Seventh 'Asian Cotton Research and Development Network Meeting' (ACRDN)

Le Meridien, Nagpur, India
September 15-17, 2017
Organized by
International Cotton Advisory Committee (ICAC),
Indian Society for Cotton Improvement (ISCI),
ICAR-Central Institute for Cotton Research (ICAR-CICR) and
ICAR-Central Institute for Research on Cotton Technology (ICAR-CIRCOT)

Theme: *Production of quality fiber and doubling cotton farmers' income*

PROCEEDINGS AND RECOMMENDATIONS

INAUGURAL SESSION: Dr. Terry Townsend, Former Executive Director, International Cotton Advisory Committee (ICAC), Washington DC inaugurated the 7th ACRDN meeting on 15 Sept. 2017. Dr. Townsend conveyed the greetings of Mr. Kai Hughes, Executive Director of the ICAC and emphasized the relevance of cotton research and technologies for the economic development in the Asian region. Dr. AK Singh, Deputy Director General (Crop Science), Indian Council of Agricultural Research delivered the presidential address.

PARTICIPANTS: Two hundred and thirty nine participants registered for the meeting. Technical experts from India, Bangladesh, Egypt, Australia and USA led the sessions. Participants comprised of farmers, researchers from the public and private institutions, Government officials and experts from trade and industry.

SESSIONS: Twenty-nine technical sessions were held during the three-days meeting. The sessions included one plenary session with two speakers, valedictory session with three speakers, one panel discussion, one open forum for young researchers, two open sessions, one poster session and 24 concurrent sessions. A total number of 126 abstracts were received, 40 of them were presented in poster session and 72 as oral presentations. The main thematic areas of the meeting focused on 'doubling farmers income', 'production of quality fiber' and development of sustainable management strategies for whiteflies, leaf curl virus and bollworms. The sessions included better management practices (BMPs) for high yield, cotton mechanization, germplasm exchange, breeding for yield and quality, climate change and abiotic stress, management of viral diseases, whiteflies and bollworms, transfer of technology, application of nanotechnology, nutrient management, CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) and CRISPR Associated System-9 (CRISPER–CAS-9), Ribo-Nucleic-Acid interference (RNAi) techniques, high density planting systems (HDPS), promotion of *Gossypium arboreum* cotton, and contamination and quality evaluation.

PLENARY SESSIONS

Dr. Terry Townsend, former Executive Director, ICAC delivered a plenary talk on "The role of research in cotton development in Asia" and emphasized the need to develop technologies to enhance yields and reduce cost of production to make cotton competitive with synthetic fibers.

Mr. Suresh Kotak, Chairman, ISCI, delivered a plenary talk on the topic "King cotton - Future for Asia" and said that cotton will remain to be the king of fibers because of its excellent qualities that enable it to be used independently as well as in blends with synthetic fibers.

VALEDICTORY SESSION:

Dr. Md. Fariduddin, Chairman, ACRDN, in his valedictory address spoke on the importance of cotton sector in Bangladesh and the imperative need for cooperative networks in progress of research, development and trade in Asian countries.

Dr C. D. Mayee, President, ISCI, delivered his plenary address on "Novel Technologies: Today and Tomorrow" and reiterated the importance of biotechnology as a game changer in the progress of cotton research and development.

Dr. Mrs. Kavita Gupta, Textile Commissioner, Government of India, delivered the valedictory plenary address and chaired the valedictory session. She spoke on the rich heritage of cotton in Asia and the current relevance of cotton production and utilization to the development of the region. Dr. Kavita Gupta emphasized on the need for doubling farm income and suggested a pathway for doing so through a combination of low cost yield enhancement technologies.

RECOMMENDATIONS

Plenary and valedictory sessions:

- There is a need to explore new uses of cotton to expand the market share of cotton.
- Genetic engineering and nanotechnology have the potential to impart unique properties to cotton fibers to make it more competitive with synthetic fibers.
- There is a need to develop technologies that can enhance yields and reduce cost of production to make cotton more competitive with synthetic fibers.
- The negative propaganda regarding the high ecological footprint in the cultivation and processing of cotton needs to be effectively countered using scientific studies and data. (Action: The ICAC panel on Social, Economic and Environmental Performance (SEEP) may be requested to address the issue).
- Bangladesh has immense potential for cotton production and mill use. New efforts should be intensified to develop short season varieties for Bangladesh and strengthen crop production technologies in the country (Action: Bilateral agreements between Bangladesh, India and Pakistan may be developed through South Asian Association for Regional Cooperation (SAARC) for germplasm sharing to develop short season varieties).

