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An overview of cotton seed industry in India : Policy implications and perspectives

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ABSTRACT : The paper attempts to study overview of cotton seed industry in India in light of various policy decisions for easy accessibility of *Bt* cotton seed. Government of India had implemented various policy measures since 1963 that caused tremendous transformation in seed sector to access quality seed and planting material to farmers. Seed markets in India have transformed immensely from conventional to genetically modified (GM) seeds over the years. The adoption of *Bt* cotton hybrids has increased remarkably since 2002 (the year of its introduction) sharing more than 95 per cent of total cotton area in India in 2015-2016. *Bt* cotton hybrids are mainly produced by private sector in India and contributed a lot in production and productivity of cotton. However, the price of *Bt* cotton hybrid is of serious concern and it has been reviewed periodically by state and central governments for better access of technology for resource poor farmers. In 2015, government of India notified a cotton seed price control order to reduce royalties by 74 per cent *i.e.* from Rs.163 to Rs.49 /450g packet and seed firms had challenged this order. In 2018, the seed prices have been further reduced to Rs 740 from Rs 800/450 g packet and the royalties have been slashed to Rs 39 / packet from Rs 49. It is argued that such a step hampers investment in innovative research and development and is contrary to the government's 'Make in India' campaign to start business for production of seed in the country. In the light of this discussion, the paper suggests alternative government policies for better accessibility and wider adoption of new technologies for poor resource farmers in India.

Key words : *Bt* cotton, GM seeds, price control

Seed is an essential component for increasing crop productivity in Indian agriculture. It is estimated that the use of quality seeds could increase agricultural productivity by 15-20 per cent and it can be further raised to 45 per cent by efficient management of other resources (Seed Net India Portal, Ministry of Agriculture, Government of India 2018)). In the seed market of agricultural crops terms of value is projected to reach USD 113.28 billion by 2022 with an increasing rate of 9.9 per cent from 2017(Seed Markets by Type, Markets and Markets, 2017). However, according to United Nations Department of Economic and Social Affair, India will become the most populous country of the World surpassing China in 2022. This calls for raising agricultural production from scarce quantity of land which is possible through quality seeds and other inputs and adoption of smart agricultural practices.

Seed Industry plays a pivotal role in raising agricultural productivity. There have been significant developments in Indian seed Industry since inception of green revolution. The National Seed Corporation, an enterprise of Ministry of Agriculture, Government of India was

established in 1963. The Government of India enacted the Seeds Act in 1966 to regulate the growing seed industry. The sixties were the most eventful times for Indian agriculture, not only because of introduction of high yielding cultivars of fine cereals(wheat and rice) but also for many other positive developments related to seed such as constitution of Seed Review Team, enactment of Seeds Act 1966 and formation of National Commission on Agriculture. A major restructuring of the seed industry by Government of India through the National Seed Project Phase I (1977-1978), Phase II (1978-1979) and Phase III (1990-1991), was carried out, which strengthened the seed infrastructure that was most needed and relevant around those times. This could be termed as a first turning point in shaping of an organized seed industry. Introduction of New Seed Development Policy (1988-1989) was yet another significant mile stone in the Indian Seed Industry, which transformed the very character of the seed industry. The policy gave access to Indian farmers of the best of seed and planting material available in India and abroad. The policy stimulated appreciable investments by private individuals, Indian corporate and MNCs in the Indian Seed Sector with strong RandD base for product development in each of the seed companies with more emphasis on high value hybrids of cereals, oilseeds, cash crops (Cotton) and vegetables.

The rise of the private seed sector is associated with the evolution of hybrid and high yielding varieties (HYVs). As is well known, if farmer obtain new crop varieties, he can save, multiply, exchange and sell the seed for many years. Consequently, the development and distribution of new crop varieties is typically an activity of the public sector. On the other hand, seed from hybrid seeded crops cannot be used in succeeding years without major yield reductions. As a result, hybrid seed tend to be repeatedly purchased by farmers, which provides a mechanism for private technology suppliers to appropriate a significant enough share of the gains from higher yields. Further, the economic reforms of 1991 lifted barriers to investments by foreign firms as well as by large Indian firms. The introduction of plant breeders' rights through the Plant Variety Protection Act and the commercialization of plant biotechnology products also seem to enhance the advantages of large firms (whether foreign or domestic) with formidable marketing and technological capabilities. This led to significant growth of private sector in seed business over time.

