

Weekly Publication of



**Cotton
Association
of India**

COTTON STATISTICS & NEWS

Edited & Published by Amar Singh

2022-23 • No. 21 • 23rd August, 2022 Published every Tuesday

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Game Changing Landmarks and Achievements in Cotton R&D in Independent India

EXPERT'S Column



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Post independence, India had to resort to massive imports of cotton, as a large part of the irrigated cotton growing area ended up in Pakistan whereas 90% of the mills were located in India. During the post-independence period India made rapid strides in cotton R&D and this backed by pro-active policy instruments made it possible to ensure uninterrupted raw cotton supply for the domestic textile industries and also adequate returns to the farming community. This article reminisces, some important events and research achievements that became success stories with an area-wide impact.

The Indian Central Cotton Committee set up in 1921 to sponsor cotton research schemes, was abolished and the research mandate was transferred to the Indian Council of Agricultural Research (ICAR). The development mandate was entrusted to the Directorate of Cotton Development under the Ministry of Agriculture. ICAR launched the All India Coordinated Cotton Improvement Project (AICCIP) in 1967. Today, the All India Coordinated Research Project (AICRP) on Cotton, a network of 21 participating centres involving 17 State Agricultural Universities is engaged in multi-location and multi-disciplinary applied research activities. The ICAR-Central Institute for Cotton Research with its headquarters in Nagpur, Maharashtra with two regional stations at Sirsa, Haryana and Coimbatore, Tamil Nadu is engaged in basic and adaptive research.

Major Achievements in Independent India

Cotton improvement research under the ICAR-CICR and AICRP on Cotton led to the release of 398 cotton varieties and hybrids recommended for commercial cultivation in different cotton growing zones in the country. Among them, 285 are varieties (188 hirsutum, 67 arboreum, 21 herbaceum and 9 barbadense varieties) and 113 hybrids (71 intra-specific hirsutum hybrids, 21 inter-specific and 21 diploid hybrids). Among these are 12 Bt cotton varieties released recently. Some important milestones in this journey are as follows:

Milestones in Cotton Varietal Improvement

- 1950: Release of Jayadhar, *Gossypium herbaceum* variety (cultivated even today)
- 1968: Release of MCU5, *Gossypium hirsutum* variety 60 counts (finest quality *G. hirsutum* variety)

- 1970: Release of Hybrid 4 - World's first commercial cotton hybrid (high yield, superior fiber traits)
- 1972: Release of Varalakshmi-World's first Inter specific tetraploid hybrid (80 counts)
- 1974: Release of Suvin, *Gossypium barbadense* variety (120 counts)
- 1976: Identification of Bikaneri Narma and its selections F41' and H 777
- 1978: Release of World's first GMS based hybrid Suguna
- 1980: Release of Hybrid H-6 with superior fiber (60 counts)
- 1981: Release of Inter specific tetraploid hybrid DCH 32 (80 counts)
- 1982: Release of Highly adaptable *Gossypium hirsutum* variety LRA 5166
- 1983: Release of World's first Inter-specific diploid hybrid DH 7
- 1983: Release of Highly adaptable hybrid NHH 44
- 1992: Release of Early maturing compact variety LRK 516
- 1989: Release of *Gossypium arboreum* variety AKA 8401 (40 counts)
- 2002: Bt-cotton approved for commercial cultivation.
- 2020: Release of Bt cotton varieties
- 2020: Release of colour cotton variety ICAR-CICR 16301 DB (Vaidehi-1)

Gamechangers in Independent India Cotton History

1. Suvin - A Landmark Giza Cotton Equivalent ELS Variety

During the 1960s, Indian textile mills were solely dependent on imported cotton for their fine count spinning. The industry longed for an Indian grown alternative for the expensive and exclusive Egyptian Giza cotton. The researchers responded with Suvin, an ELS *G. barbadense* variety.

Suvin has the unique distinction of being the longest and the finest fibre in the world.



It was developed and released by the Coimbatore center of AICRP on Cotton in the year 1974. Suvin is a cross between Sujata and St Vincent (a Sea Island Cotton variety) and derives its name from the combination of SUjata+VINcent. Suvin is categorised as extra-long staple cotton.

Suvin has unique traits like fibre length of 38-40 mm, micronaire value of 2.8-3.0 and amenable to spin from 240s Ne to 300s Ne count of yarn. Short, medium or long staple cotton can be spun only between 10s Ne to 50s Ne count of yarns.

Suvin is still cultivated by farmers in a few 100 acres in Tamilnadu. Despite several breeding efforts, there is yet no variety in India which could match Suvin in quality.

