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Does Indian Cotton Engine Need New Track?

EXPERT's Column

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Introduction

India is the second largest cotton producing country in the world. Government policies and improved production and protection technologies developed by public sector and state agricultural universities coupled with development of Bt Cotton by private industries heralded a remarkable revolution in cotton production during the past two decades. This could meet the rising demand of the domestic the textile industry and the surplus production was progressively exported. Through, the production reached 370 lakh bales, the productivity ranged from 500 to 600 kg lint/ha for the past one decade, way behind leading cotton growing countries like China, Australia and Brazil. The increase in cotton production in the recent past has been due to a significant enhancement in area under cotton and not significant improvement in productivity. The Indian cotton engine needs a new track for enhancing the productivity in a sustainable manner. This article highlights some recasting measures needed for boosting the cotton production system in India.

Causes for Low Cotton Productivity

Several reasons have been attributed to low productivity in the country including natural and socio-economic conditions. In India, cotton is cultivated in different distinct agro-ecological zones. Approximately 65% of India's cotton is produced under rainfed and rest under irrigated conditions. The states of the northern zone states adopt irrigated ecology, while in southern zones, 40% of the total

cotton area is under irrigated situation. The central zone accounts for nearly 60% of the total gross cotton area of the country but with a meagre 23% under irrigation. The major impediments in enhancing productivity are diversified agro-climate and agro-ecology, species diversity, uncontrolled proliferation of varieties/hybrid and changing pest dynamics due to climate change.

In the past two-decades, cotton cultivation scenario witnessed enormous changes, especially the varietal transformation from traditional varieties and hybrids developed for location specific conditions to genetically transformed cotton hybrids (Bt Cotton). Not all Bt cotton hybrids are equally suitable for all agro-climatic conditions. Many early studies found that Bt cottons are well suited for irrigated conditions. The returns from Bt cotton were lower in rainfed regions, especially in Maharashtra and parts of Telangana. A survey by ISCI in 2013 found that just 24% of the Maharashtra farmers consider that Bt cotton yield as a major benefit from adoption, while conversely, 79% and 100% farmers in Haryana and Punjab considered yield as a major benefit. Farmers in Maharashtra have not realised the potential yield from Bt cotton hybrids because 96% of the Maharashtra cotton area is rainfed, whereas in Punjab and Haryana farmers have realised better yields from Bt Cotton as these zones have ample irrigation facilities.

Cotton yields have stagnated since the adoption of Bt cotton in the U.S., Argentina and Colombia. While cotton productivity has increased in China, but it is still debatable if this is attributable to Bt cotton. For example, in the Xinjiang, province of China, which contributes 30-40% to the total cotton production and has the highest average yield, majority of the cotton grown is conventional non-Bt cotton. In fact, Bt cotton is not a yield enhancing technology but a technology to minimise loss due to bollworms. In addition, in India, Bt cotton is available only as hybrids in over 1,500 names/ brands, while in the rest of the world Bt cotton is available only in few straight varieties.

Between the years 2002 and 2004, only 19 Bt cotton hybrids were released. These new hybrids along with existing conventional non-Bt hybrids and varieties had increased cotton productivity level in the country from 307 to 470 kg lint/ha. Subsequently, 1109 Bt cotton hybrids were released between 2004 and 2012 and today around 90% of the total cotton area is under these hybrids and the productivity is around 500 kg lint/ha. Proliferation of too many untested Bt hybrids which are susceptible to major sap sucking pests and diseases and cultivated in unsuitable agro-climatic zones is the main impediment for improving the cotton productivity in the country.

Remedy for Enhanced Productivity

Australia, China and Brazil are the front runners in developing innovative technologies for higher cotton productivity. Some good production practices have been developed and successfully adopted in these and many other countries. Those technologies are not directly adoptable and implementable to Indian agro-climatic constraints in the country. Researchers should identify the suitability of the technologies and modify them to suit the local conditions. Some of the best practices followed in the countries which achieved higher productivity are summarised herewith:

Australia

Australia has the highest cotton productivity in the world and most of this productivity gain is attributed to breeding and seed technology. The most successful breeding achievement in Australia was the development of efficient cultures with okra leaf shape which has narrow leaflets in contrast to the broad normal leaf. The okra leaf character also gives improvement in water use efficiency.

