



# National Workshop on Enabling Technological and Policy Interventions to Increase Cotton Productivity and Stimulate Industrial Growth

25 February, 2023



*Proceedings  
and  
Recommendations*



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**National Workshop on**  
**Enabling Technological and Policy**  
**Interventions to Increase Cotton Productivity**  
**and Stimulate Industrial Growth**

25 February 2023

*Proceedings and Recommendations*

*Organized by*

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## **Acronyms and Abbreviations**

AI	Artificial Intelligence
CDRA	Cotton Development and Research Association
CICR	Central Institute For Cotton Research
CIRCOT	Central Institute for Research on Cotton Technology
CITI	Confederation of Indian Textile Industry
CMS	Cytoplasmic Male Sterility
CSIR	Council of Scientific and Industrial Research
CVRC	Central Variety Release Committee
DDPL	Din Dayal Purushottam Lal
ELS	Extra-Long Staple
FPO	Farmer Producing Organization
FRAND	Fair, Reasonable And Non-Discriminate
FSII	Federation of Seed Industry of India
FTP	Fair Trade Practices
GAP	Good Agronomic Practices
GEAC	Genetic Engineering Appraisal Committee
GMS	Genetic Male Sterility
HDPS	High-Density Planting System
IARI	Indian Agricultural Research Institution
ICAR	Indian Council of Agricultural Research
ICGEB	International Centre for Genetic Engineering and Biotechnology
INM	Integrated Nutrient Management
MoA&FW	Ministry of Agriculture and Farmers' Welfare

MSP	Minimum Support Price
NAAS	National Academy of Agricultural Sciences
NBT	New Breeding Technology
NSAI	National Seed Association of India
PPP	Public Private Partnership
PPV&FRA	Protection of Plant Varieties and Farmers' Rights Authority
RCGM	Review Committee on Genetic Manipulation
RRF	Roundup Ready Flex
SABC	South Asia Biotechnology Centre
SIMA	The Southern India Mills Association
TAAS	Trust for Advancement of Agricultural Sciences
TAG	Textile Advisory Group
TMC	Technology Mission on Cotton
UHDP	Ultra High-Density Planting



# **National Workshop on Enabling Technological and Policy Interventions to Increase Cotton Productivity and Stimulate Industrial Growth**

## **BACKGROUND**

The first decade of the current century witnessed Silver Fibre Revolution in India. Credit for it goes to the bold decision of the Government to approve commercial cultivation of Bt cotton in 2002. As a result, in less than one decade, India tripled its cotton production (from around 13 million to 40 million bales by 2013-14) and became an important exporter of cotton in the world. Also, the cotton area increased significantly (from 8 to 12 mha) on account of the popularity and faster adoption of Bt technology by cotton farmers. Between 2002 and 2020, Bt cotton cultivation resulted in an average increase in the income of cotton farmers by USD 181.8/ha (about INR 15,000 at the current exchange rate in 2023), whereas the consumption of pesticide active ingredient declined by almost 36.4 per cent. These achievements are commendable, but since 2015, there has been a steady decline in total production (from 40 to 31 million bales) and stagnancy in yield due to resurgence of pests and prevailing adverse climatic conditions. At the same time, the national average cotton productivity (428 kg/ha in 2021-22) remains lower than the global average of 781 kg/ha, requiring further efforts towards genetic improvement of cotton and adoption of good agronomic practices (GAP). Further, by 2026 we shall need around 45 million bales to meet the demand of the Indian textile industry. We, therefore, need a clear Road Map and its speedy implementation to remain a global leader in cotton production and export.

## **PRODUCTIVITY AND QUALITY CONSTRAINTS**

Development of resistance to Bt toxin in pink bollworm and outbreaks of other pests like whitefly, diseases like bollrot, and viruses are causing significant production losses in cotton. Planting of Bt cotton without non-Bt refuge was an added factor in development of resistance to bollworm and reduction in lint harvest. Firstly, cotton leaf curl virus and tobacco streak virus transmitted through insects, seeds, and mechanically, have emerged as major threats to

cotton cultivation; and secondly the increased use of insecticides for sucking pests has increased environmental pollution. On the one hand, weed infestation is a serious problem in cotton fields and on the other hand, manual weeding is becoming a challenge due to the high cost, prolonged wet spells and non-availability of labour. Unfortunately, after launching the second generation Bt cotton technology (Bollgard II) in 2006, there has been no approval of any new biotech trait in cotton in India, whereas, other countries have moved faster with the introduction of cotton with stacked bollworm resistance (BGII) and herbicide tolerance (Roundup Ready-RR) and lately the BGII and Roundup Ready Flex (RRF) technology. By deploying the next-generation BGII RRF cotton to control bollworm as well as weeds, India can achieve a higher yield increase than that has been possible with the currently deployed biotech innovations. Low ginning outturn of lint at 33-35 per cent against 40-45 per cent obtained in other countries where lint-based marketing is prevalent is another critical factor adversely affecting the production of cotton in the country.

Cotton cultivation has been expanding in India over the years and now in 2022-23, it covers 12.5 mha, including even those areas that are not well-suited for its cultivation. About 65 per cent of the cotton growing area, mainly in the central and southern zones, is rainfed and most of the soils here have low water storage capacity, poor fertility, shallow depth and low accessibility to water resources for irrigation. As a result, 72 per cent of the cotton area comes under the low (<300 kg/ha) and medium (370-455 kg/ha) productivity categories. Deterioration in soil health due to continuous monocropping, imbalanced and inadequate nutrient application, and untimely field operations are the other causes limiting cotton productivity in the country. Most of the major cotton growing countries, including China, USA and Australia grow cotton at a 90 cm × 10 cm distance (high-density planting system- HDPS), or even closer, while in India the planting distance used is 90 cm × 60 cm. HDPS is still at the experimental stage in the country and improved varieties with specific plant types suited to such cultivation need to be developed and promoted.

The textile industry faces problems in using Indian cotton, which is contaminated with multiple items of trash. Hence, clean picking and pre-cleaning of cotton would be essential to improve the cleanliness of cotton. Mechanization of cultivation and management of plant canopy with the use of growth regulators and defoliators are suggested as the way out to obtain quality harvest with acceptable levels of trash content and to reduce the cost of cultivation.

The international markets demand - traceability of the source, fair trade practices (FTP), labelling, organic cotton, and production through sustainable agricultural practices. Conformity with the required processes would enhance the

value of products like yarn, fabric and garment and consequently the profitability of farmers and the textile industry.

## **THE NATIONAL WORKSHOP**

Keeping in view the above mentioned diverse challenges to cotton production and industry, a “National Workshop on Enabling Technological and Policy Interventions to Increase Cotton Production and Stimulate Industrial Growth” was organized by the Trust for Advancement of Agricultural Sciences (TAAS) in collaboration with Indian Council of Agricultural Research (ICAR) and National Academy of Agricultural Science (NAAS) and supported by the Federation of Seed Industry of India (FSII) at the NASC Complex, Pusa Campus, New Delhi on 25 February 2023. The workshop program is given in Annexure I. The objectives of the workshop were to: (i) have an understanding of the challenges and possible options for enhancing cotton production and productivity; (ii) assess the expected benefits of new and next-generation cotton production and processing technologies; and (iii) suggest the way forward for enabling policies to accelerate the growth of cotton production and its export. Participants (85) from the seed industry, textile industry, scientists from cotton and textile research institutions, farmers/FPOs, machinery manufacturers, ginning and spinning industry, and pesticide industry-related sectors attended the Workshop (Annexure II). It was inaugurated by Prof Ramesh Chand, Member (Agriculture), NITI Aayog, Government of India.

## **INAUGURAL SESSION**

Dr RS Paroda, Chairman, TAAS welcomed the Chief Guest Prof Ramesh Chand, Member (Agriculture), NITI Aayog, Dr CD Mayee, Prof RB Singh, Dr Ramasamy, Mr Raju Barwale and other distinguished R&D experts and industry leaders on cotton. Dr Paroda recalled that India has been a global leader in cotton production for many years which was made possible by the pioneering efforts of cotton scientists and industry. Hybrid cotton technology developed by Indian breeders followed by the commercialization of Bt cotton were the significant factors in cotton productivity enhancement. The rapid adoption of Bt cotton by the Indian farmers resulted in a remarkable increase in production which touched 40 million bales in 2013-14. However, the production has been declining in recent years and our cotton productivity of 428 kg/ha in 2021-22 remains far below the world average of 781 kg/ha. We have not adopted any new GM invention since 2006, whereas, bollworm and other pests and diseases are seriously impacting production in most of the cotton-growing regions of the country. By 2026, the estimated need of the Indian textile industry will be around 45 million bales, and to fulfil that we need to explore and exploit the potential of high-density planting system (HDPS) as practiced in several major cotton-growing countries. Concerted efforts

are needed to develop cotton varieties and hybrids with compact plant type to suit HDPS. This can be achieved quickly through an intensive breeding efforts by the seed industry in partnership with ICAR and other research institutions. Greater attention also needs to be given for improving the ginning quality of cotton, which is currently 35 per cent outturn as against the outturn of 40-45 per cent in other countries which has limited the competitiveness of Indian cotton production. Mechanization, new agronomic practices and technology induction in cotton need comprehensive support from the Government through an appropriate policy environment that encourages the adoption of cutting-edge technologies for the benefit of the Indian cotton farmer and our textile industry.

