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Cotton Varieties and Hybrids

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COTTON VARIETIES AND HYBRIDS

INTRODUCTION

Cotton is a fibre, oil and protein yielding crop of global significance. It is cultivated in tropical and sub-tropical regions of more than 80 countries of the world. The major cotton producing countries are USA, China, India, Pakistan, Uzbekistan, Turkey, Brazil, Greece, Argentina and Egypt. These countries contribute about 85% to the global cotton production. India stands first in area, third in production and last in productivity among these countries.

In India, there are nine major cotton growing states which are divided into three zones, viz. north zone, central zone and south zone. North zone consists of Punjab, Haryana, Rajasthan and Western Uttar Pradesh. Central zone includes Madhya Pradesh, Maharashtra and Gujarat. South zone comprises Andhra Pradesh, Karnataka and Tamil Nadu. These states cover about 95% of cotton area and also contribute about 95% to the total cotton production in India. Three cotton growing zones differ from each other in several aspects such as soil type and topography, irrigation facilities, species cultivated, productivity level etc. (Table-1). Besides these states, cotton is also grown on small areas in Bihar, Orissia, Assam, Tripura and Meghalaya. These states cover about 5% area and also contribute 5% to the national cotton production.

Table-1: Comparison of three cotton growing zones.

S.No.	Particulars	North zone	Central Zone	South Zone
1.	Soil type	Alluvial	Black soils	Black and red soils
2.	Soil topography	Plain	Undulating	Undulating
3.	Irrigation	98%	15%	32%
4.	Species cultivated	Hirsutum, arboreum	All except barbadense	All the four species
5.	Hybrid cultivation	Less than 1%	55%	50%
6.	Area covered	20%	55%	25%
7.	Production	40%	35%	25%
8.	Yield level	High	Low	Medium

CULTIVATED SPECIES

There are four cultivated species of cotton viz. Gossypium arboreum, G.herbaceum, G.hirsutum and G.barbadense. The first two species are diploid (2n=26) and are native to old world. They are also known as Asiatic cottons because they are grown in Asia. The last two species are tetraploid (2n=52) and are also referred to as New World Cottons. G.hirsutum is also known as American cotton or upland cotton and G.barbadense as Egyptian cotton or Sea Island cotton or Peruvian Cotton or Tanguish Cotton or quality cotton.G.hirsutum is the predominant species which alone contributes about 90% to the global production. In USA and Uzbekistan, more than 90% area is covered by G.hirsutum. Perhaps, India is the only country in the world where all the four cultivated species are grown on commercial scale. In India, 45%, 30% and 24.7% area is covered by hybrids, upland cotton and diploid species respectively. G.barbadense is grown on a very little area (0.3%) in the state of Tamil Nadu and Andhra Pradesh. G.herbaceum is limited to the states of Gujarat and Karnataka. G.hirsutum and G.arboreum are grown in all the major cotton growing states in India. Distinguishing morphological features of all the four cultivated species of cotton are given in Table-2.

Gossypium arboretum

Bracts are more or less triangular and closely invest bud and flower. Bracts have 4-5 teeth at the apex. Bolls are tapering and profusely pitted with prominent oil glands. Bolls open widely on maturity. This species is also known as Indian cotton.

Gossypium herbaceum

Bracts flare widely from the bud, flower and boll. They have 6-8 teeth. Bolls are round and rarely with prominent shoulders. Bolls are smooth or with few shallow pits and few oil glands. Bolls open slightly when ripe.

Table-2: Distinguishing morphological features of cultivated species of Gossypium Linn.

S.No	Particulars	Cultivated Species of Cotton			
		G.hirsutum	G.barbadense	G.arboreum	G.herbaceum
1.	Leaves	1/2cut or less into 3-5 lobes, not constricted, also over lapping lobes	2/3 cut into 3-5 lobes, sinuses thrown into folds, lobes long and tapering	2/3-4/5 cut into 5-7 lobes long and narrow	½ cut or less 3-7 lobes only slightly constricted at the base.
2.	Bracteoles	Triangular, 4-12 long teeth	As long as broad, 10-12 acuminate teeth	Closely investing the bud and flower, entire or with fewer teeth longer than broad.	Bracteoles not investing bud, usually broader than long upper margin serrated.
3.	Petal	Light yellow to yellow	Sulphur yellow, deep Yellow	White to yellow, red	Medium yellow
4.	Bolls	Round to moderately tapering 3-5 locular, 4 common smooth to moderately pitted.	Tapering, longer than broad 3-4 usually 3 loculi, deeply pitted and glanded often, rough	Moderate Round to tapering, 3 to 4 loculi, 3 common smooth to deeply pitted, rough	Rounded, smaller, 3 loculi smooth to moderately pitted.
5.	Seeds	Moderately large, fuzzy to rarely naked, moderate to long fibres, 5-11 seed/locule	5-8 seeds/locule, tuft of fuzz on seeds, seeds often without a coat of a fuzz, lint fibres very long, seeds free	Fuzzy, smaller rarely naked, 6-17 seeds/locule	Medium size to small fuzzy, 11 seeds/locule, short to medium fibres.

Gossypium hirsutum

Flowers do not have red spot at the base of petal. The staminal column is short. The anthers are loosely arranged on the staminal column. Anther filaments are larger in the upper region than in the lower region. The capsule surface is usually smooth.