The soils on which cotton is grown are naturally fertile, have high clay content and strong shrink-swell capacities. The main changes in management of cotton soils over the past 30 years have been large scale adoption of conservation tillage or minimum tillage. For efficient nutrient management, soil and leaf testing is done to optimise fertilizer application. Availability of water for growing cotton is the main constraint on production of cotton. This was overcome with technologies to improve water use efficiency. Australia's cotton cultivation is considered among the most water-efficient in the world. Precision irrigation scheduling based on soil moisture probe for the specific requirement of each stages of the crop is followed. A combination of integrated pest management (IPM) techniques and transgenic cotton varieties resulted in an 89% decrease in insecticide use, the amount of insecticide reduced from 5.12 kg to 0.55 kg active ingredient per hectare. Strong extension system provides guidance on when, how, how much and what insecticides to spray. The cotton R&D program is funded by Australia's cotton growers who pay a compulsory levy of $2.25 per bale of cotton. This is equally matched by the Australian Government's target-oriented research.

China

China is the largest cotton producer and consumer in the world. Like in India, cotton farmers in China are typically small holders and resources poor and risk aversive with an average crop area of less than one hectare per household, of which the cotton area less than half hectare. The main reasons for continued increase in yield in China are cultivation

of cotton in areas environmentally more suitable and technological progress. Approved cotton varieties are released to the ideal agro-ecological zone, rather than to the entire province.

Most of the cotton production technologies developed indigenously in China with strong policy decisions for the locally prevailing environment and socio-economic conditions. The high unit area yield is largely due to adoption of a series of intensive farming technologies and cultural practices include seedling transplanting, minimum tillage, canopy management, plastic mulching, double cropping, plant training and super-high plant density technique.

"Short-Dense-Early" pattern is one of the most important practices found to produce 2250 kg/ha of lint yield. This involves early planting of early maturing varieties at increased plant density with the help of drip irrigation under plastic mulching. China embraced the cultivation of Bt cotton in 1997 with introduction of Bt cotton technology to the locally adapted straight varieties.

Brazil

Brazilian cotton farming was a small holders' activity in southern and south-eastern regions until 1990. Later, the main cotton production shifted towards central-west and north-east region and this transformed cotton farming to a fully mechanised corporate farming in the new regions of Cerrado zone that was erstwhile considered to be unfit for due to acidic soils low in fertility. Large quantity of lime (approximately five tonnes/ha) is applied to reclaim the soils. On reclaimed lands of Cerrado zone a corporate farming model with mechanisation, better utilisation of agro inputs and newer upland GM varieties was introduced. Large scale adoption of model transformed Brazil from large scale importer of cotton in 1980s to a net exporter.

Varietal improvement has been the major contributor for enhanced yield in Brazil. Improved varieties especially, BRS 293 and BRS 286 from Brazil are also widely adopted in African countries. The variety BRS 335 is also adopted in the United States especially in Georgia, Mississippi, Tennessee, Arkansas and Texas. During 2017, the parental BRS lines were incorporated with genetically modified traits (Boll-guard II and Roundup Ready Flex) and varieties BRS 430 B2RF, BRS 432 B2RF and BRS 433 FL B2RF were released. These varieties are capable of producing around 4500 kg/ha of seed cotton with more than 40% ginning outturn, thus yielding 1800 kg/ha of lint. Brazil also embraced GM technologies in cotton only in varieties that are compact and amenable for high density planting system (HDPS) and machine picking. To make the compact sympodial varieties more determinate, plant growth regulators are used to arrest excess vegetative growth.

Today about 95% of cotton is produced under corporate farming in Cerrado region with average farm holding of around 1,000 hectares and 80% of the farm practices including harvesting are fully mechanised. Reassessment of the technologies introduced is periodically carried out and appropriate fine tuning to suit the emerging crop cultivation situation is systematic practiced. The high mechanisation using larger tractors, planters and harvesters have caused soil compaction and hence today there is a widespread adoption of minimum tillage systems.

The recent Embrapa initiative of separating lint from seed cotton at a farm itself using small cotton gin and fibre bailing implements has enabled growers to sell the produce directly to the textile industry and increases their income up to four times compared to convention sales of seed-cotton.