Dr Paroda further pointed out that the suggested solutions need multiple policy support from several ministries encompassing agriculture, textiles, environment and forests, science and technology, and commerce and industry. He hoped that the galaxy of experts on different aspects of cotton and textile production from both academia and industry will together come out with valuable recommendations to make the country the global leader in quality cotton and textile production.

**Dr CD Mayee**, President, South Asia Biotechnology Centre (SABC), in his presentation entitled '*Overview of Cotton Scenario in India*', elaborated on the history of cotton production and improvement in the country, comparative productivity at the global level, constraints to productivity enhancement, and gave important suggestions to overcome these constraints. He explained that in recent years, India has been producing 35-37 million cotton lint bales annually, each of 170 kg, comprising 25 per cent of the world's production during 2021. Bt-cotton hybrids introduced in 2002 for bollworm resistance had a major role in the expansion of the cotton area from 7.6 to >12.2 mha, and increase in the production from 14-37 million bales, and productivity from 300 kg to 560 kg lint/ha. Because of the very large area under the crop and highly diverse agroclimatic conditions of the cotton-growing area, cotton farm productivity is much lower than that of other countries like Australia, China, Brazil and Argentina. He underlined that low yield and high cost of cultivation are the twin problems faced by Indian cotton farmers. The most critical causes of the low yield are: (i) rainfed cultivation in nearly 67 per cent of the area; (ii) spread of long duration hybrids into marginal areas; (iii) pest and disease outbreaks (whitefly, pink bollworm and boll rot); unproductive crop by November-December due to pink bollworm infestation; and deterioration in soil health due to continuous monocropping; (iv) imbalanced nutrient application; (v) increased frequency of extreme weather events (rainfall); and (vi) delay in approval of necessary technologies leading to adoption of unauthorized (Bt/HT cotton) seeds by the farmers to the extent of about 15 per cent cotton-growing area. He recommended the following actions as the way forward:

- Bridging realizable yield gaps currently estimated at 20-30 per cent
- Product profiling and deployment of cotton varieties or hybrids suited to specific agro-ecologies
- Precision cotton farming to increase resource use efficiency and productivity
- Greater focus on soil health, returning crop residue to the soil preferably with the use of machinery
- Mechanization of harvest and post-harvest operations
- Adoption of global best practice of HDPS using early maturing compact cultivars to pave the way for the mechanization of harvesting/ cotton picking
- Regulatory approval for BG III technology (Insect + HT)
- Promotion of varieties/hybrids with high ginning outturn (GoT), and lint-based marketing
- Cotton species diversification to meet stakeholder requirements - Extra-large staple, coloured, *desi* and organic cotton.

**Dr RK Singh**, ADG (Commercial Crops), ICAR, apprised the participants about the role played by the ICAR and other public sector organizations in enhancing cotton production through research and development, particularly production and protection technologies. Cotton hybrids which resulted in 1.64 times yield enhancement were first developed by Indian public sector organization. Integrated pest management, which has proved to be very successful in control of whitefly, was developed by the Central Institute of Cotton Research (CICR) along with some State Agricultural Universities (SAUs). Fourteen homozygous Bt cotton varieties were developed in the public sector though these are yet to go to the farmers' fields. An inter-ministerial project for quality seed production is operational at several cotton research and development centres. As explained by previous speakers, there has been stagnation in cotton production during recent years. There is a need to review the GM crops release system, which resulted in release of as many as 1,500 hybrids since the introduction of Bt cotton. Nearly 15-20 lakh ha are covered under illegal HT cotton, which needs to be controlled.

The following actions were suggested for the way forward:

- Adoption of HDPS and development of varieties suitable for HDPS
- Promotion of polymulch agronomy developed by ICAR-CICR, tested at several locations and proved effective in substantially enhancing the yield
- Development of specialty cotton varieties in mission mode
- Expansion of quality seed production
- Adoption of cutting-edge genetic improvement technologies including molecular breeding and gene editing.

**Prof Ramesh Chand**, Member (Agriculture), NITI Aayog in his address as the Chief Guest appreciated the pioneering work on hybrid cotton development carried out by the Indian scientists. He advised to continue with such efforts and develop indigenous technologies to solve current and emerging problems of diseases, pests, weeds, etc. which adversely impact the yield and production of cotton in the country. The innovations need to be transformative rather than incremental for which out-of-the-box thinking would be required. The technologies should be such that farmers and other technology adopters get more with less or more with the same investment. Citing the example of disease resistance and terminal heat tolerance research being carried out by the Indian NARS scientists, Prof Ramesh Chand advised carrying out such research in cotton as well. Given the highly diverse agro-ecologies under which cotton is grown in the country, the solution would have to be area specific. With regards to the mechanization of cotton and lint production, he suggested collaborating with the most appropriate and advanced institution in the country, like IITs, irrespective of these being within or outside the national agricultural research system. To tackle the problem of spurious seed, besides the government efforts, vigilance on the part of farmers is also required. He strongly urged the experts to develop a vision document on cotton during *Amritkal*. It should set the road map of cotton development for the next 25 years to be carried out through public-private participation.

**Dr JL Karihaloo**, Trustee and Treasurer TAAS presented the vote of thanks to all the dignitaries present at this workshop, including the chief guest, reputed agricultural experts, industrialists, and technical experts on various aspects of cotton and textile production who made presentations or participated in the group discussion. Dr Karihaloo also thanked the Chairman TAAS, Dr RS Paroda for his valuable guidance in developing the workshop program.

## **SESSION I: ADVANCES IN COTTON BREEDING AND BIOTECHNOLOGY**

The session was Co-Chaired by Prof RB Singh, former President, NAAS and Dr RK Singh, ADG (Commercial Crops), ICAR and convened by Dr JL Karihaloo, Trustee, TAAS. Four presentations were made in this session.

**Dr YS Prasad**, Director, ICAR-CICR, Nagpur in his presentation entitled *Innovative Breeding Approaches for Cotton Genetic Improvement*, recalled that India has by far the largest area (13.4 mha in 2020-21) under cotton cultivation whereas the productivity of 448 kg/ha was lower than most of the other major cotton producing countries (950-2,071 kg/ha). Most of the countries with high productivity have adopted HPDS whereas in India cotton is grown at wide spacing. Also, the productivity varies very prominently across different regions of the

country. Besides, new pests and diseases are emerging while pink bollworm is showing increasing resistance to *Cry* toxin. Public sector institutions have made a significant contribution to cotton variety development having released 198 varieties of *Gossypium hirsutum*, 76 varieties of *G. arboreum* and 18 *Bt* varieties of *G. hirsutum*. Nineteen compact varieties suitable for HDPS and a few with specialty cotton traits were also developed.

Cotton breeding strategies are being revamped to develop genotypes suited for specific production regions. Efficient utilization of germplasm through the development of core collections, prebreeding, and interspecific hybridization using sources of biotic and abiotic resistance, is being carried out. Multiparental advanced generation intercross populations, embryo culture for rapid generation advancement, molecular breeding, including mapping and genomic selection, and molecular detection of diseases are some other approaches being used in cotton genetic improvement. Transgenic approach is also being used for introducing novel traits, and several such events have already been approved by GEAC. It is felt that: (i) the new cultivars can address production constraints, however, the development strategy must be targeted to each production region; (ii) innovative technologies are powerful but must be supported by research and stewardship; and (iii) the national cotton breeding program requires a significant investment to enable the adoption of innovative techniques and technologies.

The following important suggestions for the way forward were made:

- Development of product profiles of varieties/hybrids suited for different production regions
- Development of compact, early maturing, and single pick genotypes
- Breeding high GoT lines for lint-based markets
- Germplasm enrichment, pre-breeding and inter-institutional exchange of parental lines
- Strategic collaborative research partnerships for breeding varieties possessing resistance to emerging viral diseases
- Adoption of new breeding and related technologies like MAS, GWAS, phenomics, speed breeding and genome editing to accelerate variety development.

**Dr James Neilsen**, Field Crops Agronomic Systems Lead, APAC Bayer made a presentation entitled *New Innovative Approaches for Genetic Improvement in Cotton*. Since the start of the Biotech era during the late 1990s, there is an increased pace of genetic gain in cotton across all advanced cotton growing regions of the world benefiting the whole cotton industry from grower to spinner. The timely protection of the crop from weeds and insects that new traits provide enables growers to achieve their seeds' genetic potential by focused efforts on good agronomic management of the crop.

Dr Neilsen mentioned that Bayer is considering to use precision breeding to further increase the rate of genetic improvement and enable matching of the products to specific growing environments, further improving grower farming experience. To deliver precision breeding, Bayer will use customer data and insights to generate data-driven ideas based on the growers' needs. Integrating cutting-edge genomic selection models and artificial intelligence (AI), supervised by scientists, to design specific types to meet concepts, and using new agronomic methods and automation will double the rate of product improvement and accelerate trait design. The material so developed will be tested in prescriptive field evaluation to improve as per the customer's recommendations and match a product to specific environments. In addition, simulated field environments and globally connected data will enrich product and system knowledge prior to launch.