Gossypium barbadense

Bracts are very large which cover the flower bud completely. The staminal column is long on which anthers are compactly arranged. The anther filament is of same length. Bolls are large and deeply pitted with black oil glands. Red spot is present at the base of petal.

Bracts are united at the base in diploid cottons and free in tetraploid cottons. Diploid cottons have high degree of resistance to biotic and abiotic stresses, whereas tetraploid cottons have high yielding capacity and good fibre quality.

COTTON VARIETIES

The varietal improvement work in cotton started as early as in 1904 when Agricultural Departments were established in various states. It was further strengthened in 1923 when Indian Central Cotton Committee (ICCC) was constituted. The varietal improvement work got momentum with the inception of All India Coordinated Cotton Improvement Project (AICCIP) in April, 1967. After inception of AICCIP, 90 varieties of upland cotton, 3 of Egyptian cotton, 39 of diploid cottons and 43 hybrids have been released for commercial cultivation in different states of India. A brief account of cotton varieties released from different states is presented below:

North zone consists of Punjab, Haryana, Rajasthan and Western U.P. In Punjab, varietal improvement work is carried out at Ludhiana and Faridkot. Ludhiana is the main centre and Faridkot is the sub-centre. In Punjab, 18 varieties of upland cotton and six of arboreum cotton have been released so far. The currently cultivated varieties include LH 900, LH 1556, F846 and F 1378 in G.hirsutum and G.27, LD 327 and LD 491 in G.arboreum (Table 3 and 4).

In Haryana, cotton improvement work is carried out at Hisar. From Hisar, 8 varieties of G.hirsutum and 5 of G.arboreum have been released so far. However, four varieties of former species (HS 6, H 974, H 1098 and HS 182) and three of latter (DS 5, HD 107 and HD 123) are presently under cultivation.

In Rajasthan, cotton breeding work is done at Sriganganagar and Banswara. The former is the main research centre and the latter is sub-centre. In Rajasthan, six varieties of G.hirsutum and two of G.arboreum have been released for commercial cultivation so far. The presently cultivated varieties include RST 9, Ganganagar Ageti and RS 875 in G.hirsutum and RG 8 in G.arboreum.

In Uttar Pradesh, cotton is cultivated in western part on few thousand hectares. Presently, the breeding work is carried out at Kanpur. The currently cultivated varieties include Vikas (upland) and Lohit (arboreum).

Central Zone includes Madhya Pradesh, Maharashtra and Gujarat. In M.P., 8 varieties of G.hirsutum and 4 of G.arboreum have been released so far. Three varieties of former (Khandwa 2, Khandwa 3 and Vikram) and two of latter (Maljari and Jawahar Tapti) are currently under cultivation. In M.P., cotton breeding work is carried out at Khandwa and Indore. Khandwa is the main research centre and Indore is sub-centre.

In Maharashtra, varietal improvement of cotton is carried out at Akola, Nanded, Rahuri and Jalgaon. The first three are main centres and the last one is the sub-centre. In Maharashtra, 14 varieties of G.hirsutum and 20 of G.arboreum have been released for commercial cultivation so far. The currently cultivated varieties include DHY 286, Purnima, AKH 081 and Rajat in G.hirsutum and AKH 4, AKH 5, AKA 8401, Y1 and PA 183 in G.arboreum.

In Gujarat, cotton breeding work is carried out at Surat, Talod, Bharuch, Charodi and Junagarh. Surat is the main research centre and rest are sub-centres. In Gujarat, G.herbaceum is also cultivated besides G.hirsutum and G.arboreum. In this state, 7 varieties of G.hirsutum, 4 of G.arboreum and 11 of G.herbaceum have been released so far. However, two varieties of G.hirsutum (G.Cot 12 and G.Cot 16), three of G.arboreum (Sanjay, G.Cot 15 and G.Cot 19) and three of G.herbaceum (G.Cot 13, G.Cot 17 and G.Cot 19) are currently under cultivation.

South Zone consists of Andhra Pradesh, Karnataka and Tamil Nadu. In A.P., cotton breeding work is carried out at Guntur and Nandyal. The former is the main centre. In A.P., 12 varieties of G.hirsutum and 8 of G.arboreum have been released for commercial cultivation so far. The currently

cultivated varieties include Kanchana, LK 861, L 389, L 603 and L 604 in G.hirsutum and Srisailam, Mahanandi and NA 1325 in G.arboreum.

In Karnataka, cotton improvement work is carried out at Dharwad, Arbhavi and Siruguppa. Dharwad is the main research centre and rest are sub-centres. In Karnataka, 10 varieties of G.hirsutum and 7 of G.herbaceum have been released so far. Varieties which are presently under cultivation sharda, Abadhita and Sahana in G. hirsutum and DB 3-12 and Raichur 15 in G.herbaceum.

In Tamil Nadu, cotton breeding work is carried out a Coimbatore, Kovilpatti and Srivilliputhur. Coimbatore is the main centre and others are sub-centres. In Tamil Nadu, 25 varieties of G.hirsutum, 3 of G.barbadense and 7 of G.arboreum have been released so far. However, 5 varieties of G.hirsutum (MCU 7, LRA 5166, MCU 5 VT, SVPR 2 and Surabhi), 2 of G.arboreum (K10 and K 11) and one of G. barbadense (Suvin) are currently under cultivation.

