79th Plenary Meeting – Virtual

MINUTES

Open Technical Session
Advances and Challenges of Hybrid Cotton Technology

08:00 am to 10:00 am (GMT-5), Wednesday 8 December 2021
Chairman: Dr. Muhammad Ali Talpur, Vice President, Pakistan Central Cotton Committee (PCCC), Pakistan

- **Topic: The Hybrid Cotton Revolution in India**
  Speaker: Dr M. Ramasami, Chairman of Rasi Seeds, India

Dr Ramasami explained that cotton is one of the most important cash crops in India, which accounts for about 37.5% of the world’s cotton area and 26% of the world’s cotton production. The sowing window in India extends over five months from April to August. Cotton is cultivated in seven agroclimatic regions that are comprised of five different soil types. More than 65% of Indian cotton is cultivated under rainfed conditions. Nearly 72% of Indian cotton area has shallow light soil conditions, most of it under rainfed conditions, because of which the productivity is low to medium. The world’s first commercial cotton hybrid was released way back in 1970 by Dr CT Patel from Cotton Research Station, Navsari Agricultural University, Surat. Subsequently, Dr Ramasami explained that hybrid cotton cultivation in India gained momentum owing to high yield potential and wider adaptability. Currently, *Bt* hybrids occupy more than 98% of India’s cotton area. Compared to open pollinated varieties, hybrids were found to possess better adaptability under diverse cotton-growing environments. Hybrids are comparatively superior in early vigor and establishment under rainfed conditions resulting in better productivity than varieties. Dr Ramasami said that hybrids are highly responsive to better crop-management practices. Research showed that combining multiple traits for biotic and abiotic stress tolerance makes higher yield and better fibre quality possible in hybrids. Cotton seed production in India is carried out in 58,000 hectares in five states with eight major seed production centres. About 120,000 farmers are involved in cotton hybrid seed production with an average seed productivity of 500 kg/ha. Currently, India has reached a plateau in cotton productivity due to a wide range of factors. Dr Ramasami stressed that there is an urgent need to break the yield barrier. This can be achieved through creating genetic variability by exploiting wild relatives and exotic land races. It is important to develop hybrids with biotic/abiotic stress tolerance, short duration with high yield, better fibre parameters such as extra-long staple and strong fibre strength. Hybrids amenable for mechanization and mechanical picking enhance productivity.

Questions and Answers:
Hybrid cotton has been grown in India since 1970 with constant improvements. However, cotton productivity has stagnated at about 500 kg/ha despite hybrid technology and Bt-cotton. Have the hybrids lost their potential or Bt lost its efficacy?

New hybrids are released every year. Hybrid cotton has not lost its vigour but the pink bollworm has developed resistance to Bt toxins.

Can India increase its productivity by shifting to varieties from hybrid cultivation?

In India, due to the wide range of cotton growing conditions, adaptability to diverse environments will much better in hybrids than variety. About 65% of the cotton growing area comes under rainfed conditions so hybrid vigour will have better establishment and will yield more than variety.

Is it true that yields under irrigated conditions fare better than rainfed, especially for (Bt) hybrid cotton?

Hybrids yield 30% more than varieties even under rainfed conditions.

What is the per-kg cost of production of cotton hybrid seed in India through conventional methods and using cytoplasmic male sterile (CMS) technology?

The production cost of cotton hybrid seed is 85 per kg of seed. We are not using CMS-based lines for seed production, but we are using genetic male sterile (GMS) based lines.

Cotton yield in India ranges between 340 and 510 kg/ha. What is the proportion of farmers who get 510 kg/ha and those who get 340 kg/ha?

Farmers who get more than 500 Kg yield per hectare comprise about 35% and farmers were get below 500 kg/acre constitute about 65%. Low yields are due to rainfed and poor soil conditions.

What is the potential yield of those hybrid cotton varieties?

The potential yield of seed cotton in irrigated conditions is 1500 kg/acre and 400 to 600 kg/acre in rainfed condition. This is applicable to hybrids.

