IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 Journal UGC CARE Listed (Group-I) Volume 11, Iss 10 2022

The Political Economy of Cotton and Bt Cotton in India

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Abstract

The political economy of cotton and Bt cotton in India is discussed in the article by critically analysing the global trade of cotton, politics of scientific advancements in cotton crop and the evaluation of various research agencies to promote cotton cultivation in India. It is argued in the article that non-growers of cotton like the Europe and America have habituated cotton and emerged as leading producers of cotton. Their scientific advancements have not only achieved high yielding varieties but also high end machines in harvesting, processing of cotton lint, spinning and cloth making machines. The technological advancements at both ends, pre and post-harvest, has led the market conditions unfavourable to India and made dependent on the technologies of the others.

Keywords: Genetically modified crops (GM crops), cotton, Bt cotton, research, policy.

"The history of cotton and of textiles is not only the history of growth of modern industry in India, but in a sense it might be considered the history of India during the past one hundred years." - Jawaharlal Nehru [1]

The word cotton is referred in Sanskrit as *Karpasa-i*, it is connected with the Greek and Latin word *Karpasis* and *Carbasus,* which originally meant Spanish flax. The English word 'Cotton' came from the Arabic word *Quntun* or *Kutun.* Cotton is '*Katoen'* in Dutch, *Cotton* in French, *Cottone* in Itlalian and *Algadon* in Spanish[2]. Cotton is native to many parts of the world, viz. Asia, Arabs, China, Mesoamerica, Africa[3] etc. It is distributed in the tropical and sub-tropical regions of the world. Each of the above mentioned civilizations have habituated cotton and it has imbibed in their cultural and social life. The civilizations had their own native species of cotton which has been grown for a long time in history. The reference of cotton use is found to be mentioned in Rig Vedic period (1500 BC) texts and the discovery of cotton material at Mohenjo-daro in Sind (2750-3000 BC) provides a strong evidence of the early use of cotton in India[4]. The scientific evidence of the presence and use of cotton in India can be traced back to

[1]M.V.Viswanthan, *Cotton in India*, New Delhi: National Institute of Science Communication and Information Resources, 2003.

[2]Ibid., p. 5.

[3]C.L.Brubaker, E.M. Bourland and J.E. Wendel, "The Origin and Domestication of Cotton" in C.Wayne Smith and J. Tom Cothren ed., *Cotton: Origin, History, Technology and Production,* NewYork: John Wiley & Sons, Inc. 1999, pp. 3-31.

[4]A. N. Gulati and A. J. Turner, "A Note on the Early History of Cotton", *Journal of the Textile Institute Transactions,* 20:1, 1929, T1-T9.

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5000 years but it is "difficult to pinpoint when the use of cotton began in India"[5]. The modern history of cotton emerged with the introduction of machines in textile industry by the English on the banks of Hooghly in Bengal[6]. The taxonomical classification of cotton had a long confused history due to the range of morphological diversity prevalent in the cultivated cottons. Cotton is classified in the Family of *Malvaceae* and Genus – *Gossypium*. There are so many cotton species domesticated throughout the world but there are four species which are taxonomical and commercially significant; New World Cotton (G. hirsutum and G. barbadense) and Old World Cotton (G. herbaceum and G. arboreum). The classification of cotton into New and Old Cotton was first proposed by Gariil Semenovich Zaitzev in 1928 by his publication titled "*A Contribution to the Classification of the Genus Gossypium L.,".* Zaitzev based his classification on the recognition of the fact that Old World cottons were diploids (26 chromosomes) and New World cotton were tetraploids (52 chromosomes). In the year1937 J. B. Hutchinson and Ghose codified the species of New World cotton belonging to Mesoamerican and South American; Old World cotton belonging to African and Asian nation[7]. The categorization of the New World cotton and the Old World cotton based on the chromosomal structure is even today an unresolved issue even after a much intensive study[8].

The species of G. herbaceum is native to the coastal strip of northwest of Karachi (Pakistan), northern Baluchistan, South Yemen, Ethiopia and Sudan. The species of G. arboreum is native to Kathiawar (Gujarat), Khandesh and the Deccan in India[9]. The two species G. arboreum and G. herbaceum "are indigenous to Asia and Africa and are popularly referred as desi cottons in India"[10]. These two species of cotton is very dominantly cultivated in India even though there were many attempts to introduce exotic (New World cotton) species which started in 1790 to grow 'Bourbon' (G. hirsutum race punctatum)[11]. The attempts to introduce exotic varieties were to create an extra source of production to balance the demands of cotton due to over reliance on American cotton and to produce 'good quality' staple of cotton[12]. The imbalance of cotton production and supply in the world was disturbed due to American Revolution (1765-1783), American Civil War (1861- 1865) and the innovations of cotton production technologies during the Industrial Revolution which increase the demand for cotton lint[13]. The other important aim of introducing exotic varieties by the colonial government in

[5]V. Santhanam and V. Sundaram, Agri-History of Cotton in India: An Overview, Nagpur: Central Institute for Cotton Research, https://www.cicr.org.in/research_notes/cotton_history_india.pdf, p. 2.