COTTON HYBRIDS

In India, hybrid cotton era started since 1970 with the release of world's first cotton hybrid "H 4" from Cotton Research Station Surat of Gujarat Agricultural University. This hybrid was developed by Late Dr.C.T.Patel who is rightly called as father of hybrid cotton. This hybrid, by virtue of its high yield potential and wide adaptability, became very much popular among the farmers wide adaptability, became very much popular among the farmers initially in the Gujarat state and lateron in other adjacent states such as Andhra Pradesh, Karnataka, Maharashtra and Madhya Pradesh. Two years after the release of H 4, the world's first interspecific hybrid between G.hirsutum and G.barbadense was released from the cotton Research Sciences, Bangalore under the name "Varalaxmi". Initially, Varalaxmi was released for cultivation in Karnataka state, but later on spread to other states such as Tamil Nadu, Andhra Pradesh and Maharashtra under irrigated areas. With the success of these two hybrids, heterosis breeding got momentum in the country and several hybrids in tetraploid cottons and few in diploid cottons were released for commercial cultivation. Now hybrids have been released for commercial cultivation in all the major cotton growing states.

Though the work for developing commercial hybrids especially in tetraploid cotton was initiated around 1930 at cotton Research Station, Surat, but the dream could be fulfilled after a gap of 40 years in 1970. The hybrids cotton era is divided into two parts, viz. (1) conventional hybrid era, and (2) male sterility based hybrid era. In the beginning, all the cotton hybrids were developed by conventional method i.e., by hand emasculation and pollination. However, the seed of conventional hybrids is very expensive as several labourers are engaged for emasculation.

With a view to reduce the cost of hybrid seed, efforts were made to develop hybrids using genetic male sterile or cytoplasmic male sterile lines. The first genetic male sterility (GMS) based hybrid was released in 1978 from Central Institute for Cotton Research, Regional Station, Coimbatore in the name of the "Suguna" in upland cotton for Tamil Nadu state. However, this hybrid could not become popular in the state of Tamil Nadu, mainly due to poor yield than conventional hybrids. Efforts were also made to develop cytoplasmic genic male sterility (CGMS) based hybrid cotton. The first CGMS based cotton hybrid was released for commercial cultivation in the Vidarbha region of Maharashtra under the name of PKV Hy3 while was developed at Cotton Research Station of Punjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola in 1993. However, yield of this hybrid is also 10-15 lower than conventional hybrid developed using the same parents.

Now, concerted efforts are being made by various cotton research centres to release CGMS based cotton hybrids. Some CGMS based hybrids are already in the pipelines which are expected to be released in years ahead. There are several problems associated with CGMS hybrids such as low productivity, susceptibility to insect pests etc. efforts are on to overcome these problems are in the

pipeline. In diploid cotton, the main constraint in the spread of hybrid cultivation is non-availability of hybrid seed due to low seed setting.

Cotton hybrids are cultivated in South and Central zones. In north zone less than 1% cotton area is covered by hybrids. The currently cultivated hybrids include H6, H8, H10 in Gujarat; DCH 32, DHB 105 and DHH 11 in Karnataka; Savita, TCHB 213, Surya and Sruthi in Tamil Nadu, LAHH 4 and JKHy-1 and JKHy-2 in Madhya Pradesh. Diploid hybrids cover very little area (1%).

Table-3: Important Features of Tetraploid Cotton Varieties Released From Different States of India

Variety/ Hybrid	Year of Release	Yield (q/ha)	Duration (Days)	Ginning Percent	M.H.L. (mm)	Spinning Counts	Area of cultivation
PUNJAB							
LSS	1932	10	215	31	21	30	Punjab, Haryana
P 216 F	1948	11	200	31	22	30	Andhra Pradesh
320 F	1951	11	180	30	23	28	Punjab,Haryana, Rajasthan
J 34	1961	11	190	34	25	36	Hisar Tract
J 205	1973	12	195	34	25	36	Punjab,Haryana, Rajasthan
B.N.	1976	13	170	33	22	32	Whole Punjab
F 414	1977	13	180	33	23	25	Punjab
LH 372	1980	15	175	33	25	30	Punjab
F 286	1983	21	165	33	22	30	Punjab
LH 900	1985	27	170	34	22	30	Punjab
BC 761 (IARI)	1985	20	160	35	23	30	Punjab, Haryana, Rajasthan
F 505	1986	24	170	34	22	30	Punjab
LH 886	1988	26	165	35	22	30	Punjab
Jurhad	1990	25	170	35	25	30	Punjab
LH 1134	1990	22	170	35	27	40	Punjab
F 1054	1993	26	170	36	23	30	Punjab
F 846	1993	26	170	35	23	30	Whole Punjab
LH 1556	1996	21	170	34	27	40	Punjab
F 1378	1997	30	175	35	23	30	Punjab
HARYANA							
H 14	1954	10	165	35	24	30	Haryana
H 655 C	1978	18	190	34	27	40	Sirsa Zone
H 777	1978	18	180	34	23	40	Whole Haryana
HS 45	1987	21	175	34	21	30	Haryana
HS 6	1991	22	175	36	22	30	Haryana
H 974	1991	21	170	35	23	30	Haryana
H 1098	1995	19	175	35	25	30	Whole Haryana
HS 182	1997	22	165	36	21	30	Whole Haryana
RAJASTHAN							
PST 9	1965	13	210	33	23	30	North Rajasthan
RS 89	1972	14	210	33	26	40	Rajasthan
G.Ageti	1978	14	190	33	23	28	Sriganganagar
RS 513	1985	16	190	34	22	30	North Rajasthan
RST 9	1991	26	175	36	23	30	North Rajasthan
RS 875	1997	30	175	35	23	30	North Rajasthan
U.P							
Pramukh	1965	10	180	33	24	30	Western U.P.

