

Status Paper of Indian Cotton



Gossypium arboreum



Gossypium herbaceum



Gossypium hirsutum



Gossypium barbadense



**Directorate of Cotton Development
Government of India**

**Ministry of Agriculture & Farmers Welfare,
Department of Agriculture, Cooperation and Farmers Welfare (DAC & FW)
Bhoomi Sarvekshan Bhavan, Near Centre Point School,
Katol Road, Nagpur 440013, Maharashtra.**

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January, 2017

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कृषि एवं किसान कल्याण मंत्रालय
कृषि, सहकारिता एवं किसान कल्याण विभाग
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Government of India
Ministry of Agriculture and Farmers Welfare
Department of Agriculture, Cooperation
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Krishi Bhawan, New Delhi-110001

Dr. S. K. Malhotra
Agriculture Commissioner



MESSAGE


As on today, 50 species of cotton have been identified in the World that includes 45 species of diploid cotton and 5 species of tetraploid cotton. Among these, 46 species are of wild cotton and the other are cultivated in the World which includes two each of diploid and tetraploid cottons.

India is the only country in the World where all four cultivated species are grown. During 1980, about 65 % of cultivated area was under tetraploid cotton and the rest 35 % under diploid cotton which has now changed to about 98% area under tetraploid and 2 % under diploid species (Cotton season 2015). As per triennium ending 2015-16, India by producing 345.82 lakh bales had occupied the first place in the World cotton production and it is persistently holding top position in the cotton acreage.

India's Textile Industry need fibre of all cultivated species and therefore it is necessary to balance the species wise production as per their requirement, taking advantage of various diversity in cultivation like short duration varieties, early sowing, use of fertilizers, use of insecticides intelligently, conserve natural control, intercropping and use of IPM tools intelligently. These will also help in better production with improved quality of seed cotton and agro-ecosystem, besides restoration of soil fertility.

Status paper of Indian Cotton document has information in brief about all sectors of cotton, which would be of great help to all the stakeholders in formulation and implementation of development programme of cotton.

I commend the hard work that has been put in by Shri R.P. Singh and his team for compilation of this publication.


11.1.17
(Dr. S. K. Malhotra)

Place: Krishi Bhavan, New Delhi.

Dr. B. Rajender, IAS
Joint Secretary



भारत सरकार
कृषि एवं किसान कल्याण मंत्रालय
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Government of India
Ministry of Agriculture & Farmers Welfare
Department of Agriculture, Cooperation
& Farmers Welfare

Foreword

Cotton is one of the principal commercial crops. It plays an important role in the National economy providing employment in the Farm, Marketing and Processing sectors, besides providing the basic input for Ginning & Pressing, Textile Industry, Import & Export of yarns fabrics etc. Cotton is cultivated across the world in about 80 countries in an average area of 329.50 lakh hectares with 1482.90 lakh bales (170 kg each) of production with productivity of 765 kg lint per hectare. India is at the first place in acreage as well as in production of cotton in the World & contribute 38.13%, (118.81 Lakh Ha) and 26.75 % (345.82 Lakh Bales), respectively as per triennium ending 2015-16. During the same period, the consumption of lint in the world was 1396.58 lakh bales including 309.52 lakh bales in India. India is self-sufficient in cotton production, however, the average productivity is 522 kg per ha against the world's average of 765 kg per hectare showing a gap of 243 kg per hectare (less by 31.76 %). The reasons for low productivity are weather aberrations including inadequate / excess rains with uneven distribution of rains in cotton producing areas, more than 65 % of area rainfed in Central and South zones, cultivation of Bt. cotton hybrids in uplands (shallow / light soil), incidence of pests, especially sucking pests and sudden wilting in Bt. cotton hybrids etc. For further accelerating the productivity, the cotton research system needs to evolve Bt. varieties having multi resistance to pests (Insect Pests, Diseases, Weeds and Nematodes), drought and flood, besides arranging the farmer friendly refinement in pre and post-harvest technologies for producing cotton fibre as per demand of Textile Industry.

Directorate of Cotton Development, which has been functioning at Bhoomi Sarvekshan Bhavan, Nagpur since 01.10.2014, has brought out the basic information on all sectors of cotton in this document, would be of great help to all the concerned stakeholders in formulation and implementation of development programme of cotton.