2. Bikaneri Narma Variety and Cotton-Wheat Cropping System in North Zone



In the North zone states of Punjab, Haryana and Rajasthan, cotton was essentially monocropped till the late seventies as the then prevalent varieties like LSS, 320 F, and J- 34 were of long duration (210-220 days). Development of a short duration (180 days) cotton

variety Bikaneri Narma from a non-descriptive hirsutum mixture in 1976 from Rajasthan was a turning point for this zone. Its early maturity facilitated cotton-rabi crop double cropping, considered impossible till then. Release of high yielding selections from Bikaneri Narma, viz. F- 414 in 1977 from Punjab and H- 777 in 1978 from Haryana along with Ganganagar Ageti in 1978 from Rajasthan, all maturing in 175-180 days, paved the way for a cotton-wheat double cropping system and enabled farmers to realise additional rabi wheat crop yielding 35-40 q/ha. Further increase in system productivity was achieved with shorter duration (160-170 days), compact varieties LH 900 (Punjab in 1985) and RS 875 (Rajasthan in 1997). Today, more than 90% of the 2.0 million ha cotton area is under cotton-wheat double cropping in India. Cotton-wheat cropping system is the second most important wheat-based system in South Asia (4.5 m ha).



LRA 5166



LRK 516

3. Versatile Varieties - G. Hirsutum Varieties LRA 5166 and LRK 516

LRA 5166, a medium staple high yielding, drought tolerant variety, developed by ICAR-CICR, was released in 1982 for rainfed and irrigated tracts of Southern cotton zone and Vidarbha (Maharashtra) and later on it was released for Gujarat and entire Maharashtra in 1984. LRK 516 (*G. hirsutum*) developed by ICAR-CICR, an early maturing, compact variety, suited for closer spacing was released in 1992 for rainfed and irrigated conditions of Maharashtra, Gujarat and South Rajasthan. This variety become popular among farmers due to its big boll size and its earliness, making it an ideal choice for double cropping in summer rice fallows of South India.

During 1980 and 1990, varieties LRA 5166 and LRA 516 were widely cultivated in the states of Maharashtra, Gujarat, Andhra Pradesh (including Telangana), Karnataka and Tamilnadu. Semi-indeterminate nature of LRK 516 and rejuvenation capacity in LRA 5166 made them very popular among rainfed farmers. Based on seed estimates, around a quarter of the area under cotton in the country was under LRA 5166 and LRK 516 during 1990-1999. The estimated value of cotton produced from LRA 5166 and LRK 516 would be Rs. 1000 crores /per annum during the period 1985-2000.

LRA 5166 was also in demand in the neighboring countries of Bangladesh and Myanmar and is amenable to transplanting and is still used in Sunderban region where it is transplanted on rice fallows. Similarly, LRK 516 is still preferred by farmers of Tamilnadu growing cotton on rice fallows. LRA 5166, its parent Laxmi and a variety Narasimha derived using LRA 5166 are widely used by cotton breeders to develop cotton hybrids



4. Bt Cotton- The Fortune Changer

The biggest challenge to successful cotton cultivation during the 1990s was the damage (40-70% loss) due to bollworms. Pesticide consumption on cotton was the highest at 54% of the total pesticides mainly used for control of bollworms.

Bt cotton containing Cry 1Ac Mon531 event that confers resistance to Lepidopteron pests of cotton, was commercialised in India as hybrid in 2002 by Mahyco in collaboration with Monsanto under their joint venture Mahyco Monsanto Biotech Limited (MMBL) in South and Central zone. Subsequently, MMBL sub-licensed its Bt cotton technology to other seed companies in India for incorporation into cotton hybrids of their choice Bt cotton was introduced into North India in 2005. Bollgard II containing cry1Ac and cry2Ab MON 15985 event was approved in 2006.

The area under Bt cotton increased from 0.29 lakh hectares in 2002 to 111.3 lakh hectares (91.4% of the cotton area) in 2011-12 making Bt cotton unarguably the fastest technology adopted by Indian farmers. During 2020-21, around 122.9 lakh ha (94.1%) of the 129.5 lakh ha under cotton is under Bt cotton. Other benefits along cotton value chain include an increase in cotton seed oil production from 488 thousand tons in 2002 to 1234 thousand tons in 2016 and the emergence of a strong and vibrant seed industry with annual sales around Rs. 3200 crore.