SH 131	1977	11	170	36	23	30	Western U.P.
Vikas	1987	20	160	33	23	30	Western U.P.
M.P							
Indore 1	1945	8	190	30	22	27	Rajasthan
Indore 2	1950	6 R	200	35	24	30	Nimar& Malwa Area
Narmada (A 51-9)	1959	5 R	200	35	24	30	Nimar Region
Badnawar 1	1961	6 R	190	34	25	36	Malwa region
Khandwa 1	1967	6 R	200	36	24	40	Nimar Region
Khandwa 2	1971	8 R	160	36	24	30	Nimar & Hoshangabad region
Vikram	1981	9 R	160	33	24	35	Malwa Region
Khandwa 3	1984	9 R	180	34	23	36	Nimar Region
MAHARASHTRA							
Buri 107	1948	4 R	220	33	24	30	Vidarbha & Nimar M.P.
Buri 0394	1950	4 R	220	34	25	30	Vidarbha & Nimar M.P.
Buri 147	1960	5 R	200	36	26	40	Vidarbha area
B 1007	1971	5 R	220	34	25	40	Vidarbha region
DHY 286	1975	10 R	200	36	25	40	Vidarbha & Marathwada
Purnima	1985	10 R	190	40	23	30	Marathwada
KOP 498	1986	24	155	37	25	40	Deccan Canal Area
AKH 081	1987	10 R	160	38	24	40	Vidarbha Region
Nagnath	1990	12 R	190	41	25	40	Marathwada
CNH 36	1993	10 R	175	35	25	40	Marathwada, Gujarat
JLH 168	1993	10 R	180	36	24	40	Khandesh
NH 452	1994	12 R	180	37	25	34	Marathwada
Rajat	1994	12 R	175	39	25	40	Vidarbha Region
Arogya	1995	12 R	180	35	21	12	Vidarbha, Gujarat
GUJARAT							
Deviraj (170CO2)	1951	12 R	235	36	27	43	Whole Gujarat
Devitej (134CO2M)	1952	8 R	240	35	27	36	Middle Gujarat
G 67	1963	10 R	250	33	30	50	South & Middle Gujarat
SRT 1 (G.Cot 10)	1974	13 R	160	37	25	40	Whole Gujarat
Vishnu (G.Cot 100)	1974	20	240	32	29	50	South Gujarat
G.Cot 12	1981	6 R	220	36	24	23	Waged area
G.Cot 16	1995	16 R	140	37	25	40	Middle Gujarat
A.P.							
Krishna (AC 122)	1968	10 R	145	33	25	36	Rice Fallows, A.P.
Mahal Laxmi		1972	5 R	180	35	23	24 Rainfed, A.P.
Amrawati (AV 1661)	1978	23 6 R	170	35	27	40	NSP and Coastal Rainfed Areas
Sangam (V 14)	1978	11	140	33	25	40	Rice Fallows, A.P.
Fedraj	1978	25	150	36	24	30	Rabi Areas, A.P.
NA 247	1982	8 R	150	35	25	40	Rayal Seema, A.P.
NA 920	1988	25	170	38	24	34	Rayal Seema, A.P.
L 389	1993	25	170	35	27	50	NSP Tract,A.P.
L 603	1997	23	155	35	28	40	Nagarjuna Sagar Tract