The seed markets in India have transformed immensely from conventional to genetically modified (GM) seeds over the years growing at growth rate of 12 per cent / annum (James, 2015). In the recent years, there has been a shift in the preference of cultivators from open pollinated varieties to hybrids in field crops as well as high value crops (fruits and vegetable). According to the Ken research report, the India seeds market will grow at a considerable CAGR rate touching to INR 283.10 billion by FY'2020 due to increase in seed replacement rate (SRR) and varietal replacement rate (VRR), improvement in production and distribution of quality seeds suitable to different agro climatic zones at affordable prices along with a determined effort to address region specific crop production constraints. The value of major crops in Indian seed market in 2015 is given in table

as under:

Table 1. Indian seed market scenario of major crops, 2017 (In value terms)

Crop Group	All Seed ($ mln)	Commercial Seed($ mln)
Cereals		
Rice	1428,14	499,85
Maize	386,58	143,03
Other Cereals	478	96
Oilseeds		
Soyabean	313,20	172,26
Rape	234,63	140,28
Sun flower	21,75	7,59
Cash crops		
Cotton	671,43	671,41
Sugarcane	0,00	0
Sugarbeet	0,00	0
Vegetables		
Potato	234,50	55,68
Total	5052,28	2206,36

Source: Kleffmann Group, Germany (2017)

The total value of seeds of major crops is $5281 millions, out of which only 36 per cent ($1945 millions) is commercial seed. It is to be noted that cotton is the only crop where almost 100 per cent of the seed is commercialised seed. It could be due to the introduction of hybrids and HYVs and later GM seed in cotton *i.e. Bt* cotton. This paper attempts to describe the story behind the successful commercialization of *Bt* cotton in India with special focus on the market structure of cotton seed industry and also discusses the contribution of various government policies towards its adoption. In the light of present literature, it suggests alternative policies to the policy makers which could enhance competitiveness in the seed industry could also lead to wider adoption of this technology for resource poor farmers in India.

In order to delve deeper into the reasons for successful commercialization of cotton seeds in India, it is imperative to look at the market structure of cotton seed industry in India.

Changing structure of cotton seed industry in India : Until 1980s, the development and distribution of cotton seeds in India was an activity of the public sector. However, policy reforms such as the New Policy on Seed Development (1988) and the New Industrial Policy (1991) encouraged private sector participation in the cotton seed market. Moreover, the rise of private seed sector is associated with the development of hybrids. Since hybrid seeds can not be saved and reused, it needs to be repeatedly purchased. This gives incentives to private sector to engage actively in the development of such seeds and reap huge gains from marketing of hybrids.

Cotton is a major cash and fibre crop grown in India. It is mainly grown in nine (9) states spread over three zones namely, northern zone (Punjab, Haryana and Rajasthan) central zone (Madhya Pradesh, Gujarat Maharashtra) and southern zone (Andhra Pradesh, Karnataka and Tamil Nadu). India is the pioneer country in the world for commercial cultivation of cotton hybrids. Cotton hybrids have 50 per cent higher productivity than high yielding varieties. Moreover, hybrids have wider adaptability, high degree of resistance to biotic and abiotic stresses and better fibre quality (Santhy *et al.,* 2008). The first public sector cotton hybrid (Intra *hirsutum* H 4) was released in 1970 from Main Cotton Research Station, Surat of Gujarat Agricultural University and followed by the development of world first inter specific hybrid 'Varalaxmi' in 1972 from U.A.S., Dharwad. Thereafter,

development of hybrids got momentum and numerous location specific superior hybrids were released in the country. The first private sector cotton hybrid MECH 11 was commercialized by Mahyco in 1979. While the hybrid breeding effort was initiated in the public sector for the first 20 years, it was in 1990 that private sector developed and many private seed companies released cotton hybrids.

