/Telan-gana	India	9440210123	palamoorseeds@rediffmail.com
54	Mr	Ravinder	Gupta G	Managing Partner	Kanaka Durga Hybrid Seeds Co.	Nizamabad	AP/Telan-gana	India	9948125999	kdhseeds@gmail.com
55	Mr	Vinay	Gupta G	Managing Director	Kanaka Durga Hybrid Seeds Co.	Nizamabad	AP/Telan-gana	India	9010663666	vinay0390@gmail.com
56	Mr	D Nageshwara	Rao	EC Member	Seedsmen Association	Hyderabad	AP/Telan-gana	India	9848045904	dnraoseeds@yahoo.com
57	Mr	P V Rama	Rao	CEO	Dhana Crop Sciences Limited	Secunder-abad	AP/Telan-gana	India	9849009748	vrrpolsani@gmail.com
58	Mr	P V Ravi	Kumar	CMD	Dhana Crop Sciences Limited	Secunder-abad	AP/Telan-gana	India	9912088588	pvrkumar@dhanacrops.com
59	Mr	Arun Kumar	Singh	Vice President	Navbharat Seeds Pvt. Ltd.	Ahmedabad	Gujarat	India	9983323813	arunkumar@navbharatseeds.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
60	Mr	Venkateswarlu	Yaganti	CEO	Harlal Seeds Private Limited	Secunder-abad	AP/Telan-gana	India	8978955678	yaaganti@gmail.com
61	Mr	N P	Patel	Managing Direc-tyor	Western Agri Seeds Ltd.	Gandhinagar	Gujarat	India	9925032618	info@westernagriseeds.com
62	Mr	Kamalakant	Hulamani	GM Sales & Marketing	Vokkal Seeds Private Limited	Bangalore	Karnataka	India	9900038635	hulmani@vokkalseeds.com
63	Mr	A Chalapathi	Rao	CEO	My Seeds Pvt. Ltd.	Secunder-abad	AP/Telan-gana	India	6303901501	msgacrao@yahoo.in,
64	Mr	B Venkateswarlu		Managing Di-rector	Lakshmi Narasimha Seeds Pvt. Ltd.	Hyderabad	AP/Telan-gana	India	9908766943	lnseeds1@gmail.com
65	Mr	Ramchandra G	Nake	Managing Di-rector	Sharayu Seeds Pvt. Ltd.	Aurangabad	Maharashtra	India	9359730350	md.sharayuseeds@gmail.com,
66	Mr	Natha P	Raut	Chairman	Novogold Seeds Pvt. Ltd.	Pune	Maharashtra	India	9923200425	natha.raut@gmail.com
67	Mr	Vishnu B	Joshi	Director	Novogold Seeds Pvt. Ltd.	Pune	Maharashtra	India	7745080595	vishnu.joshi@novogoldseeds.com
68	Mr	Buwasaheb G	Rout	Director	Novogold Seeds Pvt. Ltd.	Pune	Maharashtra	India	9657722153	bg.raut@novogoldseeds.com
69	Mr	Mehul K	Prajapati	Managing Partner	Indo Agri Genetics	Gandhinagar	Gujarat	India	9825447908	indoagri@hotmail.com
70	Mr	Rahul	Gurjar	General Manager	Kalash Crop Seeds Sciences Pvt. Ltd.	Jalna	Maharashtra	India	9421743276	rahul@kalashseeds.com
71	Dr	Kirtan Kumar Y	Patel	Research Director	Moti Seeds Pvt. Ltd.	Vijapur	Gujarat	India	9727920100	kirtan@motiseeds.com
72	Mr	Pritesh Kumar Y	Patel	Director	Moti Seeds Pvt. Ltd.	Vijapur	Gujarat	India	9925035763	pritesh6570@gmail.com
73	Mr	R D	Patel	Proprietor	Shree Ram AgroTech	Idar	Gujarat	India	9426032565	create_the_world@yahoo.com,
74	Mr	Rajesh	Khatri	Director	Devkishanji Vaktaji & Sons	Himatnagar	Gujarat	India	9925144781	khatriraju1972@gmail.com
75	Mr	Mohan	Khatri	Director	Devkishanji Vaktaji & Sons	Himatnagar	Gujarat	India	9825070231	dvssales1978@gmail.com
76	Mr	Ashish	Patel	Managing Di-rector	Avani Seeds Ltd.	Ahmedabad	Gujarat	India	9824069347	ashish@avaniseeds.com
77	Mr	Dhir	Singh	Chief General Manager (MKTG)	National Fertilizers Ltd.	Noida	Uttar Pradesh	India	9696033337	dsingh@nfl.co.in
78	Dr	A K	Singh	Chief Manager (Mktg)	National Fertilizers Ltd.	Noida	Uttar Pradesh	India	9580607790	draksingh@nfl.co.in
79	Mr	Ankur	Mehla	Manager (Mktg)	National Fertilizers Ltd.	Noida	Uttar Pradesh	India	7310950077	ankurmehla@nfl.co.in
80	Mr	Dwarika	Gupta	Managing Di-rector	Narmada Phosphate Limited	Bilaspur	Chattisgarh	India	9770220000	npl.10095@yahoo.com
81	Mr	Haribabu	Reddy	Sales Head	Littles Agrivet Private Limited	Chennai	Tamilnadu	India	9182286528	haribabu@littlesoriental.com
82	Mt	Dhanabalan		GM	Littles Agrivet Private Limited	Chennai	Tamilnadu	India	9384897733	dhanabalan@littlesoriental.com
83	Mr	Deep	Makadia	Director	Akshay Seed Tech Company	Junagadh	Gujarat	India	9033378525	deep.akshayseed@gmail.com
84	Mr	Bhavin S	Shah	Managing Di-rector	P.B Associates	Ahmedabad	Gujarat	India	9825071325	iscobeej@gmail.com,

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
85	Mr	Palak B	Shah	Director	P.B Associates	Ahmedabad	Gujarat	India	9825072325	palakshah103@gmail.com,
86	Mr	Shripad	Doshi	CEO	Partech Seeds Pvt. Ltd.	Ahmedabad	Gujarat	India	9638426630	partechgroup@gmail.com
87	Dr	A P	Patel	Director	Western Bio Vegetable Seeds Pvt. Ltd.	Gandhinagar	Gujarat	India	9726692100	info@westernbioseeds.com
88	Mr	Piyush K	Patel	Director	Goldking Biogene Pvt. Ltd.	Ahmedabad	Gujarat	India	9913544499	admin@goldkingbiogene.in
89	Mr	L Srinivasa	Rao	CEO	Eldorado Agritech Pvt. Ltd.	Hyderabad	AP/Telangana	India	8008801951	drlinga@gmail.com
90	Mr	L Mallikarjun	Rao	General Manager	Eldorado Agritech Pvt. Ltd.	Hyderabad	AP/Telangana	India	8008801954	linga.lmr999@gmail.com
91	Mr	Tapas	Konar	CEO	Ramnagar Seed Farm Pvt. Ltd.	Burdwan	West Bengal	India	6302006260	tapas.konar@sonaliphasal.com
92	Mr	S K Abdul	Zabbar	President	Seed Association of Bengal	Kolkata	West Bengal	India	8170004200	sk.zabbar@sonaliphasal.com,
93	Dr	Keyur	Shah	Director	Navkar Hybrid Seeds Pvt. Ltd.	Ahmedabad	Gujarat	India	9427605412	keyur7@gmail.com
94	Mr	Mohammed Munaf		Managing Partner	Meenakshi Agro Chemicals	Hyderabad	AP/Telangana	India	9849982760	macagrochemicals@yahoo.com
95	Mr	Mohammed Mohsin		Sales Head	Meenakshi Agro Chemicals	Hyderabad	AP/Telangana	India	9849982760	macagrochemicals@yahoo.com
96	Mr	S Jayaveer	Rao	Director	Gemini Seeds Pvt. Ltd.	Hyderabad	AP/Telangana	India	9246568603	sjayaveer@hotmail.com
97	Mr	B Muralidhar	Reddy	Chairman	Max Agri-Genetics Pvt. Ltd.	Hyderabad	AP/Telangana	India	9493344999	boochipalli@maxseeds.com
98	Mr	Sachin	Kalantre	Managing Director	Maharashtra State Seeds Corpn. Ltd.	Akola	Maharashtra	India	7588609600	homdo@mahabeej.com,
99	Mr	Prakash	Tatar	General Manager (Marketing)	Maharashtra State Seeds Corpn. Ltd.	Akola	Maharashtra	India	7588609670	homarketing@mahabeej.com
100	Mr	Subhash Chandra	Parikh	Director (Technical)	Seed Association of M P	Indore	Madhya Pradesh	India	9893036299	seedsubh@gmail.com
101	Mr.	Girishbhai	Patel	Managing Director	Alpgiri Seed sciences private limited	Gandhinagar	Gujarat	India	9727707521	girish.alpgiri@gmail.com,
102	Mr.	Mihir	Shah	CEO	Agriown Farmtech Private Limited	Ahmedabad	Gujarat	India	9428102150	mihir.shah@agriown.com,
103	Dr	Gopinath	Manne	Senior Scientist	Sri Sathya Agri Biotech Pvt. Ltd.	Hyderabad	AP/Telangana	India	9676724797	sathyaseeds@yahoo.co.in
104	Mr.	Dilipbhai	Patel	Partner	Sarvoday Trading Company	Idar	Gujarat	India	9825096155	stcidar@yahoo.co.in,
105	Mr	Aayush	Marodia	Director	Agrotech Seeds	Kolkata	West Bengal	India	9831048211	aayush@panseeds.in
106	Mr	Anshuman	Marodia	Director	Agrotech Seeds	Kolkata	West Bengal	India	9830388985	anshuman@panseeds.in