I congratulate Shri R. P. Singh, Director and staff of Directorate of Cotton Development, Nagpur for their efforts in bringing out this publication.


10.1.2015
(Dr. B. Rajender)

Place: Krishi Bhavan, New Delhi.

R. P. SINGH



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PREFACE

India is the only country where all cultivable species of cotton are grown on commercial scale. In addition to this, inter and intra specific hybrids are also cultivated including transgenic cotton. Lint and fibre made materials including readymade garments are exported which fetch foreign exchange for strengthening the economy. After independence, efforts made by Central and State Governments and ICAR / SAUs led to surplus production of cotton. During 2001-02, India imported about 31 lakh bales, which reduced to 9.94 lakh bales (average figure). Undoubtedly India is self-sufficient in cotton production, importing about 9.94 lakh bales of Extra Long Staple Fibre (ELSF). However, there is a mismatch in species wise demand and production of cotton and therefore, it is necessary to produce cotton as per species wise demand and maintaining the biodiversity in cotton production for future generation.

Indian Central Cotton Committee (ICCC) renamed as Directorate of Cotton Development in 1966, which was functioning since 1921 at Indian Mercantile Chambers, 14, R.K. Marg, Ballard Estate, Mumbai 400001 up to 30.09.2014, has now been shifted to Nagpur and this Directorate has been functioning at Bhoomi Sarvekshan Bhavan, Katol Road, Nagpur 440013, Maharashtra since 01.10.2014. At present, this Directorate is responsible for monitoring the implementation of National Food Security Mission (NFSM): Commercial Crops: Cotton since April 2014. Erstwhile Mini Mission II (MM II) of Technology Mission (TMC) on Cotton had been subsumed with NFSM: CC: Cotton during 2014-15.

To maintain the data of all cotton related aspects is also one of the assigned functions of this Directorate. Hence, basic information compiled on all aspects of cotton brought out in this document, would be of great help to all the concerned stakeholders in formulation and implementation of development programme of cotton.

I am grateful to Shri S.K. Pattanayak, IAS, Secretary (DAC & FW), Dr. S. K. Malhotra, Agriculture Commissioner and Dr. B. Rajender, IAS, Joint Secretary (Crops & Oilseeds) / National Mission Director (NFSM), Department of Agriculture, Cooperation & Farmers Welfare (DAC & FW), Ministry of Agriculture & Farmers Welfare, Krishi Bhavan, New Delhi for their valuable guidance in bringing out this publication. I am also grateful to Dr. A.P. Singh, Additional Commissioner (Crops) and Dr. Anupam Barik, Additional Commissioner (Oilseeds), DAC & FW, Ministry of Agriculture & Farmers Welfare, Krishi Bhavan, New Delhi for their suggestions from time to time in preparation of this document.

I am thankful to the State Departments of Agriculture (SDA), Office of the Textile Commissioner, SAUs, Dr. K.R. Kranthi, Director, CICR, Nagpur, Dr. P.G. Patil, Director, CIRCOT, Mumbai, Dr. Dilip Monga, Head, CICR, RS, Sirsa and Dr. A.H. Prakash, Project Coordinator, CICR, RS, Coimbatore and Mill Sector etc. for providing the information for compilation of this document. I also thank the staff of DCD, Nagpur for helping in compilation of this Status Paper.

Valuable suggestions of the readers of this document are most welcome for improvement.


(R. P. Singh)

Place: Nagpur.

Date: January, 2017

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CHAPTER 01

History of Indian cotton

1. History of Indian cotton

1.1 Nomenclature:

Cotton belongs to family Malvaceae, Tribe: Gossypieae, Genus: Gossypium. The Genus *Gossypium* consists of 50 species. Four of these are cultivated viz., *Gossypium arboreum*, *Gossypium herbaceum*, *Gossypium hirsutum* and *Gossypium barbadense*. The first two species are diploid and are confined to the old world, indigenous to Asia and Africa. The other two species are amphidiploids with centres of variability in Mexico- Central America and South America. The American cotton *G.hirsutum* and Egyptian cotton *Gossypium barbadense* are also called the new world cotton. The remaining 46 species are wild and are not cultivated. Of the species identified across the world, 45 are diploid (Desi Cotton) and other five are tetraploid (American cotton). These species are distributed in Africa, Middle East, Asia, South America, Central America, North America, Australia and Hawaii.

