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Need for a change in cotton R&D policies

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

EXPERT's Column

Dr K.R. Kranthi

Is Indian cotton R&D heading in the right direction? Have we succeeded in developing varieties and production systems that can give us high yields and better quality cotton? Can we ever dream to become global leaders in cotton with the current R&D policies? The answer is 'NO'.

All is not well: Despite having the best of all global technologies, Indian cotton yield ranks 33rd in the 80 cotton growing countries http://www.indexmundi.com/agriculture/?commodity=cotton&graph=yield Indian cotton R&D walks through a strange predicament of 'claims of successes in a maze of failures'. Though claims are made that our yields doubled after Bt cotton hybrids were introduced in 2002, the fact remains that our yields are still low compared to rest of the world. We ranked 50th prior to 2002, but ranked 33rd now with the best of technologies including Bt cotton hybrids. It is interesting that the quality of Indian cotton may only be better than Pakistan and few other countries. Nobody seems to have a clue now, as to how we can increase our yields after a stagnation of 8-9 years. The big question is -what ails us? It is probably 'the frog in the well' syndrome that keeps us in the comfort zone of thinking and believing that 'all is well' even when the country is stagnant at low yields and stuck with poor quality fibre.

Low Yield and Lame Excuses: With the best of technologies India attained 'record' yields of 500-540 kg lint per hectare. The pooled average of rest of the world (79 countries excluding India) is 940 kg lint per hectare. The Indian cotton yield is less than one-fourth of Australia's national average of 2361 kg/ha and one third of the average of about 1500 kg/ha harvested by Brazil, Mexico, China and Turkey. The yield in Maharashtra is 330 kg/ha in 40 lakh hectares and ranks 50th in 80 countries, but behind several poor rain-fed African countries such as Mali, Ghana, Benin, Burkina Faso, Cameroon, Senegal and Sudan. Even Pakistan and Bangladesh have better yields than India. The low yields in India are blamed on poor management practices, poor extension, poor weather, rain-fed farming etc. These, at best can be classified as 'lame excuses'. The fact could be that, Indian cotton yields are low because we pursued wrong R&D policies.

Poor quality cotton: Hybrid cotton currently occupies more than 95% of India's total cotton area. Prior to 2002, before Bt cotton was introduced, when only 40% of the area was under hybrid cotton, long staple cotton constituted 38% of the total production. By 2012, long staple cotton was more than 90% of the total cotton produced, mainly because of the 93% area occupied by Bt cotton hybrids, most of which produce long staple fibre. The Confederation of Indian Textile Industries (CITI) estimate that in the 25.8 m bales utilisation capacity, the current requirement of the Indian textile Industry is 37% long and extra-long staple cotton, 53% medium staple and 10% short staple. The textile industry has specific requirements of raw cotton quality for spinning and weaving. It is estimated that the textile industry in India needs

about 136 lakh bales of medium staple cotton with 26-28 mm of 24 g/tex (ICC mode) and micronaire of 4.0. But the market is flooded with 80-90% long staple cotton with low strength, poor micronaire, immature fibre, sometimes with neps and motes. Majority of the current Indian cotton hybrids produce 30-31mm fibre which have lesser strength of 19-22 g/tex and declining micronaire values of 3.3 to 3.6 especially in the later pickings. This problem is characteristic of Indian hybrid cotton, because boll production extends 100 to 120 days of the crop growth. This leaves a wider window with variable soil moisture and nutrient availability, thus leading to differential fire quality in bolls produced by the same plant at various times in a staggered manner. It is not uncommon to find farms cultivating F-2 seeds either purchased from the market as 'spurious' brands or using their own seeds. Such cotton fields invariably produce bolls with varying fibre traits. Interestingly, all the major cotton producing countries, such as USA, Australia, Brazil and China have developed good varieties with fibre traits ideally catering to the demands of the textile industry. Raw cotton also caters to the requirements of the 'non-woven' segment of the industry, mainly technical textiles, absorbent cotton, surgical cotton etc. Over the past century, there have been tremendous advances in plant breeding to cater to the needs of the textile sector. However, the expectations of the textile industry appear to remain unfulfilled. Strangely, though the requirement of non-woven sector has a demand of about 20 lakh bales in India alone, there seems to be no effort to even to understand their requirements.