L 604	1997	26	160	36	26	40	Rice Fallows, A.P.
KARNATAKA							
Laxmi	1948	12	180	35	23	30	Karnataka
Hampi	1968	8	190	34	23	34	Karnataka
Mysore Vijay	1968	14	210	36	26	40	Karnataka
Bhagya	1972	5 R	170	38	24	36	Karnataka
DS 51	1980	16	170	38	28	50	Karnataka
Sharda	1981	12 R	180	38	28	40	Karnataka Rainfed
Sowbhagya(DS 59)	1981	19	165	36	25	40	Tungbhadra area
Abadhita	1988	25	180	37	27	50	Karnataka
JK 119	1988	25	180	40	27	40	Tungbhadra Tract
Sahana	1996	20	170	40	26	40	South Zone
TAMIL NADU							
CO2	1929	7	190	31	24	24	T.N.Winter Crop
CO4	1939	9	190	34	24	24	T.N.Summer Crop
MCU 1	1950	9	180	32	27	36	Tamil Nadu
MCU 2	1955	10	180	35	27	36	Tamil Nadu
PRS 72	1966	8	125	36	25	40	Tamil Nadu
MCU 4	1967	10	165	37	28	50	Summer Tract
MCU 5	1968	19	165	35	30	50	Tamil Nadu, A.P.
Sujata *	1969	14	180	30	32	90	Tamil Nadu
MCU 6	1970	5 R	160	37	25	40	Tamil Nadu
MCU 7	1972	12	145	35	23	30	TN Rice Fallows
MCU 8	1974	15	160	35	28	50	Summer Tract
Suvin*	1974	15	190	30	36	120	Tamil Nadu
Suman	1976	14	150	38	26	40	T.N.,A.P.,K.S.
MCU 9	1978	18	165	36	30	50	Winter Tract
Supriya	1979	18	145	38	29	50	T.N. and A.P
KC 1	1980	9	180	34	23	40	Tamil Nadu
TNB 1*	1981	13	170	32	33	80	Tamil Nadu-
MCU 5 VT	1982	20	165	34	29	50	WinterTract, T.N.
MCU 10	1982	8 R	165	36	25	40	Rainfed areas
LRA 5166	1982	10 R	180	35	24	34	TN,AP,MS,KS
MCU 11	1988	22	155	35	26	50	Winter Tract
SVPR 1	1991	16 R	135	35	25	40	Summer Tract
Paiyur 1	1991	11.5	150	37	23	40	WinterRainfed Tract
ADT 1	1992	12	125	34	22	40	Rice Fallows
LRK 516	1992	12 R	160	36	25	36	Maharashtra, Gujarat
SVPR 2	1996	16	160	36	25	30	Summer Tract
Surabhi	1997	35	170	35	29	55	South Zone
KC 2	1997	7.5	150	37	25	40	Tamil Nadu

R=Rainfed yield
*G.barbadense varieties.

Table-4: Important Features of Diploid Cotton Varieties Released from Different States of India

Variety/ Hybrid	Year of Release	Yield (q/ha)	Duration (Days)	Ginning Percent	M.H.L. (mm)	Spinning Counts	Area of cultivation
PUNJAB							
231 R	1959	10	180	35	16	8	North Punjab
G 27	1969	10	165	37	16	9	Punjab, Haryana
LD 133	1978	12	170	35	17	9	Punjab
LD 230	1981	20	170	38	18	9	Punjab
LD 327	1987	20	170	41	16	8	Punjab
LD 491	1996	14	175	39	20	10	Punjab
HARYANA							
HD 11	1978	10	155	40	15	9	Haryana
DS 1	1984	20	180	38	18	9	Haryana
DS 5	1987	23	170	40	16	9	Haryana
HD 107	1996	36	175	38	18	10	Haryana
HD 123	1997	23	165	39	18	10	Haryana
U.P							
Shyamali	1965	4 R	180	39	19	14	Western U.P.
Lohit	1969	4 R	170	38	18	10	Western U.P.
RAJASTHAN							
Ganganagar 1	1942	9	180	40	17	9	Sri Ganganagar area
RG 8	1986	17	180	39	16	9	Sri Ganganagar area
M.P							
Malvi 9	1935	4 R	180	33	20	14	Malwa and Nimar Tracts
Bhoj	1942	4 R	190	32	21	21	Malwa and Nimar Tracts
Maljari	1954	6 R	180	33	21	20	Malwa and Nimar Tracts
Jawahar Tapti	1992	15	150	35	24	30	East and West Nimar
MAHARASHTRA							
Jarila	1930	4 R	200	34	22	22	Khandesh
V 434	1933	3.5 R	210	29	19	20	Vidarbha
Gaorani 6	1936	4 R	210	32	22	26	Marathwada, A.P.
Virnar	1949	5 R	220	38	22	20	Khandesh,Vidarbha, M.P.
H 420	1949	5 R	210	33	22	20	Vidarbha, A.P., K.S.
Gaorani 12	1950	3 R	180	31	22	26	Marathwada
Gaorani 46	1953	4 R	180	36	22	32	Western Maharashtra
Gaorani 22	1955	4 R	180	37	23	30	Western Maharashtra
Daula t	1955	3 R	180	36	22	20	Parbhani, M.S.
AK 235	1959	4 R	220	40	23	29	Vidarbha
AK 277	1959	5 R	200	41	23	30	Buldhana
Y1	1962	5 R	190	39	24	30	Khandesh
Jyoti	1973	6 R	190	39	24	26	Khandesh
AKH 4	1975	7 R	190	39	24	30	Vidarbha and Marathwada
AKA 5	1981	7 R	180	39	22	30	Vidarbha and Marathwada
Eknath (PA 32)	1981	9 R	180	39	21	20	Marathwada
Rohini	1984	8 R	175	39	24	26	Marathwada
AKA 8401	1989	10	200	38	25	40	Vidarbha region
PA 183	1996	18	180	39	27	35	Marathwada region

AKA 7	1998	10	150	41	22	25	Vidarbha region
GUJARAT							
Waged 8*	1930	6 R	230	37	19	14	Waged area
Vijay*	1943	4.5 R	220	39	21	24	Middle Gujarat
Kalyan*	1947	6 R	220	39	20	20	North Gujarat