The way forward suggested is as follows:

- Bayer will continue to deliver new traits that build on the success of Bollgard® and Roundup® Ready technologies. These future traits will provide sustainability and enhance the capability of the current trait portfolio.
- An ongoing commitment to the effective stewardship of any trait remains critical and must be implemented to ensure that full value is achieved for the industry while delivering higher benefits to growers, especially smallholder cotton farmers.
- For further development of Indian cotton, the approval of current and future cotton traits would provide a platform to drive further genetic improvements. To achieve this, the full alignment of the industry is required, in particular the trait and seed suppliers. These approvals will ensure the best solutions for cotton growers and the overall prosperity of the industry.

**Dr Bharat R Char**, Mahyco Research Centre, Mahyco Private Limited speaking on *Harnessing the Potential of Technology for Cotton Improvement*, elaborated upon three sets of innovations that provide new opportunities in cotton improvement. Digital tools are being utilized in agriculture for: phenotyping; remote sensing of soil fertility; plant stand, vigour and yield analysis; and quality assurance. Examples were given of drone-based technology for crop health analysis. Predictive breeding allows *in silico* prediction of phenotype for all genotypic combinations before actual planting, off-season selection and advancement, and avoid bias in selection. Finally, new breeding technologies including gene editing are providing tools to make precise, fast, low cost and easy-to-apply modifications in the genome.

The suggestions made for the way forward are given below:

- Multiple technology approaches are needed to sustain genetic gains achieved through plant breeding, and address the major challenges associated with climate change as well as tolerance to biotic stress factors.



- Digital agriculture is offering new methods of assessing crop performance. These include precise phenotyping and yield estimation using artificial intelligence and machine learning approaches.
- To aid the crop breeder, molecular marker and genomics approaches have been used successfully and now the focus is on predictive breeding models for making decisions in breeding programs. Predictive breeding approaches can reduce time to develop a product and save on resources.
- New breeding techniques have opened a myriad of opportunities to introduce new traits in crop breeding programs.

**Dr R Mahale**, Research Head, Seedworks made a presentation entitled, *Breeding Strategies to Meet Industry Needs and Improve Farmers' Income*. He informed that India ranks first in cotton cultivation area in the world with about 12.8 mha (36% of global cotton area). It is the world's second largest producer of cotton (6.16 mt in 2021-22). In terms of productivity, India is at 42<sup>th</sup> rank with yield of 465 kg/ha. Nearly 65 per cent area is rainfed. Average yields are low due to drought, pests, diseases, narrow genetic base and low plant density.

The approval and commercialization of first generation Bt cotton hybrids in 2002 enhanced yield levels significantly. However, productivity has reduced by 2 per cent CAGR in the last decade mainly due to pink bollworm and low genetic gains. The projected requirement of cotton lint is expected to be almost 40 per cent more in the next ten years. Keeping future needs and sustainability in mind, it is critical to strengthen and fast-track cotton breeding programs in India. About 95 per cent cotton area is sown with hybrids, largely from the private sector. Further genetic gains depend on the development of superior and diverse germplasm and faster integration of plant defence traits into the product development process. At present, the seed industry is facing challenges in getting access to diverse germplasm and GM traits. Hence, germplasm diversity and enhancement through global exchange of superior germplasm should be the topmost priority. Dr Mahale suggested the formation of a cotton consortium modeled to begin with on the lines of CGIAR consortium. ICAR institutes NBPGR and CICR have good collections of 12,236 exotic accessions of four cultivated and 36 wild species of *Gossypium* from more than 55 countries, which need to be made available to the seed industry. Development of climate resilient cotton has become a necessity for the diverse agroclimatic regions of cotton in India. The wild cotton germplasm could be a good source of novel genes related to drought and heat stress tolerance, adaptability, fibre quality, oil content, and genetic male sterility (GMS) and cytoplasmic male sterility (CMS). Apart from genetic improvement of the traditional plant type, intense efforts are needed for the development of HDPS suitable genotypes, increasing harvest index, and GMS based hybrid seed production through honeybees, etc.

Access to large functional genomics database and advancement in sequencing technologies has opened up enormous opportunities to further strengthen ongoing classical breeding-based cotton research programs through the implementation of breeding by design approach. Rapid progress in genome editing technologies such as CRISPR/Cas9 system is expected to offer solutions to further enhance genetic gains and manage defense and quality traits more efficiently. A seamless regulatory mechanism and faster approval and deregulation of new GM traits for *Lepidoptera* resistance, herbicide tolerance, drought tolerance, CLCuD/TSV and sucking pests resistance, are important to enhance farmers' profitability and productivity. Adoption of integrated nutrient management (INM) technology may further enhance the overall productivity of cotton.

The following actions were suggested as the way forward to meet industry needs and improve farmers' income:

- Strengthen and fast-track cotton breeding programs in India to meet at least 4 per cent CAGR target in the next 10 years. Formation of cotton consortium on CGIAR consortium model could be a key driver to accelerate cotton improvement efforts.
- At present seed industry is facing challenges to get access to diverse germplasm and GM traits. Hence, germplasm diversity acquisition and enhancement should be given high priority. In this regard, the germplasm available with ICAR-NBPGR and ICAR-CICR need to be shared with the private sector to accelerate their evaluation and utilization.
- Use of wild species and wide hybridization and other breeding tools should be used to source novel genes related to drought and heat stress tolerance, disease tolerance, adaptability, fibre quality, oil content, sterility, and integrated into mainstream breeding materials.
- Efforts on development of climate resilient cotton should be increased to address the product needs of farmers in diverse agroclimatic regions of cotton in India.
- Intense efforts are needed to increase harvest index, fiber quality and ginning outturn in cotton.
- Development of HDPS should be a high priority to enhance productivity.
- Seed production technology interventions such as GMS/CMS based hybrid seed production through honeybees should be explored.
- Classical breeding should be strengthened by integration of breeding by design model using large functional genomics information.
- Leverage the genome editing technologies such as CRISPR/Cas9 to further enhance genetic gains and manage defensive and quality traits more efficiently.

- A seamless regulatory mechanism and faster approval and deregulation of new GM traits for *Lepidoptera* resistance, herbicide tolerance, drought tolerance, CLCuD/TSV and sucking pests, is important to enhance the farm's profitability and productivity.
- Promotion and adoption of integrated nutrient management (INM) technology is also important to further enhance overall productivity of cotton.

## **General Discussion**

The presentations were followed by a general discussion during which Dr Bhagirath Choudhary, Prof Deepak Pental and Dr RS Paroda sought clarifications from the speakers on the status of research and development on combating cotton pests that have become predominant during the recent years, and on biotechnology regulatory issues. It was informed that Bollgard technology will continue to develop to overcome the evolving resistance of pink bollworm to *Cry* toxin. Similarly, work is underway on protection technology against sucking pests. The need for the regulatory system to take timely and effective science-based decisions was emphasized.

Prof RB Singh, Co-Chair, in his concluding remarks, stressed on the need for thorough characterization of cotton germplasm, including genomic analysis, to make the best use of germplasm. He advised paying more attention to medium staple, tinted *desi* cotton, and improving its quality traits. Multiple institutions may work together to get the desired results while due credit should be shared by all the collaborating partners.

## **SESSION II: ADVANCES IN COTTON PRODUCTION AND TEXTILE INDUSTRY**

The session was chaired by Dr CD Mayee, President, SABC, and convened by Dr Rajvir Rathi, Director, PA & Science, Bayer Crop Sciences. Five presentations were made during the session.

Dr SK Shukla, Director, ICAR-Central Institute for Research on Cotton Technology (CIRCOT), Mumbai, made the presentation entitled, *Challenges in Mechanisation of Cotton Harvesting in India and Appropriate Technology for Processing of Mechanically Harvested Cotton*, authored prepared jointly by SK Shukla, VG Arude and C Sundaramoorthy, ICAR-CIRCOT. In India, efforts have been made for over two decades towards mechanisation of cotton harvesting. It is an extremely challenging task connecting several activities, like links of a chain. Earlier, a 2-row cotton picker was imported from USA and evaluated extensively in different parts of India by experts from ICAR-CIRCOT, Mumbai; ICAR-CICR, Nagpur; ICAR-CIAE, Bhopal; PAU, Ludhiana, and Dr PDKV, Akola. The imported harvester was suitable for harvesting cotton grown

in the country provided there are appropriate plant types with synchronised boll opening, plant height restricted to 4 ft, and effective defoliation of leaves, etc.

Dr Shukla apprised that considerable efforts were made to indigenise the manufacturing of cotton picker by several public and private organisations. However, limited success was realised. Later on, a well-known global picker manufacturer, New Holland (India) developed a 2-row front mounted cotton picker and Messrs John Deere (India) came out with a side mounted 1-row picker suitable for Indian farms. The performance of both of these pickers was at par with the picking machines working in western countries for over 5 decades. However, our farmers could not adopt these technologies because of the: unavailability of suitable plant genotypes having synchronised boll openings, medium plant height; unavailability of proper defoliant; absence of cleaning machinery; etc. Very recently, an Indian company, M/s. Shaktiman, Rajkot developed a front-mounted 2-row cotton picker, and it was extensively evaluated in fields for 2-3 years, and its performance was found at par with the pickers used in western countries. However, the unavailability of suitable plant genotypes, defoliant, and special cleaning machinery is hindering the adoption of this technology also.