Cotton Production and Protection Research

Location specific crop production technologies like crop establishment techniques, crop geometry, integrated nutritional management, weed management, rainwater conservation and recycling, location specific intercropping system, application of PGRs canopy management and plant architecture management, foliar application macro and macronutrients, seed, soil and foliar application of bio-inoculants etc. for improved



HDPS in cotton

cotton varieties and hybrids of all the cultivated cotton species, were revised and updated depending on the productivity potential of the genotype and with the availability of new input sources. Soil health management- sub soiling, minimum tillage, green manuring and cover crops were also standardised and popularised. Organic cotton production technology was developed and transferred during 1994-1998. Optimising of water use efficiency through drip and fertigation/drip cum polymulch was developed for profitable yields in different locations. Several attempts are underway to develop machines for picking and other important operations in cotton cultivation in small scale production systems. Simulation of the impact of projected climatic scenarios using simulation models and impact of higher concentration of CO₂ using open top chambers have provided valuable insights about impact of climate change on regional cotton production and on adaptation strategies to mitigate climatic adversities. High density planting system (HDPS) using early maturing compact genotypes with a location specific agronomy is becoming popular among farmers.

Initial research was on developing chemical control measures for the management of sucking pests and bollworms. Later, research was concentrated on screening for host plant resistance. Subsequently, location specific crop protection technologies like Integrated Pest Management (IPM) of insect pests and disease management strategies using cultural, mechanical and chemical components to reduce the insecticide application and make it more environmentally friendly and sustainable.

Biocontrol based IPM using *Trichogramma*, NPV virus and botanical like Neem, cotton pests have helped to reduce the dependence on chemical pesticides. Biocontrol based IPM efforts were intensified during 1980s and 1990s. Availability of Bt cotton added a new dimension for cotton pest management research. Immunodiagnostic tools

were developed to identify BT toxins. Several cotton genotypes have been identified for their insect pest and disease tolerance and have been appropriately deployed in the resistance breeding programme for development of multi adversity resistance lines with better yielding ability for different regions. Today, the management prescriptions are based on ETL, principles of Insecticide Resistance Management and also taking into cognizance

the biological control options. Discovering new genes for pest management, introduction of new concepts such as gene silencing are some new initiatives.

Some landmark policies, institutions and technologies that were game changers and their impact in the journey of cotton R&D in the independent India are summarised below:

Important Milestones and the Story Line

Milestone	Year	Location	Organisation/ Person associated	Impacts of the event
Grow More Cotton scheme	1950-51	All cotton growing regions of India	Government of India	44 percent increase in cotton area and 55 percent production increase between 1950-51 and 1955-56.
Establishment of Directorate of Cotton Development (DCD)	1966	Mumbai, Maharashtra	Government of India	Channelised system for implementing Government schemes for development of cotton sector.
Intensive Cotton Cultivation Scheme "Package Programme"	1962-63	Pan India	Government of India	12% increase in cotton production during III plan period mainly due to yield increase.
Establishment of All Indian Coordinated Cotton Improvement Project	1967	Head quarters in Coimbatore	ICAR	New fillip and direction for multi- disciplinary and multi-centre approaches in variety development and technology generation with the active involvement of State Agriculture Universities.
Release of Hybrid 4 (H 4)	1970	NAU, Surat, Gujarat	Dr Chandrakant T. Patel	Hybrid-4 produced a record high of 6,918 kg kapas/ha (2,352 kg lint/h) and became highly successful in Central India. Heralded hybrid cotton revolution. By 1995-96, around 20 popular hybrids occupied 40% of the cotton area and contributed to 50% of the cotton production.
Establishment of the Cotton Corporation of India	1970	Mumbai	Ministry of Textiles	Helping farmers in realising fair price of their produce.
Release of ELS cotton Suvin	1974	ICAR-CICR	Dr.V. Santhanam	Spinnable at 120s and was acclaimed as the pride of India and a substitute for the Egyptian cotton imported. Was grown extensively during 1970s upto1990 and the production was upto 14000 bales (170 kgs) per annum.
Establishment of Central Institute for Cotton Research	1976	Nagpur, Maharashtra	ICAR	Central institution for carrying out research on fundamental areas of cotton production and also to provide basic support to location specific applied research work.
Intensive Cotton Development Programme (ICDP)	1979-80	Pan India	Government of India	Strengthened the cotton extension scheme to disseminate package of practice with district as the focal point. The country has exported 119.56 lakh bales of cotton over 26 years (1970-71 to 1995-96) after meeting the requirements of its own domestic industry.
Release of variety LRA 5166	1982	South and Central Zone	ICAR-CICR	<ul style="list-style-type: none"> Occupied more than 30% of area under cotton in India during 1990-1999. Period 1985-2000 - estimated value of cotton produced from LRA 5166 and LRK 516 - Rs. 1000 crores / annum. LRA 5166 and its parent Laxmi are widely used by cotton breeders of both public and private sectors to develop cotton hybrids. In demand in neighboring countries of Bangladesh, Pakistan and Myanmar.

