



## Cotton Hybrids and their Role in Indian Economy

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### ABSTRACT

India is the pioneer country in the world for cultivating hybrid cotton on a commercial scale. The world's first intra-hirsutum hybrid i.e. H4 was released in 1970 from Surat (Gujarat) and the world's first interspecific tetraploid hybrid i.e. "Varalaxmi" was released from Dharwad (Karnataka). Later on, several high yielding hybrids in tetraploid cottons and a few in diploid cottons were released especially for central and southern zones. Recently, some hybrids have been released for north zone also. Hybrid cottons now cover about 40% of the total cotton area and contribute about 50% to the national cotton production. Hybrid cottons have helped India in achieving self sufficiency in cotton production and also in providing employment opportunities to millions of rural people. Now India earns about 420 thousand million rupees of foreign exchange per annum by way of cotton export in the form of lint, yarn and fabrics, half of which comes through hybrids. Besides yield remarkable improvement has been achieved in fiber quality. Various aspects of hybrid cotton such as area under cultivation, types of hybrids, hybrid research centres, practical achievements, hybrid seed production, role of hybrids, limitations and future outlook are discussed.

### Introduction

India is the pioneer country in the world for cultivation of hybrid cotton on commercial scale. The world's first cotton hybrid i.e. Hybrid 4 (also called H4) was released for commercial cultivation from Cotton Research Station, Surat of Gujarat Agricultural University in 1970 for the state of Gujarat by Dr. C. T. Patel. Several other hybrids were released later for commercial cultivation in different cotton growing states. The first hybrid, H4 was released from central zone and the second, Varalaxmi, from south zone (UAS Dharwad). The work on hybrid cotton has been reviewed by various workers (Basu, 1983; Basu and Paroda, 1995; CICR 1990, ICAC 1997; Narayanan *et al.* 1988; 1990; Paroda and Basu, 1990; Singh, 1987; and Singh, 1998). This paper deals with various aspects of hybrid cotton with particular reference to India.

### Area Under Hybrid Cotton

The first cotton hybrid (H4) was released for commercial cultivation in 1970, which became very much popular among farmers by virtue of its high yield potential and wider adaptability. As a result, the area under hybrid cotton started increasing. In 1975, the area under hybrid cotton was only 3% of total cotton area in India, which increased to 11% in 1980, 26% in 1985, 36% in 1990 and 40% in 1997. Thus there is continuous expansion of area under hybrid cotton. Now the largest area of cotton is covered by hybrids (40%) followed by *G. hirsutum* (36%), *G. arboreum* (16%) and *G. herbaceum* (8%). The area under *G. barbadense* is negligible (0.2%).

There are four types of commercial hybrids in cotton, viz., (1) Intra-hirsutum hybrids (2) Interspecific hybrids between *G. hirsutum* and *G. barbadense* (3) Interspecific hybrids between *G. arboreum* and *G. herbaceum* and (4) Intra arboreum hybrid. The maximum area is covered by intra hirsutum hybrids (35%) followed by interspecific hybrids between *G. hirsutum* and *G. barbadense*. Less than 1% area is covered by diploid hybrids especially those involving *G. arboreum* and *G. herbaceum*.

The first cotton hybrid (H4) was released in Gujarat state and second in Karnataka state (Varalaxmi). Later on these hybrids spread to adjacent states like Tamil Nadu, Andhra Pradesh, Maharashtra and Madhya Pradesh and some new hybrids were released in these states. After the release of first cotton hybrid, the cultivation of hybrid cotton was confined to Central and South zones for more than 23 years. Now hybrids have also been released for northern zone. However, hybrids could not become popular in the northern zone and they cover less than 1% area. The area of cotton hybrids in different states is presented in Table 1.