Hand-held cotton plucker developed by SIMA, Coimbatore was extensively evaluated jointly by scientists of ICAR-CIRCOT, Mumbai; ICAR-CICR, Nagpur; and ICAR-CIAE, Bhopal. However, by using this technology about 50 per cent less cotton could be picked up as compared to traditional hand picking. In addition, it is also causing drudgery to the operator because of carrying fixed load (1 kg) and dynamic load (2 kg) on the picking arm.

The field performance data and fibre quality results revealed that the commercial pickers developed by M/s. New Holland (India), M/s. John Deere (India) and M/s. Shaktiman are promising. In order to adopt this technology at farmers' fields, we have to work on the development of suitable genotypes, optimization of pre-cleaning systems, optimizing effective defoliation system, and establishment of a demonstration plant for processing of mechanically harvested cotton. ICAR-CIRCOT has developed prototypes of a line of pre-cleaning and post-cleaning machinery for processing mechanically harvested cotton in association with M/s. Bajaj Steel Industries Ltd, Nagpur. We could reduce the trash content from 6-7 per cent to 2-3 per cent on raw cotton. There is a need to further optimize the machinery and improve the defoliation effectiveness to reduce the leaf content in mechanically harvested cotton.

The following important actions were suggested as the way forward:

- All stakeholders including farmers, seed companies, ginners, spinners, agri-machinery manufacturers and the Government must join hands and be united

for a common purpose in “Mission Mode” for a quick transition to mechanical picking of cotton.

- Increasing cotton productivity to offset the additional cost incurred on defoliation, growth regulators, boll openers, additional cleaners, maintenance cost, etc.
- Improvement in synchronized boll opening
- Optimization of defoliants, especially for low temperatures
- Optimization of pre-cleaners and post cleaners
- Establishment of pilot plant at CIRCOT, Nagpur (as done under Technology Mission on Cotton)

**Mr Mukesh Joshi**, Senior Scientist (Agronomy), Shaktiman Agrimachinery in his talk on *New Technologies for Cotton Production for Economical Production and Maximising Yields*, presented a detailed account of the machinery developed by the company to facilitate cotton production and harvesting. The company is the leader in indigenous cotton-picking machines. It developed a complete set of machine solutions from land preparation to residue management, which will help farmers in getting better and more effective harvest/yield. Shaktiman has a global presence through its sale and international collaboration for equipment development. Services are also offered as a package for cotton mechanization under HDPS, which also addresses the issue of labor shortage and high cost. Some of the continuing challenges of cotton mechanization that need to be addressed on priority are:

- Development of pre-cleaners suited to Indian needs
- Facilitating defoliants availability and standardization of applications
- Improvement in machinery for ginning seed handling
- Encouraging the adoption of technologies by farmers through financial support and skills development.

**Mr T Rajkumar**, President, Confederation of Indian Textile Industry (CITI) made an online presentation entitled, *Views of Textile Industry*, during which he detailed the current status, future prospects and priority areas of attention for accelerating the growth and profitability of the Indian cotton industry. Indian cotton has over 5,000 years of history and has been the engine of growth for the development of the Indian textile industry. Cotton being one of the prominent cash crops is quite attractive for farmers and today it is sustaining the livelihoods of around 6.5 million farmers who are involved directly in cotton cultivation and over 25 million people involved in the manufacture of various products out of the home-grown cotton. Contrary to the world, the Indian Textile and Apparel (T&A) Industry is mainly cotton based with Indian exports being dominated by cotton-based T&A products. Hence, institutions like TAAS, ICAR and NAAS have a

critical role in the growth of the Indian textile industry in general and cotton-based textiles in specific. Today India accounts for about 23 per cent of the world's cotton production. However, the fact that this production is coming from about 38 per cent of the world's cotton acreage is worrisome for the entire cotton value-chain. This huge difference between acreage and production is mainly due to the low cotton yield of India, which is constantly declining and currently hovering around 450-500 kg/ha as against around 800 kg/ha of world productivity level. Moreover, there are many countries like China, Brazil, Russia, Israel, etc. which have achieved cotton productivity above 1,700 kg/ha.

Ginning is the primary processing industry that plays a major role in controlling the contamination level and gin-out ratio. Indian ginning and processing industry is one of the largest in the world. There have been many recent advancements in ginning and processing such as moisture control in seed cotton and lint, modern baling presses, contamination scanners, efficient cleaning devices for seed cotton and lint, etc. However, Indian cotton is still one of the most contaminated cottons in the world. Moreover, the gin-out ratio in India is also low as compared to other cotton-producing nations in the world. It affects both the quantity and quality of the downstream industry.

Mr Raj Kumar informed that since a long time, the industry has been demanding the Government to announce policy measures to deal with the current cotton situation. Now the Government is working actively towards the development of cotton economy through continuous stakeholder discussions and is also adopting a PPP mode to work towards improving the quality, productivity, and branding of Indian cotton. The recently constituted Textile Advisory Group (TAG) under the Chairmanship of Shri Suresh Kotak, Chairman, Kotak Ginning & Pressing Industries Ltd, who is also a Corporate Member of CITI is proving to be a game changer for the Indian Cotton Sector. TAG is having representation from the Ministry of Textiles, Ministry of Agriculture & Farmers' Welfare, Ministry of Commerce & Industry, Office of the Textile Commissioner, The Cotton Corporation of India Ltd, ICAR-CIRCOT and industry stakeholders. TAG is working at its full capacity in identifying and resolving the various underlying issues of the cotton value chain including the low productivity and high contamination issues. As mandated by TAG, CITI through its cotton development and extension activities arm CITI-Cotton Development and Research Association (CDRA) has submitted a master plan for the development of the Indian cotton economy highlighting the need for efforts towards productivity enhancement, improving farming practices, improving availability of better seeds to farmers, irrigation facilities and branding for better value realization of Indian cotton in the global markets.

He further informed that based on the recommendation, the Government has now come up with a Pilot Project on Cotton in association with ICAR-CICR,

CITI-CDRA, The Southern India Mills Association (SIMA)-CDRA, KVK's, seed companies, and various other stakeholders to augment the supply of cotton, especially extra-long staple cotton. In its first year of operation, the Pilot Project on Cotton will cover about 15,000 ha of land in different cotton-producing states and will involve three technological interventions: (i) high-density planting system (HDPS) in low-productivity areas with shallow soils, (ii) closer spacing planting system in low-productivity areas with medium deep soils under rainfed cotton ecosystem with canopy, nutrient, soil health management, and (iii) production technology for extra-long staple (ELS) cotton in niche areas under the irrigated farming situation.

The project is aimed at increasing Indian cotton productivity to a level of the world's average yield and also reducing the level of cotton contamination. The best agronomic practices evolved from this project will be replicated in other cotton-growing regions so as to have a significant impact on India's cotton productivity and quality. As the largest cotton producer in the world, India stands to gain a lot from strengthening of the cotton sector and addressing the current issues of improving productivity, yield and technology.

Mr Raj Kumar urged all stakeholders attending the workshop to come up with more such Pilot Projects or extend their cooperation to the ongoing projects so that together rapid progress is made for the cotton economy and for uplifting millions of cotton farmers socio-economically. He also invited all to work in collaboration with CITI-CDRA and utilize its years of experience and strong farmer connect to make a positive impact in the Indian cotton sector.

**Dr M Ramasami**, Rasi Seeds in his presentation on *HDPS method of cotton cultivation to improve yields* highlighted the advances made and future R&D needs, especially for the success of HDPS cotton in India. Cotton production in India has seen a revolution after the approval of Bt cotton in 2002. The coverage of Bt technology has seen rapid growth reaching nearly 95 per cent by 2007-2008. The productivity also kept increasing reaching lint production of 392 lakh bales in 2013-2014 and productivity of 565 kg/ha. After 2014, the production went down to the level of 311.18 lakh bales in 2021-2022. Hence, there is an urgency to take appropriate steps to increase the productivity of cotton in India. While examining the best cotton cultivation practices being used in different countries, it was realized that we have to change our cultivation practices and agronomy. Many countries are adopting high plant populations and mechanical planting and harvesting, so Rasi Seeds has decided to work on increasing plant population as being followed in the USA, Brazil and Australia. The aim is to ultimately reach one lakh plants per hectare population. To accommodate such a high population, it becomes very important to breed a new plant type. The Project Rasimax is being implemented to standardize the cotton high density planting system.

The objective is to develop early hybrids suitable to grow in light soil, rainfed areas where the yield ranges around 273 kg lint/ha. It is aimed to double the productivity of such areas, which comprise 4 mha of cotton growing area. Rasi Seeds aims to develop early compact plant type with 15-20 big bolls per plant with ginning outturn of 40-45 per cent.