Open Session 1: Global best practices for high yields

- Best Management Practices (BMPs) for high yield of cotton in Australia, Egypt, Bangladesh and India were discussed. Australian agriculture deploys scientific findings to develop and constantly upgrade BMPs. Publications on sustainable practices are provided to cotton growers every year. Employing good management practices is the only option to improve yields, reduce production costs and make cotton more competitive. Although BMPs are available, there is a need to strategize and prioritize them. Also it is necessary to strengthen the extension system in the Asian region to hasten the diffusion and uptake of BMPs.

Concurrent Session-2: Cotton Mechanization

- Labor shortages and high wages in India, Pakistan and China are prompting the need for mechanization in cotton cultivation in the Asian region. Mechanization makes production systems more efficient and improves the farmers' income significantly by reducing the cost of cultivation particularly the cost of picking. Asian countries must develop region specific machinery suitable for operations in small-scale farms for planting, crop care and harvesting operations.

- Cotton breeders, agronomists, tractor & harvester manufacturers, ginning machinery manufactures, trade and industry and government must work together to achieve

mechanization in cotton crop. In view of small size land holdings in Asian region, the low cost machinery developed by Argentina for cotton mechanization may be examined and modified.

Concurrent Session-3: Panel discussion germplasm exchange among SAARC countries

- Germplasm resources must be enriched, exchanged and utilized to broaden the genetic based of cultivated cotton cultivars. For effective exchange of cotton germplasm between countries of the South Asian Association for Regional Cooperation (SAARC) region, memoranda of understanding (MoU) and bilateral agreements need to be worked out within the purview of the National Biodiversity Act in respective countries. Sound and systematic benefit sharing protocols have to be established for exchange of cotton germplasm among the private and public institutions after discussion with all the concerned stakeholders.

CONCURRENT SESSIONS:

4A: Cotton Viral Diseases

- Cotton leaf curl disease (CLCuD) is caused by a complex of whitefly (*Bemisiatabaci*) transmitted Begomoviruses. The disease is a serious threat to American cotton in north India and Pakistan. Recent reports suggest that CLCuD was detected in China and could pose problems to cotton in future. Speakers resolved that quarantine measures need to be strengthened to contain movement of recombinant viruses and whitefly vectors of the leaf curl disease. There is a need to develop and utilize good diagnostic tools to identify, restrict and manage the viruses.
- Plant breeders must give impetus to breeding genotypes for resistance to viral diseases by stacking multiple mechanisms of resistance for durable resistance. The resistant genetic stocks for different strains of viruses may be identified, pyramided and strengthened with transgenes for Ribo-Nucleic-Acid interference (RNAi) based gene silencing so as to ensure sustainable management.
- Plant protection scientists must develop integrated strategies for the management of different strains of viruses and different species of the whitefly vector. Monitoring of whitefly vector populations and disease occurrence is crucial for efficient and effective management of whitefly and the leaf curl disease.

4B: Breeding for quality & high yields

- Improvement of harvest index is of critical importance in cotton breeding programme especially under rain-fed conditions. New germplasm lines and genotypes with good harvest index have been identified in India, Pakistan and China. These can be used for the development of compact varieties required for High Density planting Systems (HDPS). Work on this aspect needs to be intensified in Asian countries especially India, Pakistan and Bangladesh.

4C: Abiotic stress and Climate change

- Climate change is a crucial factor that poses immense risk to cotton cultivation. Research on developing genotypes with specific plasticity to abiotic stress, water logging, salinity and drought has to be intensified to minimize yield losses in the Asian region. Germplasm lines with definite tolerance to abiotic stresses need to be shortlisted and utilized.
- There is a need for systematic studies on the architecture of root system by using modern imaging tools. The variability in rooting pattern in relation to the adaptation mechanisms of cotton varieties to different abiotic stresses needs to be studied.