1.2 Composition:

Cotton fibre is basically cellulosic polymers. Raw unpurified cotton as such is hydrophobic in nature, i.e. it does not absorb water and on the contrary it repels water. This hydrophobic property of the cotton is due to the presence of non-cellulosic substances such as waxes, pectin, proteins etc on the fibre. A typical chemical composition of cotton fibres is (%): Cellulose: 94, Waxes: 0.6, Pectin: 0.9, Protein: 1.3, Mineral matters: 1.2, Organic compounds: 0.8, total Sugars: 0.3 and other substances 0.90.

1.3 Origin:

Scientists found bits of cotton bolls and pieces of cotton cloth in caves in Mexico. These bits and pieces may be of around 7000 years old. From time immemorial, India was the only country known for its cotton fabrics, the rest of the world being clad mostly in wool. Cotton in India has the unique distinction of being the cynosure both of the pre-Industrial Revolution economy of manufactures and the post revolution economy of raw materials. Cotton has played a dominant part in the economic development of India. India has been the producer of cotton and also of the finest and most beautiful cotton fabrics since the Indus - Valley -Civilization which flourished in the Indian sub-continent some 5000 years ago. Practically, till the end of 18th Century, no source of supply of cotton other than India was known to the World.

The *Gossypium herbaceum* (Desi cotton- very short fibre cotton) is found from the coastal strip North West of Karachi, Northern Baluchistan to South Yemen, Ethiopia, and Sudan.

The *Gossypium arboreum* was found in Kathiawar, Khandesh and Deccan in India. In Indus river valley in Pakistan, cotton fibres were woven in to cloth which might be 3000 BC. At about the same time, Natives of Egypt's Nile valley were making & wearing cotton cloth. It is likely that Gujarat & Sindh are places where *arboreum* cotton was in cultivation. Arab merchants brought cotton cloth to Europe about 800 A.D. *Gossypium hirsutum* and *Gossypium barbadense* existed as distinct species in the wild, in Central America.

1.4 Spread of cotton cultivation:

Until the middle of the 18th Century, only the *arboreum* and *herbaceum* varieties of cotton were grown in different regions of the country. The first attempt was made in 1790 A.D to grow *hirsutum* variety (American Cotton) in Bombay & Madras province but it was not successful. American cotton was carried out in the Deccan, Konkon, Hubli in 1840-1842 A.D. In Punjab, the first attempt was made in 1846 A.D to introduce American cotton. The most significant development and spread of American cotton in India was the introduction of Cambodia variety in 1904-05.

When the British Rulers in India formed Ministry of Agriculture for the first time in the beginning of the 19th Century, cotton was one of its main considerations, because the Mills in Britain depend mainly on raw cotton produced in India. The different problems associated with cotton cultivation, were systematically studied. With the establishment of Agricultural Departments in various provinces of India in 1904, the setting up of Indian Cotton Committee (ICC) in 1917 at Bombay further boosted the spread of *hirsutum* & long staple cotton in India. This committee established Indian Central Cotton Committee (ICCC) in 1921 as technical advisory Body to the Government for promoting Agricultural & Technological Research in cotton. The ICCC became a statutory Body in 1923 and established Central Technological Research Laboratory (CTRL) in 1924 at Bombay. Presently known as Central Institute for Research on Cotton Technology (CIRCOT). Since 1924 to 1966, ICCC had formulated many cotton schemes with a view to improve cotton quantitatively & qualitatively and operated various developmental schemes for overall development of four cultivated species of cotton in India. The concentrated efforts of the ICCC could cross double the production during 1966. The major activities of ICCC were Breeding- varietal improvement, Seed multiplication, Cotton agronomy, Control of insect pests & diseases and Cotton physiology.

The partition of the country in 1947, led to serious imbalance between demand & supply of cotton, which resulted in massive imports of cotton for a number of years. A large part of the irrigated cotton growing areas went over to Pakistan, whereas most of the (90%) mills were existing in India itself. However, with the Cotton Development Schemes, implemented by the Government during the successive Five Years Plan Period, cotton production increased.