Several factors were responsible for the rapid development of private sector hybrids in 1990s. Firstly, the private sector has relied heavily on retired public sector breeders and thus the knowledge spill overs from public sector R and D activity have been substantial. Also, the private sector was quick to spot the market opportunities which were left unexploited by the public sector (Murugkar *et al.,* 2007) Thirdly, the decade of 1990s was a period of economic reforms. The removal of Industrial licensing and restrictions on foreign direct investment (FDI) provided opportunities to many foreign companies to enter into Indian seed industry. During this period, the productivity of cotton in India was among the lowest in the world. The main reason for the low productivity is severedamage caused by insect pests commonly referred to as American bollworm. The chemical control used to kill these insect pests was proving ineffective as these pests have developed high level of resistance for recommended chemicals. Ultimately, it leads to repeated application of agro chemicals leading to excessive expenditures, crop failures and high burden of debt on farmers. Therefore, it has been argued that adoption of *Bt* cotton is one of the option to attain high yield, reduction in use of chemicals and mitigate /reduce the risk of crop failures. Even before the official approval of *Bt* cotton for cultivation in 2002, unauthorized (illegal) hybrids of genetically modified cotton seeds was available to farmers of Gujarat, sold by a private seed firm namely Navbharat seeds. These hybrids had not undergone the rigorous testing and trials as mandated by bio safety regulations and were not approved by the Genetic Engineering Approval Committee(GEAC); hence are termed as “illegal seeds”.

At the end of nineties, *Bt* cotton with a potential to provide protection against bollworm, was considered to be a solution for the high cost of pesticide use in the country. Thus, in 2002 after a review of satisfactory field trials and bio safety data by the regulatory authorities, partly prompted by the spread of illegal *Bt* cotton seeds in India in 2001, government of India gave permission for the official hybrids of *Bt* cotton to be commercially cultivated in 2002. *Bt* cotton contains a foreign gene which produces a toxin called *Bt* toxin that binds to receptors in a gut, killing the insect. With the advent of biotechnology, this bacterial gene has been introduced genetically into the cotton seeds and it protects the plants from bollworms. The worms feeding on the leaves of *Bt* cotton plant become lethargic and sleepy and are gradually eliminated (Gandhi and Namboodiri, 2006). This significantly reduces chemical use and provides a major benefit to cotton growers and environment.

As discussed previously, *Bt* cotton was developed by Monsanto (a U.S based firm) as one of the first GM crop technologies and was commercialized in the mid 1990s. It was first introduced in U.S in 1996. Since then, the technology has spread rapidly to Australia (1997),

South Africa (1997), Argentina (1998), Mexico (1996), China (1998), and Indonesia (2000). Mahyco (Maharashtra Hybrid Seed Company) in collaboration with Monsanto has introduced *Bt* cotton technology into India. India made its entry into agricultural biotechnology in March 2002 with the approval of three *Bt* cotton hybrids for commercial cultivation