What Should India Do Differently?

There is no dearth of technologies locally as well as adoptable from other countries with appropriate fine tuning. Some of the technologies perhaps suitable for Indian conditions with sustainable use of natural resources are enlisted below.

Breeding Programme:

- Early maturing and short duration cultures with uniform boll formation and bursting can escape late season infestation of pink boll worm.
- Focus on increasing cotton lint per seed (ginning percentage) while maintaining the seeds per boll constant.
- Improving architecture to combat biotic and abiotic stresses. The focus should be on the development of okra leaf type cultures in order to minimise infestation of sucking pests.
- Development of climate resilient plant types with no monopodia and zero branching to suit High Density Planting System and machine picking.
- Development of elite biotech cotton in straight varieties instead of hybrids which are more input intensive including water, nutrients and insecticides.
- Breeding and promotion programme for ELS cotton with better fibre quality, short duration, with resistance from pest and disease.

Production Programme:

- Development and evaluation of conservation tillage or minimum tillage systems suitable for Indian conditions.

- Production and processing of cotton consumes voluminous amounts of water. Ground water table has drastically reduced in the states of Gujarat, Punjab and Haryana due to large scale lifting of ground water. Equally, ground water irrigation in the other central and southern states is being depleted. Exploitation of ground water is increasing soil salinisation also. There is a need to develop and validate irrigation scheduling based on soil moisture probe for the specific requirement of each stage of the cotton crop to judiciously use this precious resource.

- Canopy Management strategies need to be developed –in order to regulate plant growth, reduce boll shedding, increase boll size and number of fruiting nodes. Plant topping and removing old leaves and empty fruit branches improves ventilation, light penetration, reduced soil humidity and facilitates redistribution of nutrients to cotton reproductive parts.

- Seedlings can be raised in nurseries in order to ensure precision planting, water saving during initial stage irrigation and also ensures systemic pesticides application, protect the seedlings from insects, nematodes and pathogens.

- Planting of early maturing varieties with increased plant density, with the help of drip irrigation under plastic mulching wherever possible.

Protection Programme:

- IPM and IDM strategies should be developed for different agro-climatic conditions; for different species; for varieties and hybrids as cotton cultivated under these spectrums.

- In the dynamic pest and disease scenario, Integrated Pest Management and Integrated Disease Management strategies should be reviewed periodically. Irrelevant and undesirable interventions need to be removed from the package.

- Novel research should be initiated with the help of biotechnology for the control of sucking pests as sucking pest have been menace after the introduction of Bt cotton.

Policy Decisions:

- Need to identify the low productivity areas especially in Maharashtra and appropriate crop diversification strategies need to be developed for these areas.

- Strong government policy required to curb the cotton cultivation in the unsuitable area where cotton is not remunerative but is contributing to deterioration of the soil and environment.

- Value addition to the produce at cotton village level or clusters with small community ginning units for de-linting of seed cotton in order to eradication of middle men and additional income to farmers. This method has been successfully followed in Brazil.

- Release of the varieties and hybrids should be for micro domain. Approved cotton varieties are to be released to that production zone which is conducive for cotton cultivation, rather than to the entire zone covering many districts or states.

- Improved extension methodology needs to be developed with better coordination among central, state governments and private seed industries for inculcating the appropriate technologies to the farmers for the prevailing local condition.

- Strict compliance should be followed for release of newer varieties. Proliferation and cultivation of too many varieties result in multiplicity of pest and disease infestation.

- The researchers and policy makers should take note of the demand of the local textile industries especially on the quantity and quality demand.

- Use of technologies like satellite imaging and drones should be encouraged for developing high-tech cotton cultivation, monitoring and management.

The real spin-off from increased productivity is reduced use of natural resources and lower production cost. These could be achieved through knowledge intensive technological initiatives involving stakeholders – farmers, public sector researchers, policy decision makers and private sector agencies including seed producers and textile industries.

Authors' Note: The views expressed above by the authors are prepared based on the numerous research articles published across the countries and individual analyses of facts and figures on cotton in India.

(The views expressed in this column are of the authors and not that of Cotton Association of India)