5A: Whiteflies:

- The cotton whitefly, *Bemisia tabaci* (Gennadius) is a serious polyphagous pest that causes damage to cultivated crops throughout the world. Different species of whiteflies have been found to occur periodically in an epidemic form in the cotton growing regions of Asia. Hence, an in-depth basic research must be undertaken to understand the factors triggering their periodic epidemics. There is an immediate need to develop effective proactive and pre-emptive strategies to prevent further recurrences of whitefly outbreaks.
- There is a need to strengthen various components of integrated pest management (IPM) for the management of whitefly. Insecticide resistance monitoring and eco-system management are vital to whitefly management programs and hence there is a need to strengthen these aspects of research in India and Pakistan.

5B: Socio-economics and technology transfer:

- Both customary and contemporary information and communications technology (ICT)-based extension methodologies have certain merits and limitations. There is a need to develop and validate a 'transfer of technology module' integrating all available extension tools so as to accelerate the diffusion and uptake of best management practices (BMPs) in Asia.

5C: Nanotechnology and its applications in Cotton

- A networking project on "Application of Nanotechnology in Cotton" may be initiated among the cotton growing countries to tap the potential of nanotechnology across the cotton value chain.
- Biotechnology and nanotechnology tools must be used to develop novel methods of traceability to detect the fiber genetic and molecular identity through the cotton value chain.

6A: Bollworms- Integrated Pest Management (IPM) and Insecticide Resistance Management (IRM).

- Pink bollworm has been reported to develop resistance to Bt-cotton. The pest is causing serious damage to Bt-cotton in India and Pakistan. There is an imminent need to fine-tune management strategies based on genotypes that express Bt genes in homozygous condition, deployment of short season varieties, identification of appropriate sowing time for different regions, pheromone based mass trapping and mating disruption techniques, sterile insect release techniques and cultural practices that ensure disruption of diapausing insects.
- There is a need for basic studies that are essential to understand the biology of key pests of cotton so that eco-friendly protection technologies could be developed without the need to resort to repeated use of insecticides.
- The use of synthetic pyrethroids on cotton may be discouraged especially during the early stages of the crop as overuse or misuse of these insecticides induces resurgence of whiteflies as well as the cotton bollworms. In addition, excessive use of synthetic pyrethroids disrupts the cotton crop ecosystems, the crop cycle and reproductive phase of the crop, which could necessitate additional sprays.
- Management of insect resistance to insecticides and Bt toxins is extremely important to ensure sustainable efficacy of insecticides and Bt cotton. Continuous monitoring of resistance of *Helicoverpa armigera* &*Pectinophora gossypiella* to new insecticides and the two Bt proteins, Cry1Ac and Cry2Ab needs to be done on priority. Pest management recommendations must emphasize the need for refugia compliance and also to avoid overuse and misuse of pesticides and Bt-cotton.

6B: Nutrient management technologies

- There is a narrow genetic variability in the working collection of germplasm across the Asian region. Hence, improved management technologies like manipulating plant geometry, use of foliar nutrition to supplement soil application and plant growth regulators for canopy management must be developed to harness high yields. These technologies should be standardized, validated, refined and deployed as components of best management practices (BMPs).
- There is a need for extensive testing of *Trichoderma* and *Azotobacter* bio-films to establish their role in altering soil nutrient dynamics and enhancing plant growth. If consistent benefits are obtained, these biological products can serve as cost-effective and environment-friendly inputs for yield improvement in cotton.

6C: Bio-reviews

- Multi-parental Advanced Generation Inter Cross (MAGIC) populations help in shuffling of genes across different parents enabling novel rearrangement of alleles. This method also brings in greater genetic variability and enhanced chances to get best combination of desirable genes and phenotypic selection in advanced generations thereby reducing the frequency of deleterious/undesirable alleles from donors. MAGIC populations may be used for precise quantitative trait loci (QTL) mapping and breeding of multi-trait varieties.
- The phyllosphere of cotton harbors significant populations of *Beijerinckia* sp., *Enterobacter* sp. and *Klebsiella*sp. Incidentally, all these belong to Gram –ve type perhaps due to the presence of gossypol in cotton, which inhibits Gram +ve bacteria. These could be used to explore for the presence of novel insecticidal toxins. The toxin genes cloned from *Xenorhabdus* and *Photorhabdus* elicit insecticidal activity and may have the potential for use to strengthen Bt cotton.