[6]M.V.Viswanthan, n.1, 2003, p. 6.

[7]Ibid., p. 5.

[8]Government of India, Ministry of Environment and Forests and Department of Biotechnology, Ministry of Science and Technology, K. K. Tripathi et. al., *Biology of Gossypium spp. (Cotton),* 2011, p.2.http://www.geacindia.gov.in/resource-documents/biosafety-regulations/resource-documents/Biology_of_Cotton.pdf

[9]Dr. V.Sundaram, Dr. A.K. Basu, et al., *Handbook of Cotton in India*. Mumbai: Indian Society for Cotton Improvement, 1999, p. 5.

[10] M.V.Viswanthan, n.1, 2003, p. 2.

[11]V. Santhanam and V. Sundaram, n. 5, 2021, p. 8.

[12]C. Shambu Prasad, "Suicide Deaths and Quality of Indian Cotton: Perspectives from History of Technology and Khadi Movement", *Economic and Political Weekly*, vol. 34, no. 5, 1999, p. PE-13.

[13]See Sven Beckert, Empire of Cotton: A New History of Global Capitalism, New York: Alfred A. Knopf, 2014, Giorgio Riello, *Cotton: The Fabric that Made the Modern World,* Cambridge: Cambridge

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India was targeted to produce extra-long staple which is considered to be 'good quality' cotton. The desi varieties cotton lint is considered to be 'bad quality' cotton since their staple length[14] is comparatively smaller than the exotic variety which does not suit the machines of the west[15].

The innovations during the Industrial Revolution paved way for the improvement in spinning and weaving machine which strengthened the Lancashire textile industry in Britain to produce more cotton materials. The increased production of cotton materials made the colonial governments to change the colonies into suppliers of raw cotton to their factories at home. The colonies once a vibrant economy of cotton products was turned into just suppliers of raw cotton to the industries in Europe. There were policies measures like the enactment of an act by the British Parliament in 1721 A.D to prohibit the public from wearing "Calicoes" (Cotton imported from the port of Calicut, the present Kozhikode) to protect the local economy. The East India Company in 1793 revised its policy of importing finished cotton materials in its colony to import raw cotton from the colonies to feed the factories in Lancashire. The policy shift was followed strictly which resulted in India becoming the largest consumer of British textiles and one of the largest supplier of raw cotton by 1850. The fine weaving and manufacture of cotton clothes from India dominated the world economy "from the earliest time until well into the nineteenth century—that is, for several millennia—the people of the Indian subcontinent were the world's leading cotton manufacturers"[16]. Sven Beckert argues that the dominance of Indian cotton gradually shifted towards the Europeans which did not happen "from technical advances, nor from organizational advantages, but instead from a far simpler source: the ability and willingness to project capital and power across vast oceans"[17]. The Europeans often violently reorganized the networks of global cotton trade "within Asia as well as between Asia and the rest of the world—before using that same power to create entirely novel networks between Africa, the Americas, and Europe"[18]. The study of Koray Caliskan on the global cotton trade reinforces the presence of various networks which operates with an unequal distribution of resources, power and knowledge[19].

The reorganization of the cotton trade and the market demand for 'good quality' cotton by the mills in the Europe influenced the cultivation of cotton in India. The influence has become an everlasting one which was pursued by the colonial government and the GoI with same the vigour[20]. The governments narrowed down the cotton cultivation to increase the yield

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University Press, 2013, Julian Roche, *The International Cotton Trade*, Cambridge: Woodhead Publishing Ltd., 1994.

[14]The length of fibre in cotton is grouped into Short Staple(below 20mm), Medium Staple(20.5 to 25.5mm), Medium Long Staple(26 to 27.mm), Long Staple (28 to 33.5mm) and Extra Long Staple (35.4mm and above)

[15]C. Shambu Prasad, n. 12, 1999, pp. PE-12 – PE21.

[16]Sven Beckert, Empire of Cotton: A New History of Global Capitalism, New York: Alfred A. Knopf, 2014, p. 28.

[17]Ibid., p. 52.

[18]Ibid., p. 52.

[19]Koray Caliskan, *Making a Global Commodity: The Production of Markets and Cotton in Egypt, Turkey and the United States,* New Jersey: Princeton University Press, 2010.

[20]C. Shambu Prasad, n.12, 1999, PE-12.

of crop and cultivate 'good quality' cotton in India. The above objective of cotton cultivation was shaped by the traders and got it promoted by the governments to initiate various steps;

"(a) introduction of exotic seeds that would give high yields; (b) establishment of government farms to 'prove' superiority of exotic varieties and cultivation practices; (c) despatch of planters from America to introduce better cultivation practices; (d) introduction of machines for cleaning and pressing of cotton; and (e) Investment in public works for transportation of cotton to the ports and irrigation for increasing the yields"[21].