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
107	Mr	Arvind	Dharmal-ingam	CEO	The Hitron Herbal Seedcoat	Coimbatore	Tamilnadu	India	9043001881	arvind@hitronhtc.com,
108	Mr	Hinesh	Taneja	Director	Shipra Vegetables and Grains Pvt. Ltd.	Delhi	Delhi	India	9810082852	shipraoverseas61@gmail.com,
109	Mr	M Ravi	Kumar	Director	Nandini Agri Sciences Pvt. Ltd.	Hyderabad	AP/Telan-gana	India	9866234506	nandiravi_2000@yahoo.com
110	Mr	Kirtibhai S	Patel	Director (CMO)	Goldking Biogene Pvt. Ltd.	Ahmedabad	Gujarat	India	9825988532	admin@goldkingbiogene.in
111	Mr	Hemant Kumar	Singh	Proprietor	Haldhar Seeds & Farms	Etah	Uttar Pradesh	India	9675950409	haldharseeds9@gmail.com
112	Mr	Arthur Santosh	Attavar	CMD	Indo American Hybrid Seeds (India) Pvt. Ltd.	Bangalore	Karnataka	India	9844014442	santosh@indamseeds.com
113	Mr	Om Prakash	Choud-hary	Managing Di-rector	Welcome Crop Science Ltd.	Bangalore	Karnataka	India	9980045682	choudharyom@yahoo.co.in
114	Mr	Surinder	Singh	Director	Welcome Crop Science Ltd.	Bangalore	Karnataka	India	9980045682	choudharyom@yahoo.co.in
115	Mr	Shashank	Dharma-dhikari	Managing Di-rector	Tokita Seed (India) Pvt. Ltd.	Bangalore	Karnataka	India	9740061967	shashank@tokitaseedindia.in
116	Mr	Senthil	kumar	Secretary	Tamilnadu Seed Association	Coimbatore	Tamilnadu	India	9585917333	tnseedassociation@gmail.com
117	Mr	Mirza Karim	Baig	Managing Di-rector	New Hope Seeds India Pvt. Ltd.	Hyderabad	AP/Telan-gana	India	8917309494	newhopeseeds2@gmail.com
118	Mr	Bikrm Kr	Khuntia	Zonal Manager	New Hope Seeds India Pvt. Ltd.	Hyderabad	AP/Telan-gana	India	7008636364	newhopeseeds2@gmail.com
119	Mr	Harish	K G	Partner	Solar Seeds	Bangalore	Karnataka	India	9880692774	harish@solarseeds.co.in
120	Mr	Nagaraj	BM	Partner	Solar Seeds	Bangalore	Karnataka	India	9886100144	nagaraj@solarseeds.co.in
121	Mr	Siddhartha	Sen	Director	Parasmoni Organic & Agri Products Pvt. Ltd.	Bankura	West Bengal	India	8250445500	sidh_sen@rediffmail.com,
122	Mr	Sudarshan	Mandal	Rice Breeder	Parasmoni Organic & Agri Products Pvt. Ltd.	Bankura	West Bengal	India	7908912989	
123	Mr	Bharat Kumar Jayantibhai	Patel		Expert Genetics Pvt.Ltd.	Ahmedabad	Gujarat	India	9427873544	expertgene@gmail.com,
124	Mr	Kamal O	Zunzun-wala	Director	Safal Seeds & Biotech Limited	Jalna	Maharashtra	India	9545515954	safalseeds@rediffmail.com
125	Dr	Jaswant	Singh	ManagingDirector	Inventive Seeds Pvt. Ltd.	Bangalore	Karnataka	India	8884050040	jsingh@ispseeds.com,
126	Dr	Dinesh P	Goswami	Director (R&D)	Western Bio Vegetable Seeds Pvt. Ltd.	Gandhinagar	Gujarat	India	9879011765	info@westernbioseeds.com
127	Mr	Neel A	Bhavsar	Director	Western Bio Vegetable Seeds Pvt. Ltd.	Gandhinagar	Gujarat	India	9726692100	info@westernbioseeds.com
128	Mr	Ritesh B	Patel	Director	Western Bio Vegetable Seeds Pvt. Ltd.	Gandhinagar	Gujarat	India	9726834869	info@westernbioseeds.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
129	Mr	S Naresh	Babu	Supply Chain Manager	Image Crop Sciences Pvt. Ltd.	Kurnool	AP/Telangana	India	8897855001	naresh@sriramseeds.com
130	Mr	Mohammed Samadullah	Baig	Chairman	Global Agritec Seeds	Aurangabad	Maharashtra	India	9372549443	baig@globalagritecseeds.in
131	Mr	Mohammed Mohib	Baig	Partner	Global Agritec Seeds	Aurangabad	Maharashtra	India	9595959514	mohib_555@yahoo.com
132	Mr	Amul	Sanghani	CEO	Uniagro Exports Company LLP	Secunderabad	AP/Telangana	India	9885789433	amul@uniagro.in
133	Mr	Dhruv	Sanghani	Assistant to CEO	Uniagro Exports Company LLP	Secunderabad	AP/Telangana	India	9948085000	dhruv@uniagro.in
134	Dr	Syamal Krishna	Ghosh	VP & Head, R&D	Trimurti Plant Sciences Pvt. Ltd.	Hyderabad	AP/Telangana	India	8374633388	ghosh@trimurti.in
135	Mr	Ankush	Chugh	Director	MSN Agro Seeds Pvt. Ltd.	Delhi	Delhi	India	9910032973	ankush25200@hotmail.com
136	Mr	Akhilesh	Kushwaha	Director	MSN Agro Seeds Pvt. Ltd.	Delhi	Delhi	India	9910033672	akhileshmaurya333@gmail.com
137	Mr	Siddharth	Choudharh	General Manager	Surya Seeds and Chemicals	Fatehabad	Haryana	India	9990706600	siddharth.ftb@gmail.com
138	Mr	Su Youg	Eom	Director Internaional Sale & Marketing	Asia Seed India Pvt. Ltd.	Bangalore	Karnataka	India	821033263744	eom@asiaseed.co.kr
139	Mr	Ji Hoon	Shin	Managing Director	Asia Seed India Pvt. Ltd.	Bangalore	Karnataka	India	9731446539	jhshin@asiaseed.in
140	Mr	Veerabhadraiah T N		Manager Business Development	Asia Seed India Pvt. Ltd.	Bangalore	Karnataka	India	9945822155	veerabhadraiah.tn@asiaseed.in
141	Mr	Rajat	Sabharwal	Sales Manager	CIMBRIA		Delhi	India	9560453082	rajat.sabharwal@agcocorp.com
142	Mr	Michael	Petzmann	Grain Seed Sales,Greater Asia	CIMBRIA		Delhi	India	436648250610	michael.petzmann@agcocorp.com
143	Mr	Dhananjay	Walimbe	Manager India	Data Detection Technologies Ltd.	Pune	Maharashtra	India	9850821162	dhananjay@data-technologies.com
144	Mr	Ajay	Yadav	Service Engineer	Data Detection Technologies Ltd.	Pune	Maharashtra	India	9850821162	dhananjay@data-technologies.com
145	Mr	Gurjot Singh	Thind	Managing Director	Harvest Green Seeds	Patiala	Punjab	India	9569020123	harvestgreenseeds@gmail.com,
146	Mr	Shardul Sheth	Sheth	Co-Founder & CEO	AgroStar	Pune	Maharashtra	India	9820434146	shardul.sheth@agrostar.in
147	Dr	Devraj Arya	Arya	Vice President-Farm Solutions	AgroStar	Pune	Maharashtra	India	9004390061	devraj.arya@agrostar.in
148	Mr	Vamsi Krishna	Chelikani	Associate Vice President - Seeds	AgroStar	Pune	Maharashtra	India	9704472333	vamsi.krishna@agrostar.in