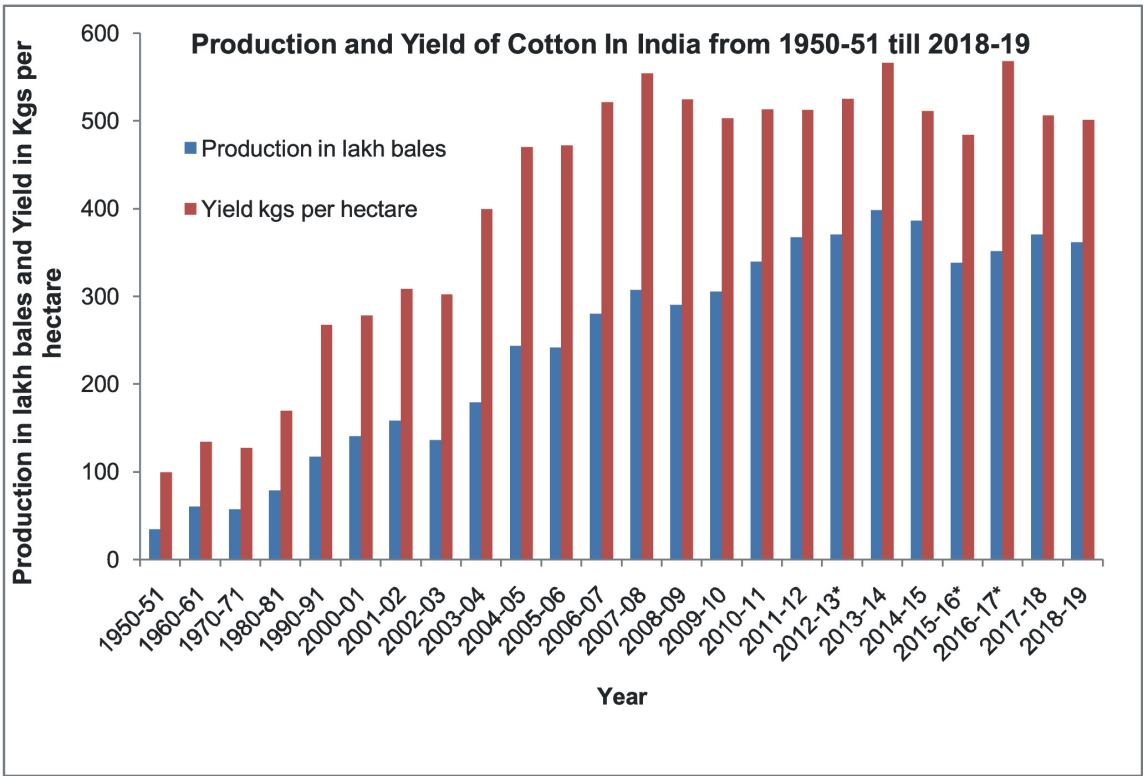

Fig 1. Production and productivity of cotton (From 1950-51 till 2018-19)
Source: Cotton Corporation of India (Accessed at https://www.cotcorp.org.in/nationalcotton.aspx)

As it is evident from the above Fig. 1, technological innovations and policy reforms have led to a tenfold increase in cotton production and productivity during the last seven decades. The production of cotton recorded around 9 per cent increase from only 34.3 lakh bales to around 351 lakh bales in 2016-2017. This substantial increase was due to improvement in cotton productivity from 99 kg/ha during 1950-1951 to 568 kg/ha in 2016-2017. However, cotton production reduced to a large extent in 2001-2002 due to severe incidence of American bollworm. A notable point is that much of the improvement in cotton productivity took place since 2002-2003 *i.e.* the year of commercialization of *Bt* cotton in India. Although hybrid technology was available since 1970s and seed policy reforms led to liberalization of private sector to enter Indian seed market but still adoption rate of hybrids was only about 50 per cent until 2002. With the advent of *Bt* cotton in 2002, both the area under cotton and hybrid cotton increased which led to substantial increase in cotton production and productivity. The overall growth in area, production and productivity of cotton in India was 0.49, 2.98

and 2.51 per cent , respectively during last seven decades.

Since the introduction of *Bt* cotton in India in 2002, the adoption of technology has increased remarkably from 50,000 ha in 2002 to 11.4 million ha by 2017. In 2015, India displaced China to become the world's top cotton producing country. In 2017, the area under *Bt* cotton in India increased by 600,000 ha from 10.8 million ha in 2016 to 11.4 million ha equivalent to 93 per cent of the total cotton area of 12.24 million ha grown in the country (James, 2018).India was estimated to have enhanced farm income from *Bt* cotton by US$21.1 billion in the 13 year period 2002 to 2016, and US$1.5 billion in 2016 alone (Brookes and Barfoot, 2018).

The given Fig. 2 depicts the value of exports of cotton lint from India starting 1997 to