The initial attempts to grow exotic varieties were meet with many incidence of failures; the attempt to grow Bourbon in Bombay and Madras Provinces (1790), subsequent trials with New Orleans and Sea Island (G.barbadense) in Coimbatore, in United Provinces (Uttar Pradesh, 1826), in Punjab (1853), American, Peruvian, Egyptian, and Sea Island varieties in Madras Presidency (1905), upland Georgian and New Orleans varieties in Dharwar (now Dharwad) and Gadag during the first decade of the 20th century[22]. The initial successful experience came from Madras Presidency in 1904-5 is the variety known as *Cambodia* in Madras Presidency, *Punjab Narma* in Punjab (1902) and *Cawnpore-American* in the United Province (Uttar Pradesh, 1909). The following are the agricultural scientists who were instrumental in the successful experiments to introduce exotic varieties around the country; G.R Hilson and V.Ramanatha Ayyar in the regions of Coimbatore, D. Milne in Punjab, Youngman and D.N. Mahta in Central Provinces, H.M. Leake and Ram Prasad in the United Province, T.B. Fletcher and M.L.Patel in Gujarat, G.L. Kottur in Bombay Province, S.H. Prayag in Central Province and Berar.

The colonial government set up an Indian Cotton Committee in 1921 under the Chairmanship of J.MacKenna to study the possibilities of increasing the cotton production due to the decreased supply of cotton from America. The committee provided an overall view of the status of cotton cultivation and observed that the long staple cotton could be grown in parts of Madras Presidency and Punjab and other parts of the country not qualified due to various other reasons like lack of irrigation facility. The committee strongly insisted to set up a permanent Central Cotton Committee to further the possibility of increasing the area of production under the long staple cotton[23]. In 1923 the colonial government enacted a legislation which made the Indian Central Cotton Committee as a permanent statutory body at Bombay. The committee established a Cotton Technological Research Laboratory (presently known as Central Institute for Research on Cotton Technology) under it aegis in 1924 with Dr A J Turner as its first Director. By 1966, the functions of the committee were transferred to the Indian Council of Agricultural Research (ICAR), Ministry of Agriculture, Government of India.

[21]Ibid., p. PE-13.
[22]V. Santhanam and V. Sundaram, n. 5., 2021, p. 8-9, See Deepak Kumar, "Science in Agriculture: A Study in Victorian India", *Asian Agri-History,* 1 (2), 1977, pp. 77-103.
[23]V. Santhanam and V. Sundaram, n.5, 2021, p. 8-9.

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The ICAR abolished the Indian Central Cotton Committee and launched an All India Coordinated Cotton Improvement Project (AICCIP)[24] in the year 1967. The major "objective of AICCIP is to develop agronomic practices for improving the productivity and profitability from the improved varieties/hybrids developed"[25]. The project aimed to give a multi-disciplinary and multi-centre approach to improve the cotton production with the involvement of the State Agriculture Universities. "The All India Coordinated Cotton Improvement Project (AICCIP) has in ten cotton growing states 10 main centres at Faridkot, Hisar and Sriganganagar in North Zone, Surat, Khandwa, Akola and Nanded in central zone, Guntur (Lam farm), Dharwad and Coimbatore in South Zone; 11 Sub-centres at Ludhiana, Banswara, Kanpur in North Zone; Junagadh, Indore, Pune, Rahuri and Bhawanipatna (central zone) and Nandyal, Siruguppa, Srivilliputhur (South zone)"[26].

The project also aimed to develop a Centre of excellence which can guide on the long term research on cotton and to support various research centres located in different parts of India catering to the needs of the farmers under various climatic conditions. The various other reasons like the irrigation pattern in different zones; the Northern zone (Punjab, Haryana and Rajasthan) cultivates cotton under almost irrigated conditions, in the Central zone (Maharashtra, Madhya Pradesh and Gujarat) the irrigation level is 23% and in the Southern zone (Tamilnadu, Andhra Pradesh and Karnataka) the irrigation level is 40%; needs all India coordination in research, selection of seed varieties etc. which led to the establishment of Central Institute for Cotton Research (CICR) at Nagpur in April 1976 to monitor the overall research and development of cotton. The CICR also in the due course carved out two more centres Sirsa (Haryana) and Coimbatore (Tamilnadu) of the erstwhile centres of PIRRCOM (Project on Intensification of Regional Research cotton, oilseeds and millets) from 1958 and subsequently research centres of Indian Agricultural Research Institute, New Delhi.

[24]The headquarters of AICCIP is established in Coimbatore, Tamilnadu.

[25]M. V. Venugopalan et. al., "Advances and Milestones in Agronomic Research on Cotton in India", *Indian Journal of Agronomy*, no. 57, 2012, pp. 64-71.

[26]http://aiccip.cicr.org.in/main_aiccip_mandate.html. Accessed 15 April 2018.