For over a century, introduction, acclimatization and testing of Extra Long Staple (ELS) varieties of *G.barbadense* cotton had been carried out in India. However, the most intensive and systematic programme was initiated in the year 1947 by the Cotton Specialist of the Madras State. A separate Scheme on Sea Island Cotton Research was implemented under the auspices of the erstwhile Indian Central Cotton Committee during 1949 to 1956. The Sea Island Andrews variety was identified as a “bread and butter” strain for cultivation in the West Coast Districts of Mysore and Kerala then part of Madras State as a monsoon season crop. A five year development scheme was also launched in April 1957 to extend Sea Island cotton over three lakh acres and produced 02.25 lakh bales. However, the objectives were not fulfilled due to soil and crop management problems and lack of adequate infrastructure for marketing in the non-traditional cotton growing tracts.

1.5 Efforts on Cotton Development:

“Cotton Extension Scheme” and “Grow More Cotton” campaigns, sponsored by the Government of India, was launched from 1950-51, constituted the earliest development efforts on cotton in Independent India. The accents under those schemes were to on the expansion of cotton area, as the objectives were to achieve increase in production quickly as possible to tide over the imbalance in cotton supply and demand (First Plan Period). This drive, led to 44 percent increase in cotton area during the First Plan Period (1951-52 to 1955-56), which boosted the production by 55 percent. But in the Second Plan Period (1956-57 to 1960-61), there was little scope for area expansion due to competition from other crops, production, however, recorded a 24percent increase mainly due to increased productivity.

As there was little scope to expansion of area, the emphasis was shifted to increasing the productivity. Intensive Cotton Cultivation Scheme (ICCS), popularly known as “Package Programme”, was launched in 1962-63 (Third Plan Period), which focussed over limited area in a few states.

The special field staffs were appointed for dissemination of technical knowledge to farmers, besides providing incentives (Seed, Pesticides, Appliances, Operational cost, Ceiling prices etc.).

In spite of worst drought, increase in production during Third Plan Period was 12 %, for which increase in area as well as productivity had contributed. As a result of all these measures, cotton production reached to 54.97 lakh bales by the end of 1968-69. Though there was increase in production, it could not keep pace with rapid raising demand with sizable expansion of Textile Mills during this period. The Cotton area, production and yield scenario during phase I are given in **Table 1**.

Table 1: Cotton area, production & yield scenario during Phase -I (1947-1969)

Year	Average Area (lakh ha)	Average Production (lakh bales each 170 kg lint)	Average Yield (kg lint/ha)	% Change in Production
Before Plan Period (1947 to 1951)	49.50	24.96	85	-
First Plan Period (1951-52 to 1955- 56)	71.10	38.74	92	+ (55.21)
Second Plan Period (1956-57 to 1960- 61)	77.80	48.09	105	+ (24.13)
Third Plan Period (1961-62 to 1965- 66)	80.50	53.99	114	+(12.27)
Annual Plan Period (1966-67 to 1968- 69)	78.10	54.97	120	+(1.82)

Source: Status Paper of Directorate of Cotton Development, DAC & FW, Ministry of Agriculture and Farmers Welfare, Bhoomi Sarvekshan Bhavan, Katol Road, Nagpur.

In 1966, the ICCC was abolished and the research duties were transferred to the Indian Council of Agricultural Research (ICAR) under the Ministry of Agriculture and Developmental activities had been owned by Govt of India/State Governments. After the abolition of ICCC in 1966, Government of India set up Directorate of Cotton Development (DCD) at Mumbai to look after the Developmental aspects of cotton crop in the country.

ICAR launched the All India Coordinated Cotton Improvement Project (AICCIP) in 1967 and strengthened the Research infrastructure in State Agriculture Universities (SAUs) of various cotton growing zones. AICCIP embarked on the Cotton Improvement Programme through Multi Location and Multi- Disciplinary Approaches for realization of objectives in limited time. The AICCIP has 10 main centres at Faridkot, Hisar and Sriganganagar in North Zone; Surat, Khandwa, Akola, Nanded, in Central Zone; Guntur (Lam farm), Dharwad and Coimbatore in South Zone. In addition to these Centres, AICCIP also has 11 Sub-centres at Ludhiana, Banswara, Kanpur, Junagadh, Indore, Pune, Rahuri Bhawanipatna, Nandyal, Siruguppa and Srivilliputhur. The infrastructure of the cotton Research further boosted with the establishment of Central Institute for Cotton Research (CICR) at Nagpur in April 1976 with two Regional Stations located at Sirsa in Haryana & Coimbatore in Tamil Nadu. As a result of the sincere efforts of ICAR & SAUs, more than 150 varieties including hybrids have been developed. Improved production technologies like Seed, Fertilizer, Plant Protection, Water Management were standardized at all India basis.