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
149	Mr	Appa	Mule	Lead - Veg Seeds Category & Procurement	AgroStar	Pune	Maharashtra	India	9100441564	appa.mule@agrostar.in
150	Mr	Vivek	Kushwah	Director	Vigour Biotech Pvt. Ltd.	Indore	AP/Telangana	India	8889500005	vivekkushwah05@gmail.com
151	Mr.	Kuninti Ganga	Reddy	Partner	Sri Ganga Hybrid Seeds Company	Nizamabad	AP/Telangana	India	9848154321	srigangaseeds@gmail.com
152	Mr	Kunta Ganga	Reddy	Partner	Sri Ganga Hybrid Seeds Company	Nizamabad	AP/Telangana	India	9848665544	srinithyabio@gmail.com
153	Mr	B K	Tripathi	CEO	Bhalsar Seeds India Pvt. Ltd.	Bangalore	Karnataka	India	9980948621	bktripathi@bhalsarseeds.com
154	Mr.	Praveen Reddy	Rachamalla	Sr. Business Consultant	Agro Business Solutions	Hyderabad	AP/Telangana	India	9966230006	praveen.rachamalla@agrosolutions.nl
155	Mr	Wouter van Stuyvesant Meijen		Director	Agro Business Solutions	Hyderabad	AP/Telangana	India	9966230006	praveen.rachamalla@agrosolutions.nl
156	Mr.	Sudheer	Grandhi	Business Consultant	Agro Business Solutions	Hyderabad	AP/Telangana	India	9966230006	praveen.rachamalla@agrosolutions.nl
157	Mr	Sanjay	Kapoor	Managing Director	Ambala Agro Machineries Pvt. Ltd.	Ambala Cantt	Haryana	India	9896238366	ambala_2004@yahoo.co.in
158	Mr	Saurabh	Kapoor	Director	Ambala Agro Machineries Pvt. Ltd.	Ambala Cantt	Haryana	India	9996010753	ambala_2004@yahoo.co.in
159	Mr	Mangapuram	Ramanath	Director	Bejo Seeds India Pvt. Ltd.	Bangalore	Karnataka	India	9182740802	r.mangapuram@bejoindia.in
160	Mr	YVS Murali	Krishna	Business Lead Veg	JK Agri Genetics	Hyderabad	AP/Telangana	India	7738235275	yvsmurali@jkagri.com
161	Mr	Kamlesh B	Shah	CEO	Dharti Seeds Corporation	Anand	Gujarat	India	9825097210	dhartiseedscorp@gmail.com
162	Mr	Lakkaram	Poshetty	Partner	Gayathri Seeds Corporation	Hyderabad	AP/Telangana	India	9848887283	gayathriseedscorporation@gmail.com
163	Mr	Aleti Bharath	Reddy	Proprietor	Suba Ganga Seeds	Hyderabad	AP/Telangana	India	8096804996	shubagangaseeds@gmail.com
164	Mr	Baddam	Ravi	Proprietor	Baddam Agri Sciences	Hyderabad	AP/Telangana	India	9441538453	srrhs2012@gmail.com
165	Mr	Maggidi	Rajeshwar	Proprietor	Sun Hybrid Seeds	Hyderabad	AP/Telangana	India	9848012201	sunseedsarmoor@gmail.com
166	Mr	Doma Konda	Bajanna	Proprietor	Sri Rama Seeds Company	Hyderabad	AP/Telangana	India		
167	Mr	Akhtar	Ali	Manager Agritech India	Intertek	Hyderabad	AP/Telangana	India	8140888786	akhtar.ali@intertek.com
168	Mr	Donakanti Naveen	Kumar	Proprietor	Sri Laxmi Seeds	Hyderabad	AP/Telangana	India	9848206256	srilaxmi.seed@gmail.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
169	Mr	Gaddam Tirupathi	Reddy	Proprietor	Gangadevi Seeds Company	Hyderabad	AP/Telangana	India	9573555150	egaddam1@gmail.com
170	Mr	Abhas	Patidar	Director	Asian Seed Private Limited	Indore	Madhya Pradesh	India	8889997414	asianseedsltd@gmail.com
171	Mr	Sanjeev Kumar	Saroha	Managing Director	Chamunda Agro Pvt. Ltd.	New Delhi	Delhi	India	9899665466	sanjeevkumar4191@gmail.com
172	Mr	A M	Rao	Seesds Coordinator	Syngenta Foundation India	Hyderabad	AP/Telangana	India	8466981920	am.rao@syngenta.com
173	Mr	D	Raghavender	Key Accounts-Manager	Syngenta Foundation India	Hyderabad	AP/Telangana	India	9959094972	raghavender.dantapuram@syngenta.com
174	Mr	Sangbin	Lee	Managing Director	Nongwoo Seed India Pvt. Ltd.	Bangalore	Karnataka	India	7338677625	md@nongwooseedindia.com
175	Ms	Philomina	Ashwani	Visa Managing Director	Nongwoo Seed India Pvt. Ltd.	Bangalore	Karnataka	India	9686084888	philomina@nongwooseedindia.com
176	Mr	Ramesh S	Mor	Proprietor	Mayur Seeds Corporation	Pachora	Maharashtra	India	9422292337	mayurseeds@yahoo.co.in
177	Mr	Rahul	Agrawal	Director	Mayur Seeds Corporation	Pachora	Maharashtra	India	9893052244	mayurseeds@yahoo.co.in
178	Mr	Sudipta	Ghosh	Director	Bankim Prosad Ghosh Seeds Pvt. Ltd.	Bally	West Bengal	India	9433239671	seedsbankim@gmail.com
179	Mr	Kartikay	Gupta	Partner	Din Dayal and Sons	Delhi	Delhi	India	9971566504	info@dindayalandsons.com
180	Mr	Kuldeep	Kundlia	Manager	Din Dayal and Sons	Delhi	Delhi	India	9911706700	info@dindayalandsons.com
181	Mr	KRISHNENDU	Mondal	GENERAL MANAGER	Centor India Agri Pvt. Ltd.	Hyderabad	AP/Telangana	India	9035276034	kmondal@centorindia.com,
182	Mr	Darren	Driscol	Global Business Manager	Centor India Agri Pvt. Ltd.	Hyderabad	AP/Telangana	India	9030262450	ddriscoll@centoroceania.com
183	Mr	Yogesh	Patel	Owner	Gangamani Bio Agritech Seeds Company	Vadodara	Gujarat	India	9824059902	gangamanibioagritech@gmail.com
184	Mr	Alpesh	Patel	Director	Dhanlaxmi Crop Science Pvt. Ltd.	Himatnagar	Gujarat	India	9825098550	account@dhanlaxmiseeds.com
185	Mr	Narayan V	Patil	Managing Director	Suvarna Hybrid Seeds Pvt. Ltd.	Bangalore	Karnataka	India	9341231422	nvp962@gmail.com
186	Mr	Sripadraj N	Patil	R & D Incharge	Suvarna Hybrid Seeds Pvt. Ltd.	Bangalore	Karnataka	India	9606134422	patil.sripadraj@gmail.com,
187	Mr	Abhishek B M		Proprietor	Karnataka Seeds Corpotation	Bangalore	Karnataka	India	9482952457	karnatakaseedscorporation@gmail.com
188	Mr	Akshat	Medakker	Country Head - India	Key Gene N.V	Hyderabad	AP/Telangana	India	9849513697	akshat.medakker@keygene.com
189	Mr	Kalpit	Patel	Proprietor	Pranami Seeds	Godhra	Gujarat	India	9714413444	pranamiseeds@gmail.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
190	Mr	Ketan	Mehta	Director	Ecosense Labs (I) Pvt. Ltd.	Mumbai	Maharashtra	India	9820028696	info@eecosense.com
191	Mr	Vinay	Goyal	Head Marketing	Regal Woven Sack Pvt. Ltd.	Ghaziabad	Uttar Pradesh	India	9958066811	vinay.goel@regalsacks.com
192	Mr	Yash	Shah	Director	Paras Genetech Pvt. Ltd.	Ahmedabad	Gujarat	India	9898945789	parasgenetech@yahoo.co.in
193	Mr	Zameer	Ahmed	General Manager	Genetic Seeds Pvt. Ltd.	Bangalore	Karnataka	India	9986667351	admin@geneticseeds.co.in
194	Mr	Jubin	Goyal	Managing Director	Hari Ganga Hybrid Seeds	Hisar	Haryana	India	8607475160	jubingoel07@gmail.com
195	Mr	Subhashree	Dey	Research Associate	Intertek	Hyderabad	AP/Telangana	India	8140888786	akthar.ali@intertek.com
196	Mr	Sandip	Thakur		Solvay Specialities India Pvt. Ltd.	Vadodara	Gujarat	India	9833060576	sandeep.thakur@solvay.com
197	Mr	Ekkehard	Schroeder	Indo- German Project team leader	Indo- German Cooperation on Seed Sector Development	Hyderabad	AP/Telangana	India	9676276362	ekkehard.schroeder@adt.de
198	Dr	Sowmini	Sunkara	National Project Coordinator	Indo- German Cooperation on Seed Sector Development	Hyderabad	AP/Telangana	India	7330882275	sowmini-sunkara-adt@outlook.com
199	Dr	Kavali	Raghavendra	National Project Coordinator	Indo- German Cooperation on Seed Sector Development	Hyderabad	AP/Telangana	India	7337225886	kavali-raghavendra-adt@outlook.com
200	Mr	Rohitkumar Dahyalal	Patel		Patel Hybrid Seeds Pvt. Ltd.	Ahmedabad	Gujarat	India	9428813967	patelhyd.seeds@yahoo.in
201	Mr	Siddharth	Mehta	Proprietor	KDM Seeds and Infrastructure Pvt. Ltd.	Khandwa	Madhya Pradesh	India	9406687000	siddharthmehta187@gmail.com
202	Mr	Subhash	Mehta	Director	KDM Seeds and Infrastructure Pvt. Ltd.	Khandwa	Madhya Pradesh	India	9425326187	kdsseeds@gmail.com
203	Mr	Parth D	Shah	Director	Dharti Seeds Corporation	Anand	Gujarat	India	8866288520	dhartibiotech@gmail.com
204	Mr	Manish M	Shah	Director	Dharti Seeds Corporation	Anand	Gujarat	India	8128126074	dhartibiotech@gmail.com
205	Mr.	Meet	Savaliya		Mantavya Seeds	Gandhinagar	Gujarat	India		meetsavaliya7056@gmail.com
206	Mr.	Viral	Kanani		Mantavya Seeds	Gandhanagar	Gujarat	India		meetsavaliya7056@gmail.com
207	Mr	Yuvraj	Singh	Manager Business Development	IPL Biological	Gurgaon	Haryana	India	9811114974	yuvraj.singh@iplbiologicals.com
208	Mr.	Dhananjay	Edakhe		IPL Biological	Gurgaon	Haryana	India	9811114974	yuvraj.singh@iplbiologicals.com
209	Mr	Harshvardhan	Bhagchandka		IPL Biological	Gurgaon	Haryana	India	9811114974	yuvraj.singh@iplbiologicals.com
210	Mr.	Satish	Munjal	Proprietor	Sai Agro Seeds	Gadarpur	Uttarakhand	India	9837071275	saiagroseeds@gmail.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
211	Mr	Himanshu	Taneja		Bharat Kaveri Overseas India	Delhi	Delhi	India	9810054840	sunnytaneja62@gmail.com
212	Mr	N Saketh		Director	Prabhakar Hybrid Seeds Pvt. Ltd.	Rayachoty	AP/Telangana	India	9553251111	prabhakarseeds@gmail.com
213	Mr	N Kireethi		Director	Prabhakar Hybrid Seeds Pvt. Ltd.	Rayachoty	AP/Telangana	India	9030555618	prabhakarseeds@gmail.com
214	Mr	Meet	Patel	Managing Director	Gujarat Agro Seeds Co.	Junagadh	Gujarat	India	9426128865	meetpatel1417@gmail.com
215	Mrs	Sushmita	Roy	VP Sales & Marketing	UACI Seed & Biotech Pvt. Ltd.	Kolkata	West Bengal	India	9836000576	sushmita.roy@universalagri.net
216	Mr	Mayuresh	Patel	Sales Head	Sabar Agro Seeds	Himatnagar	Gujarat	India	9979991717	mayur@sabaragroseeds.com,
217	Mr	V Soundararajan			Sri Krishna Seeds C/o Tamilnadu Seed Association	Coimbatore	Tamilnadu	India	8754188188	tnseedassociation@gmail.com
218	Mr	V Subramanian			Vinayagar Seeds C/o Tamilnadu Seed Association	Coimbatore	Tamilnadu	India	8754188188	tnseedassociation@gmail.com
219	Mr	A Nagarajan			Evergreen Hitech Seeds C/o Tamilnadu Seed Association	Coimbatore	Tamilnadu	India	8754188188	tnseedassociation@gmail.com
220	Mr	A Santosh	Reddy	Managing Director	Armoor Hybrid Seeds	Armoor	AP/Telangana	India	9848034163	armoorhybridseeds@yahoo.com
221	Mr	A Anil	Reddy	Director	Armoor Hybrid Seeds	Armoor	AP/Telangana	India	9848034163	armoorhybridseeds@yahoo.com
222	Mr	Asham Anil	Yadav	Director	Raama Agrotech India LLP	Medchal	AP/Telangana	India	9948335057	yadav.anilyadava@gmail.com
223	Mr	A Gangaram	Reddy	Managing Director	Green Vision Agritech	Nizamabad	AP/Telangana	India	9848612392	pvrkumar@dhanacrops.com,
224	Mr	G Divakar	Reddy	Research	Laxmi GBR Seeds	Jagityal	AP/Telangana	India	9840100680	divakarreddy680@gmail.com
225	Mr	Sanjeev Kumar			Renuga Seeds	Dharapuram	Tamilnadu	India	9585917333	tnseedassociation@gmail.com
226	Mr	Mahendra S			Nutan Agri Experts	Ranebennur	Karnataka	India	9900638688	mahendra.nutanagri@gmail.com
227	Mr	Prawut	Phongchawan	Coutry Manager	Chiatai India Pvt. Ltd.	Bangalore	Karnataka	India	9606087583	pawut.ph@chiataigroup.com
228	Mr	Krinpat	Watkaew	Head of Commercial	Chiatai India Pvt. Ltd.	Bangalore	Karnataka	India	9606087585	krinpat.wa@chiataigroup.com
229	Ms	Tejeswini R		Marketing Section Manager	Chiatai India Pvt. Ltd.	Bangalore	Karnataka	India	9945807826	tejeswini.r@chiataigroup.com
230	Mr	Alpesh	Patel	Director	Knack Packaging Pvt. Ltd.	Ahmedabad	Gujarat	India	9825444476	alpesh@knackpackaging.com
231	Mr	H N Devakumar		Managing Director	Unisem Agritech Pvt. Ltd.	Ranebennur	Karnataka	India	9448358115	devkumarhn.unisemagritech@gmail.com
232	Mr	Meghraj	Jat	Sales Head	Nandi Seeds Pvt. Ltd.	Mumbai	Maharashtra	India	9130019065	meghraj.jat@biostadt.com
233	Dr	Shailendra	Warathe	R&D Head	Nandi Seeds Pvt. Ltd.	Mumbai	Maharashtra	India	9980911200	shailendra.warathe@biostadt.com
234	Mr	Karan	Chugh	Proprietor	Eknaam Packaging	Delhi	Delhi	India	9899776887	eknaam.printers@gmail.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
235	Mr	Shashi	Chugh		Eknaam Packaging	Delhi	Delhi	India	9899776887	eknaam.printers@gmail.com
236	Dr	Surender	Kumar	Product Development Manager	Verdesian Life Sciences		USA	USA	9783682788	surender.kumar@vlsci.com
237	Mr	Deepak	Munjal	Proprietor	Guru kripa Seeds	Panipat	Haryana	India	9896253132	indiaseedscorp@yahoo.co.in
238	Mr	Karunakara	TB	Managing Director	Sanklap Agri Enterprises	Bangalore	Karnataka	India	9742012553	karunakar.thumari@gmail.com
239	Mr	Linga Reddy	Gutha		International Rice Research Institute	Delhi	Delhi	India	7893440077	l.r.gutha@irri.org
240	Mr	Mahendra	Patel	Partner	Patel Seeds Corporation	Delhi	Delhi	India	9711978097	patelseeds@yahoo.co.in
241	Mr	Ankit	Tomar		Analytik Jena India Pvt. Ltd.	Jiwana	Uttar Pradesh	India	7827294706	
242	Mr	Piyush kumar	Danani	Managing Director	Danani Seeds	Ahmedabad	Gujarat	India	8980894949	piyushdanani@yahoo.co.uk
243	Mr	Prakashbhai	Patel	Manager	Danani Seeds	Ahmedabad	Gujarat	India	8980894949	dananiseeds@gmail.com
244	Mr	Rohan	Gogia	Director Domestic Trade	Hindustan Seeds and Pesticides	Delhi	Delhi	India	7011579881	hindustanseeds1970@gmail.com
245	Mr	Karan	Gogia	Director International Trade	Hindustan Seeds and Pesticides	Delhi	Delhi	India	7011579881	hindustanseeds1970@gmail.com
246	Dr	Jeetendra	Solanki	Director	Novel Seeds Pvt. Ltd.	Jalgaon	Maharashtra	India	7507775338	dr.solanki@novelseeds.com
247	Mr	Nagaraj V		BDM	Hygrotech Engineers	Bangalore	Karnataka	India	9886144100	nagarajv@hygrotechindia.com
248	Mr	Ajai		Asst. Manager Projects	Hygrotech Engineers	Bangalore	Karnataka	India	9886144100	ajai@hygrotechindia.com
249	Mr	Rajesh Kumar	Munjal	Chairman / MD	Rama Krishna Hybrid Seeds	Delhi	Delhi	India	9810079404	rajesh@rkhsgroup.com
250	Mr	E Ganga	Reddy	Research	Laxmi GBR Seeds	Jagityal	AP/Telangana	India	9840100680	gangareddy4005@gmail.com
251	Mr	Sachin	Laddha	CFO	Comienzo Agri Science Ltd.	Raipur	Chattisgarh	India	8275233044	srathi@comienzoagri.com
252	Mr	Hemant K	Naik	Sales Co-Ordinator	Comienzo Agri Science Ltd.	Raipur	Chattisgarh	India	8818939616	hemant.n@comienzoagri.com
253	Mr	Akansh	Chugh		Ganga Seeds Pvt. Ltd.	Delhi	Delhi	India	9873925200	gangaseeds135@gmail.com
254	Mr	Satish	Kagliwal	Managing Director	Nath Bio-Genes (I) Ltd.	Aurangabad	Maharashtra	India	9325459999	md@biogenes.in
255	Mr	Rajgopal M	Bhandary	Managing Director	Tropica Seeds Pvt. Ltd.	Bangalore	Karnataka	India	9980708240	r.bhandary@tropicaseeds.com
256	Mr	N H Jaisimha		Chief Executive Officer	Tropica Seeds Pvt. Ltd.	Bangalore	Karnataka	India	9900268775	j.haritsen@tropicaseeds.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
257	Mr	Purnachandra Rao S		Managing Director	SP Hitech Printers Pvt. Ltd.	Hyderabad	AP/Telangana	India	9246171120	hitechprinters4u@gmail.com
258	Mr	Lakshay	Taneja	Business Operations Head	Religro Hybrid Seeds	Delhi	Delhi	India	9999605473	lakshay.taneja@religro.com
259	Mr	P B Paranjape		Director	Prime Seel and Weigh Technologies Pvt. Ltd.	Pune	Maharashtra	India	9822030177	pranjape@gmail.com
260	Mr	Sanjeev	Sagar	Managing Director	Osaw Agro Industries Pvt. Ltd.	Ambala Cantt	Haryana	India	9812068642	sanjeevsagar@agrosaw.com
261	Mr	Dinkar	Khurma	Sales Head	Osaw Agro Industries Pvt. Ltd.	Ambala Cantt	Haryana	India	9416024093	dinkarkhurma@agrosaw.com
262	Mr	Naveen	Labana	HOD-Marketing	Osaw Agro Industries Pvt. Ltd.	Ambala Cantt	Haryana	India	9416027043	marketing@agrosaw.com
263	Mr	Bhupinder	Garg		Seed Science technology pvt ltd.	Gidderbaha	Punjab	India	9814425382	su_nnygarg@yahoo.com
264	Mr	Ramesh B	Shiragupi	Sr. General Manager	Sakata seed India pvt.ltd	Bangalore	Karnataka	India	9845146911	rameshbs@sakata.in
265	Mr	N.ANEEL	KUMAR	Senior Manager	Coromandal International Limited	Secunderabad	AP/Telangana	India	9000303193	kumarna@coromandal.murgappa.com
266	Mr	Deepak	Dogra	Director	Bharat Agro Overseas (India)	Delhi	Delhi	India	9810048747	deepakdogra_64@yahoo.com
267	Mr	Karunesh	Saini	Managing Partner	India Seed House	Delhi	Delhi	India	9811283360	karuneshsaini@gmail.com
268	Mr	Ishwar Chander	Pahuja	Managing Director	Pahuja Seeds Pvt. Ltd.	Delhi	Delhi	India	9811180250	pahujasales100@gmail.com
269	Mr	Amarendra Kumar	Tilak	Joint Vice President	DCM Shriram Limited (Unit Shriram Farm Solutions)	Gurgaon	Haryana	India	981800160	aktilak@dcmshriram.com
270	Mr	Rajesh	Tripathi	Joint Vice President	DCM Shriram Limited (Unit Shriram Farm Solutions)	Gurgaon	Haryana	India	9815219872	rajeshtripathi@dcmshriram.com
271	Mr	Sanjeev	Sharma	Manager Seeds	DCM Shriram Limited (Unit Shriram Farm Solutions)	Gurgaon	Haryana	India	9690012014	sanjeeckumae2@dcmshriram.com
272	Mr	Vishal	Kakkar	Product Manager	DCM Shriram Limited (Unit Shriram Farm Solutions)	Gurgaon	Haryana	India	9814317700	vishalkakkar@dcmshriram.com
273	Mr	Ashish	Khurana	Director	Green Seeds Pvt. Ltd.	Delhi	Delhi	India	9891029528	greenseedsindia@gmail.com
274	Mr	Jiaul	Haque		Jiaul Haque	Tripura	Tripura	India	9612197291	ikbalhosson96@gmail.com
275	Mr	Sumit	Taneja	Product Development Manager	Asian Seeds Corporation	Delhi	Delhi	India	8686463686	sumit14taneja@gmail.com
276	Mr	Atik	Khan	Key Account Manager	Syngenta India Limited	Pune	Maharashtra	India		
277	Mrs	Ananda UVL		Head Corporate Communation and Public Affairs	East-West Seed India	Bangalore	Karnataka	India	9866102075	ananda.uvl@eastwestseed.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
278	Dr	Bibhuti Bhusan	Pattanaik		Anima Seeds	Sambalpur	Odisha	India	9818372724	pattanaik181@yahoo.com
279	Mr	M Venkat	Rao	Managing Partner	Bhulaxmi Seeds	Bargarh	Odisha	India	9937365675	bhulaxmiseeds17.2009@rediffmail.com
280	Mr	G V Bhaskar	Rao	CMD	Kaveri Seed Company Limited	Secunderabad	AP/Telangana	India	9848023934	bhaskarrao@kaveriseeds.in
281	Mr	Gundavaram	Pawan	Whole Time Director	Kaveri Seed Company Limited	Secunderabad	AP/Telangana	India	7995999544	pawan.g@kaveriseeds.in
282	Mr	C Vamsheedhar		Whole Time Director	Kaveri Seed Company Limited	Secunderabad	AP/Telangana	India	9866120780	vamshi@kaveriseeds.in
283	Mr	C Mithun	Chand	Whole Time Director	Kaveri Seed Company Limited	Secunderabad	AP/Telangana	India	9000232325	mithun@kaveriseeds.in
284	Mr	Narendrabhai G	Matholiya		Nidhi Seeds	Rajkot	Gujarat	India	9824418544	rutucropcare@gmail.com
285	Mr	Amrutbhai G	Matholiya		Nidhi Seeds	Rajkot	Gujarat	India	9824418544	rutucropcare@gmail.com
286	Mr	Jagdishbhai R	Kachhadia		Nidhi Seeds	Rajkot	Gujarat	India	9824418544	rutucropcare@gmail.com
287	Mr	Nayan	Khandhar	Plant Breeder	Nidhi Seeds	Rajkot	Gujarat	India	9824418544	rutucropcare@gmail.com
288	Mr	Pawan Kumar	Kansal	CMD	Kohinoor Seed Fields (India) Pvt. Ltd.	Delhi	Delhi	India	9582222891	pkk@kohinoorseeds.com,
289	Mr	Jatin	Kansal	Director	Kohinoor Seed Fields (India) Pvt. Ltd.	Delhi	Delhi	India	9582222801	jatin@kohinoorseeds.com
290	Mr	Sudhir	Kansal	Director	Kohinoor Seed Fields (India) Pvt. Ltd.	Delhi	Delhi	India	9350888012	sudhir@kohinoorseeds.com
291	Mr	Gubba	Kiran		Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/Telangana	India	7337052626	ishika@gubbagroup.com
292	Mrs	Gubba	Deepthi		Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/Telangana	India	7337052626	ishika@gubbagroup.com
293	Mr	K Anil Kumar	Reddy	Managing Director	Foragen Seeds Pvt. Ltd.	Hyderabad	AP/Telangana	India	9448754286	mas_34@yahoo.co.in
294	Mr	G Prabhakar	Babu	CEO	Foragen Seeds Pvt. Ltd.	Hyderabad	AP/Telangana	India	9000002334	uplprabhakar@gmail.com
295	Mr	Ashwin	Patel	Director	Classic Hybrid Seeds	Ahmedabad	Gujarat	India	9825531777	classicseeds888@yahoo.co.in
296	Mr	Nakshatra	Patel		Classic Hybrid Seeds	Ahmedabad	Gujarat	India	9825531777	classicseeds888@yahoo.co.in
297	Mr	Mandava Prabhakar	Rao	CMD	NSL Group	Hyderabad	AP/Telangana	India	9581099999	mprmd@nslindia.com
298	Mr	K Praveen	Kumar	Senior Vice President	NSL Group	Hyderabad	AP/Telangana	India	9581412313	praveenk@aaglindia.com
299	Mr	Tarak	Dhurjati	Senior Vice President	NSL Group	Hyderabad	AP/Telangana	India	9999741839	tarak.d@nslgroup.in