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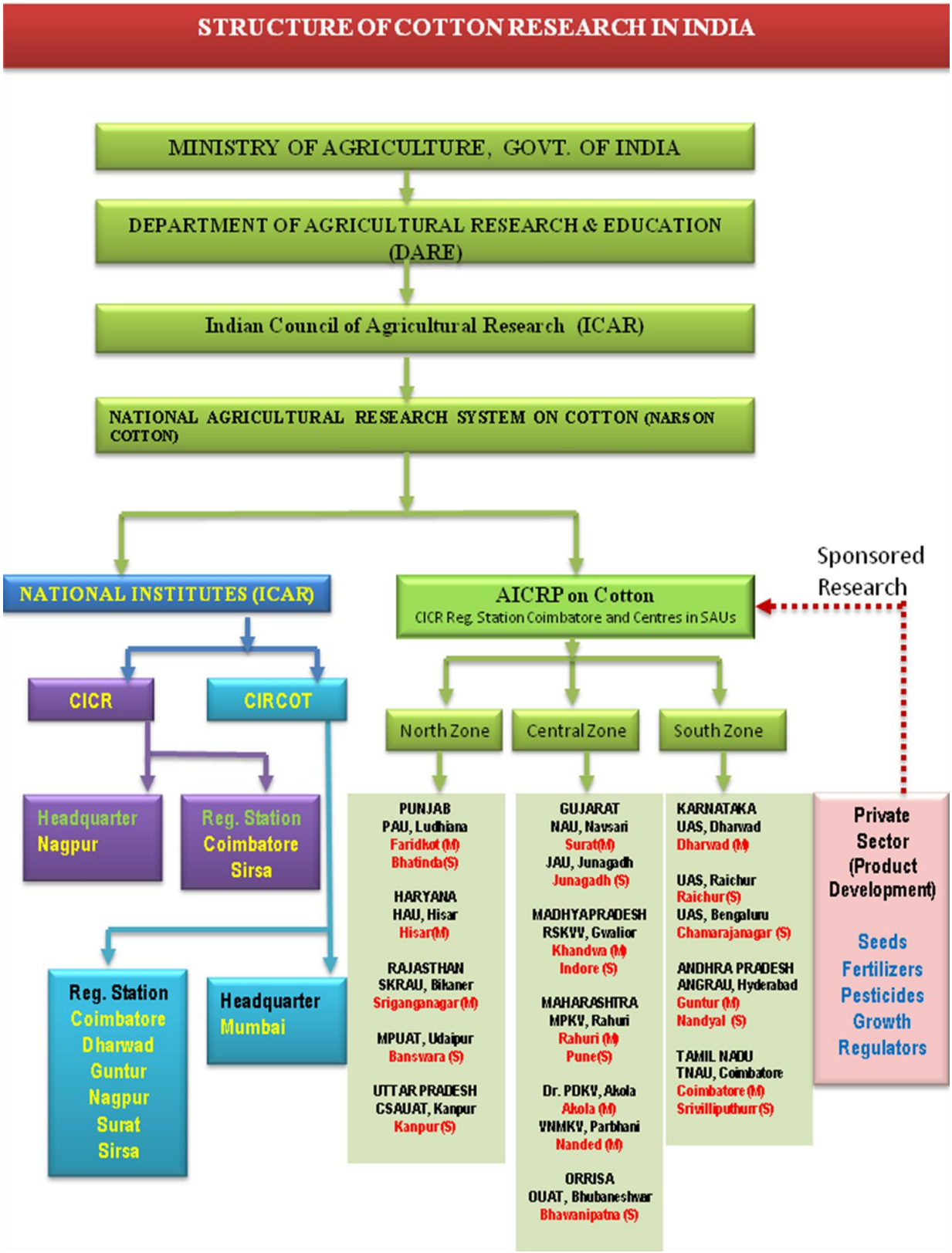

Source: Mangat V. Venugopalan, Mahendra Singh Yadav and Vandana Satish, "Institutional Structure of Cotton Research in India", in Ibrokhim Y. Abdurakhmonov, *Cotton Research,* Tashkent, Uzbekistan: Academy of Science, 2016, p. 25.

The network of research centres coordinated by the government sought to address the varied need of the crop grown in different agro-climatic condition but the research agendas on cotton converged mainly on the need of the industry to grow long staple cotton which made possible by the hybridization of new and old cotton. The attempts to introduce the new world cotton by the colonial government were not as commercially successful as it occupied less than 2.5% of the total area of cotton cultivation during the time of independence in 1947[27]. The failure of new world cotton in the Indian soil gave rise to more focus on the hybridization[28] of new and old world cotton to increase productivity and produce long staple cotton. The success came in 1970 by the efforts of Dr. C. T. Patel with the commercial release of *Hybrid 4* which is a intra species hybrid of new world cotton belonging to the hirsutum species. The hybridization programme witnessed more influenced towards the new world cotton and especially the hirsutum species since it is considered to give more productivity and 'good cotton'. It is observed that;

"During 1999–2000, G. hirsutum represented 69% of the total cotton in India followed by G. arboreum (17%), G. herbaceum (11%) and G. barbadense (3%). In the post-Bt era, species composition changed drastically. Presently 97% of the cotton area is under intra-hirsutum hybrids leaving less than 3% of the area under the Asiatic cotton varieties. The area under Egyptian cotton also declined and is now confined to a limited area in south India"[29].