7A CRISPER-CAS-9 and biotech ideas for cotton

- CRISPER-CAS-9 system is a new potential tool for genome editing and should be exploited for resistance to CLCuD and for knocking down delta-cadinene synthase genes in seeds of cotton to get gossypol free cotton seeds.
- New events of biotech cotton available with the Universities, public sector institutions and private sector organizations may be pyramided for effective and long-term management of cotton pests.

7B: Field experiments for high yields

- In the era of changing climate, a re-establishment of optimum sowing window may be attempted for obtaining higher yields. Alternative weed control method of stale-seed bed with cover crop can be encouraged to reduce cost of weed management.
- Plant breeding methods for the selection of novel traits following the creation of new variability are integral components of crop improvement programs. Efficient individual plant selections per progeny in each of the early and segregating generations can reduce cost of plant breeding in terms of time, labor and other resources without compromising on efficiency.

7C: High density planting system in cotton

- Recently, early maturing compact short season genotypes with high yield potential, possessing good fiber quality, have been developed in India, Pakistan and China. These can be validated for their performance under high density planting systems (HDPS) to harness high yield potential. A SWOT analysis of HDPS can be done to identify specific recommendations. The success of HDPS experiments documented in India can be suitably refined and adapted using locally available compact and semi compact genotypes in other Asian countries to enhance cotton yields and farmers income.

8A: Sustainable technologies for high yields

- In Bangladesh, *Rabi* planting of cotton with sustainable intercrops is found promising and should be validated, reaffirmed and recommended.
- Short duration varieties should be developed with good fiber quality attributes suitable for different production systems in Bangladesh.

8B: Breeding for *G. arboreum* cotton improvement

- Diploid cotton species *Gossypium arboreum* and *Gossypium herbaceum* are ideally suited for organic cotton production because of their environmental robustness in tolerating biotic and abiotic stress factors. There is a need to intensify both research and promotional activity of *G. arboreum* cotton in all the cotton growing countries of Asia. There is a need to intensify efforts of introgression Breeding to develop new varieties possessing desirable traits such as abiotic stress, pest resistance and fiber quality.

8C: Ginning and quality evaluation

- There is a need to reduce the cost of ginning per bale to make cotton more competitive.

SPECIAL SESSION: YOUNG SCIENTISTS OPEN FORUM –NEW IDEAS

Nineteen young scientists presented their ideas and vision for research and development. The priority areas suggested were as follows:

- Dr. Milia Binte Momtaz: There is a need to strengthen networks amongst researchers for effective exchange of ideas and research methods.
- Dr. Santosh (Dr PDKV): Ensure compliance of IRM strategies for sustainability.
- Dr. A. Arputraj & Dr. P. K. Mandhyan: Develop traceability methods using fluorescent particle based nanotechnologies coupled with bale tagging so as to create a new brand 'Indian cotton'.
- Dr. H. B. Santosh (ICAR-CICR): Breeder and farmer rights must receive top priority in germplasm exchange.
- Dr. Manoj Kumar, Dr. A. Manikandan & Dr. V. Mageswaran: Cotton seed is a valuable source of oil and Protein. Removing gossypol through microbial, biochemical and biotechnological tools can provide excellent proteins as food and feed supplements.
- Dr. Upender Mahesh: Network projects must be developed to use 'Single Nucleotide Polymorphisms (SNPs)' for the development of new varieties with high yield potential.
- Er. Archana Mahapatra: Nano-cellulose technology provides opportunity for paint and coatings
- Dr. S. Gangadhar: Water management and irrigation can greatly enhance cotton yields
- Dr. J. Joshi & Dr. Rajendra Akhani: Price forecasting protects farmers from risks. Policies should be framed to provide right price for right quality. Digital agriculture will make a huge difference in technology transfer and capacity building.
- Dr. M. Saravanan: Several varieties of *Gossypium arboreum* (Desi) cotton species are amenable for organic farming, which in turn would be an ideal option to combat climate change.
- Dr. R. Raja: Zonation of varieties will solve several intractable problems. Separate conferences should be organized for similar categories of farmers such as small-scale, marginal and progressive farmers.
- Dr. G. Balasubramani and Dr. Rakesh Kumar: Cotton fiber quality can be tremendously improved through biotechnology. Molecular engineering tools should be used to develop bullet proof cotton and fire resistant cotton
- Dr. B. K. Patel: Judicious use of insecticides and monitoring of pesticide quality hold the key for effective and sustainable pest management in the Asian region.
- Dr. V. N. Chinchane: There is an imminent need to reduce cost of production by promoting long linted Desi cotton in HDPS