Variety/ Hybrid	Year of Release	Yield (q/ha)	Duration (Days)	Ginning Percent	M.H.L. (mm)	Spinning Counts	Area of cultivation
Pratap	1947	3.5 R	220	32	19	18	Mathio Tract
Vijalpa*	1952	5 R	220	36	22	26	South Gujarat
Digvijay*	1956	6 R	170	39	23	38	Middle Gujarat
Sanjay	1958	5 R	165	34	23	36	Mathio Tract
V 797*	1966	8 R	160	39	22	30	Waged Zone
Sujay*	1971	6 R	250	40	24	35	Middle Gujarat
G.Cot11 (1449)*	1979	10 R	140	38	24	37	South& Middle Gujarat
G.Cot 13*	1981	8 R	190	39	23	30	Waged Area
G.Cot 15*	1989	16 R	150	38	22	30	Mathio Tract
G.Cot 17*	1995	11 R	210	37	23	40	Middle Gujarat
G.Cot 19*	1997	11 R	140	34	23	30	Mathio Tract
G.Cot 21*	1998	11 R	215	42	22	30	Part of Waged Area
A.P							
N 14	1918	3.5 R	200	25	24	32	Kurnool District
Gaorani 6	1936	4 R	180	32	23	27	Rayal Seema
Cocanada 1	1947	5 R	220	28	20	18	A.P.
Cocanada 2	1951	5 R	220	30	20	18	A.P.

Rayal Seema 1	1952	3 R	220	33	20	24	RayalSeema, A.P
Srisailam	1976	5 R	150	35	22	26	Kurnool, A.P.
Mahanandi	1978	5 R	180	32	22	26	A.P.
Saraswati	1978	5 R	180	36	25	36	A.P.
NA 1325	1993	8	180	36	24	30	Andhra Pradesh
KARNATAKA							
Jayawant*	1928	6 R	230	28	21	26	Raichur and Gulbarga
Western 1*	1930	3 R	190	29	21	24	Karnataka
Selection 69*	1942	2.5 R	230	30	20	20	South and Central Karnataka
Jayadhar*	1950	4 R	180	30	23	30	Karnataka
Suyodhar*	1963	3 R	180	28	22	35	Karnataka
Raichur 51*	1968	3 R	200	34	21	26	Karnataka
DB 3-12	1979	4 R	170	33	22	30	North East Karnataka
TAMIL NADU							
K 5	1944	2 R	200	27	23	26	Tamil Nadu
K 2	1947	2.5 R	210	31	23	26	Tamil Nadu
K 7	1964	4 R	200	34	25	34	Tamil Nadu

K 8	1971	5 R	160	35	26	37	Tamil Nadu
K 9	1978	5 R	150	37	25	35	Tamil Nadu
K 10	1984	7 R	145	38	24	30	Tamil Nadu
K 11	1992	8 R	135	35	24	30	Tamil Nadu

R=Rainfed yield
*G.herbaceum varieties

Table -5: Important Features of Cotton Hybrids Released from Different States of India

Variety/ Hybrid	Species involved	Year of Release	Yield (q/ha)	Duration (Days)	Ginning Percent	M.H.L (mm)	Spinning Counts	Area of cultivation
GUJARAT								
H 4	HH	1970	35	230	33	28	50	Gujarat,A.P.,Karnataka, Maharashtra
H 6	HH	1980	35	210	34	27	60	Gujarat,Maharashtra, A.P.
DH 7	hA	1985	15 R	190	37	22	30	Gujarat State
DH 9	hA	1988	15 R	190	34	28	40	Gujarat State, M.P.
H 8	HH	1989	35	180	36	28	50	Gujarat State
H 10	HH	1995	18 R	150	35	26	40	Gujarat State
KARNATAKA								
Varalaxmi	HB	1972	30	210	35	31	80	South Zone and Maharashtra
DCH 32	HB	1981	35	190	36	33	80	South Zone and Maharashtra
DDH 2	hA	1992	12 R	180	34	22	20	South Zone
DHB 105	HB	1996	30	190	34	33	80	South Zone
DHH 11	HH	1996	30	190	35	27	50	South Zone

Variety/ Hybrid	Species involved	Year of Release	Yield (q/ha)	Duration (Days)	Ginning Percent	M.H.L (mm)	Spinning Counts	Area of cultivation
TAMIL NADU								
CBS 156	HB	1974	30	180	32	33	100	Tamil Nadu
Suguna	HH	1978	30	150	35	25	40	Tamil Nadu
KCH 1	HB	1980	30	150	34	31	60	Tamil Nadu
Savita	HH	1987	30	170	34	30	60	TN and AP
HB 224	HB	1989	30	170	33	31	80	Tamil Nadu
TCHB 213	HB	1990	30	190	32	33	80	Tamil Nadu
Surya	HH	1997	25	170	38	31	60	South Zone
Sruthi	HB	1997	30	150	33	37	80	South Zone
MAHARASHTRA								
Godavari (NHH 1)	HH	1978	15 R	180	35	28	50	Marathwada Region
Savitri (RHR 253)	HB	1978	28	175	32	30	60	Deccan Canal Area
PKV hy2	HH	1981	12 R	180	36	27	40	Vidarbha

NHH 44	HH	1983	23	180	35	24	50	Marathwada
RHH 195 (Sampada)	HH	1986	21	160	36	24	40	Deccan Canal Area
NHB 12	HB	1989	30	180	33	33	80	Marathwada
CICR HH1	HH	1991	25	185	35	25	36	Marathwada

