Replanting Indian cotton

Pink bollworm infestation in **Bt cotton in India has turned the spotlight** on an important question: has hybrid cotton lived up to its promise? India was a pioneer in this technology in the 1970s; today, it is the only country that exclusively grows cotton hybrids. Yet, cotton researchers are now asking if our over-reliance on this technology is responsible for our biggest problems in Bt cotton, such as infestation and low yield.

The world's first commercial cotton hybrid, Hybrid-4 (H-4), was developed in 1970 by the scientist Chandrakant T. Patel. The crop revolutionised cotton farming in India. Due to a genetic phenomenon called heterosis, hybrids often outyield open-pollinated (OP) varieties. So, from paltry yields of 122 kg of lint per hectare, production in India rose to 290 kg per hectare by 1992-93. The advent of hybrids also led to a mini-employment boom in the 1980s, with some 25 million people, mostly women, joining the labour-intensive hybrid industry.

But the high cost of hybrid seeds prevented farmers from adopting them in a big way until 2002. This was the year when Bt cotton changed the economics of cotton production by cutting down on the costs of pesticides for bollworms. Farmers adopted Bt cotton in great numbers, despite Monsanto restricting it to hybrids. As a result, by 2011, over 95% of cotton in India was under hybrids, from less than 50% before 2002. Bt cotton's insecticidal traits helped raise Indian yields further.

Eventually, though, productivity plateaued. As of today, India's average yield is around 500 kg of lint per hectare, about a fourth of Australia and Turkey which plant OP varieties. This is puzzling. Why has India's productivity stagnated despite an ostensibly high-yield technology?

Too many factors have contributed to this problem, some of which are uncontrollable, like climatic conditions and the sheer area under cotton production (11 million hectares). But other factors, such as the suitability of hybrids grown, are within India's control and it is crucial to understand them.

Bt cotton no marvel

A big mistake that India made was in going overboard with the number of hybrids it approved after Bt cotton arrived. Until then, approval of new hybrids was a careful process: every time a seed company applied to release one, the Indian Council of Agricultural Research tested its agronomic traits in field trials for three years. This testing became less stringent after 2002, when the Genetic Engineering Approval Committee (GEAC) took over the process of Bt hybrid approval. Concerned that hybrid approval was taking too long and costing too much for seed companies, the GEAC simplified it. It said that as long as the genetic event (such as Monsanto's Bt event, Mon 531) had been tested in field trials, the cotton hybrid containing it required testing for only about a year.

This led to a deluge of poor-quality hybrids in India, with 1,128 hybrids being approved till 2012. Many of these inadequately tested hybrids were unsuited for the regions in which they were approved and hurt farmers and yield. "Farmers had to go through the harrowing experience of experimenting with new hybrids, only to burn their fingers in trying to identify the best," says K.R. Kranthi, who headed Central Institute for Cotton Research (CICR) in Nagpur till 2017 and is now with the International Cotton Advisory Committee in Washington, DC.

What was the problem with an inadequately tested hybrid? Sometimes the seeds were of poor quality, sometimes the hybrids didn't express enough Bt toxin, and sometimes hybrids meant for one agro-climatic zone were approved in other zones. For example, many hybrids that were meant

for irrigated farmlands ended up in areas with no irrigation, a recipe for disaster. Hybrids are a high-cost, high-reward technology; they need the right irrigation at the right time, as well as large doses of fertilizers and pesticides. All this is expensive and beyond the reach of poor farmers. Vijay Kumar, a researcher who headed CICR's Cotton Research Station in Surat, cites the example of Wagad tracts in Gujarat. These are barren lands where only a few Indian OP cotton varieties can survive. "People started growing Bt hybrids there," he laments. "It pulled down yields."

Indian hybrids had another downside. Many were designed to be tall and bushy, unlike OP varieties which are short and straight. This meant that hybrids could not be planted in large densities — one of the contributors of high yields in Australia and Brazil. Low densities led to farmers prolonging the cotton-growing season to increase output, which in turn triggered pink bollworm attacks.

Apart from being bushy, some of these hybrids also had a low harvest index, meaning that the mass of their seeds and lint was low compared to the mass of the rest of the crop, like shoots and leaves. This meant that fertilizers pumped into these hybrids were diverted to leaves rather than lint. This pulled down yield even in irrigated regions like Punjab. Further, Punjab suffered repeated whitefly infestations, which Bt cotton doesn't protect against. Tackling this needed well-timed insecticide sprays, which farmers did not always do.

Some cotton researchers believe that it is time to ditch hybrids and return to OP varieties, at least in rain-fed regions. Varieties are compact and can be selected for resistance against pests like whiteflies. When planted at high densities, they can rival hybrid yields, Mr. Kranthi and Mr. Kumar say.

What route India takes towards varieties depends on the patent issues surrounding Bt cotton. The Delhi High Court ruled this month that the patent on Bollgard-2, Monsanto's second generation Bt cotton, was unenforceable. This means that India has the option to use Bollgard-2, which confers resistance against pests like the American bollworm, in OP varieties. This was impossible until now, given Monsanto's licensing agreement with seed companies. However, Monsanto may appeal the decision in the Supreme Court.

Another, more radical, option is for India to skip Bt technologies altogether in OP varieties. Some researchers argue that Bt cotton is unnecessary, at least in some parts of the country. It was the cultivation of long-duration cotton that triggered both the pink and American bollworm infestations in these regions, creating the need for Bt cotton, they say. In a 2015 study, Andrew Paul Gutierrez, who studies pest control at the University of California, Berkeley, modelled data from Maharashtra's Yavatmal district to show that pink-bollworm infestations began with the advent of irrigated, long-duration cotton. Mr. Gutierrez argued that if rain-fed farmers can control pink-bollworm with short-season cultivation alone, the comparative benefits of Bt cotton wouldn't outweigh its high costs.

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With limited resources and time, it is crucial for States to assess which skills policies will make the biggest impact

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