The interest in ELS *G.barbadense* was revived after the release of Sujata variety in 1969 from Coimbatore Regional Station. This was accomplished in variety Suvin released in 1974 and rated equivalent to Giza 45 then imported from Egypt. The textile industry acclaimed Suvin as the pride of India and considered it a suitable substitute for the Egyptian cottons imported during the 1970's.

The Centrally Sponsored Intensive Cotton Development Programme (ICDP) was launched in 1979-80 for implementation in major cotton growing states for sizable increase in production and wipe out the existing deficits as quickly as possible. The whole identified district was taken as a unit for coverage by the recommended package & practices. Field staffs were employed on a more intensive manner to cover more number of farmers.

In order to enable the farmers to fetch remunerative prices with the quality of the produce, the Government of India established Cotton Corporation of India (CCI) in 1970. Initially, the CCI was mostly engaged in imports of cotton and its distribution among the needy Mills. From 1971-72 onwards, it was entered in domestic market and has been purchasing raw cotton both under Minimum Support Price (MSP) and at the ruling market prices. The Corporation has gradually increased its purchases and market interventions for export, import & commercial purchase. In addition to CCI, the State Marketing Federations, particularly Punjab, Haryana, Rajasthan and Gujarat are also providing price support to the farmers. In Maharashtra, the entire cotton produced in the state is procured from the farmers was monopoly upto 2002 through Maharashtra State Cooperative Marketing Federation.

Efforts of CICR, AICCIP, ICDP and CIRCOT helped to raise cotton production in the country. The gap between the demand & supply was again widened. The cotton output, which scaled the height of 54.97 lakh bales in 1967-68, came down to 47.60 lakh bales in 1970-71. During the fourth to seven plan period, the area slightly reduced due to continuous pressure for other remunerative crops and high attack of Boll Worm Complex (BWC). But the productivity, which was 130 Kilograms lint per ha in Fourth Plan Period, increased to 198 Kilograms lint per ha in Seventh Plan Period (**Table 2**).

Table 2: Cotton area, production& yield scenario during Phase- II (1969-1990)

Five year Plan Period	Aver. Area(lakh ha)	Average Prod. (lakh bales each 170 kg lint)	Average Yield (kg lint/ha)	% Change in production
Fourth Plan Period (1969-70 to 1973-74)	76.80	58.64	130	+ (6.68)
Fifth Plan Period (1974-75 to 1978-79)	75.56	68.29	153	+ (16.46)
Annual Plan Period (1979 to 80)	81.30	76.50	160	+ (12.02)
Sixth Plan Period (1980-81 to 1984-85)	77.71	74.64	164	- (2.43)
Seventh Plan Period (1985-86 to 1989-90)	71.96	84.36	198	+ (13.02)

Source: Status Paper of Directorate of Cotton Development, DAC & FW, Ministry of Agriculture and Farmers Welfare, Bhoomi Sarvekshan Bhavan, Katol Road, Nagpur.

A sea change was brought in cotton scenario both qualitatively and quantitatively & India became first country to develop hybrid cotton (H-4) in 1970, which was able to produce 25-30 percent more yield. Since then, farmers preferred to grow hybrid cotton, especially under irrigated and assured rainfall conditions and its adoption increased year after year to the tune of 60-70 percent of the total cultivation by the end of 1990s. More than 200-250 hybrids of cotton were developed by ICAR/SAUs and private sector during 1990-2000 suitable for various agro-climatic conditions of different states. Due to large scale adoption of hybrids in most of the states, the area under *arboreum*, *herbaceum*, and *barbadense* species of cotton decreased drastically and was replaced by *hirsutum* varieties and *hirsutum* hybrids. In 1990, the area occupied by *hirsutum* was 85% and the remaining 15% by other three species.

The Centrally Sponsored Intensive Cotton Development Programme (ICDP), which was under implementation since 1971-72, was merged with Centrally Sponsored Mini Mission II of Technology Mission on Cotton (MM II of TMC) for implementation from 1999-2000. The main objective of TMC was to accelerate the production and productivity of cotton by bringing improvement in Research, Extension, Market Infrastructure and Ginning and Pressing Factories of cotton. The Technology Mission on Cotton (TMC) was under implementation during the period from 1999-2000 to 2013-14. The Centrally Sponsored National Food Security Mission: Commercial Crops: Cotton has been implementing in 15 states since 2014-15. The Five Year Plan (FYP) wise behaviour of cotton area, production and productivity during Third Phase (1990-91 to 2016 -17) and State wise from 2011-12 to 2015-16 are given in **Table 3 and Table 4** respectively.