Variety/ Hybrid	Species involved	Year of Release	Yield (q/ha)	Duration (Days)	Ginning Percent	M.H.L (mm)	Spinning Counts	Area of cultivation
NHH 302	HH	1991	20	170	35	25	40	Marathwada
PKV Hy-3	HH	1994	15 R	180	37	25	40	Marathwada and Gujarat
PKV Hy-4	HH	1996	20	165	35	28	50	Vidarbha Region
Pha 46	Ha	1996	17	180	32	28	40	Marathwada
M.P.								
JKHY-1	Hh	196	25	210	35	27	50	M.P.,A.P.
JKHY-11	Hb	1782	18	240	31	31	60	Irrigated areas M.P.
JKHY-2	Hh	1997	30,15 R	180	34	27	50	M.P.
A.P.								
NHB 80	Hb	1982	20	170	34	27	50	NSP area
LAHH 1	Hh	1987	28	150	35	29	60	Whole A.P.
LAHH 4	Hh	1997	30	170	35	31	40	All three zones
PUNJAB								
Fateh	HH	1994	30	180	34	25	30	Punjab
LDH 11	AA	1994	20	175	36	22	20	Punjab
LHH 144	HH	1998	28	180	35	28	50	Punjab
HARYANA								
Dhanalaxmi	HH	1994	25	180	35	26	40	Haryana
Om Shankar	HH	1996	28	165	34	25	40	North zone
AAH 1	AA	1999	24	180	38	16	Below 10	Haryana
RAJASTHAN								
Maru Vikas	HH	1994	30	180	34	24	30	Rajasthan

R=Rainfed yield
HH=Intra-hirsutum, HB=hirsutum x barbadense, AA=Intra-arboreum, hA=herbaceum x arboreum

SIGNIFICANT ACHIEVEMENTS

In India, remarkable progress has been made in cotton breeding after independence. The major achievements of cotton breeding include: (1) improvement in yield, (2) improvement in quality, (3) resistance to insects and diseases, (4) earliness, and (5) adaptability. These aspects are briefly discussed below.

- **Improvement in yield**

In cotton, yield is measured in two ways, viz seed cotton yield and lint yield. Seed cotton yield refers to yield of cotton before ginning. It includes both lint and seed. On the other hand, lint yield refers to yield of fibre after ginning. In cotton, fibre or lint is the main product. In cotton, boll number per plant and boll weight are the major yield components. Ginning per cent is an important component of lint yield.

In India, significant improvement has been achieved in cotton yield after independence. The present average (1999-2000) lint yield of cotton is 320 kg/ha which was only 81 kg/ha during 1947-48. Moreover, the present average seed cotton yield of best variety/hybrid is 40 q/ha which was only 15 q/ha during 1947-48 (Table-6). This increase in cotton yield could be achieved through development of high yielding varieties and hybrids. India is the pioneer country in the world for successful exploitation of heterosis (hybrid vigour) in cotton on commercial scale. The first hybrid was released in 1970 from Cotton Research Station, Surat of Gujarat Agricultural University by late Dr.C.T.Patel. Since then several cotton hybrids have been released for cultivation in south and central cotton growing zones. Recently, some hybrids have been released in Punjab (Fateh, LHH 144, LDH 11), Haryana (Dhanalaxmi and AAH_1) and Rajasthan (RAJ HH 16). Hybrid Omshankar has been released for cultivation in the entire northern zone. Besides hybrids, superior varieties have been released in all cotton growing states of India. The first cotton hybrid i.e. H4 which was developed at Surat, recorded seed cotton yield up to 100 q/ha under telephone system of cotton cultivation under Gujarat conditions. Hybrids with high yield potential have also been released in diploid cottons (DH 7, DH 9, Pha 46, LDH 11 and DDH 2) from Surat, Parbhani, Ludhiana and Dharwad. All India Coordinated Cotton Improvement Project (AICCIP) has played significant role in the development of high yielding varieties and hybrids.

- **Improvement in Fibre Quality**

In cotton, fibre or lint is the main product. Fibre quality includes fibre length, strength, fineness, maturity and uniformity. The spinning capacity is also an indication of fibre quality. Significant achievements have been made in fibre quality especially fibre length and spinning capacity. The MCU 5 was the first extra long staple variety of G.hirsutum released in India. Lateron, still better variety known as MCU 9 was released. In G.barbadense, release of variety Sujata resulted in significant breakthrough in quality improvement. It was capable of spinning 100 counts and was comparable to several Egyptian and Sudan types. In G.barbadense release of another variety named as Suvin which is capable of spinning 120 counts, is a distinct landmark in the quality improvement in India. This variety is cultivated in Tamil Nadu and is comparable to Egyptian Giza 45 in quality. At present, the staple length of best variety is 37 mm and spinning ability is 120 counts which were 24 mm and 28 counts in 1947-48. Thus, significant improvement has been made in fibre length and spinning cspacity. Moreover, long staple varieties have also been released in G.arboreum. The long staple varieties of G.arboreum include K 8, K 9, K 10, K 11, Saraswati and AKA 8401. In cotton, there is an increasing demand for easy care fabrics that are washed easily and need little pressing. Some varieties have been developed which have easy care properties.