Technology Mission on Cotton with 4 mini-missions	2000	Cotton growing states of India	Ministry of Agriculture and Ministry of Textiles, Government of India	Boost research and extension capabilities as well as modernise the marketing and processing sectors.
Insecticide Resistance Management (IRM)	2002	11 cotton growing states of India	ICAR-CICR and State Agricultural Universities	Implemented in 9 cotton growing states and benefitted more than 5 lakh farmers between 2002 and 2016. Resulted 14.01% yield increase besides 45.49% reduction in insecticide use, saving 166.64 crore rupees.
Commercialisation of Bt Cotton	2002	Central and South zone (2002), North zone (2005)	Mahyco-Monsanto	More than 94% area is under Bt cotton. High adoption rate Huge economic and environmental benefits.
Immunodiagnostic kits -Bt Quant ELISA kit and Bt GUS in cotton	2006	ICAR-Central Institute for Cotton Research	Dr.K.R. Kranthi	Bt-detection kits enabled regulation, streamlining and ensuring Bt-cotton seed quality for farmers in the country. About Rs.250 crore yield loss was avoided. Percentage of sub-standard seed samples reduced to 5.23% in 2007-08 from 69% in 2003-04.
Constitution of Interstate Committee for cotton pest (whitefly) management	2016	Punjab, Haryana, Rajasthan	Government of Punjab	Reduction in pesticide usages @ Rs. 2589, 2808 and 3060 per hectare in Punjab alone during last three years (2016, 2017 and 2018) The productivity of cotton in North zone increased from 359 kg/ha in 2015-16 to 574 kg/ha, 530 kg./ha, 557 kg/ha, 636 kg/ha in 2016-17, 2017-18, 2018-19, 2019-20 respectively.

The Challenge Ahead

India is the largest producer of cotton in the world but the productivity is low. There is a continuous demand for improving yield and fiber quality. Low productivity of cotton is now being deliberated across all segments of the cotton value chain. Cotton is a climate sensitive crop and productivity is a product of complex genotype x environment x management interaction. Climate variability has been seriously undermining our productivity in the recent past and climate proofing the cotton production should be the main emphasis in future. Precision farming is the next step to improve factor productivity and reduce production costs. The development of resistance to Bt toxins in all the three zones now is an immediate threat to profitable cotton production. Popularisation of short duration Bt varieties without yield penalty is an immediate necessity especially in Central and South India to reduce damage due to pink boll worm.

Crop improvement should focus on trait specific breeding, development of product profiles and segmentation for deployment to

enhance productivity. In the short term, there is a need to demonstrate the productivity potential of new Bt varieties/early maturing hybrids with tailored agronomy under high density planting system in rainfed areas along with crop nutrition, canopy, water, integrated pest and disease management. Another promising option is the drip-polymulch technology for irrigated areas. In the long term, pre-breeding approaches will facilitate effective utilisation of wild species and unadapted germplasm for widening the genetic base for different traits and breed for climate resilience, abiotic and biotic stress tolerance.

There is a need to utilise the power digital interactive multimedia to facilitate dissemination of cotton production technology and marketing information to farmers and help them to realise higher yields and better returns for their produce.

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

Glimpses of Independence Day Celebrations

The Cotton Association of India has a venerable tradition of celebrating Independence Day every year. This year too, the Azadi Ka Amrit Mahotsav was celebrated with great fervour on Monday August 15, on the premises of the CAI. The flag hoisting ceremony was performed by Shri. Sharad Kumar Saraf, Director and senior member of CAI; in the presence of Shri. Vinay N. Kotak, CAI Additional Vice-President and Shri. Shyamsunder M. Makharia, Hon. Treasurer, along with staff members and office bearers in attendance.

This was followed by felicitation of the chief guest and screening of a short documentary patriotic film in the Conference Room on the 2nd floor.