Table 3: Cotton area, production & yield scenario during Phase- III (1990-91 to 2016-17)

Five year Plan Period	Aver. Area (lakh ha)	Average Prod. (lakh bales)	Average Yield (kg lint/ha)	% Change in production
Annual Plan Period (1990 to 1991)	75.50	97.80	221	+ (15.93)
Eight Plan Period (1991-92 to 1996-97)	81.80	122.20	254	+ (24.95)
Ninth Plan Period (1997-98 to 2001-02)	89.20	108.40	207	-(11.29)

Table 3: Cotton area, production& yield scenario during Phase- III (1990-91 to 2016-17)

Five year Plan Period	Aver. Area (lakh ha)	Average Prod. (lakh bales)	Average Yield (kg lint/ha)	% Change in production
Tenth Plan Period (2002-03 to 2006-07)	83.76	159.82	324	+ (47.44)
Eleventh Plan Period (2007-08 to 2011-12)	104.74	280.76	456	+ (75.77)
Twelfth Plan Period (2012-13 to 2016-17)	118.26	334.39	481	+ (19.10)

Source: Directorate of Economics and Statistics, DAC& FW, Ministry of Agriculture and Farmers Welfare, GOI, Krishi Bhavan, New Delhi.

Table 4: State wise behaviour of cotton area, production and productivity of cotton from 2011-12 to 2015-16.

State	Area in lakh hectare					
	11-12	12-13	13-14	14-15	15-16*	Average
Andhra Pradesh	18.79	24.00	23.89	8.21	6.66	16.31
Gujarat	29.62	24.97	25.19	27.73	27.19	26.94
Haryana	6.41	6.14	5.36	6.48	6.03	6.08
Karnataka	5.54	4.85	6.62	8.75	6.33	6.42
Madhya Pradesh	7.06	6.08	5.14	5.47	5.47	5.84
Maharashtra	41.25	41.46	41.92	41.90	38.27	40.96
Odisha	1.02	1.19	1.24	1.27	1.25	1.19
Punjab	5.60	4.80	4.46	4.20	3.39	4.49
Rajasthan	4.70	4.50	3.93	4.87	4.48	4.50
Tamil Nadu	1.33	1.28	1.52	1.87	1.42	1.48
Telangana	New State Established w.e.f. 02.06.2014			17.13	17.73	17.43
Others	0.46	0.50	0.33	0.31	0.50	0.42
All India	121.78	119.77	119.60	128.19	118.72	121.61

Table 4: State wise behaviour of cotton area, production and productivity of cotton from 2011-12 to 2015-16.

State	Production in lakh bales (170 kg/bale)					
	11-12	12-13	13-14	14-15	15-16*	Average
Andhra Pradesh	49.00	73.50	69.56	28.41	24.00	48.89
Gujarat	120.00	88.50	101.50	105.00	97.00	102.40
Haryana	26.50	25.00	23.02	23.00	13.50	22.20
Karnataka	12.00	12.55	18.75	23.11	16.00	16.48
Madhya Pradesh	20.00	22.00	17.30	17.50	20.98	19.56
Maharashtra	72.00	76.55	88.34	70.00	65.00	74.38
Odisha	3.25	4.00	2.99	4.00	4.00	3.65
Punjab	23.00	20.00	19.68	16.00	4.50	16.64
Rajasthan	13.35	14.00	12.87	15.27	13.20	13.74
Tamil Nadu	4.50	5.00	4.08	6.86	3.69	4.83
Telangana	New State Established w.e.f. 02.06.2014			38.00	38.60	38.30
Others	8.40	1.10	0.93	0.90	1.00	2.47
All India	352.00	342.20	359.02	348.05	301.47	340.55

Table 4: State wise behaviour of cotton area, production and productivity of cotton from 2011-12 to 2015-16.