- **Insect and Disease Resistance**

Cotton crop is attacked by several diseases and insect pests resulting in considerable losses in yield. The genetic resistance is the cheapest and the best way of reducing such losses in yield. In India, work on insect and disease resistance breeding has been extensively reviewed by various workers. In upland cotton, variety MCU 5 VT resistant to Verticillum wilt was released from Coimbatore. In G.arboreum and G.herbaceum, all the varieties released after 1967 are resistant to Fusarium wilt. In G.hirsutum, some jassid resistant varieties (B 1007, SRT 1, Khandwa 2, DHY 286, PKV 081) and hybrids (PKV hy2 and NHH 44) have been released. Varieties LK 861 and Kanchana are resistant to white fly. In USA, Monsanto Seed Company has developed transgenic cotton which is resistant to Helicoverpa armigera.

Table-6 : Progress of cotton breeding from 1947 to 1999-2000

Particulars	1947-48	1999-2000	Remarks
Area lakh hectares	43	87	Roughly double
Production lakh bales	23	164	About seven times
Lint yield (kg/ha)	81	320	Nearly four times
Yield potential (seed cotton) of the best variety/ hybrid (q/ha)	40	100	Two and half times
Average seed cotton yield of the best variety/ hybrid (q/ha)	15	40	More than double
Highest spinning capacity (count)	37	120	Significant milestone
Spinning spectrum (count)	6-40	6-120	Significant achievement
Egyptian cotton varieties	No	Yes	Acclimatization
Hybrid cotton	No	Yes	Significant milestone
Long staple varieties in G.arboreum	No	Yes	K 9, K 10, K 11, AKA 8401 significant achievement

- **Earliness**

Earliness is a desirable character which has several advantages.Early varieties permit multiple crossing system, escape from late season pests, reduce costs on pesticidal sprays and crop management resulting in reduction in the cost of cultivation. In cotton, maturity duration has been significantly reduced. Most of the earlier cotton varieties used to mature in 240-270 days. Similarly, hybrids had maturity duration of 230-240 days. This maturity duration has been reduced from 270 days to 170 days in case of varieties and from 240 days to 180 days in case of hybrids. Variety LRK 516 matures in 170 days and hybrid H 8 matures in 180 days. Early varieties/ hybrids have less incidence of pink bollworm compared to long duration varieties.

- **Adaptability**

Adaptability refers to capacity of a variety for adaptation over a wide range of environmental conditions. In other words, it refers to suitability of a variety for general cultivation over a wide range of environmental conditions. Adaptability of a variety is measured in terms of phenotypic stability over multilocations. Varietal adaptability is important for stabilization of production over regions and seasons. In cotton, some varieties and hybrids with wide adaptability have been released from 1970 onwards. Examples of adaptable varieties are Bikaneri Narma, MCU 5, SRT 1 and LRA 5166. Variety Bikaneri Narma was developed in Punjab, which spreads to Haryana, Rajasthan and Northern Madhya Pradesh due to its wide adaptability. Variety SRT 1 was released in Gujarat but also became popular in Maharashtra and Madhya Pradesh. Similarly, varieties MCU 5 and LRA 5166 released for Tamil Nadu state spread to Andhra Pradesh, Maharashtra and Madhya Pradesh by virtue of their wide adaptability. Hybrid H 4 was released for Gujarat state in 1970 but by virtue of its wide adaptation it spread to other states like Maharashtra, Madhya Pradesh, Andhra Pradesh and Karnataka. Similarly, hybrid DCH 32 (Jayalaxmi) was released for Karnataka state, but to its wide adaptability it spread to Tamil Nadu, Andhra Pradesh and Western Maharashtra.

FUTURE THRUSTS

The present mills' requirement of cotton in India is about 140 lakh bales per annum. This will be about 190 lakh bales by 2001 A.D. To keep pace with the increasing cotton demands, the future breeding efforts have to be made on the following thrust areas.

1. Development of cytoplasmic genic male sterility (CGMS) based hybrids for irrigated and rainfed conditions.

2. Development of short duration (165 days) tetraploid or diploid hybrids with 4 tonnes of seed cotton yield / hectare for northern zone.

3. Development of hybrids and varieties suitable for machine picking.

4. Development of short duration, short statured and compact cultivars in tetraploid cotton to achieve quantum jump in the productivity by adopting closer spacing (population explosion).

5. Development of hybrids and cultivars resistant to moisture stress conditions.

6. Development of transgenic cotton varieties / hybrids resistant to bollworms using B.t gene.

7. In North zone, there is an increasing incidence of leaf curl virus in upland cotton (G.hirsutum). Hence, there is need to develop varieties of upland cotton resistant to leaf curl virus for northern zone.

8. Development of cotton cultivars suitable for late sowing.

9. Development of cotton hybrids and cultivars with wide adaptability.

10. Development of varieties / hybrids with high fibre strength suitable for high speed (jet and rotobar) spinning. Development of such cultivars is also necessary to compete in the global market.

11. Development of G.barbadense varieties better than suvin.

12. Development of neps and motes free intra-barbadense hybrids for irrigated areas of Tamil Nadu.

13. There is an increasing demand of naturally coloured cotton. Hence, efforts have to be made to develop high yielding and good quality varieties and hybrids of naturally coloured cotton.

14. There is demand from some countries like Germany and U.K. for organic cotton. Hence, there is need to develop varieties and hybrids of cotton suitable for organic cultivation.

--- The End ---