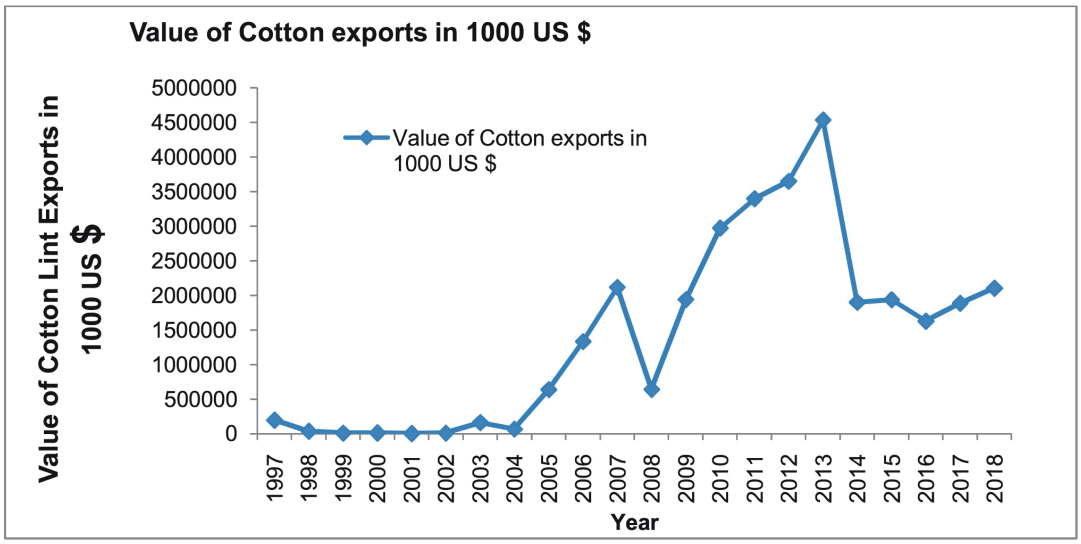

Fig 2. Export potential of Cotton (1997-2013)

Source: Cotton Corporation of India and Agricultural and Processed Food Products Export Development Authority (APEDA)

2013. It can be seen from the figure that before 2002 exports of cotton were below 2 lakh 1000 US $. It was because before 2002, production was insufficient to meet domestic demand and India was a net importer of cotton. However, after 2002, year of commercialization of *Bt* cotton, exports picked up and finally after 2004, there was a tremendous increase in cotton exports making India a net exporter of cotton. However, recent trends depict that exports have declined in 2014 due to fall in demand of cotton lint from China. Moreover, due to drought conditions in 2014-2015 and 2015-2016 and outbreak of whitefly exports declined further during this period. Again in 2016-2017, exports of cotton lint have increased towards Vietnam and Bangladesh and have picked up again.

Market structure of cotton industry : Mahyco-Monsanto Biotech (MMB), a joint venture between Maharashtra Hybrid Seeds Company (Mahyco) and Monsanto had released three (3)*Bt* cotton hybrids for cultivation in India in March 2002 with the approval of GEAC. These

hybrids contained the *Bt* gene *cry1Ac* owned by Monsanto, which licensed the gene to MMB. The other Indian seed companies also showed interest in the technology and by the end of 2007 about 22 companies had become sub licensees of MMB. Until 2005, MMB dominated the market for cotton hybrids, either directly through selling hybrid seeds or indirectly through sub-licensing to private seed companies. The domestic companies that licensed *Bt* trait from MMB were required to pay a one time license fee as well as a royalty for availing the gene. This led to a large price difference between *Bt* and non *Bt* hybrids. The price for official *Bt* cotton seeds in India in 2006 was around Rs 1600/packet of 450 g, which was around four times the price of non *Bt* hybrid. Out of the seed price of Rs 1600., Rs 1250 was charged by MMB as the trait value or royalty (Sadashivappa and Qaim, 2009).

The large gap between the price of *Bt* cotton hybrid and non *Bt* hybrid led to the fears that monopolistic market structure was prevailing in the cotton seed market that has resulted in excessive seed prices. Concerns were raised that high seed prices may restrict access of technology for resource poor farmers (Lalitha, 2004). In response to these concerns, the state of Andhra Pradesh imposed a ceiling of Rs 750 (inclusive of technology fee) on *Bt* cotton seed price in Andhra Pradesh in 2006. The other states of India also imposed the same ceiling.

In 2006, Bollgard II, stacked with two *Bt* genes, namely, cry 1Ac and cry 2Ab2 with Event 15985. also developed by MMB, was approved by GEAC. Bollgard-II is supposed to be a better resistance management tool than Bollgard I (single gene *Bt* cotton hybrids). In addition to bollworm, Bollgard II claims to offer protection against another pest, the spodoptera caterpillar, thereby ensuring higher yields.

In the same year, 2006, two domestic seed companies JK Agri Genetics Ltd. and Nath Seeds also released their own approved events of *Bt* cotton. JK Agri Genetics developed a modified *cry1Ac* gene sourced from IIT (Indian Institute of Technology) Kharagpur, and Nath Seeds developed a 'fusion' *cry1Ac/cry1Ab* gene sourced from the Chinese Academy of Agricultural Sciences. In addition, approval was granted to the *Bt* cotton variety '*Bt Bikaneri nerma*' developed by University of Agricultural Sciences, Dharwad, in collaboration with Central Institute of Cotton Research, Nagpur, and National Research Centre on Plant Biotechnology, New Delhi. In 2009, a new *cry1C* event, Event 9124, transferred in two hybrids by Metahelix, Bangalore, was approved for commercial cultivation. Thus, the number of *Bt* cotton hybrids approved for commercial cultivation increased significantly over the years and reached 780 in 2010 (James, 2010).