Special Session: Taking ICRA forward

Dr. Md. Negm, Vice-Chair of ICRA conveyed the greetings of Dr. Michel Fok, Chairman ICRA. He said that The International Cotton Researchers Association (ICRA) was created in 2012 to compensate the lack of a specifically dedicated international cotton research institute or program. ICRA is an independent organization, open to the membership of any individual researcher working substantially on cotton production research in the world. Researchers from the public and private sectors, retired or in service, can become members of ICRA. ICRA is governed by an Executive Committee comprising of 15 members representing different countries such as 4 from Asia, 3 from Africa, 2 from North America, 2 from South America, 1 from Australia, and 2 from international organizations which are ICAC and CIRAD). The primary objectives of ICRA are to promote and strengthen networking among cotton researchers mainly through interactions on the ICRA web-site, deliberations at WCRC (World Cotton Research Conferences), information dissemination, management of a database on cotton research activities, facilitating training and sharing of problems hampering cotton production to find solutions. ICRA has updated its web-site integrating wiki function and also to facilitate uploading of user profiles, publications and forum discussions. ICRA is expecting researchers to share new ideas, methods and innovative findings through the network forums on the ICRA website. The 'Pakistan Central Cotton Committee' will soon host the ICRA secretariat. The largest numbers of researchers are concentrated in the Asian region. They have the greatest potential to make a significant impact on ICRA's activity and visibility. ICRA is expecting the Asian researchers to take up the leadership role to initiate a vibrant interactive scientific forum. Recently in June 2017, ICRA initiated the ICRA Young Scientist Innovation Medal within the purview of each of the four regional network meetings in Asia, Africa, Mediterranean and Latin America. The first medal was announced for Asia in August 2017.

ICRA-ASIA YOUNG SCIENTIST INNOVATION MEDAL 2017

The INTERNATIONAL COTTON RESEARCH ASSOCIATION (ICRA) launched a new medal for young scientists (<40 yrs), in the framework of the four regional cotton research networks in Asia, Mediterranean, Africa and Latin America. Applications for the ICRA-ASIA Young Scientist Innovation Medal 2017 were invited in July with the following criteria:

- The most innovative research work published in a research paper as first author on a subject strictly related to cotton
- The most innovative granted patent as first author on a subject strictly related to cotton
- The total number of citations (Google scholar) from five best papers as first author on a subject strictly related to cotton
- Total number of citations (Google scholar) from all publications all through scientific career, *h*-index
- i10 index and Research Gate (RG) score.

ICRA received 8 applications from Pakistan, China, India and Iran. A committee comprising of six judges from six countries evaluated the applications and arrived at the decision to declare Dr. Abdul Qayyum Rao as the winner of the 'ICRA-ASIA Young Scientist Innovation Medal 2017'.

Dr. Rao works as Assistant Professor at the Centre of Excellence in Molecular Biology (CEMB), University of Punjab, Lahore, Pakistan. He is also a guest professor Humboldt Fellow, Germany. Dr. Rao has a commendable publication record in reputed international journals. His citation records are equally impressive. In addition to his citations, his paper on "*Over-expression of Phytochrome B gene from Arabidopsis thaliana increases plant growth and yield of cotton (Gossypium hirsutum)*" and his patent "*Novel transgenic approach to decrease cost of production in Pakistan*" were considered by the Panel of judges to merit his selection for the Medal.

ELECTION OF NEW CHAIR OF ACRDN

Dr. P.G. Patil, Director, ICAR-Central Institute for Research on Cotton Technology was elected as the new Chairman of the Network until the next ACRDN meeting. Dr. Md. Fariduddin, Chairman ACRDN and Executive Director Cotton Development Board, Bangladesh, congratulated the new chairman and handed over the charge to Dr. Patil in the valedictory session.