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How India Can Double the National Average Cotton Yield

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The views expressed in this column are his own and not that of Cotton Association of India)

Why is it that out of 80 cotton growing countries, India is the only country that cultivates cotton hybrids commercially and that too in more than 94.0% of the area. Why is it that with the best of technologies such as Genetically Modified (GM) Bt-cotton in Hybrids in the entire country, India still ranks 33rd rank in yield per hectare? What can be done to increase the yield per hectare so that India can emerge as a global leader?

EXPERT's Column

Dr K.R. Kranthi

In this context it is important to raise a question whether hybrid cotton is the ideal technology for the entire country. If hybrids were to be the ideal choice, India would have become the global leader by now. There is no doubt that hybrid cotton is a good technology. But some fundamental questions remain. The intention of this article is to initiate an open discussion on the relevance of hybrid cotton technology for Indian conditions and to explore viable alternative systems to enhance yields.

I would like the reader first to know some basic terminologies.

Variety: Seeds of crop varieties can be reused by farmers for several generations with less cross pollination from other varieties. Seeds when planted over generations result in plants that have distinct and uniform characters inherited in a stable manner.

F-1 Hybrid seeds:

a. For F-1 seed production, two different varieties 'A' and 'B' are grown as parents.

b. Emasculation: The pollen from the flower buds of variety 'A' are removed just before the flower opens. The emasculated flowers are covered with a paper bag to prevent pollination from other open flowers.

c. Pollination: The next day pollen of flowers of the variety 'B' are dusted on the stigma of the variety 'A'. The bolls formed from such crosses contain F-1 hybrid seeds which give F-1 hybrid plants.

F-2 seeds:

The seeds obtained from the F-1 hybrid plants are called 'F-2 seeds'. These cannot be reused by the farmer for sowing because the plants from F-2 seeds are not uniform for many of the plant and fiber characters.

Hybrid vigour or Heterosis: When hybrid plants show improvement in any biological quality

compared to the parents, it is called hybrid vigour or heterosis.

Advantages of hybrid cotton

- Lesser seed rate of 2 kg per hectare as compared to 10-12 kg/ha with varieties
- Wider adaptability to varied soil and climatic conditions
- High yield per plant. More boll numbers, bigger boll size and heavier bolls
- More pickings in irrigated cotton with extended crop resulting in higher yields
- Superior fibre quality of higher count yarn
- Excellent boll opening with Bt hybrids for clean picking and low picking cost
- Highly responsive to fertilizers

Disadvantages of Hybrid cotton

- Higher seed cost due to labor intensive and laborious seed production methods
- Higher seed cost due to isolation distance and wastage of flowers from male parent and 20-30% of improper boll setting on female plants
- Needs skilled labor
- High density planting (HDP) can be expensive because of the exorbitant seed cost of about 15 paise per seed
- Nutrient, water and input wastage due to hybrid vigour in unnecessary vegetative biomass
- Long duration leads to longer exposure to insect pests and diseases
- Shallow soils and rainfed conditions lead to stunted plants with few bolls and low yields because of less plant population at 10 to 15 thousand plants per hectare
- Low yields of hybrids in some regions is due to cultivation of hybrids in unsuitable conditions, mismatch of several hybrids in different agro-eco-regions and release of excessive number of hybrids and susceptibility of majority of the hybrids to sap-sucking insects and diseases

Some questions and some answers

Why was Bt technology only available as Bt hybrids, why not as Bt varieties?

The seeds from hybrid crop cannot be reused for sowing whereas seeds of varieties can be reused for sowing. Farmers will have to purchase hybrid seeds every year. Therefore seed companies preferred Bt hybrids over Bt varieties.

Did cotton hybrids improve yields in India?

Hybrid cotton improved yields in some parts of India such as in Gujarat and some irrigated parts of South India. There is no evidence to show that hybrid cotton gave any advantages in North India.

Do hybrids contribute to enhancement of genetic diversity?

Hybrids do not contribute to genetic diversity because the seed from hybrid crop is not used for re-sowing or selection of new cultures/varieties from progeny.

Hybrid Cotton in India

Hybrid technology was developed and used by plant breeders in India to lay the foundation for high yields. The area under hybrid cotton was 28.0% in 1990; 40.0% in 2000; but increased to more than 95.0% by 2013. The area under hybrid cotton was negligible in North India in the year 2000, but by 2013, more than 96.0% of the area was covered with hybrid cotton.

It is estimated that about 40 intra-hirsutum hybrids were developed by the public sector institutions in the past 40 years but more than 1000 cotton hybrids were released by the private sector in just 6 years during 2006-2012.

How can India double the National average yield per hectare

It is crucial to identify the best Bt hybrids for each of the agro-ecological regions and develop package of practices for yield enhancement. In this context the following recommendations will be important:

1. Approve only 2 best hybrids per company in each district
2. Approve varieties of Bt hybrids that are resistant/tolerant to Cotton Leaf Curl Virus & Whitefly in North
3. Permit varieties or Bt hybrids that are resistant to sap-sucking pests
4. It should be made mandatory for a minimum of two year multi-location trials by ICAR-SAU before any variety or hybrid is approved for cultivation in any part of the country.

5. Hybrids are suitable for irrigated regions of central and south India and should be promoted in such regions only.

6. Short duration hybrids also perform well in rainfed regions especially if early sown.

7. For rainfed regions short duration varieties of 130-150 days with compact plant type are ideally suited for high density planting at 200,000 plants/ha especially in shallow soils especially when early sown.

High Density Planting Systems (HDPS) are commonly followed to obtain high yields with straight varieties across the world, especially in the major cotton growing countries such as USA, Australia, China, Brazil and Uzbekistan. The planting geometry is 8-10 cm distance between plants in a row with row to row distance at any of the spacings at 18 or 30 or 45 or 60 or 75 or 90 or 100 etc. The planting methods are referred as narrow row (NR) if the row-to-row spacing is less than 75 cm and ultra-narrow-row (UNR) if the spacing is less than 45 cm. Generally wider row-to-row spacing is followed in deep soils and irrigated farms and ultra-narrow row spacing in rainfed conditions.

HDPS is more relevant to India to establish sustainable production systems. Cotton is cultivated under rain-fed conditions in 60.0% area in India. Productivity of cotton in these regions is low. Protective and supplemental irrigations are rarely available in rainfed conditions. Water and nutrient requirement during peak boll formation phase are most critical for high yields. Rainfall starts in June and recedes in September in majority of the rainfed cotton zones. Boll formation in long duration varieties and hybrids starts in October after and reaches a peak in November. Boll formation and retention get negatively affected due to low soil moisture, especially in shallow soils thus resulting in low yields.

Soils with very low moisture retention capacity have been found to produce low yields in long duration cotton varieties/hybrids. On such soils, high density planting system with short duration varieties is an approach for improving productivity in rainfed region. Early maturing compact plant types with shorter sympodia have been identified by CICR and efforts are being made to lay foundation for a new system of compact varieties for yield enhancement especially in rainfed regions of the country. Doubling the National average yields to 1000 kg lint per hectare should not be very difficult with the new systems.