The first genetic event approved for commercialization in India belonged to MMB. Although MMB does not hold an Indian patent over its gene, but since bio safety approvals are obtained for the composite of the gene and the germplasm, the hybrids that incorporate MMB's gene but do not go through the bio-safety process are illegal. Further since the regulatory authorities are unlikely to approve a *Bt* hybrid that incorporates an unlicensed version of the MMB gene, most seed companies licensed the *Bt* technology from MMB. Thus, MMB has derived a measure of protection for its gene through biosafety laws in India, in other words, these laws have created 'defacto' intellectual property

rights for the legal *Bt* cotton (Lalitha, *et al.,* 2008).

Bio safety regulatory processes in India have also acted as an entry barrier for new *Bt* genes. A firm can access *Bt* hybrids either through licensing an already approved gene construct from a technology provider, or can develop its own *Bt* gene by undertaking research and development. *Bt* related investments can be recovered easily if the firm follows the first route. Until 2006, the only supplier of *Bt* technology was MMB, which licensed its *Bt* gene to other cotton seed companies. Developing one's own *Bt* genes, on the other hand, entails huge RandD investment costs. In addition, bio safety regulatory processes for approval of new genes are considerably expensive and time consuming. In 2006, two Indian seed companies, JK Agri-Genetics Limited and Nath Seeds Limited, developed their own *Bt* cotton hybrids that incorporated non Monsanto genes and received regulatory approval for the same. Thus even though a few non MMB *Bt* gene providers did enter the market, their ability to compete in the technology market was constrained by the first mover advantage of MMB. The discussion suggests that the MMB does exercise its monopoly power and its market power is somewhat facilitated by the government's bio safety regulatory requirements.

Research and development (RandD) expenditures on new and patentable genetic traits and seeds are an important part of the production cost of seeds. The price markup acts as an incentive for seed companies to develop new technologies and therefore, in the long run price controls could have negative implications for product development. Price controls may also adversely affect new entrants. Although the price ceilings were supposedly directed at controlling (MMBs) monopoly pricing, they probably disadvantaged the alternative gene providers such as JK Agri Genetics Limited and Nath Seeds Limited even more as their costs couldn't be recouped easily (Murugkar, *et al.,* 2007).

In 2010, keeping in view the rising labour costs and production costs for *Bt* cotton and increasing pressure from seed companies, state government of Gujarat and Andhra Pradesh have increased seed prices of both BG I and BG II trait to Rs 830 and Rs 930 for a packet of 450 g from Rs 650 and Rs 750, respectively (Times of India, 2011). So far the state governments were regulating the sale price of cotton seed, however recently government of India has decided to control prices of cotton seeds including the genetically modified versions by fixing a uniform maximum sale price from March 2016 .The notification comes at a time when there is a tussle between the MMBL and seed companies over payment of royalty for using Bollgard technology in hybrid cotton seeds. MMBL has dragged eight seed firms for non-payment of about Rs 400 croreroyalty for using its technology in cotton hybrids and for breach of the contract. On the other hand, National Seed Association of India (NSAI) has sought refund of over Rs 1,300 crore paid as royalty to MMBL for using latter's technology in last five years arguing that the seed firms paid this amount over and above the state government stipulated trait value. The government of India in 2015 notified a cotton seed price control order following which it reduced royalties on *Bt* cotton seeds by 74 per cent *i.e.* from Rs.163 to Rs. 49 /packet. The seed firms thus filed a case against MMBL for not

complying with the stipulated order and charging the trait fee higher than allowed under Indian laws. So in a recent decision of high court, it held MMBL guilty for not complying with the GOI order. In retaliation, Monsanto has challenged provisions of the price control order allowing the government to determine trait or royalty fees at the Delhi High Court in a separate case. The hearing of case is still pending in court. In 2018, the government further slashed the cotton prices to Rs 740/packet of 450g and this has reduced trait value from Rs 49 to Rs 39 / packet (Economic Times, March 2018).