	Percent of total cotton area						
Species	1947	1970	1980	1990	2000	2007	2013
G. arboreum	65	30	20	30	17	4	2
G. hirsutum	3	53	54	48	69	90	96
G. herbaceum	32	17	14	12	11	5	1
G. barbadense	–	–	11	10	3	1	<1

Source: D. Blaise and K. R. Kranthi, "Cotton Production in India", in Khawar Jabran and Bhagirath Singh Chauhan *ed. Cotton Production*, Washington D.C.: John Wiley & Sons Ltd. Published, 2020, p. 196.

The hybrids in hirsutum species have gradually engulfed the cotton cultivation and by the introduction of Bt in hirsutum hybrids led to total domination of its in cotton cultivation. India is the only country to introduce Bt in hybrids whereas in other countries Bt is introduced in the

[27]D. Blaise and K. R. Kranthi, "Cotton Production in India", in Khawar Jabran and Bhagirath Singh Chauhan *ed. Cotton Production*, Washington D.C.: John Wiley & Sons Ltd. Published, 2020, p. 194.

[28]It is important to draw a distinction between varieties and hybrids. Variety is a pure inbred line and its seeds can be rescued for cultivation for three-four seasons without any significant loss of vigour in subsequent generations. Hybrids are developed through a cross between parents that are genetically unlike – different genera, species, or varieties. The resulting seed (F1) then produces plants that exhibit hybrid vigour or heterosis only in the first generation and the hybrid vigour is largely lost in the second generation. This means that the seed of hybrid varieties has to be replaced each time to maintain hybrid advantage. Because of this characteristic of hybrids, farmers cannot reuse the seed produced on the farm to realise the benefits.(P. Ramasundram, A. Suresh and Ramesh Chand)

[29]D. Blaise and K. R. Kranthi, n. 27, 2020, p. 196.

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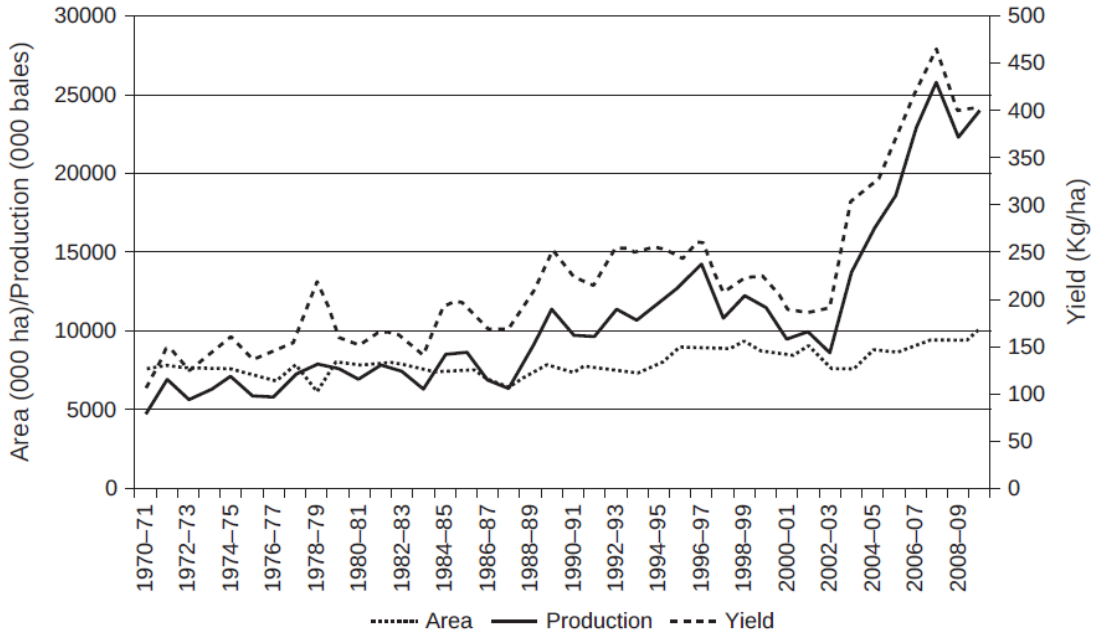
varieties. The high incidence of Bt adoption in India displaced many desi varieties which showed there is a demand for Bt gene rather than for the Bt hybrids[30].