UPCOUNTRY SPOT RATES													(Rs./Qtl)
Standard Descriptions with Basic Grade & Staple in Millimetres based on Upper Half Mean Length [By law 66 (A) (a) (4)]								Spot Rate (Upcountry) 2021-22 Crop August 2022					
Sr. No.	Growth	Grade Standard	Grade	Staple	Micronaire	Gravimetric Trash	Strength /GPT	15th	16th	17th	18th	19th	20th
1	P/H/R	ICS-101	Fine	Below 22mm	5.0 – 7.0	4%	15		18672 (66400)	19093 (67900)	19093 (67900)		19093 (67900)
2	P/H/R (SG)	ICS-201	Fine	Below 22mm	5.0 – 7.0	4.5%	15	H	18868 (67100)	19290 (68600)	19290 (68600)	H	19290 (68600)
3	GUJ	ICS-102	Fine	22mm	4.0 – 6.0	13%	20		17575 (62500)	18137 (64500)	18137 (64500)		17997 (64000)
4	KAR	ICS-103	Fine	23mm	4.0 – 5.5	4.5%	21		18419 (65500)	18840 (67000)	18840 (67000)		18840 (67000)
5	M/M (P)	ICS-104	Fine	23mm	4.5 – 7.0	4%	22	O	20528 (73000)	20949 (74500)	21090 (75000)	O	21371 (76000)
6	P/H/R(U) (SG)	ICS-202	Fine	27mm	3.5 – 4.9	4.5%	26		26264 (93400)	26573 (94500)	26714 (95000)		26714 (95000)
7	M/M(P)/SA/TL	ICS-105	Fine	26mm	3.0 – 3.4	4%	25		21090 (75000)	21512 (76500)	21793 (77500)		21934 (78000)
8	P/H/R(U)	ICS-105	Fine	27mm	3.5 – 4.9	4%	26	L	26376 (93800)	26658 (94800)	26798 (95300)	L	26798 (95300)
9	M/M(P)/SA/TL/G	ICS-105	Fine	27mm	3.0 – 3.4	4%	25		21512 (76500)	21934 (78000)	22215 (79000)		22496 (80000)
10	M/M(P)/SA/TL	ICS-105	Fine	27mm	3.5 – 4.9	3.5%	26		23199 (82500)	23480 (83500)	23761 (84500)		23902 (85000)
11	P/H/R(U)	ICS-105	Fine	28mm	3.5 – 4.9	4%	27	I	27529 (97900)	27979 (99500)	27979 (99500)	I	27979 (99500)
12	M/M(P)	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27		26995 (96000)	26995 (96000)	26995 (96000)		26995 (96000)
13	SA/TL/K	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27		27051 (96200)	27051 (96200)	27051 (96200)		27051 (96200)
14	GUJ	ICS-105	Fine	28mm	3.7 – 4.5	3%	27	D	26714 (95000)	26714 (95000)	26714 (95000)	D	26714 (95000)
15	R(L)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28		26714 (95000)	26995 (96000)	27276 (97000)		27276 (97000)
16	M/M(P)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28		27979 (99500)	27979 (99500)	27979 (99500)		27839 (99000)
17	SA/TL/K	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	A	28036 (99700)	28036 (99700)	28036 (99700)	A	27895 (99200)
18	GUJ	ICS-105	Fine	29mm	3.7 – 4.5	3%	28		27839 (99000)	27839 (99000)	27839 (99000)		27698 (98500)
19	M/M(P)	ICS-105	Fine	30mm	3.7 – 4.5	3.5%	29		28401 (101000)	28401 (101000)	28401 (101000)		28261 (100500)
20	SA/TL/K/O	ICS-105	Fine	30mm	3.7 – 4.5	3%	29	Y	28542 (101500)	28542 (101500)	28542 (101500)	Y	28401 (101000)
21	M/M(P)	ICS-105	Fine	31mm	3.7 – 4.5	3%	30		28682 (102000)	28682 (102000)	28682 (102000)		28542 (101500)
22	SA/TL/K / TN/O	ICS-105	Fine	31mm	3.7 – 4.5	3%	30		28823 (102500)	28823 (102500)	28823 (102500)		28682 (102000)
23	SA/TL/K/ TN/O	ICS-106	Fine	32mm	3.5 – 4.2	3%	31		N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)		N.A. (N.A.)
24	M/M(P)	ICS-107	Fine	34mm	2.8 - 3.7	4%	33		26995 (96000)	26995 (96000)	26855 (95500)		26855 (95500)
25	K/TN	ICS-107	Fine	34mm	2.8 - 3.7	3.5%	34		27417 (97500)	27417 (97500)	27276 (97000)		27276 (97000)
26	M/M(P)	ICS-107	Fine	35mm	2.8 - 3.7	4%	35		27558 (98000)	27558 (98000)	27417 (97500)		27417 (97500)
27	K/TN	ICS-107	Fine	35mm	2.8 - 3.7	3.5%	35		27839 (99000)	27839 (99000)	27698 (98500)		27698 (98500)

(Note: Figures in bracket indicate prices in Rs./Candy)