### Types of Cotton Hybrids

As stated above, there are four types of cotton hybrids which have been released for commercial cultivation in India. Intra hirsutum hybrids are cultivated in south and central zones both under irrigated as well as rainfed conditions. Interspecific hybrids between *G. hirsutum* and *G. barbadense* are cultivated under irrigated conditions mainly in Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu. Interspecific diploid hybrids are

cultivated on small areas in Gujarat and Karnataka states. Interspecific hybrids suffer from the problems of neps and motes. Interspecific hybrids between *G.hirsutum* and *G.barbadense* cannot be grown in drought prone areas, because the *barbadense* parent is very much susceptible to drought conditions.

### **Hybrid Research Centres**

In India, research on hybrid cotton is carried out by two types of organizations, viz. Public research centres and Private seed companies. Public Research centres include Cotton Research Institutes of ICAR and Cotton Research stations of SAUs. There are 13 public research centres where research on hybrid cotton is carried out. These research centres are located at Ludhiana, Hisar, Sirsa, Sriranganagar, New Delhi, Khandwa, Akola, Nanded, Surat, Nagpur, Dharwad, Guntur and Coimbatore (Table 2).

In 1989, ICAR launched a hybrid cotton research project on nine crops including cotton to develop high yielding and superior quality hybrids. Initially, this project included above 13 research centres. Later on IARI, New Delhi centre was dropped. Remarkable progress has been made by these research centres. Till 1997, the above 12 research centres have released 18 cotton hybrids for commercial cultivation in different cotton growing states. Besides these centres, several institutes are engaged in development of cotton hybrids.

### **Practical Achievements**

Remarkable achievements have been made in development of commercially cultivated hybrids in India. The first cotton hybrid was released in 1970. Later on several high yielding hybrids with good fiber quality and resistance to insects and diseases were released for commercial cultivation. Initially, cotton hybrids were released for central and south zones. Now hybrids have also been released for north zone. One hybrid through the use of genic male sterility (Suguna) and two based on cytoplasmic genic male sterility (PKV Hy3 and PKV H4) were also released. A list of cotton hybrids released up to 1988 and after 1989 is presented in Table 3.

### **Hybrid Seed Production**

In India, two types of organisations, viz. Public sector organizations and Private sector agencies, produce hybrid seed of cotton. Public sector agencies include State Seed Corporations and State Farm Corporations of India. These agencies produce seed of hybrids developed by National or to different states, resulting in increase in production. Hybrid seed production programme provides employment to millions of rural people. Export of cotton in the form of lint, yarn and textiles, earns

Central Institutes and State Agricultural Universities. Private sector organizations include various seed companies. Private seed companies produce seed of all the hybrids developed by public sector Institute or private seed companies. There are several Indian and multinational seed companies that are engaged in hybrid seed production in cotton.

There are two methods of hybrid seed production viz. conventional method (hand emasculation and pollination method) and male sterility based method. For production of hybrid seed the female and male parents are planted in the ratio of 3:1 or 4:1. The sowing of parents is done in such a way that there should be nicking in the flowering time of both the parents. Both genic and cytoplasmic genic male sterility systems are available in cotton. Three hybrids viz. MECH 4, PKV HY 3 and PKV HY 4 through the use of CGMS and one hybrid (Suguna) through the use of GMS have been developed. However, male sterility based hybrid could not compete so far with conventional hybrids due to poor yield of the former. The cost of hybrid seed production comes to Rs.125/- per kg. However, the hybrid seed is sold at the rate of Rs.700-800 per kg to the farmers by the private seed companies.

### **Role for Hybrids**

Hybrids have higher productivity, wider adaptability and high degree of resistance to biotic and abiotic stresses. In cotton, hybrids give 50% higher yield than simple varieties. The wider adaptability of hybrids is due to their high buffering capacity to environmental fluctuations.