The need to increase the acreage and the production was forced upon the newly independent India since the large part of the irrigated cotton lands got partitioned to Pakistan and most of the textile mills remained with India[31]. The young nation promoted policies like 'Grow More Cotton' and cotton extension schemes to encourage farmers to increase the acreage of cotton. The most important impetus to increase the production of cotton began with the All India Coordinated Cotton Improvement Project (AICCIP) in 1967. It promoted technological intervention which presented initial successful release of hybrids for cultivation in the 1970s. The technological success was coupled with the policy initiatives like the state of Maharashtra started provisioning minimum support price, the establishment of Commission for Agricultural Costs and Prices (CACP) and Central Institute for Cotton Research (CICR) to promote cotton research and development which influenced the cotton production in India[32].

Cotton in India: Trends in area, production, and yield, 1970-1 to 2009-10



Trend growth rates of the yield of cotton in selected States, phase-wise, 1978-9 to 2009-10 in per cent per annum

[30]A. Suresh et. al., *"Cotton Cultivation in India since the Green Revolution: Technology, Policy, and Performance", Review of Agrarian Studies*, vol. 4(2), 2014, p. 49.
[31]D. Blaise and K. R. Kranthi, n. 27, 2020, p. 194.
[32]A. Suresh, n. 30, 2014, p. 28.

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States	Early hybrid phase (1978-9 to 1991-2)	Late hybrid phase (1992-3 to 2001-2)	Bt phase (2002-3 to 2009-10)	Entire period (1978-9 to 2009-10)
Andhra Pradesh	2.83	−1.93	7.60	2.12
Gujarat	0.87	2.36	20.63	3.17
Haryana	1.15	−2.79	10.33	1.21
Karnataka	5.64	0.29	7.35	2.84
Madhya Pradesh	2.69	3.11	10.93	3.40
Maharashtra	1.62	1.06	11.68	3.41
Punjab	4.07	−8.62	11.07	1.72
Rajasthan	3.35	−3.56	11.37	1.05
Tamil Nadu	1.62	0.21	2.58	0.36
All India	2.35	−2.67	12.94	2.59

Source: A. Suresh et. al., "Cotton Cultivation in India since the Green Revolution: Technology, Policy, and Performance", *Review of Agrarian Studies*, vol. 4(2), 2014, p. 29-30

The hybrid phase which started in the 1970s witnessed an increase in the yield and acreage of cotton. The cotton yield registered a spike in the 1980s but slumped during the 1990s. The yield was about 180kg/ha in the 1980s but contained to an increase of 20 kg/ha until the 1990s. The yield got slumped during the 1990s but increased to 424 kg/ha with the introduction of Bt cotton by the year 2009-10. The slump in the yield of cotton is attributed to many reasons such as the decreased use of inputs due to increase in cost, infestation of bollworms, dependency of external inputs, decrease in profit, policy reforms initiated in the 1990s, privatization of research and development and distress in the rainfed areas of cultivation. The displacement of desi varieties which are less dependent on external inputs, unsuitability of hybrids to rainfed cultivation, difficulty in choosing appropriate hybrid for the region and soil, management of hybrids due to long duration and high cost of hybrids are continuous problems which does not increase the yield of cotton in comparison to the high yields achieved in USA, Australia, China, Mexico, Turkey, and Brazil.

Bt cotton in India

Bt cotton was commercially released in 1996 in the US and also in China by Monsanto which holds the patent for Bt in cotton. The company also approached the Indian government as early as 1990, but its application was rejected citing the high technology transfer fees. The Maharashtra Hybrid Seeds Private Company Limited (Mayhco)[33] seed company based in Mumbai, India was able to get approval from the government to import 100 grams of GM cotton from Monsanto[34] company. The Indian seed company successfully back crossed the imported GM cotton with the native varieties to develop three Bt cotton varieties namely Mech

[33]Seed company based in Dawalwadi, Jalna, Maharashtra, India.
[34]US based company; headquarter in St. Louis, Missouri. It is acquired by Bayer; headquarter in Monhein, Germany, in the month of June 2018.

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- 12, Mech - 162 and Mech – 184. The Monsanto company bought 26 percent shares of Mayhco in 1998 which resulted in the establishment of Mayhco-Monsanto Biotech (India) Ltd. (MMB). In the same year Review Committee on Genetic Manipulation (RCGM) approved 40 field trials in nine states, and followed by a review of the data submitted, the Committee requested ten further trials in 1999. The data of the requested new trails were submitted to RCGM in April 2000 for approval. The data was accepted by RCGM and it gave permission to take approval from GEAC for large scale field trials. The GEAC considered the data of RCGM for field trials in large scale, the committee permitted MMB to conduct field trials in 85 acres. The company conducted the large scale trials and submitted the report to GEAC for the commercial release of the seed.

The Committee which met on 29th June 2001 declined to accept the data due to irregularities in the conduct of field trials as well as the committee laid down new conditions to be followed in field trials. The GEAC also wanted some government agency to establish the agronomic benefits of Bt cotton since it was only relying on the private seed developers. The Indian Council of Agricultural Research (ICAR) accepted the request of GEAC to conduct field trials and verify the agronomic benefits of Bt cotton developed by MMB. The government agency after detailed analysis and field trials endorsed the claim of the company that benefits from the cultivation of Bt cotton is greater than the hybrid cotton seed. Meanwhile, there were incidences of illegal Bt cotton cultivation reported from Gujarat. The GoI ordered the State Government to destroy the illegal cotton plantations and to arrest the company owner of Navbharat seeds who was supplying the illegal seeds to the farmers[35].