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
300	Mr	Sharad	Khurana	CCO	NSL Group	Hyderabad	AP/Telangana	India		sharad.khurana@nuziveeduseeds.com
301	Mr	Vaibhav R	Kashikar		Ankur Seeds Pvt. Ltd.	Nagpur	Maharashtra	India	9822201123	vrkashikar@ankurseeds.com
302	Dr	Ashwin	Kashikar		Ankur Seeds Pvt. Ltd.	Nagpur	Maharashtra	India		ashwinkashikar@ankurseeds.com
303	Dr	Ashwin	Khobragade		Ankur Seeds Pvt. Ltd.	Nagpur	Maharashtra	India		
304	Mr	Kosana Ramakoteswara	Rao	CMD	Sri Sathya Agri Biotech Pvt. Ltd.	Hyderabad	AP/Telangana	India	9848036039	krkraocmd@sathyaseeds.com,
305	Mr	Kosana Ram		Executive Director	Sri Sathya Agri Biotech Pvt. Ltd.	Hyderabad	AP/Telangana	India	9666278289	ramkosana@sathyaseeds.com
306	Mr	Kosana Narendra	Prasad	Chief Admin. Officer	Sri Sathya Agri Biotech Pvt. Ltd.	Hyderabad	AP/Telangana	India	9948094079	narenkosana@sathyaseeds.com,
307	Mr	Ch Rambabu		Managing Director	Sri Rama Agri Genetics India Pvt. Ltd.	Kurnool	AP/Telangana	India	9440024567	babu@sriramaseeds.com
308	Mrs.	Ch Vani Sri		Administrative Manager	Sri Rama Agri Genetics India Pvt. Ltd.	Kurnool	AP/Telangana	India	9398273911	vani@sriramaseeds.com
309	Dr	Chaitra V		QA/QC Incharge	Sri Rama Agri Genetics India Pvt. Ltd.	Kurnool	AP/Telangana	India	8722336787	chaitra@sriramaseeds.com
310	Mr	Veeranjaneyulu	Dronadula		Invicta Agritech India Pvt. Ltd.	Secunderabad	AP/Telangana	India	9701531606	anji.dronadula@yahoo.com,
311	Mr	K Shiva Prakash		R &D Head	Invicta Agritech India Pvt. Ltd.	Secunderabad	AP/Telangana	India		
312	Mr	Mandalapu Ravi	Kumar	Director	Amar Biotech Limited	Hyderabad	AP/Telangana	India	9866234506	nandiravi_2000@yahoo.com
313					Amar Biotech Limited	Hyderabad	AP/Telangana	India		
314	Mr	M Mahesh	Kumar	Managing Director	Royal Seeds Pvt. Ltd.	Hyderabad	AP/Telangana	India	7997744222	royalseeds19@gmail.com
315	Mr	S Krishna	Mohan	GM (R&D)	Royal Seeds Pvt. Ltd.	Hyderabad	AP/Telangana	India	9885493006	royalseeds19@gmail.com
316	Mr	Sangappa B	Nelge	Head (PD)	Indo American Hybrid Seeds (India) Pvt. Ltd.	Bangalore	Karnataka	India	9342658965	sangamesh@indamseeds.com
317	Mr	James	Williams	Head Strategic Business Unit Field Crops	Indo American Hybrid Seeds (India) Pvt. Ltd.	Bangalore	Karnataka	India	9845491900	james@indamseeds.com
318	Mr	Dilip Singh	Bhadauria	National Sales Manager	Indo American Hybrid Seeds (India) Pvt. Ltd.	Bangalore	Karnataka	India	9926084296	dilip@indamseeds.com
319	Mr	Vanka	Raghavaiah		Reliance Automation Solutions	Hyderabad	AP/Telangana	India	9346238469	r.vanka@relianceautomations.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
320	Mr	Dharmendra Kumar	Verma	Area Sales Manager North	Reliance Automation Solutions	Hyderabad	AP/Telangana	India	8813999099	dkverma@relianceautomations.com
321	Mr	Ajeet	Mulay	Managing Director	Green Gold Seeds Pvt. Ltd.	Aurangabad	Maharashtra	India	9822011111	md@greengoldseeds.co.in,
322	Dr	Ashish	Kambe	Cotton New Project-Lead	Green Gold Seeds Pvt. Ltd.	Aurangabad	Maharashtra	India	9822060505	cotton.research@greengoldseeds.co.in
323	Ms	Sangeeta	Dawar	Govt. Affairs, Public Affairs, Science & Sustainability	Bayer Crop Sciences Ltd	Delhi	Delhi	India	011-49296700	
324	Mr	P J Suresh		Lead Regulatory Advocacy & Scientific Affairs	Bayer Crop Sciences Ltd	Delhi	Delhi	India	011-49296700	
325	Mr	Manjinder	Singh	Commercial Unit Lead-Central	Bayer Crop Sciences Ltd	Delhi	Delhi	India	011-49296700	
326	Mr	Akshay D	Bhartia	President	Basant Agrotech (I) Ltd.	Akola	Maharashtra	India	9860148297	adb@basantagro.com
327	Mr	Rajoli Vijayakumar		Company Consultant	Basant Agrotech (I) Ltd.	Akola	Maharashtra	India	9849742785	vkrrajoli@gmail.com
328	Mr	Pravin	Dravid	Company Consultant	Basant Agrotech (I) Ltd.	Akola	Maharashtra	India	9766617103	pravin_dravid@hotmail.com
329	Mr	Amrendra	Singh		Green Agrevolution Pvt. Ltd.	Gurgaon	Haryana	India		
330	Mr	Kamlesh	Sharma		Green Agrevolution Pvt. Ltd.	Gurgaon	Haryana	India		
331	Mr	Pramod	Murari		Green Agrevolution Pvt. Ltd.	Gurgaon	Haryana	India		
332	Mr	Prashant	Singh		Green Agrevolution Pvt. Ltd.	Gurgaon	Haryana	India		
333	Mr	Sree	Harsha		The Hitron Herbal Seedcoat	Coimbatore	Tamilnadu	India		
334	Mr	D Nitish	Kumar	Managing Director	Lorven Flex and Sack India Pvt. Ltd.	Medak	AP/Telangana	India	9666000657	cmd@lorvengroup.in
335	Mr	Sreedhar	Koka	Marketing Head	Lorven Flex and Sack India Pvt. Ltd.	Medak	AP/Telangana	India	9885094071	cmd@lorvengroup.in,
336	Mr	Rakesh	Kumar	Marketing Executive	Lorven Flex and Sack India Pvt. Ltd.	Medak	AP/Telangana	India	9885094071	cmd@lorvengroup.in,
337	Mr	Raj Kumar	Diwedi	Marketing Executive	Lorven Flex and Sack India Pvt. Ltd.	Medak	AP/Telangana	India	9885094071	cmd@lorvengroup.in,
338	Mr	M Narender		Head Graphic Design	Lorven Flex and Sack India Pvt. Ltd.	Medak	AP/Telangana	India	9885094071	cmd@lorvengroup.in,
339	Mr	K Suresh		Manager Customer Service	Lorven Flex and Sack India Pvt. Ltd.	Medak	AP/Telangana	India	9885094071	cmd@lorvengroup.in,
340	Dr	Manish	Patel	Director	INCOTEC	Ahmedabad	Gujarat	India	9998980829	manish.patel@incotec.com
341	Mr	Ganesh Laxman	Patel	Director Marketing & Sale	Hytech Seed India Pvt. Ltd.	Medchal	AP/Telangana	India	9689914401	g.patel@hytechseed.in