- **Topic:** The Future of Organic cotton, GM Cotton and Hybrid Cotton

  **Speaker:** Dr Yusuf Zafar, Former Chairman of Pakistan Agricultural Research Council (PARC), Islamabad

In his presentation, Dr Zafar made comparative analyses of three types of prevailing farming systems in cotton-producing countries. Cotton is a unique crop with major contributions in food, feed and fibre (3 Fs) of human need. The usage of GM cotton is the most prevalent in the top five major cotton producers whereas a hybrid cotton system is now mostly restricted to India and a few other countries. The demand for organic cotton as ‘nature-plus technology’ is gaining importance and its growth is now in double digit. However, Dr Zafar said there are many challenges associated with adopting any of the three systems, either alone or in combination. The major thrust should be to achieve higher productivity of lint (natural fibre-NF) with reduced production costs to compete with man-made fibres (MMF). The approach of 3Ps — Profitability for People (farmers to consumers in field to fashion value chain) by taking care of this Planet — is the most desirable approach to achieving sustainable development goals (SDGs) to mitigate the negative effects of climate change.

**Questions and Answers:**

**African soils are less exploited and chemical usage is less by default. Will African countries lead organic cotton production?**
There are opportunities for organic cotton, but for technologies such as hybrid cotton, there could be challenges due to high seed production costs.

How serious is the effect of gene flow from GM cotton to the environment? Have Pakistan and India started to notice an effect on biodiversity? So far there have been no serious reports or negative effects on biodiversity.

How can we keep sustainability in cotton production with GM cotton as insects and weeds are getting resistant to these GMOs? We will have to keep pace with technological improvements and deploy them as and when new challenges arise to ensure sustainability.

- **Topic: Bt Varieties for Increasing Cotton Yields under Rainfed Ecosystem in India.**
  **Speaker:** Dr HB Santosh, Scientist (Plant Breeding), ICAR-CICR, Nagpur, India

Dr Santosh began by saying that Bt cotton was developed as an alternate strategy to the hazardous insecticides previously used to circumvent bollworm in cotton. In contrast to other countries, Bt technology was introduced to India exclusively in the form of Bt hybrids. Even today, with more than 90% of planted area under Bt hybrids, cotton productivity in India is low compared to the world average (>750 kg/hectare). Cotton yields in India have stagnated at around 500 kg/ha for the past 15 years. He stated that one of the causes of this productivity stagnation is deployment of Bt technology in the form of Bt hybrids in rainfed conditions, which accounts for more than 65% of the cotton area in India. Generally, Dr Zafar explained, hybrids possess high vigour and demand more inputs. The majority of the popular Bt hybrids are of long duration that suffer moisture stress at the boll formation stage due to poor water retention in the shallow soils in rainfed regions. Productivity enhancements in India can come from yield improvement in rainfed ecosystems through the development and deployment of Bt cotton varieties. In this regard, a dedicated transgenic backcross breeding programme was initiated in 2006 using popular elite varieties chosen from different agro-ecological regions of the cotton growing zones. Consequently, a total of 11 Bt varieties have been released and notified until now for commercial cultivation in different cotton growing zones of India. The Bt varieties can provide higher yields with an option of high-density planting apart from providing better protection against bollworms due to presence of the transgene in a homozygous condition. The varieties are less input-demanding and more climate-resilient. They also usher seed sovereignty to farmers because the seed of these varieties can be saved for re-use next year. These released Bt varieties offer tolerance against sucking pests at early growth stages thus reducing the cost of cotton cultivation with environmental benefits. Economic analysis has revealed that the benefit to cost ratio was 2.81. Field demonstrations in rainfed conditions have shown 9% to 18% yield increase with the ICAR-CICR Bt varieties over the BG II hybrid of farmers' choice. In conclusion, Dr Zafar said that these released Bt varieties and promising early-maturing, jassid-tolerant Bt varieties, which are currently in the pipeline, can help India achieve better productivity, profitability, and sustainability of cotton production especially in rainfed regions and on marginal soils.