State	Yield in Kg/hectare					
	11-12	12-13	13-14	14-15	15-16*	Ave.
Andhra Pradesh	443	521	495	588	613	510
Gujarat	689	603	685	644	606	646
Haryana	703	692	730	603	381	620
Karnataka	368	440	481	449	430	437
Madhya Pradesh	482	615	572	544	652	569
Maharashtra	297	314	358	284	289	309
Odisha	542	571	410	535	544	519
Punjab	698	708	750	648	226	630
Rajasthan	483	529	557	533	501	519
Tamil Nadu	575	664	456	624	442	553
Telangana	New State Established w.e.f. 02.06.2014			377	370	374
Others	3104	374	479	494	340	998
All India	491	486	510	462	432	476

Source: Directorate of Economics and Statistics, DAC & FW, Ministry of Agriculture and Farmers Welfare, GOI, Krishi Bhavan, New Delhi.

*: 4th advanced estimates.

The Union Ministry of Agriculture & Farmers Welfare has been implementing the Centrally Sponsored National Food Security Mission to improve the production scenario of Rice, Wheat and Pulses since October, 2007. During 2014-15, the Union Ministry of Agriculture & Farmers Welfare had merged the Mini Mission II (MM II) of Technology Mission on Cotton (TMC) and Jute Technology Mission (JTM) with Centrally Sponsored National Food Security Mission (NFSM). Besides ongoing three components, two more components i.e. NFSM- Coarse Cereals and commercial crops (NFSM- Cotton, NFSM-Jute and NFSM - Sugarcane) have been implementing through NFSM since April 2014-15.

The cost of implementation of all components of NFSM was funded 100 % by the Government of India to the implementing agencies up to 2014-15. From 2015-16 NFSM is a part of Krishi Unnati Yojana (State Plan). The cost of implementation of NFSM scheme is being shared between central and state Governments from 2015-16 in the ratio of 60:40 for general category States and 90:10 basis for North Eastern / Hilly states, whereas there is 100 % funding to Central Government Agencies involved in implementation of NFSM: Commercial Crops: Cotton..

To achieve the objective of NFSM:CC: Cotton, the components of 1) Insecticide Resistance Management (IRM), 2) Online Pest Monitoring and Advisory Services (OPMAS), 3) Frontline Demonstrations (FLDs) on i) Integrated Crop Management (ICM), ii) Deshi and Extra Long Staple (ELS) Cotton / ELS cotton seed production and iii) Inter cropping, 4) Trials on High Density Planting System (HDPS) and 5) Monitoring, evaluation & electronic print Media are under implementation. The pattern of assistance under different types of FLDs is shown in **table 5**.

Table 5: Pattern of assistance under NFSM:CC: Cotton

Type of FLDs	Critical inputs (Rs.)	Contingencies (Rs.)	Total Assistance (Rs. /Ha)
FLDs on ICM	6000	1000	7000
FLDs on Deshi & ELS cotton	7000	1000	8000
FLDs on ELS Cotton Seed Production	7000	1000	8000
FLDs on Intercropping	6000	1000	7000
Trial on HDPS	8000	1000	9000

Budget allocation is made to the components of 1) Insecticide Resistance Management and (IRM) and Online Pest Monitoring and Advisory Services (OPMAS) based on project basis to the concerned agencies.

The critical inputs for FLD include costs of seed (Non Bt.), bio-fertilizers, Micronutrients, Bio-pesticides, seeds of intercrops, Pheromone Traps /Light traps etc. A part of FLD funds is earmarked as contingencies for field day, publicity material, POL, visit of scientists etc.

The Frontline Demonstrations were conducted under MM II of TMC right from implementation to 2013-14 under the supervision of scientific community. The latest production and protection Technologies were demonstrated at the farmers' fields to disseminate the technologies effectively. Yield obtained in Frontline Demo fields ranged 1586 - 2781 Kilograms seed cotton (**Kapas: Seed + Lint**) per hectare over the average yield of States ranged 957 -2081 Kilograms seed cotton per hectare. On an average, 569 kilograms more yield of seed cotton per hectare achieved in demo fields.

The information on FLDs conducted and seed cotton yield obtained from frontline demonstration field vis-a-vis State average seed cotton yield are given in the summary form for ready reference in **Table6**.