In order to develop high population of about 30,000 plants per acre, manual planting is very difficult. To achieve the optimum population, mechanical planter, preferably pneumatic planters, are to be used for planting. This planting method gives uniform germination and growth of seedlings. In order to control the growth, induce synchronized flowering and boll bursting, there is a need to spray plant growth regulator. It is very essential to standardize the doses and the number of sprays of plant growth regulator (PGR) for each variety separately. The availability of labor for field work has become very scarce. Hence, mechanization is becoming essential. For machine harvesting, the bolls opening should be synchronous and it is necessary to remove old and green leaves by spraying defoliant. The defoliant, however, is not readily available and needs to be made available for effective cotton machine harvesting. Shakthiman agricultural machines and implement manufacturers have developed a harvester which is being used at present for harvesting trials on cotton.

In India, farmers sell their cotton as *kapas* to ginners and *mandis*. The price is fixed by the buyers based on cleanliness, and other fiber parameters. Cotton harvested by machine has 10-15 per cent trash, which has to be removed from *kapas* before sending to market. In developed countries, since farmers have large land holdings, they themselves have implements like planters, sprayers, harvesters, pre-cleaners and ginnery. For Indian conditions, it is suggested to develop mobile pre-cleaners which can be hired by farmers to clean their cotton harvest. Thus, for HDPS to become successful, pneumatic planters, cotton harvesters and pre-cleaners should be made available to farmers. The success of these efforts depends on how end-to-end mechanization becomes successful. With the available plant type of HDPS the Rasi Seeds is able to achieve an average of 30-40 per cent yield increase by mostly manual sowing and with limited machine sowing. We are very confident to increase the yield by 50-60 per cent through improving the genotype and by the use of pneumatic planters.

Suggestions for the way forward included:

- Developing early, dwarf plant type, with 15-20 bigger bolls amenable to high density (90 cm × 15 cm) planting
- Government support initially for 3-5 years for planting machines by way of subsidy to farmers, machinery hiring centers, FPOs and NGOs working for supporting the farmers involved in cotton cultivation



- Standardization and use of plant growth regulators to control the canopy of the plant and to induce flowering, and hastening faster development of bolls
- Defoliants be imported or license issued to manufacture the defoliants in India itself and standardization of application to be ensured
- Harvesters, portable pre-cleaners—machinery refining and standardization
- Extension – training and educating farmers in new systems of cultivation and machinery

Mr Mahesh Sharda, Din Dayal Purushottam Lal (DDPL) Group of Industries in his presentation on *Path for Indian Cotton Farmers* recounted his experience as a cotton producer and trader. He opined that cotton farming in India is very challenging involving many risks and, hence, farmers grow it out of compulsion. While making several suggestions on enhancing cotton productivity and international competitiveness of Indian cotton, he strongly advocated the use of the latest farm technologies and knowledge. Comparing with the rapid adoption of mobile technologies in the country and the benefits it has brought, he strongly advocated the adoption of biotech seeds. He pointed out that GM products are being consumed in several countries without any ill effects. Even in India, there has been no report of any adverse health effects due to the consumption of cotton seed oil produced largely from GM cotton seed.

Following suggestions were given as the way forward:

- Crop mulching, efficient nutritional management, and drip irrigation
- Development of transgenic genotypes suitable for HDPS
- Promoting the use of artificial intelligence and mobile apps for farmers to select the best seeds for their specific locations
- Productivity needs to be raised to match the global levels as also to release the land for food and other needed crop production
- MSP and crop insurance policies to be changed so that these can best serve the need to enhance the productivity and income of farmers
- Substantial increase in cotton research investment based on the income gain that increased productivity
- Value-addition of cotton products including organic cotton, traceability, and environmental friendliness

### **SESSION III: PANEL DISCUSSION - ENABLING POLICIES TO ENHANCE COTTON PRODUCTIVITY AND STIMULATE INDUSTRIAL GROWTH**

The session was co-chaired by Prof RB Singh, Former President, NAAS; Dr RS Paroda, Chairman, TAAS and Dr Ram Kaundinya, Director General, FSII, and

convened by **Dr Bhagirath Choudhary**, Director SABC. Six panelists participated in the discussion.

**Dr PK Singh**, Agriculture Commissioner, Government of India speaking on *Strategy for Improving Cotton Production* emphasized the contribution of cotton R&D in accelerating the growth of cotton sector. India has achieved remarkable growth in cotton production and has been consistently producing around 35 million bales of lint. The area under cotton increased to 12 mha with yield surpassing 550 kg lint/ha resulting in the country being recognized as a cotton surplus country. The cotton export has also increased manifold to an estimated 10 lakh bales annually for the last 15 years. The Technology Mission on Cotton launched in 2000 to improve the production, productivity, quality, marketing infrastructure and ginning capabilities implemented in conjunction with approval and large-scale adoption of Bt cotton from 2002 onwards have had far reaching implication for a robust cotton textile value-chain. However, despite good progress, India remained deficit of extra-long staple (ELS) cotton. To overcome the supply constraints of ELS cotton, Government of India will be launching a program in 2023-24 to enhance the productivity of extra-long staple cotton by adopting a cluster-based and value-chain approach through Public Private Partnerships (PPP). The ELS cotton program will strengthen collaboration between farmers, state and industry for input supplies, extension services, and market linkages to increase the supply of ELS cotton.

While delivering the lecture on *Quality Seed Production*, **Dr DK Yadava**, ADG (Seeds), ICAR stated that the Central Variety Release Committee (CVRC) has released a total of 472 cotton varieties and hybrids since 1969. The cotton breeder seed indent for the recently approved cotton varieties and hybrids in *kharif* 2023 from the States of Punjab, Tamil Nadu and the National Seed Association of India (NSAI) was merely 1.63 quintals, foundation seeds of 81.5 quintals and certified seeds of 4,075 quintals. These cotton varieties and hybrids include CICR-H Cotton 36 (Suraksha), Central Cotton CCH 14-1 (Sunantha), ICAR-CICR Bt-6, ICAR-CICR 16 Bt, ICAR-CICR 23 Bt, LD 1019 and Central Cotton CCH 4474 (Subhiksha) etc. It is ironic that of the total requirements estimated at 2,40,963.5 quintals for cotton seeds, almost 99.9 per cent is met by the private sector while the remaining 0.1 per cent is from public sector institutions comprising State Seed Corporation, Department of Agriculture and State Agency.

Dr Yadava informed that the Committee of the Ministry of Agriculture and Farmers' Welfare (MoA&FW) under the Chairmanship of Secretary, DARE and DG, ICAR has discussed the issues related to seeds on 14 September 2022 and has recommended various measures to strengthen seed chains including: (i) no un-notified varieties except those registered by Protection of Plant Varieties and

Farmers' Rights Authority (PPV&FRA) be allowed in seed chain; (ii) the current AICRP protocol of testing the experimental varieties/hybrids in multi-location trials for three years may be reduced, based on their performance and quality of data submitted by the sponsoring agency, to 2 years testing; (iii) constitution of the state-wise/zone-wise committees by the Director, Indian Institute of Seed Science, Mau, for monitoring truthfully labeled seeds to ensure the quality; and (iv) the Department of Agriculture and Farmers' Welfare may examine the extant guideline for the issuance of the notification regarding a national certification agency under ICAR. While concluding his interventions, he highlighted the following important issues in cotton seed production:

- Need for phasing out or banning of hybrids based on criteria of performance, resistance to pink bollworm and susceptibility to whitefly
- Preventing rampant cultivation of unauthorized Bt hybrids
- Ensuring the quality of truthfully labeled seed
- Efficient seed certification system
- Promotion of Bt varieties in the seed chain
- Development of varieties suitable for HDPS
- Rationalization in seed indenting, licensing and regulation by the states.

**Mr Simon Wiebusch**, Executive Director, Bayer India echoing the *Views of Crop Protection Industry*, conveyed his appreciation to TAAS and NAAS for organizing this important National Workshop at a time when the country is deliberating on ways and means to improve cotton productivity and increase cotton production. In the past, India has adopted technologies such as Bt cotton and hybridization to tackle biotic and abiotic stresses and boosted cotton production, which peaked in 2013-14. Over a decade now, there have been delays in decision-making on field testing and deregulation of new cotton traits, and overarching uncertainty around the biotech ecosystem. The investor community has shown trust and resilience to a certain degree in the cotton seeds and trait market. However, cascading delays may have compounding effects and become counter-productive in the long run. The key stakeholders may suggest concrete measures to revamp policy and regulatory landscape for the transformation of cotton production amidst climate change threat.