The GEAC examined the agronomic benefits and concerns of environment from the vast data submitted by the company and the government agency to approve Bt cotton for cultivation. The Committee was satisfied with the data and gave its approval for the release of Bt cotton developed by MMB in the meeting held in March 2002. The Bt cotton seed varieties namely Mech 12, Mech 162 and Mech 184 received the approval for three years in six states. The GEAC in its approval also gave number of conditions to be followed in cultivation; to leave a refuge area[36] around the Bt cotton plot, early removal of cotton crop after the harvest and continuous monitoring for pest attacks. After the initial release in 2002 the Bt cotton seed varieties in the market has grown phenomenally; until 2017 there has been more than 2000 varieties of Bt cotton seeds released, and 49 private companies are producing these seeds. The private seed companies by paying royalty to MMB or through collaboration with MMB transformed their business to evolve GM crops. The adoption rate of Bt cotton by farmers also largely motivate lot of private seed companies to the business of GM crops.

The GEAC was regularly giving approvals after examining the data submitted by the seed companies. The seed companies developed an advance technology of stacking two Bt genes to fight against two pests. The double gene is the stacking of two Bt genes; namely

[35]Ian Scoones, *Science, Agriculture and the Politics of Policy*, New Delhi: Orient Longman, 2006, p. 235.

[36]20% of the cotton crop field has to be planted with any other crop which helps in the prolongation of resistance in bollworm. The refuge area is given at the periphery of the cotton field.

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Cry1Ac giving protection against bollworms and Cry1Ab which give additional protection against spodoptera (a lead eating tobacco caterpillar). These varieties were released for the Central and the South zones. "In 2006 IIT Kharagpur, in collaboration with J K Seeds Pvt Ltd., developed the truncated Cry1Ac gene into cotton known as Event 1. In the same year Nath seeds developed GFM Cry1A (Cry1Ab and Cry1Ac) in collaboration with Chinese Academy of Sciences. There was also an unsuccessful attempt by the Central Institute of Cotton Research, Nagpur, in association with the University of Agricultural Sciences, Dharwad and ICAR National Research Centre on Plant Biotechnology, to develop a Bt cotton variety, BNLA-601, with the use of the Cry1Ac gene" [37]. This variety was an open pollinated variety, popularly known as 'Bt BikaneriNerma', but discontinued in 2010 after failing scientific validation and evaluation. In 2008, Metahelix Life Sciences Pvt. Ltd., developed two hybrids Event 9124 (Cry1c) which added to the continuous efforts of improving the technology by various agencies.

The Government of India claims that "Bt cotton was welcomed by the farmers throughout India which can be inferred from the universal adoption of Bt cotton over desi cotton seeds. The Bt cotton acreage in 2002-03 was 0.29 lakh hectare out of 76.70 lakh hectare which increased to 119.40 lakh ha out of 128.19 lakh ha in 2014-15"[38]. The farmers of all categories in the land holding showed high rates of adopting Bt cotton which established the fact that Indian farmers are progressive farmers and support biotechnology research. The technology of BG-II was made available in 2007, but by the crop season 2009-10, nearly 25-30 percent of the farmers had adopted it. There are now serious efforts to bring herbicide tolerant Bt cotton in the market to curtail the spurious and illegal herbicide tolerant Bt cotton already being cultivated in some parts of the country.

Evaluation of the Approval Process

The introduction of Bt cotton in India, first Genetically Modified crop in non-food category, evoked lot of debates on the relevance of GM technology, the procedures of release, agro-economic benefits to farmers and consumer choice of food. The introduction of GM crops in India paved way for the public to understand the politics in science and decisions of government in the introduction of new technologies. It also gave a chance for the government to take informed decisions on new technology in their developmental agendas. It had become a trial crop for the government to establish elaborate implementation and monitoring structures for the introduction of various other GM crops. Also, the debates on GM crops and process of introducing Bt cotton witnessed the influence of science on politics and politics on science.

The introduction of Bt cotton is considered to have ushered an new era in Indian agriculture[39]. It is entirely a new technology which would herald new experience for the farmers and considered to uplift the ailing agriculture from issues like productivity of crops

[37]Government of India, Ministry of Agriculture & Farmers' Welfare, *Status Paper of Indian Cotton*, New Delhi: Directorate of Cotton Development, January 2017, p. 39.

[38]Government of India, Ministry of Agriculture & Farmers' Welfare, *Impact Evaluation & Socio Economic Study of Bt cotton,* New Delhi: Department of Agriculture & Cooperation, May 2016. p. 28.

[39]R. Ramachandran, "Green Signal for Bt-Cotton", *Frontline,* vol. 19, no. 9, April 2002.