**Questions and Answers:**

*What kind of efforts are being made by Indian government to popularize and promote the Bt varieties?*

The ICAR-CICR is undertaking rigorous efforts to establish collaborations for seed production and marketing of Bt varieties with many public and private organisations based in states where the majority of cotton area is under rain-fed ecosystems, with a target to promote and upscale adoption of Bt varieties in a target of nearly 30% of rainfed area under cotton.
In developed countries, there is a strong producer-led effort when it comes to adopting technologies. How is ICAR involved at the grassroots level?

Indian agricultural extension agencies have been actively involved in technology transfer through an extensive network and are largely successful in ushering changes into the agricultural sector. A ‘Public-Private-Partnership’ mode is also being explored as detailed in the presentation, apart from demos on farmers field and extension programmes from the institute.

- **Topic: Will hybrid cotton be suitable for rainfed Africa?**
  - **Speaker:** Prof. Emeritus Andrew Paul Gutierrez. Ecosystem Science, University of California, Berkeley, CA; Center for the Analysis of Sustainable Agricultural Systems (CASAS Global), Kensington, CA

Mr Gutierrez said the question implied by the title ‘Will hybrid cotton be suitable for rainfed Africa?’ can be answered only qualitatively and is based on a holistic analysis of the experience of hybrid Bt cotton implementation in India, augmented with parallel insights gained from prior pest disasters and solutions in cotton that are applicable to India and likely Africa. Agroecosystem analyses based on detailed, weather-driven, physiologically based models of cotton growth and development, and the dynamics of its key pest — pink bollworm — proved critical in analysing hybrid Bt cotton production in India. The presentation posits that before implementing any new technology in agriculture (insecticides, hybrids, GMOs, etc.), we need to: (1) Clearly identify the problem that the technology targets; (2) determine if the technology is needed; (3) estimate the costs and the benefits of the technology to farmers; (4) anticipate unwarranted eco-social consequences; and (5) propose alternative technologies. The presentation questions the claims:

- That Bt hybrid cotton was a grand success in India based on the meagre increases in yield;
- the introduction of hybrid Bt cotton to solve an insecticide-induced problem with ‘American’ bollworm;
- the high costs of the hybrid and Bt hybrid technologies;
- insecticide use continued and increased to pre-hybrid Bt cotton levels but now targets sucking insect pests (such as whitefly) not controlled by Bt cotton;
- resistance to Bt toxins is increasing in pink bollworm; and
- the general economic unsustainability of the current low-density, long-season rainfed hybrid Bt cotton technology.

Mr Gutierrez said that the analysis shows how rain-fed, non-GMO, non-hybrid, short-season, high-density cotton varieties as developed by the Central Institute for Cotton Research (CICR) could double yields and farmer income; avoid pink bollworm infestation; reduce insecticide use and induced pest outbreaks; and lower cotton-farmer suicide numbers. To answer the question posed regarding rainfed hybrid cotton in Africa requires similar sound analysis, he explained.

*Can moisture stress due to lack of irrigation explain the stagnation of yield levels in India when compared to world average yields?*

Yes, soil moisture is a critical component in rainfed farming. Moisture deficiency does impact yields negatively.

*Given that we have American bollworm — which is still a major pest in India — and Bt is still quite effective against them, why is that non-GM varieties can be better than GM varieties for India?*

Deployment of Bt-technology depends on the pest status. Sometimes there are misconceptions about some pests being of major importance. Pests can be induced by pesticides too.
Therefore, the current pest status of American bollworm needs to be determined before exploring the need for deployment of cotton.

Many studies have found that Bt cotton is suitable for irrigated cotton with high-input conditions. Francophone countries in Africa grow cotton under rainfed conditions with low inputs. Will Bt technology still be a viable solution to enhance yields? Studies will have to be conducted in Africa for a proper assessment.