**Mr Raju Barwale**, Chairman, Mahyco Grow presenting the *Views of Agri-biotech Industry* reminded that the application of biotechnology for helping crop protection and securing crop yields is globally well-proven for over the last twenty-five years. During this period, the biotechnology application areas have expanded successfully to cover insect resistance, herbicide tolerance, drought tolerance, and nutrition quality improvement. In spite of such multiple applications with no verifiable adverse effects, there is ideological resistance in promoting this

technology due to some vested interests. In India, Bt Cotton has been a great success helping the country to become the largest cotton producer globally, and after the introduction of this technology, become the second largest exporter from being a net importer. There are a number of research reports from independent sources to show the benefits to various stakeholders. The adoption of Bt cotton by over 95 per cent of cotton farmers in less than a decade is resounding evidence of the success of the technology. India exported over ₹ 1,140 billion (Rupees one lakh fourteen thousand crore) worth of cotton and cotton products during the last fiscal year, enabled by improved availability of cotton in the country. India's cotton productivity is still much less than the global average. There are opportunities to deploy crop biotechnology further to help improve cotton productivity. HT technology which can minimize the labour requirement for weeding is one such opportunity. Recently, the USA has approved super stacked GM cotton with seven genes including a gene to control sucking pests for commercial application, which is another such opportunity.

India has a large number of well-qualified scientists specializing in the promising field of crop biotechnology. If the enabling policies of encouraging the scientists and the industry are brought in, these can not only help improve cotton productivity but also bring about similar productivity transformation in many other crops for the benefit of our farmers and our country. While these are clear opportunities for Indian cotton farmers, following are the areas where the agribiotech industry in India requires support from the policymakers to invest further in product development for the benefit of our farmers:

- Science-based and predictable regulatory process to be in place so that there is clarity and certainty to get the regulatory approvals for the technology products
- Protection of IP rights of the inventors/researchers, which is a reasonable expectation from any sector where the innovations are capital and skill intensive
- Pricing freedom based on market-based approach over the administered one to enable the investors to recover and reinvest in R&D
- Alignment and consistency amongst the central and state policymakers to minimize the uncertainties for the agribiotech sector
- Adequate communication initiated by the governments to minimize the adverse impact amongst the stakeholders and public of deliberate miscommunication on the usefulness and safety of agricultural biotechnology by some interested quarters.

**Mr M Prabhakar Rao**, President, National Seed Association of India while presenting *NSAI's Views on Cotton Seed Industry*, emphasized that India can

produce more than 600 lakh bales of high-quality contamination-free cotton by adopting high density planting and mechanization where the seed industry can play a major role. Following specific recommendations as the way forward were made by him:

- Spreading awareness among the farmers about high density planting including timely use of growth retardants, defoliant, genotypes suitable for such agronomy is very important since changing agronomy is very difficult to achieve as compared to changing a variety or a crop protection practice.
- NSAI and FSII reached a broad understanding on fair, reasonable and non-discriminate (FRAND) trait licensing. The framework of understanding also enables to broad-base the insect or HT resistance traits which need to be leveraged by the industry players for the development of better varieties.
- Development of varieties with stacked traits can become a great opportunity for the farmers to move towards ultra high-density planting (UHDP) for shortening the cotton crop duration and mechanizing the cotton harvest. Shorter duration cotton can lead to two crop systems in the Central and South zones thereby adding about 6-7 mha of additional cropped area, which can contribute not only to higher income to farmers but also contribute to enhanced production of pulses, oilseeds and minor millets having great demand in our country.
- Strengthening of breeders' rights as provided in the PPV&FR Act can help in giving the confidence to the breeders to move towards breeding new cotton varieties to meet such futuristic requirements of the farmers which can happen over a 5-10 years period from now.
- Development of new traits using gene-editing techniques through a consortium of research institutes cutting across Council of Scientific and Industrial Research (CSIR), ICAR, Indian Agricultural Research Institute (IARI), International Centre for Genetic Engineering and Biotechnology (ICGEB) and even the global agri-technology companies to bring new traits for insect resistance, fibre quality, ginning percentage enhancement, drought tolerance etc., is the need of the hour which can be coordinated by a High-Power Committee comprising eminent experts from the Government and the private sector representing both textile and seed sectors.

**Mr Suresh Kotak**, Chairman, Textile Advisory Group (TAG) appointed by the Government of India gave an online talk on *Cotton Productivity for Textile Industry Growth* during which he dwelt upon the policy framework, governance and systems aspects that impact cotton productivity. The latter in turn impacts the industrial growth. He highlighted the following important points:

- To stimulate industrial growth, there is need to improve, improvise and upgrade our systemic lacunae and infirmities.

- Despite deploying the largest acreage of 33-35 per cent of global land, we are one of the lowest in productivity.
- There are various systemic defects that must be addressed right away. This would improve cotton productivity to a good extent, and with systemic changes, achieving average productivity of 900-1,000 kg/ha should not be difficult.
- Australia has a well-framed system of ensuring appropriate seed availability, best and continuously evolving agro-practices. Despite meager rains, water management in Australia is superb due to a very well-structured irrigation system. The Australian research institutes guide the farmers very well and the whole system moves in a unified rhythmic way to have an efficient reach-out guide to the farmers at large.
- In contrast, the deficiencies in the Indian system are glaring, especially in the area of seeds, which is a pivotal factor in productivity. The farmer in India remains confused and at the onset of monsoon runs helter-skelter and picks up any seeds that become available. Though there are a plethora of seeds - notified and non-notified, there is no readily available information about their germination data, agroclimatic appropriateness and related data. Our farmers suffer from lack of awareness and advice.
- Institutions like ICAR-CICR have produced several varieties/hybrids, which are known as public seeds but these could not be multiplied in educate quantities. It is deplorable that the efforts of our brilliant scientists remain on paper and seeds remain on shelves for want of appropriate communication and outreach.
- Even the private companies suffer from various hang-ups. They have to become more communicative, educating farmers, also become proactive and even socially more responsible. They have equal national responsibility for farm productivity.
- The seeds availability becomes so poor at the time of onset of rains, that any seeds that come at hand, even duplicate and spurious seeds, are utilized. Thus, we remain impoverish in productivity as the seed is the most important component of productivity. Therefore, we need to completely revamp our seed systems.
- Other systemic pillars are our agro-practices such as rain mapping for sowing and regulated picking of only matured cottons as per the guidance of extension services which needs to be strengthened, well-informed and well responsive.
- Our irrigation systemic pillar needs to be appropriate as per the zonal agroclimatic conditions.

- Another systemic pillar- crop protection methods - has scope for improvement and can deliver much better with due diligence and guidance.
- In order to get the advantage of economies, cooperation and awareness a well-governed system for better bargaining and sound marketing, the producers must form clustered well-governed FPO's which can garner better strength.
- If we improve our systemic pillars and reframe our methodology and have well-organized, efficient inputs with well-administered norms and regulatory advice in time, we can substantially improve cotton productivity to at least 1,000 kg/ha within a reasonable period.

## **PLENARY SESSION**

The Plenary Session was co-chaired by **Prof RB Singh**, Former President, NAAS, **Dr RS Paroda**, Chairman, TAAS, and **Dr Ram Kaundinya**, Director General, FSII, **Dr Bhagirath Choudhary**, Director, SABC convened the Session.

The convenors of the three sessions presented summaries of the outcomes of their respective sessions. Dr JL Karihaloo listed the factors identified by various speakers in Session I to be responsible for the stagnation in production and low productivity of cotton in the country (national average 455 kg lint/ha, inter-district range 334 kg to 776 kg lint/ha). These include: (i) rainfed cultivation in 67 per cent of the total cotton area, (ii) spread of long-duration hybrids into marginal areas; (iii) pest and disease outbreaks (whitefly, pink bollworm and boll rot), unproductive crop by November-December due to PBW; (iv) deterioration in soil health due to continuous mono cropping and imbalanced nutrient application; (v) poor adoption of HDPS due to limited availability of suitable genotypes, farm machinery and defoliants; and (vi) deficiencies in seed quality control, farmer awareness and outreach.

Proposed strategies for cotton improvement through breeding and biotechnology included:

- Germplasm acquisition including that of wild species with specific traits, and screening for disease and pest resistance
- Utilizing germplasm through intensive characterization and evaluation, wide hybridization, pre-breeding, and use of conventional and advanced molecular breeding approaches
- Breeding genotypes especially suited to HDPS
- Use of molecular markers, genomics and predictive breeding approaches to accelerate cotton improvement efforts
- Phenotyping and yield estimation using artificial intelligence and machine learning approaches

- Use of gene-editing technologies that have emerged as powerful tools of precise genome changes for a multitude of useful traits. The new regulatory policy on genome editing is likely to accelerate research efforts on utilizing gene editing technologies (SDN1 and SDN2).
- Use of transgenic technologies for solutions to the current and emerging pests, diseases and other biotic and abiotic stresses challenging cotton productivity.