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and environmental sustainability of cultivation. Cotton is one of the most important cash crop grown in India which reached all time low yield in the year 1998-99 (1.79q/ha) due to the infestation of American Bollworm. The increasing pest infestation led to use of more pesticides in cotton cultivation, more than 50% of the total pesticide usage in Indian agriculture was consumed by cotton[40]. The farmers tend to lose their profit due to the repeated spray of pesticide and became very hard for them to reap even the cultivation cost. This made the government to initiate various Integrated Pest Management (IPM) programmes like FAO-European Programme (2000), National Agricultural Technology Programme of IPM (2000) and Insecticide Resistance Management Programme (2002) to train farmers in effective control of pest. During this period the Bt cotton was very much in the international market and it's success stories influenced the government to prefer the introduction of Bt cotton to reduce the use of pesticides in cotton cultivation.

The patent of Bt technology in cotton is owned by Monsanto which was sub-licenced to Mahyco in the year 1993. Mahyco obtained permission from the government to cross bred the Indian varieties of cotton with Bt in the year 1996. By 1998, Monsanto acquired 26 percent shares of Mahyco and set up a 50-50 joint venture seed company in the name of Mahyco Monsanto Biotech(MMB). This partnership unleashed intense debate and active intervention by several groups. The foot hold of Monsanto in the India soil was not well received by the anti-GM group which led to organisation of protests and intensification of the opinion that GM crops a threat to seed diversity and MNCs would monopolize the seed market. The political tug-of-war that ensued between those in support of GM crops and those opposing it was played out at various levels and in different arena. The pro- and anti-GM crop groups resorted to articulating their respective positions using the media and by taking recourse to seeking judicial intervention. The highly volatile debate and contestation acquired deepened political colour with bureaucracy, politicians and pressure groups of farmers, scientists and intellectuals getting drawn into it with varying degrees of involvement. It further established the long accepted premise that technology in case of GM crops was far from neutral and that in fact, introduction and implementation of agricultural technology was deeply mired in the political. To this premise, there was an added question that raised level of suspicion- were the pre-introduction trials adequate and did they assuage the auxieties of all the stakeholders? The anti-GM group made co-ordinated efforts to attract the media attention to influence the opinion of the public that GM crops are environmentally unsustainable, not remunerative to farmers, and would result in health concerns for the public. The campaigns of 'Monsanto Quit India[41]' and 'Cremate Monsanto'[42] attracted huge media attention and intensified the debate on GM crops. Monsanto, in turn, attracted media attention by highlighting the success story of Bt cotton in

[40]Rajinder Peshin, A K Dhawan, Kamal Vatta and Kamaldeep Singh, " Attributes and Socio-economic Dynamics of Adopting Bt Cotton", *Economic and Political Weekly*, vol.42, no. 52, December 2007, p. 73.

[41]The slogan was made by Vandhana Shiva in 1998 to garner support for her protest against Monsanto.

[42]Prof M D Nanjundaswamy, leader of Karnataka Rajya Ryota Sangha, attracted lot of media attention due to his aggressive campaign against GM crops and Monsanto. The supporters of the movement burned GM crop plantations of farmers and attempted to destroy GM trials in various agricultural universities of Karnataka.

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the US, sought the help of renowned scientists to write on the good prospects of GM crops and lobbied with the bureaucrats, politicians, farmers' groups and the judiciary[43].

In the ensuing melee, the role of the government in addressing and resolving contentious issues is worth noting. The central government too, experienced pressure from server sources on the issue, compounding an already complicated, and severely contested, problem. In the year 2001, the government to its dismay was informed that 4500 acres of illegal Bt cotton cultivation in Gujarat. The GEAC ordered the Gujarat government to destroy the illegal crops but later by the request of the state government the order was withdrawn and asked to buy the illegal cotton and store in a place till further orders. The central government claimed that the Bt is performing well and there are lot of pressures from the state government to approve the Bt cotton. The Minister of Environment and Forest, T.R.Baalu in his reply(August 30, 2001 and March 1, 2002) to the status of GM crops in Rajya Sabha claimed that there is a formal request from the Karnataka government to approve Bt cotton[44]. The Kisan Co-ordination Committee which consists of farmers leaders from Maharastra, Andhra Pradesh, Karnataka, Punjab and Gujarat in 2002 reported to launch a civil disobedience movement by cultivating Bt cotton if it is not approved soon by the government[45]. The culmination of events finally ended with the approval of Bt cotton in 2002 which witnessed a conflation of interests in the success of science over politics.

[43]Marie-Monique Robin, *The World According to Monsanto: Pollution, Politics and Power*, translated by George Holoch, New Delhi: Tulika Books, 2010, p. 296.

[44]R. Ramachandran, 2002, n.39, p. 2.

[45]Ronald J Herring, "Stealth Seeds: Bioproperty, Biosafety, Biopolitics", *Journal of Development Studies,* vol. 43, no. 1, January 2007, p. 134.