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
342	Mr	Channamallikar-juna	M	Director Supply Chain	Hytech Seed India Pvt. Ltd.	Medchal	AP/Telan-gana	India	9440947948	c.mallikarjuna@hytechseed.in
343	Mr	S Jagadeshwar	Reddy	Executive Director	Seedsmen Association	Hyderabad	AP/Telan-gana	India	7036163555	ed@seedsmen.in
344	Dr	Ali Afzal		Vice President	Bangladesh Seed Associ-ation	Tejgaon	Dhaka	Bangla-desh	8801844514621	ed@bsaba.org
345	Mr	Md.Emran Hossain	Emon	Assistant General Secretary	Bangladesh Seed Associ-ation	Tejgaon	Dhaka	Bangla-desh	8801844514621	ed@bsaba.org
346	Mr	Mohammad Anwar	Hossain	Executive Mem-ber	Bangladesh Seed Associ-ation	Tejgaon	Dhaka	Bangla-desh	8801844514621	ed@bsaba.org
347	Mr	Shaligram D	Wank-hede	Executive Director	Seed Industries Association of Maharashtra	Aurangabad	Maharashtra	India	9423052000	dr.shaligramwankhede@gmail.com,
348	Mr	Raj	Kumar	Manager Asia & Pacific	Suba Seeds Company SPA	Longiano (FC)	Italy	Italy	9880090364	raj.kumar@subaseeds.com
349	Mr	Alessandro	Brunacci	Sales Manager	Suba Seeds Company SPA	Longiano (FC)	Italy	Italy	9880090364	alessandro.brunacci@subaseeds.com
350	Mr	Linda	Antimi	Export Assistant	Suba Seeds Company SPA	Longiano (FC)	Italy	Italy	9880090364	linda.antimi@subaseeds.com
351	Mr	Foschi	Davide	Sales Manager	Anseme SPA		Italy	Italy	390547382421	anseme@anseme.it,
352	Mr	Priyanga	Demata-wa		Plantseed Private Limited	Dambadeniya		Sri Lanka	94778034639	ayesha.dilrukshi@dimolanka.com
353	Mr	Hemal	Athapath-thu		Plantseed Private Limited	Dambadeniya		Sri Lanka	94778034639	ayesha.dilrukshi@dimolanka.com
354	Mr	Sandun	Edirising-he		Plantseed Private Limited	Dambadeniya		Sri Lanka	94778034639	ayesha.dilrukshi@dimolanka.com
355	Ms	Rinter	Marutara-lert	Sale Director	Lion Seeds Co. Ltd.	Bangkok		Thailand	66818194421	rin@lionseeds.com
356	Ms	Phaphatsorn	Janpram		Lion Seeds Co. Ltd.	Bangkok		Thailand	66819345647	qualityseed@lionseeds.com
357	Mr	Elie EL Haddad		President	Apollo Seeds USA INC			USA	969613283318	elie.haddad@apolloseeds.com
358	Mr	Antonio	Larosa		Larsca Seeds Sri	Trani		Italy	9915461180	info@larscoseeds.it
359	Mr	Walter William	Scarin-gella		Larsca Seeds Sri	Trani		Italy	9915461180	info@larscoseeds.it
360	Mr	Sukhwinder	Singh		Larsca Seeds Sri	Trani		Italy	9915461180	info@larscoseeds.it
361	Mr	Boonme Okman		AVP-Sales Distrib-utor	Chia Tai Co. Ltd.	Bangkok		Thailand		boonme.ok@chiataigroup.com
362	Dr	Rangsi Divarang-koon		General Manager Sales	Chia Tai Co. Ltd.	Bangkok		Thailand		rangsi.di@chiataigroup.com
363	Mr	Oman Ali	Farugue	Executive Mem-ber	Bangladesh Seed Associ-ation	Tejgaon	Dhaka	Bangla-desh	8801844514621	ed@bsaba.org