Dr Rajvir Rathi summarized the outcome of Session II, and mentioned that though the developing cotton economy is a big opportunity yet there are several pressing challenges that need to be effectively addressed. This urgently requires all stakeholders to come together and join hands for planning and execution; and the following points need consideration:

- Manual cotton picking is major problem faced by the farmers due to time and cost involved as well as the non-availability of labour on time.
- To improve the processing and produce high quality textile, there is an urgent need to promote and adopt a holistic cotton value chain focusing on key aspects:
  - (i) Mapping of key cotton areas and districts across India
  - (ii) Promote mechanical picking through multi-stakeholders' collaboration and partnership and availability of right kind of mechanical harvester, trash cleaning facilities, right seed fit for various cotton growing areas
  - (iii) Promote and adopt HDPS in mission mode
  - (iv) Availability of growth promoters and defoliant
  - (v) Humanize technology as far as possible

Dr Bhagirath Choudhary highlighted the following seven key outcomes of the panel discussion:

- Developing an enabling policy for cotton seed and biotech sector such as doing away with cotton price control and clarity in public-private partnership for R&D to transform cotton value-chain.
- Facilitative legislative mechanism and legal system for intellectual property rights (IPRs) and ensuring enforcement of rights on seeds and traits, and market-driven mechanism for pricing, which needs to be leveraged by the seed and biotech industry for the development of better hybrids/varieties suitable for HDPS cotton production.
- Simplification and rationalization of GMO regulatory system including time-bound approval, science-based and predictable system, doing away with NOC



requirement for field testing, implementation of notified sites for testing new cotton traits and fast-tracking of the commercial release of BG-II/RRF cotton.

- Seamless coordination between the Central Government and respective cotton growing States to avoid delay in support trialing, testing and monitoring of new biotech events and traits in a time bound manner.
- Ensuring a collaborative and cohesive approach for PPP for development of new traits using biotech and genome editing approach through a consortium of research institutes cutting across CSIR, ICAR, ICAR-IARI, ICGEB and even the global agri-technology companies to bring new traits for insect resistance, fibre quality, ginning percentage enhancement, drought tolerance, etc., is the need of the hour.
- Developing standards, certification protocols and testing mechanism, building extension and promotion schemes for harnessing the global opportunity of sustainable and organic cotton.
- Revamping cotton seed sector and promoting a novel high-density planting system (HDPS) by developing suitable genotypes, Bt/HT trait introgression, approval of plant growth promoter and defoliant, HDPS agronomy aligned mechanization for planting and harvesting of cotton for developing of globally competitive, clean and contamination free cotton.

In his concluding remarks, **Prof RB Singh** emphasized that our cotton research, development and promotion policies should be science-based. The technologies being developed and marketed must be humanized by making them farmer-friendly and shared with equitable benefits. A value-chain approach needs to be adopted for the farmers to realize appropriate benefits of their efforts. Also, in view of the liberalized markets, local capacities and competitiveness need to be enhanced. Governance and regulation of seed flow need to be improved to ensure that the farmers get the best quality seed material. ICAR has to play an important role in the registration of new varieties and ensuring the purity and quality of the seed being marketed. While recommending public-private participation in cotton technology development and dissemination, Prof Singh also emphasized the need to ensure differentiated responsibilities and accountability among the partners.

**Dr RS Paroda**, in his concluding remarks, opined that discussion on the whole gamut of cotton cultivation and industry related issues was necessary in view of the importance of cotton to a large section of Indian farmers and industry. Bt cotton demonstrated the power of technology through which the farmers, industry and the country gained substantially. Along with, the seed sector became strong and better organized. More recently, there has been a slowing down of cotton production while our demands are increasing. Hence, there is a need to develop

a future road map with the participation of public and private sectors. R&D needs to be strengthened and new traits and events need to be incorporated. Farmers should not be deprived of new technologies. The farmers need appropriate technologies, and seed price is not a serious factor since good technology gives high dividends. Access to the availability of germplasm including that of wild species and those with special traits should be facilitated. ICAR needs to play a more proactive role in biotech variety/hybrid release system to ensure the quality of products being made available to the farmers. A new seed policy needs to be developed to appropriately address the new and emerging seed related issues. Public private participation is recommended to utilize the strengths of each sector in benefitting the farmers and the cotton industry. However, such partnerships should involve the participation of the sectors right from conceptualization to the development of finished products with appropriate benefit sharing. There is also a need to analyse how cotton expansion is benefitting the farmers and, if needed, restrict the cultivation to more productive areas while the unproductive areas could be sown with more productive crops. For this purpose, an in-depth eco-regional planning is required. Extension and outreach are important for which, besides public sector, private sector also can play an important role.

Dr Bhag Mal, Secretary TAAS proposed vote of thanks to the Chief Guest, Dignitaries, Invited Guests, Co-Chairs, Convenors, Speakers, Panelists and all the participants as well the organizers.

## **RECOMMENDATIONS**

The participants of the workshop were unanimous in expressing the urgent need and resolve to enhance productivity, improve product quality, and take other steps that lead to increasing the international competitiveness of Indian cotton and cotton products. It was emphasized that the Indian cotton sector requires multipronged research, development and policy interventions of all concerned stakeholders, including central and state ministries, R&D institutions, and industry. The major cotton growing and cotton industry states must also align with the emerging policy and developmental interventions.

The recommendations made by individual experts and those emerging from the discussions held in each session were consolidated under three operational heads, viz., Policy, Development, and Research. Urgent action in implementing these is required from all the concerned public and private organizations to ensure the much-needed enhancement of efficiency, productivity and quality of cotton and textile production in India, and for India to become, besides being the largest, the most competitive cotton and textile producing and exporting country of the world.

## **I. Policy**

1. Establishment of a Cotton Development Board on lines of other cash commodities like coffee, tea, rubber, tobacco, and spices is urgently needed to address under one umbrella the diverse policy, development and trade-related issues of cotton and its products.
2. There is an urgent need to revisit the earlier Technology Mission on Cotton (TMC-2002-10) and implement its second phase to catalyse existing cotton production, productivity, quality, and marketing network. The second phase of TMC should involve the Ministries of Agriculture and Farmers' Welfare; Science and Technology; Environment, Forests and climate change; Textiles; and Commerce and Industry with an active involvement of concerned cotton-growing states and other key stakeholders. Strong linkages also need to be established with the ongoing national programs on development and commercialization of cotton.
3. Higher research investment is critical for India becoming a true global leader in cotton production. This fully justifies doubling the R&D allocation in cotton both by the Government and the private sector institutions. To ensure effective private sector investment and to scale new innovations, the Government may consider withdrawing price control on cotton seeds and to provide intellectual protection (IP) for new technology events in cotton varieties/hybrids. Also, the agreed license fees between parties for trait development, seed production and distribution be respected in the larger public interest.
4. To encourage investment in the development of high ginning outturn and HDPS-suited varieties/hybrids and their adoption, there is an urgent need to: (i) incentivise seed companies to invest in cotton research for developing improved varieties/hybrids with higher ginning outturn and suitability for HDPS; (ii) incentivise farmers to grow cotton varieties/hybrids with higher ginning outturn; and (iii) offer differentiated minimum support price (MSP) for cotton varieties/hybrids with higher ginning outturn. Also, there is a need to urgently review the existing process of registration of varieties/hybrids that requires deposition of parental seeds and their field testing to the Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA).
5. Appropriate incentives need to be provided to farmers, custom hiring centres, farmer producing organizations (FPOs), entrepreneurs and service providers to improve cotton production efficiency and to increase the income of cotton farmers.
6. Crop protection industry needs to ensure the required supply of plant growth regulators and defoliant to enable HDPS and mechanical harvesting to become a reality for large scale adoption by the cotton growers.

7. The biotechnology regulatory system (Review Committee on Genetic Manipulation (RCGM) and Genetic Engineering Appraisal Committee (GEAC)) should ensure quick decision-making process that is transparent and time-bound. Also, the present requirement of state NOCs for the field testing of GEAC-approved products for environmental release is rather unnecessary and be dropped in the national interest.

## **II. Development**

8. Urgent attention is needed on the approval and availability of defoliants, custom hiring of cotton picking machines, modernising ginneries to handle machine-picked cotton by designing and installing additional line of pre-cleaners to remove trash, incentivise additional cost in the processing of machine-picked cotton, spinning and textile industry to facilitate the development of the cotton value-chain, and developing infrastructure for labelling, traceability, etc. to meet the international standards of cotton quality and trade practices.
9. The Ministry of Environment, Forests and Climate Change (MoEF&CC) is urged to announce the long pending decisions on the next-generation cotton insect and weed management GM events. In this regard, immediate adoption of HtBt cotton is required to overcome the current losses by the farmers. Towards this, a round table dialogue be organised at the earliest jointly by the Heads of ICAR and DBT, involving senior officials/scientists of concerned Ministries and representatives of the private sector to decide future Road Map.
10. Concerted efforts are needed to strengthen science-based public awareness by both central and state governments on the usefulness and safety of new events of new breeding technology (NBT) innovations, like HtBt cotton, that will considerably help cotton farmers and other stakeholders save the costs and protect the environment.
11. To realize full economic potential of cotton crop, the value of cotton seed as a source of oil, animal feed and bioenergy be also given focused attention.
12. There is an urgent need to encourage, incentivise and promote the adoption of good agronomic practices (GAPs), including efficient nutritional management, crop mulching and drip irrigation, for cotton cultivation.
13. Multiple measures, including variety registration and seed quality control measures, are required to be taken to ensure that only high-performing varieties/hybrids and seeds with desired yield, biotic and abiotic resistance and quality traits are marketed.