Commercial cultivation of hybrids has resulted in significant change in cotton production in India both in quality and production. The major contributions of cotton hybrids are self-sufficiency in production, improvement in quality, stability in production, earning of foreign exchange, generation of employment for millions of people, and development of seed industry. India attained self sufficiency in cotton production within one decade after the release of first commercial hybrid. This could become possible due to high yield potential of hybrids compared to simple varieties. Significant improvement has been achieved in spinning capacity through the release of hybrids. Interspecific tetraploid hybrids are capable of spinning 80s counts. Some hybrids such as H4, H6, JKHY1, Varalaxmi, DCH 32, NHH 44 etc have wider adaptability, hence their cultivation extended

about 420 thousand million rupees foreign exchange per year and constitutes about 33% of the total export of the country. About half share of the exported cotton belongs to the long and extra-long staple

categories, which is contributed mainly by the tetraploid hybrids.

### **Limitations of Cotton Hybrids**

There are four major problems which are associated with cotton hybrids or which act as barriers in the expansion of area under hybrid cotton. These are (1) high cost of hybrid seed; (2) high cost of cultivation; (3) difficulty in seed production especially in case of diploid hybrids; and (4) problem of neps and motes especially in interspecific hybrids.

### **Future Outlook**

In India, remarkable progress has been made in developing commercially cultivated hybrids. The future work on cotton hybrids needs to be directed towards the following thrust areas.

1. Development of high yielding hybrids (4 tonnes/ha) for cotton-wheat cropping systems of northern zone
2. Development of bollworm resistant hybrids through the use of transgenic line as one of the parents
3. Development of hybrids with multiple adversity resistance (drought, salinity, water logging, major insect pests and diseases)
4. Development of high yielding hybrids through the use of male sterility
5. Development of interspecific hybrids free from neps and motes
6. Development of intra *barbadense* hybrids
7. Development of coloured linted hybrids

8. Development of hybrids suitable for organic cotton cultivation
9. Development of hybrids suitable for machine picking

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**Table 1. Area (%) of cotton hybrids in different states.**

<i>States</i>	<i>Area in %</i>
Punjab, Haryana and Rajasthan	<1%
Gujarat State	50
Maharashtra	50
Andhra Pradesh	65
Karnataka	70
Madhya Pradesh	42
Tamil Nadu	15

**Table 2. Hybrid cotton research centres in India.**

<i>Sr.No.-</i>	<i>Name of Research Institute/SAU</i>	<i>Location of centre</i>
1	Central Institute for Cotton Research	Nagpur (Coordinating centre)
2	Punjab Agricultural University	Ludhiana
3	Haryana Agricultural University	Hisar
4	CICR Regional station,	Sirsa
5	Rajasthan Agricultural Univesity	Sriganganagar
6	Indian Agricultural Research Institute	New Delhi
7	Jawaharlal Nehru Krishi Viswa Vidyalaya	Khandwa
8	Punjabrao Deshmukh Krishi Vidyapeeth	Akola
9	Gujarat Agricultural University	Surat
10	University of Agricultural Sciences	Dharwad
11	Marathwada Agricultural University	Nanded
12	Tamil Nadu Agricultural University	Coimbatore
13	Andhra Pradesh Agricultural University	Guntur

**Table 3. Cotton hybrids released from different research centres.**

<i>Research centre</i>	<i>Hybrids released up to 1988</i>	<i>Hybrids released after 1989</i>
PAU, Ludhiana	-	Fateh, LHH 144, LDH 11
HAU, Hisar	-	Dhanlaxmi
RAU, Sriganganagar	-	Maruvikas
CICR, Nagpur	-	CICR HH1
CICR, Coimbatore	Suguna, Savitha, HB 224	Surya, Sruthi
CICR, Sirsa	-	Om Shankar
GAU, Surat	H 4, H 6, H 8, DH 7, DH 9	H10
UAS, Dharwad	Varalaxmi, DCH 32, DDH 2	DHH 11. DHB 105
JNKVV, Khandwa	JKHY1	JKHY 2
PDKV Akola,	PKV Hy2	PKV HY, PKV HY4
MAU, Nanded	Godavari, NHH 44, NHB 12	NHH 332, Pha 46
APAU, Guntur	-	LAHH 4
TNAU, Coimbatore	KCH 1, CBS 156, TCHB 213	