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
364	Mr	Robert MC Guinness			Prana Life	Asaka		Japan	8067053330	rob.mcguinness@gmail.com
365	Mrs	Saluja	Shrestha	Executive Secretary	CGNS Seeds Nepal	Kathmandu		Nepal	9851175661	saluja.shrestha@blc.com.np
366	Mr	Md. Alamgir Hossain		Proprietor	Zanith Seed Company	Dhaka		Bangladesh	880727032145	zanithseed@yahoo.com
367	Mr	Md Shakil Ahmed	Tuhin	Director	Kashem Beej Bhandar	Dhaka		Bangladesh	1715040643	kashemseed@yahoo.com
368	Mr	Md Hedayetul Islam	Shahin	Managing Director	Kashem Beej Bhandar	Dhaka		Bangladesh	1715040643	kashemseed@yahoo.com
369	Mr	Mohammed Saiful	Islam	International Coordinator	Kashem Beej Bhandar	Dhaka		Bangladesh	1703874966	kashemseed@yahoo.com
370	Mr	Ram Sharan	Timalsina	Deputy General Manager	Muktinath Krishi Company Limited.	Kathmandu		Nepal	9802350104	sagar.pandey@muktanathkrishi.com
371	Mr	Sagar	Pandey	R&D Manager	Muktinath Krishi Company Limited.	Kathmandu		Pepal	9802350104	sagar.pandey@muktanathkrishi.com
372	Mr	Sudhir Chandra	Nath	Business Director-ACI Seed	Advanced Chemical Industries Limited	Dhaka		Bangladesh	8801708467579	sudhir.nath@aci-bd.com
373	Mr	Mohammad Mizanpur	Rahaman		ACI Limited	Dhaka		Bangladesh	1730024476	mizanur@aci-bd.com
374	Mr	Chetan	Rao	Senior Manager Sales & Marketing (Ve. & Flower Business)	Sakata Seed India Pvt. Ltd.	Gurgaon	Haryana	India	9871115541	chetan @Sakata.in
375	Mr	Adarsh	Bapna		Bapna Seeds Pvt. Ltd.	Indore	Madhya Pradesh	India	9826598339	adarsh.bapna@bapnaseeds.com
376	Mr	Ujwal	Patil	Business Development Manager	Aligiri Seed Science Pvt. Ltd.	Gandhinagar	Gujrat	India	9687631300	ujwal.patil@alpgiri.com
377	Mr	Dwaraka	Nandina		Godavari Plant Sciences Pvt. Ltd.	Jeedijetla	AP/Telangana	India	7032264558	dwaraka50@gmail.com,
378	Mr	Jay	Karnawat		Hinkar Seeds	Indore	Madhya Pradesh	India	9589728555	hinkarseeds@gmail.com
379	Mr	Rajat	Arya	Assistant Director	Shakti Vardhak Hybrid Seeds Pvt. Ltd.	Hisar	Haryana	India	9167019425	rajat@shaktivardhakhspl.com
380	Mr	Karthik K		Director	Taiyo Gold Agri Biotech India Pvt. Ltd.	Secunderabad	AP/Telangana	India	7680020044	taiyoseeds@gmail.com
381	Mr	Vemuri Suman			Taiyo Gold Agri Biotech India Pvt. Ltd.	Secunderabad	AP/Telangana	India	7680020044	taiyoseeds@gmail.com
382	Mr	Prashant	Goel		Indigo Seeds Pvt. Ltd.	Bangalore	Karnataka	India	8218290063	prashantgpb@gmail.com,
383	Mr	Madassar	Patel	Manager IBD	Nath Bio-Genes (I) Ltd.	Aurangabad	Maharashtra	India	9970992965	mudassar.patel@nathseeds.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
384	Mr	Aman	Gupta	Marketing Director	Nutranta Seeds Pvt.Ltd.	Hyderabad	AP/Telangana	India	9814521969	nutrantaseeds@gmail.com
385	Mr	Manoj	Aggarwal	Chief Operating Officer	Nutranta Seeds Pvt.Ltd.	Hyderabad	AP/Telangana	India	9871163290	manoj.aggarwal@nutrantaseeds.com
386	Mr	Bhaskar V		Co-Founder & Director BD	Elevatoz Loyalty Pvt. Ltd.	Bangalore	Karnataka	India	9845080036	bhaskar.venkataramasetty@elevatozloyalty.com
387	Mr	Saurabh	Kumar	Regional Manager-Loyalty	Elevatoz Loyalty Pvt. Ltd.	Gurgaon	Haryana	India	9540724158	saurabh,kumar@elevatozloyalty.com
388	Mr	Hutashan		Managing Director	Manvik Hybrid Seeds Pvt. Ltd.	Malout	Punjab	India	9876835555	hutashan0927manu@gmail.com
389	Mr	Sunil Kumar			Bapna Seeds Pvt. Ltd.	Indore	Madhya Pradesh	India	9826598339	adarsh.bapna@bapnaseeds.com
390	Mr	Yong Gon Shin		Area Manager/ Overseas Sales. Seed Division	Farm Hannong Co. Ltd.	Seoul	Korea	Korea	82-2-31595700	shinyonggon@farmhannong.com
391	Mr	M H Bogwan		Executive Director	Bassal Seeds Company	Silod	Maharashtra	India	8888917144	bassalseeds@gmail.com
392	Mr	M Ikram		Managing Director	Tokyo Seeds Corporation	Malerkotla	Punjab	India	9814582386	tokyoseedscorporation@gmail.com
393	Mr	Surinder	Arora	Chairman	Proline Seeds Company India Pvt. Ltd.	Delhi	Delhi	India	9810128119	surinder@prolineseeds.com
394	Mr	Prince	Arora	Director Research	Proline Seeds Company India Pvt. Ltd.	Delhi	Delhi	India	9911499110	prince@prolineseeds.com
395	Mr	Ashish	Taneja		Taneja Seeds Corporation	Delhi	Delhi	India		
396	Mr	Juwel	Ahmed	ManagingDirector	JF Agro Pvt. Ltd.	Dhaka	Dhaka	Bangladesh	8801968773337	jfagropl@gmail.com
397	Mr	Sudhir	Kaur		S S Seeds Export	Bangalore	Karnataka	India	6386570239	ssseedexports97@gmail.com
398	Mr	Md. Tabrez		Director	Landis Seeds India Pvt. Ltd.	Hyderabad	AP/Telangana	India	9391033015	landisseeds@yahoo.co.in
399	Mr	George	Gialamas	Managing Director	EMKAT S.A		Athens	Greece	302106729170	ggialamas@emkat.gr
400	Mr	Kapil	Arora		Seeways Agri Seeds Pvt. Ltd.					
401	Mr	Rajani	Kantha	Director	Visk Agro Pvt. Ltd.	Bangalore	Karnataka	India	9448125012	rajanikantha@viskagro.com
402	Mr	Sataveer	Rotti	Managing Director	Visk Agro Pvt. Ltd.	Bangalore	Karnataka	India	9561125268	sataveerr@yahoo.com
403	Mr	Sree	Harsha	Manager Marketing & Sales	The Hitron Herbal Seedcoat	Hyderabad	AP/Telangana	India	9652173420	harsha@hitronhtc.com
404	Mr	Vikas	Tomar		Chamunda Agro Pvt. Ltd.	Delhi	Delhi	India	9899665466	sanjeevkumar4191@gmail.com
405	Mr	Ashok	Kumar		Punjab Seeds Co.	Gidderbaha	Punjab	India	9814425382	su_nnygarg@yahoo.com