### **III. Research**

14. There is an urgent need to intensify efforts on acquisition, characterisation and evaluation of wild and cultivated germplasm from abroad possessing high fibre quality and biotic and abiotic stress tolerance traits.
15. Breeding efforts also need to be accelerated for improved lint yield and quality, higher ginning outturn, resistance to current and emerging pests and diseases, and tolerance to abiotic stresses (drought, high temperature, water-logging and salinity).
16. Concerted efforts are needed towards the introduction of new and desirable traits in cotton through new breeding technologies (NBTs), including GM, genome-editing and haplotype breeding.
17. To remain global leader, in addition to the use of current HtBt hybrids, there is an urgent need to harness the potential of new RRF and BGIII innovations in India.
18. Simplified diagnostic methods need to be developed for multiple viruses and strains and control strategies developed through transgene, RNAi, gene editing and bioagent technologies.
19. Much needed thrust should be given for the development of plant types suitable for high-density planting system (HDPS), use of defoliant to reduce trash content and adoption of mechanical harvesting.
20. To save on cost of seed, we also need to accelerate the development of public sector cotton varieties rather than hybrids alone. Also, for higher income, there is an urgent need to breed and promote colour and specialty cotton varieties.
21. Region-specific best package of practices for HDPS and mechanised cotton farming needs to be developed and promoted for realizing the full potential of the crop and enhancing the income of cotton farmers.

# Program

**SATURDAY, 25 FEBRUARY 2023**

08.45-09.30	<b>REGISTRATION</b>	
09.30-11.00	<b>INAUGURAL SESSION</b>	
09.30-09.45	Welcome & Setting the Context	RS Paroda, Chairman, TAAS
09.45-10.10	Overview of the Cotton Scenario in India	CD Mayee, President, SABC
10.10-10.20	Remarks	RK Singh, ADG (Commercial Crops), ICAR
10.20-10.45	Address by Chief Guest	Ramesh Chand, Member (Agriculture), NITI Aayog
10.45-10.50	Vote of thanks	JL Karihaloo, Trustee, TAAS
10.50-11.20	<i>Group Photo &amp; Tea/Coffee</i>	
11.20-12.50	<b>SESSION I : Advances in Cotton Breeding and Biotechnology</b>	
<i>Co-Chairs</i>	: RB Singh, Former President, NAAS : RK Singh, ADG (Commercial Crops), ICAR	
<i>Convenor</i>	: JL Karihaloo, Trustee, TAAS	
11.20-11.35	Innovative Breeding Approaches for Cotton Genetic Improvement	YG Prasad, Director, ICAR-CICR
11.35-11.50	New Innovative Approaches for Genetic Improvement in Cotton	James Neilsen, Field Crops Agronomic Systems Lead APAC
11.50-12.05	Harnessing the Potential of Technology for Cotton Improvement and Farmers' Benefit in India	Bharat Char, Chief Science Officer, MAHYCO
12.05-12.30	Breeding Strategies to Meet Industry Needs and Improve Farmers' Income	R Mahala, Research Head, Seedworks

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12.20-12.50 Discussion

12.50-13.45 Lunch

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13.45-15.15 SESSION II : Advances in Cotton Processing and Textile Industry

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**Co-Chair** : CD Mayee, President, SABC

**Convenor** : Rajvir Rathi, Director, PA & Science, Bayer Crop Science

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13.45-14.00 Technology for Processing of Mechanically Harvested Cotton **SK Shukla**, Director, ICAR-CIRCOT

14.00-14.15 New Technologies for Cotton Production for Economical Production and Maximising Yields **Mukesh Joshi**, Sr Scientist (Agronomy), Shaktiman Agrimachineryery

14.15-14.30 Views of Textile Industry **T Rajkumar**, President, CITI

14.30-14.45 HDPS Method of Cotton Cultivation to Improve Yields **M Ramasami**, Chairman, Rasi Seeds

14.45-15.00 Path for Indian Cotton Farmers **Mahesh Sharda**, DDPL Group

15.00-15.15 Discussion

15.15-15.30 Tea/Coffee

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15.30-16.30 **PANEL DISCUSSION : Enabling Policies to Enhance Cotton Productivity and Stimulate Industrial Growth**

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**Co-Chairs** : RB Singh, Former President, NAAS

: RS Paroda, Chairman, TAAS

: Ram Kaundinya, Director General, FSII

**Convenor** : Bhagirath Choudhary, Director, SABC

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15.30-15.40 Strategy for Improving Cotton Production **PK Singh**, Agriculture Commissioner, Gol

15.40-15.50 Quality Seed Production **DK Yadava**, ADG (Seeds), ICAR

15.50-16.00 Views of Crop Protection Industry **Simon Wiebusch**, ED, Bayer India

16.00-16.10 Cotton Productivity for Textile Industry Growth **Suresh Kotak**, Chairman TAG

16.10-16.20 Views of Cotton Seed Industry **M Prabhakar Rao**, President NSAI

16.20-16.30 Views of Agri-Biotech Industry **Raju Barwale**, Chairman, MAHYCO

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**16.30-17.00 Discussion**

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**17.00-18.00**

**PLENARY SESSION**

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**Co-Chairs** : **RS Paroda**, Chairman, TAAS  
 : **RB Singh**, Former President, NAAS  
 : **Ram Kaundinya**, Director General, FSII

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17.00-17.20	Summary of Sessions by Convenors	Session I: <b>JL Karihaloo</b> Session II: <b>Rajvir Rathi</b> Session III: <b>Bhagirath Choudhary</b>
17.20-17.55	<b>Concluding Remarks</b>	<b>RB Singh</b> , Former President, NAAS <b>RS Paroda</b> , Chairman, TAAS
17.00-18.00	<b>Vote of Thanks</b>	<b>Bhag Mal</b> , Secretary, TAAS

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## **Recent TAAS Publications**

1. Policy and R&D Interventions to Increase Cotton Production and Industrial Growth - Policy Brief, March 2023.
2. National Dialogue on Sustainable Growth and Development of Indian Dairy Sector - Proceedings and Recommendations, 16-17 December, 2022.
3. National Symposium on Food, Nutrition, and Environmental Security: Towards Achieving SDGs - Proceedings and Recommendations, 29-30 August, 2022.
4. Resilience in Dairy Farming - A Success Story by Nikki Pilania Chaudhary, November 2022.
5. National Dialogue on Innovations in Agricultural Extension: A Way Forward, 8-9 April, 2022.
6. Towards Secure and Sustainable Agriculture - Strategy Paper by Dr RS Paroda, August, 2022.
7. Expert Consultation on Promoting Efficient Irrigation Technologies for Water Saving Across Scales and Sectors, 25 February, 2022.
8. Expert Consultation on Accelerating Export of Seed Spices: Challenges and Opportunities - Proceedings and Recommendations, 22 November 2021.
9. National Workshop on Bridging the Yield Gaps to Enhance Foodgrain Production: A Way Forward - Proceedings and Recommendations, 26 August, 2021.
10. Report on Policies and Action Plan for a Secure and Sustainable Agriculture in Hindi, October, 2021.
11. Youth as Advisory Agents, Input Providers and Entrepreneurs - Article by Dr RS Paroda, September, 2021.
12. Brainstorming Session on Regenerative Agriculture for Soil Health, Food and Environmental Security - Proceedings and Recommendations, 26 August, 2021.
13. Stakeholders Dialogue on Enabling Policies for Harnessing the Potential of Genome Editing in Crop Improvement - Proceedings and Recommendations, 17 March, 2021.
14. Harnessing Genome Editing for Crop Improvement - An Urgency: Policy Brief, May, 2021.

15. Accelerating Science-Led Growth in Agriculture: Two Decades of TAAS, May, 2021.
16. A Road Map on Stakeholders Dialogue on Strategies for Safe and Sustainable Weed Management, January, 2021.
17. Fish Farming in North India-A Success Story by Dr Sultan Singh, December, 2020.
18. A Road Map on Stakeholders Dialogue on Current Challenges and Way Forward for Pesticide Management, September, 2020.
19. A Road Map on Stakeholders Dialogue on Way Forward for the Indian Seed Sector, June, 2020.
20. Biofertilizers and Biopesticides for Enhancing Agricultural Production - A Success Story by Dr Basavaraj Girenavar, June, 2020.
21. A Road Map on Policy Framework for Increasing Private Sector Investments in Agriculture and Enhancing the Global Competitiveness of Indian Farmers, December, 2019.
22. Crop Biotechnology for Ensuring Food and Nutritional Security - Strategy Paper by Dr J.L. Karihaloo and Dr R.S. Paroda, December, 2019.
23. A Road Map on Efficient Land Use and Integrated Livestock Development, November, 2019.
24. National Dialogue on Land Use for Integrated Livestock Development - Proceedings & Recommendations, 1-2 November, 2019.
25. Horticulture for Food & Nutritional Security - Strategy Paper by Drs KL Chadha & VB Patel, October, 2019.
26. Urgency for Scaling Agricultural Innovations to Meet Sustainable Development Goals (SDGs) - Strategy Paper by Dr RS Paroda, April, 2019.
27. Tenth Foundation Day lecture on "Can India Achieve SDG 2 - Eliminate Hunger and Malnutrition by 2030" by Dr Prabhu Pingali, Professor in the Charles H Dyson School of Applied Economics and Management at Cornell University, January 24, 2019.



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