The wrong myths: Listed below are several myths that have propelled wrong policies in India:

Myth 1-Hybrids are for high yields: Even with 95% of the area under hybrid cotton in India has not resulted in high yields. Hybrids are cultivated only in India. All other cotton growing countries cultivate only varieties and at least 32 countries produce significantly more than India. Australia harvested national average is more than 6000 kg seed-cotton per hectare using 'varieties' (not hybrids) as compared to 1500 kg seed cotton produced with hybrids in India. China, Brazil, Mexico and Turkey having harvested 4500 kg seed cotton per hectare only with varieties. Brazil has varieties with more than 75% area under non-Bt cotton. Hybrids are developed for more number of bolls per plant. India harvests low yields because it is difficult to get more bolls per plant without extra care and additional inputs. About 30 bolls per plant at a national average of 12,500 hybrid cotton plants per hectare results in a yield of 1500 kg seed cotton (about 500 kg lint) per hectare. To double the yield 60 bolls per plant are required, which is not conceivable at the national scale, especially in rain-fed regions, with any of the current practices. Unfortunately, most of the hybrids show hybrid vigour in production of excessive foliage that consumes more water and nutrients and result in plant stress at boll formation stage. The excessive foliage results in more humidity, diseases and insect pests. There is not even a single district in India that has an average of more than 3000 kg seed cotton per hectare with hybrids. Thus, there is no reason to believe that India can improvise the yields any further over and above the 1500 to 1600 kg per hectare if we continue with hybrid cotton.

Myth 2 -High yields in irrigated cotton: Cotton needs less water and is drought tolerant. While irrigation at early crop stage can be harmful, late irrigation only extends the crop growth phase and relatively higher yields can be expected with the extended cotton with additional inputs. High yields of more than 4500 kg seed-cotton can be obtained in rain-fed farming as is the case with many parts of the world including USA, Mexico, China and Brazil.

Myth 3 -Low yields due to rain-fed farming: High yields of more than 5000 kg seed cotton are obtained in many countries under rain-fed conditions with varieties. The general belief is that the yields are low because India has 60% area under rain-fed cotton. Interestingly, USA also has 60% area under rain-fed cotton, but harvests double the yield per hectare compared to India. Brazil has 98% area under rain-fed farming, but harvests three times the yield compared to India. Some say that the yields in Brazil are high because of the high rainfall at more than 1600 mm. But, cotton in Brazil is planted during mid-monsoon to utilise only 700-800 mm rain water. The paradox is that cotton is a drought tolerant crop with a need for only 250 mm water. However, adequate amount of soil moisture or supplemental irrigation of 6 mm per day at peak boll formation phase generally results in higher production. It is important to note that excess water is bad for cotton. The low yields in India are not because of rain-fed farming. It is the unsuitability of majority of the hybrids under marginal soils in rain-fed conditions, especially in AP, Karnataka, Maharashtra and Madhya Pradesh that result in low yields. It is the unsuitability of hybrid cotton in 100% irrigated North India that results in low yields.

If India has to increase the yields by three times from 1500 kg to 4500 Kg seed-cotton per hectare, some significant changes must be made in its R/D policies as suggested below:

1. **Back to varieties, but at high density:** It is important to work towards reorienting plant breeding strategies to develop early maturing compact varieties suitable for high density planting of 250,000 plants per hectare in marginal soils in rain-fed farms at a spacing of 40x10 cm. It is possible to obtain high yields of 5000 kg per hectare with just five bolls (4.0 g boll) per plant at 250,000 plants per hectare. Globally the average density is 110,000 plants per hectare with plant to plant spacing is 8 or 10 cm, whereas the average

density in India is is 12,500 plants per hectare at a spacing of 30 to 90 cm between plants.