S.No.	Title	Fname	Surname	Designation	Organisation	City	State	Country	Mobile	Email1
406	Mr	A K Trivedi		Director	Swarup Chemicals (P) Ltd.	Lucknow	Uttar Pradesh	India	0522-2653602	info@swarupchemicals.com
407	Mr	B.N Singh			Swarup Chemicals (P) Ltd.	Lucknow	Uttar Pradesh	India	0522-2653602	info@swarupchemicals.com
408	Mr	S K Tripathi			NSL Group	Delhi	Delhi	India	9582158101	sktripathi@nslindia.com
409	Mr	Rakesh	Jain	Managing Director	Malav Seeds Pvt. Ltd.	Indore	Madhya Pradesh	India	9827033215	info@malavseeds.com
410	Mr	Rajarshi	Kumdu	Managing Director	Mali Agritech Pvt. Ltd.	Nadia	West Bengal	India	9332182935	maliseeds@yahoo.co.in,
411	Mr	A A	Kateshia	Executive Director	Gujarat Seed Industry Association	Gandhinagar	Gujarat	India	9427000375	gspa2013@gmail.com
412	Mr	K Amaleswara	Rao		Reliance Automation Solutions	Hyderabad	AP/Telangana	India	8455240356	amaleshkagita@mmtechnologies.net
413	Mr	K G Krishnamurthy		Business Transformation Lead-IBSL	Bayer CropScience Limited	Mumbai	Maharashtra	India	9779433307	krishnamurthy.kg@bayer.com
414	Mr	Subramani			Tamilnadu Seed Association	Coimbatore	Tamilnadu	India		tnseedassociation@gmail.com
415	Mr	B S Gupta		Seed Certification Officer	Rajasthan State Seed Certification Agency	Jaipur	Rajasthan	India	9413385486	bsguptass@gmail.com
416	Ms	Anjali	Tyagi		Krishi Jagaran	Delhi	Delhi	India	9811078105	mamta.jain@krishijagran.com
417	Mr	Saksham	Kaparwar		KrishiJagaran	Delhi	Delhi	India	9811078105	mamta.jain@krishijagran.com
418	Mr	Rohit	Singh		Krishi Jagaran	Delhi	Delhi	India	9811078105	mamta.jain@krishijagran.com
419	Mr	Aarifa	Khan	DGM Marketing	Fasal Kranti (Aroxy Crops Solutions Pvt. Ltd.)	Delhi	Delhi	India	9990516662	aarifa@fasalkranti.in
420	Mr	Farha	Khan	Vice President Marketing	Fasal Kranti (Aroxy Crops Solutions Pvt. Ltd.)	Delhi	Delhi	India	8287552616	farha@fasalkranti.in
421	Mr	Pardeep	Singh		Fasal Kranti (Aroxy Crops Solutions Pvt. Ltd.)	Delhi	Delhi	India	8287552616	farha@fasalkranti.in
422	Ms	Muskan	Malik	Marketig Executive	Fasal Kranti (Aroxy Crops Solutions Pvt. Ltd.)	Delhi	Delhi	India	9990406665	muskan@fasalkranti.in

ANNEXURES

INDIAN SEED CONGRESS 2023

CEO Conclave

2nd March 2023, JW Marriott, Aerocity | New Delhi, India

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 2023	02:45 PM-02:50 PM
3	Address by President, NSAI	02:50 PM- 03:00 PM
4	First Session Speaker: Swami Gyanvatsal Ji Theme: How to remain calm and balanced under stress Situation	03:00 PM-04:45 PM
5	High Tea	04:45 PM-05:15 PM
6	Second Session Speaker: Shri Pramod Parkar	05:15 PM-06:30 PM
7	Third Session Speaker: Shri Bhupen Dubey Theme: Globalising the Seed Sector	06:30 PM-07:30 PM
8	Vote of Thanks by Executive Director NSAI	07:30 PM
9	Cocktail Dinner	07:30 PM onwards

INDIAN SEED CONGRESS 2023

Seeds for Global Unity

Day 1- Friday, 3rd MARCH, 2023

Programme Schedule of the Technical Sessions

Time	Event
9:00-9:45 AM	Registration & Tea
9:45-10:15AM	Inauguration of Exhibition Hall by Shri Ashish Bahuguna, Former Secretary (Agriculture), GoI and visit to stalls.

Technical Session I: Seeds for Global Unity – Perspectives for Growth

Time: 10:15 AM- 11:50 AM

Chair – Mr. Ashish Bahuguna, Former Secretary (Agriculture), Govt of India

Co- Chair- Dr. A. K. Singh, DDG (Horticulture), ICAR, New Delhi

Rapporteur- Dr. Anshuman Singh, Scientist, Rani Laxmi Bai Central Agriculture University, Jhansi

SN	Duration	Topic	Speaker
1	10:20 -10:40 AM	Global competitive advantage to India through Integrated Millet value chains	**Dr. Arvind Kumar** Deputy Director General-Research ICRISAT, India (Headquarters)
2	10:40- 11:00 AM	Carbon Offsets in Agriculture sector- Mechanism and monetization for Agriculture sectors	**Ms. Rajasree Ray** Economic Adviser, MoEFCC, GoI
3	11:00 -11:20 AM	Seeds without Borders: IRRI initiatives on Global and Regional Cooperation for Seed Sharing	**Dr. Sudhanshu Singh** Director, IRRI South Regional Centre
4	11:20 – 11:40 AM	Current status of global carbon market and possible opportunity in agriculture sector	**Mr. Kentaro Takahashi**, Deputy Director, Climate and Energy Area, Institute for Global Environmental Strategies (IGES)