Association of Biotech Led Enterprises Agriculture focused Group (ABLE- AG), a non profit organization representing *Bt* cotton seed producers expressed serious concern with regards to the recent decision by the Ministry of Agriculture and Farmers Welfare, Government of India to regulate the maximum sale price of cotton seeds in the country. It argued that such a step hampers confidence in making investment in innovative research and development and is contrary to the Government's 'Make in India' campaign and impacts ease of doing business. This may happen as Multinational Companies (MNC) having patent of a particular gene to protect cotton crop from biotic stresses will not collaborate with Indian firms at low rate of royalty and ultimately seed industry for cotton will not expand.

In light of the above discussion and arguments, government could resort to alternative government policies (*eg* subsidizing RandD, simplification of regulatory approval process etc) apart from price controls, which could prevent monopolistic market structure in the cotton seed market and promote competition in this sector.

Conclusion and policy implications : Cotton seed industry is expanding with introduction of hybrids of *Bt* cotton because of more than 95 per cent of cotton area covered under *Bt* cotton in the country. However, cost of cotton seed has increased considerably with introduction of *Bt* cotton in 2002. No doubt, cultivation of *Bt* cotton has increased production and productivity of cotton and presently country is exporter of cotton lint, however, the large gap between the price of *Bt* cotton hybrid and non *Bt* hybrid signifies that market for *Bt* cotton is captured by private sector. Government of India and state governments have taken various measures to control the price of *Bt* cotton hybrids. In 2015, government of India has reduced royalties on *Bt* cotton seeds by 74 per cent *i.e.* Rs.163 to Rs.43 (excluding taxes) / packet to benefit cotton growers for bringing large area under cultivation of *Bt* cotton. There is contradiction for fixation of maximum sale price of *Bt* cotton by central government. This policy decision will discourage investment in innovative research and development and not favourable for 'Make in India' campaign.

No doubt, government interventions in seed pricing may be important to improve disadvantaged farmers' access to beneficial new technologies. However, such intervention should be enforced based on careful situation analysis in order to avoid negative long term consequences for agricultural innovation considering the investment of private sector in crop improvement research. Government of India should also create an environment for sustaining research in development of seed and

other innovations in private sector by promoting recent Intellectual Property Rights (IPR) Policy.

Alternatively, government could create necessary infrastructure for national and state seed corporations for production of seed of *Bt* cotton hybrids to create competitiveness among public and private sectors for quality improvement and cost reduction. Research institutes must also be strengthened to focus on research for exploring of inoculation of *Bt* gene in high yielding varieties of cotton to address various other biotic stresses. The Producer Public Private- Partnership (PPPP) and Farmer Producer Organization (FPO) models could also be encouraged to avoid seed cost escalation of *Bt* cotton. FPOs and PPP model are being promoted by central and state governments with a view that small and marginal farmers may be benefitted through adoption of various activities like seed production and seed procurement, access to credit and improved technologies, reduce transaction costs, facilitate value addition, tap high value markets and enter into partnerships with private entities on more equitable terms. These models helps to reduce the escalation of seed cost by reducing labor cost, land rent, managerial cost, cost incurred in other farm operations etc involved in seed production up to certain extent by active involvement of farmers/producers. Similarly, with regard to PPP, it has been widely recognized that when a new seed is introduced, then all the multifarious activities from research to marketing of finished products cannot be undertaken by public or private sector alone. Therefore, it is imperative to recognize the roles of public and private sector organizations delineate responsibilities and create favorable environment for PPP to operate successfully and help in meeting the goal of food and nutritional security.

Further, it becomes imperative to analyze various public policy decisions periodically for active involvement of private sector in generation of improved production technologies including seed for yield enhancement , development of cost cutting technologies and fast diffusion of innovations. The decision on price control for *Bt* cotton should be reviewed to assure private players that the returns on their investment will not be eroded.

Apart from price controls, government could resort to various other policy measures such as simplification of regulatory approval process for *Bt* cotton hybrids, subsidizing Research and development in the generation of germplasm and also encouraging indigenous research by farmers and scientists who develop their own hybrids. These policies could promote competition in the cotton seed industry without curbing the incentive of private firms to innovate in future.

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