2. **Breeding for few bolls with quality fiber and resistance to pests and diseases:** It is relatively much easier to breed for high quality fiber of 30 mm with 25 g/tex and 4.0 micronaire, uniform and synchronous maturity and resistance to insect pests and diseases, if the expectation from each plant is only 8-10 bolls. Plant protection will be easier if the varieties can be converted to Bt. Thus plant breeders should focus on developing short duration (130-140 days) compact varieties with 8-10 bolls of superior fibre quality, resistant to sucking pests and diseases that will give high yields with high density planting. Thus far, plant breeders in India have been struggling unsuccessfully to develop varieties/hybrids with 100-150 bolls or more per plant with superior fibre traits, synchronous maturity combined with resistance to diseases and pests.
3. **Location specific breeding:** Many private sector Bt hybrids grown in Maharashtra are actually developed for irrigated deep soils and fertile regions of Gujarat and Andhra Pradesh. The hybrids developed for irrigated high input conditions are not suited for rain-fed regions, but are sold in Maharashtra. More than 95% cotton in Maharashtra is rain-fed. Thus there is a mismatch between the hybrids developed for irrigated regions being unsuitable for rain-fed areas of Maharashtra. Some on-farm demonstrations are also shown to farmers by private companies and Government agencies using hybrids cultivated with pre-monsoon sowing on ridges, under drip irrigation, fertigation, plastic mulching and high input use of fertilisers, manures, micronutrients, pesticides and irrigation during boll formation stage to get 3000 to 4000 kg seed cotton per hectare. Such demonstrations mislead farmers, since the conditions of deep soils, drip, etc., are not at all possible to be replicated in more than, may be 10% of Maharashtra or many other rain-fed farms. It is important to place emphasis on breeding varieties suited for specific locations such as rain-fed or irrigated farms and also for soil types and ecological conditions.
4. **Hybrids only for high input farming:** Hybrids respond well to fertilisers and water. The hybrid vigour in foliage results in the need for pesticides to control insect pests and diseases. The generally longer duration with irrigation can result in higher yields. Thus hybrids may be cultivated by farmers who can afford high level of inputs under irrigated conditions for longer durations of 180-200 days crop.
5. **Only short duration varieties/hybrids in rain-fed farms:** Ideally, the best results in rain-fed farms can be obtained through early dry-sowing of short duration (130-140 days) compact varieties that are resistant to sucking pests and diseases. Sowing can be done on ridges at 45x10 cm or 60x10 cm to circumvent drought or excess rains. Dry sowing or early sowing of the short duration non-Bt varieties helps to escape bollworm attack and also to avoid moisture stress during boll formation stage. Early maturing Bt hybrids may also be cultivated in rain-fed regions under high density, if the seed cost is affordable.
6. **Cotton hybrids unsuitable in North India:** Hybrids were not popular in North India prior to the Bt-era mainly due to the fact that hybrids were unsuitable for double cropping systems. The yields in North India are significantly 25-30% less than the yields in Pakistan, primarily because Pakistan has been cultivating varieties and not hybrids. Pakistan is also able to take up wheat cultivation after early harvest of the Bt cotton varieties. The area of wheat in North India is declining because of the extended duration of Bt cotton hybrids, which do not easily facilitate sowing of wheat by mid-November. High density planting of varieties in North India has been giving excellent results and should be explored further with compact varieties that are resistant to the leaf curl virus diseases (CLCuD). The disease resurfaced because of the hasty approval of several untested Bt cotton hybrids for cultivation in North India.
7. **High yields with desi cotton at low production costs:** In view of the high demand for non-woven cotton, the short staple desi varieties can be promoted to obtain high yields through low production costs. The desi species are highly tolerant to drought, water logging, insect pests and diseases and thus need least inputs. Under high density planting, many desi varieties can yield up to 4000 kg seed-cotton per hectare with least expenditure and efforts.
8. **GEAC should approve only genes/events not varieties or hybrids:** It is strange that for more than 10 years the Genetic Engineering Appraisal Committee (GEAC) under the Ministry of Environment and Forests is approving hybrids for commercial cultivation in various parts of the country. The GEAC has thus far approved 1128 Bt cotton hybrids, many of which are susceptible to several insect pests and diseases, thus creating problems for farmers across the country. It is widely believed that the resurgence of the dreaded CLCuD (Cotton Leaf Curl Virus) in North India after 2007 is a result of such indiscriminate release of hybrids without stringent evaluation for susceptibility, as per the prevalent norms under the coordinated trials of the ICAR. It is extremely important to ensure that the approval of any variety or hybrid must be done only after proper multi-location testing for 2-3 years and endorsement by agricultural scientists of the all India coordinated cotton improvement project under the ICAR.