11:40 - 11:50 AM	**Q & A and Closing Remarks by Chair / Co-Chair**

Tea Break- 11:50 AM to 12:00 Noon

Technical Session I: Seeds for Global Unity – Perspectives for Growth

Time: 10:15 AM- 11:50 AM

Chair - Mr. Ashish Bahuguna, Former Secretary (Agriculture), Govt of India

Co- Chair- Dr. A. K. Singh, DDG (Horticulture), ICAR, New Delhi

Rapporteur- Dr. Anshuman Singh, Scientist, Rani Laxmi Bai Central Agriculture University, Jhansi

SN	Duration	Topic	Speaker
1	12:05-12:25 PM	Molecular breeding of oilseeds to address quality and key challenges of productivity.	**Dr. Janila Pasupuleti**, Principal Scientist (Groundnut Breeding) & Cluster Leader – Crop Breeding, ICRISAT
2	12: 25- 12:45 PM	CRISPR based Bioengineering for novel Agriculture and food product development relevant to seed industries	**Dr. Anindya Bandyopadhyay**, Vice President, Bioengineering R&D, Reliance Industries Ltd, India
3	12:45-01:05 PM	Genetic gains in Corn- From Labs to Market	**Dr. B. M. Prasanna**, Director Global Maize Program CIMMYT
1:05 PM- 1:15 PM		**Q & A and Closing Remarks by Chair / Co-Chair**	

Lunch – 1:15 PM to 2:00 PM

Technical Session III: New approaches in Seed technology for enhancing Seed Value

Time: 02:00 PM- 03:15 PM

Chair: Dr. Panjab Singh, Chancellor, Rani Lakshmi Bai Central Agriculture University, Jhansi, Uttar Pradesh

Co- Chair: Dr. S.K. Chakrabarty, Head, Seed Science & Technology, IARI

Rapporteur: Dr. Anshuman Singh Scientist, Rani Laxmi Bai Central Agriculture University, Jhansi

SN	Duration	Topic	Speaker
1	02:05- 02:25 PM	Role of physiology-based breeding to evolve stress adaptive varieties in various crops	**Dr. M. S. Sheshshayee** Professor & Head Department of Physiology UAS, GKVK, Bangalore
2	02:25 – 02:45 PM	Breaking yield barriers in pulses productivity enhancement through Molecular approaches	**Dr. Rajiv Varshney**, Director, State Agricultural Biotechnology Center, Murdoch University (Australia)
3	02:45- 3:05 PM	New technology trends in Seed Quality assessment and certification	**Dr. Arun Kumar**, Principal Scientist, IARI
03:05 PM- 03:15 PM		**Q & A and Closing Remarks by Chair / Co-Chair**	
Tea Break 03:15 PM to 03:30 PM			

Technical Session IV: Adding Value-Novel approaches for promoting Vegetable and Forage Seeds

Time: 03:30 PM – 05:05 PM

Chair: Mr. R. K. Singh IAS, Secretary (Animal Husbandry), MoFAHD, Govt of India

Co- Chair: Dr. S .K. Malhotra, ICAR-Directorate of Knowledge Management in Agriculture

Rapporteur: Dr. Rakesh Chaudhary, Scientist, Rani Laxmi Bai Central Agriculture University, Jhansi

SN	Duration	Topic	Speaker
1	03:35– 03:55 PM	Prospects for development of high value vegetable seed industry in India	**Dr. Ramakrishnan M. Nair**, Regional Director, South & Central Asia, World Vegetable Centre
2	03:55 – 04:15 PM	Potato Seed an opportunity for Indian Seed Industry	**Dr. Brajesh Singh**, Director, ICAR-CPRI Shimla
3	04:15 – 04:35 PM	Building sustainable growth in Vegetable value chain- A perspective from breeding to market	**Dr. T. K. Behera**, Director, IIVR, Varanasi
4	04:35 – 04:55 PM	Fodder, Feed and Dairy Industry- New paradigms and approaches for sustainable growth	**Dr. Amaresh Chandra**, Director, IGFRI, Jhansi
04:55-05:05 PM		**Q & A and Closing Remarks by Chair / Co-Chair**	

Technical Session V: Seed Industry Leaders Panel-Discussion on Indian Seed industry issues

Time: 05:15 PM -06:30 PM

Chair: Dr. Panjab Singh, Chancellor, Rani Lakshmi Bai Central Agriculture University, Jhansi, Uttar Pradesh

Moderator:	**Dr. K. Keshavulu**, President, ISTA and Director (TSSOCA)	
Rapporteur:	**Dr. Tarak Durjati**, Senior Vice President, Nuziveedu Seeds	
Panelists:	1. **Mr. M Prabhakar Rao**, Nuziveedu seeds Pvt Ltd	2. **Dr. Ram Kaundinya**, Federation of Seed Industry of India
	3. **Dr. V. Subbarao Kolli** Agriculture Business Advisor	4. **Dr. Rajvir Rathi**, Bayer Crop Science
	5. **Mr. Vaibhav R Kashikar** Ankur Seeds Pvt Ltd	6. **Mr. Dineshbhai Patel** Mahalaxmi Cropscience Pvt Ltd
	7. **Mr. K. C. Sahoo** Director Commercial, NSC	
07:00 PM- 9:30 PM	**CULTURAL PROGRAM & WELCOME DINNER**	

INDIAN SEED CONGRESS 2023

Seeds for Global Unity

Day 2- SATURDAY, 4th MARCH, 2023

Time	Event
09:30-10:00 AM	i. Presentation by Bangladesh Seed Association and ii. Presentation by sponsors on innovative technology and product/ services
Tea Break 10:00 AM -10:15 AM	

Technical Session VI: Seed Quality Regulation

Time: 10:15 AM – 11:30 AM

Chair: Dr. S. K. Pattanayak, Former Secretary (Agri.), Govt of India

Co- Chair: Dr. D. K. Yadava, ADG (Seeds), ICAR, Govt of India

Rapporteur: Dr. Rakesh Chaudhary, Scientist, Rani Laxmi Bai Central Agriculture University, Jhansi

SN	Duration	Topic	Speaker
1	10:20 – 10:40 AM	Seed quality Standards, Regulations and Enforcement and their harmonization for a globally competitive industry	**Dr. K Keshavulu**, President-ISTA, MD, TSSDC and Director, TSSOCA
2	10:40 - 11:00 AM	Capability / Infrastructure of Seed Testing Laboratories and NABL accreditation	**Mr. N. Venkateswaran**, CEO, NABL
3	11:00 – 11:20 AM	Harmonization of seed regulatory system and need for amendment of Seed (Control) order, 1983	**Dr. B. B. Pattanaik**, General Secretary, NSAI
11:20 -11:30 AM		**Q & A and Closing Remarks by Chair / Co-Chair**	

11:30 AM-12:40 PM	**Unveiling of Seed Wall, visit to stalls and address by Hon'ble Agriculture Minister Shri Narendra Singh Tomar**
12:40 - 01:00 PM	**Signing of MoU for APSA University Connect Programme**
Lunch – 01:00 PM to 02:00 PM	
Technical Session VII: India in Global Seed Trade: Opportunities and Challenges **Time:** 02:00–03:30 PM **Chair**: **Mr. Sanjay Agrawal**, Former Secretary (Agri.), Govt of India **Co- Chair**: **Dr. P. K. Singh** Commissioner Agriculture, Govt of India **Rapporteur**: **Dr. Anshuman Singh** Scientist, Rani Laxmi Bai Central Agriculture University, Jhansi	

SN	Duration	Topic	Speaker
1	02:05 – 02:25 PM	Indian seed industry in global seed trade: Challenges, Present status and future strategies	**Mr. Soumen Sarkar** Business Lead – Europe & Global Oilseeds Crop Asset Lead Advanta Seeds, UPL
2	02:25 – 02:45 PM	Improving Seed Replacement Rate (SRR), Varietal Replacement Rate (VRR) and Seed Export through Agri Infra Fund	**Mr. Samuel P. Kumar**, JS (AIF), DA&FW
3	02:45 – 03:05 PM	Plant Quarantine Regulation and PRA for hassle free export-import of Seeds	**Dr. J. P. Singh**, Plant Protection Adviser, DPPQS
4	03:05 - 03:20 PM	Outcome of exposure visit to Germany and the Netherlands of the Members from Indian Seed Industry	**Dr. Raghavendra Kavali**, National Project Coordinator, Indo-German Seed Project
03:20 -03:30 PM		**Q & A and Closing Remarks by Chair / Co-Chair**	
Tea Break 3:30 PM to 03:45 PM			

Technical Session VIII: IPR, Legal framework and Traceability in Seed industry

Time: 03:45– 05:00 PM

Chair: **Dr. S. K. Pattanayak**, Former Secretary (Agri.), Govt of India

Co- Chair: **Mr. Sanjay Kumar**, Director, ICAR-IISS

Rapporteur: **Dr. Rakesh Chaudhary**, Scientist, Rani Laxmi Bai Central Agriculture University, Jhansi

SN	Duration	Topic	Speaker
1	03:50 – 04:10 PM	IPR for Plant Varieties- Implementation challenges and Road ahead	**Dr. K. V. Prabhu**, Former Chairperson PPVFRA
2	04:10 – 04:30 PM	Commercialization of Technologies for Seed Development – Agrinnovate India Approach	**Dr. Praveen Malik**, CEO, Agrinnovate India
3	04:30- 04:50 PM	Status of implementation of National Seed Traceability System	**Ms. Pratibha R. Lokhande**, DDG, NIC
04:50 – 05:00 PM		**Q & A and Closing Remarks by Chair / Co-Chair**	
5:00 PM -6:00 PM		**VALEDICTORY SESSION AND AWARD PRESENTATION CEREMONY**	
7:00 PM – 9.30 PM		CULTURAL PROGRAM & GALA DINNER	

NOTES

NOTES

National Seed Association of India

909, Surya Kiran Building,
19, Kasturba Gandhi Marg, New Delhi - 110001 (INDIA)

Ph.: 011-43553241-43; Fax: 011-43533248
E-maill: info@nsai.co.in
Web: www.nsai.co.in