Table 6: Seed cotton yield obtained from Demo field vis-a-vis State average seed cotton yield

State	Average yield obtained under				
	FLDs (Seed cotton Kilogram / Ha)				
	09-10	10-11	11-12	12-13	Average
(1)	(2)	(3)	(4)	(5)	(6)
Andhra Pradesh	3669	2438	2235		2781
Gujarat	2525	2194	2113		2277
Haryana	2385	1946	2251	2433	2254
Karnataka	2001	1803	2197		2000
Madhya Pradesh	1576	1636	1547		1586
Maharashtra	1790	2099	1770	1202	1715
Punjab	2505		2266	2347	2373
Rajasthan	2107	2310	2438	1624	2120
Tamil Nadu	2150	1970	2020	651	1698
Average	2301	2050	2093	1651	2089

FLD: Frontline Demonstration.

Table 6: Seed cotton yield obtained from Frontline demonstration field vis-a-vis State average seed cotton yield

State	State (Seed cotton Kilogram / Ha)					Difference (12)= (6)(11)
	09-10	10-11	11-12	12-13	Ave.	
	(7)	(8)	(9)	(10)	(11)	
Andhra Pradesh	1133	1454	1342	1579	1377	1404
Gujarat	1670	2033	2027	1827	1889	388
Haryana	1957	1833	2130	2097	2004	250
Karnataka	979	1133	1115	1333	1140	860
Madhya Pradesh	721	767	1297	1863	1162	424
Maharashtra	864	1112	900	951	957	758
Punjab	2021	2042	2115	2145	2081	292
Rajasthan	1045	1385	1463	1603	1374	746
Tamil Nadu	1115	1900	1742	2012	1692	6
Average	1278	1518	1570	1712	1520	569

FLD: Frontline Demonstration.

The cotton area, production and lint yield along with coverage under irrigation in India at a glance during the period from 1970-71 to 2016-17 is given at **Annexure A**. As per this annexure, it is pertinent to mention here that the highest area was recorded at 128.19 lakh hectares in 2014-15. The highest production and productivity were recorded at 359.02 lakh bales and 510 kilogram lint per hectare in 2013-14.

CHAPTER 02

Textile Industry of India

2. Textile Industry of India

Cotton is the backbone of textile industry, which consumes 59 % of the country's total fibre production. It accounts for 34% of the country's export and fetches about Rs.50, 000 crores annually to the exchequer. Along with the industry, which it sustains, it touches the country's economy at several points including employment and export earnings. India annually cultivates more than eleven million hectares, the largest in the world. In fact, one out of every four hectares of land under cotton in the world is in India. Around 6 to 6.5 million farmers grow the crop in about 10 States (Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Telangana, Karnataka and Tamil Nadu). Around 60 million people are estimated to depend on it one way or the other to make out their living.

2.1 Cotton Textile industry:

The cotton textile industry is the oldest and one of the largest single industries in the country. In the year 1854, the foundation of the mill sector of the industry was truly and formally laid. Since then, the industry witnessed a continued expansion and by about 1940, emerged as a powerful competitor in the world market. Phenomenal growth of Indian cotton textile industry in number of mills, weaving capacity, spindle & loom installed and yarn output were realized during the period 1880-1950.

The Indian Textile industry has made phenomenal progress since 1960 onwards. The number of textile mills increased from 378 in 1950-51 to 1035 in 1989-90. Over this period, the number of spindle increased from 11.0 millions to 28.70 millions. With the growth in the textile industry, the cotton consumption in the country shot up from 37.88 lakh bales in 1950-51 to 92.53 lakh bales in 1987-88. Traditionally India has been an exporter of the short staple Bengal Deshi Cotton. The export till 1970-71, mostly constituted Bengal deshi and other short staple cotton. During 1975-76 onwards, long staple cotton was also being exported. Medium staple cotton export was permitted since 1981-82 onwards. In the year 1984-85, Long & Extra Long Staple Cotton (ELSC) also included in the export basket of cotton. Export quota is approved every year by Govt of India on the basis of the actual export depending upon the actual production of staple wise cotton and surplus available. Cotton is the raw materials for 1500 mills (4 million Handlooms, 7 million Power looms) and the livelihood of 60 Million people.

The Indian textile industry contributes to about 14% of the industrial production and 4% of the GDP. This sector uses cotton as its major raw material.

Constituting about 59.4 % of the fibre used, unlike the global textile industry that has a mix of 35% cotton and 65% non- cotton fibre. While 35 million people are directly dependent on this sector for their employment. The hand loom sector consumes nearly 12.50 % of raw cotton while power loom sector about 62.70 %. Mills and Hosiery sector consume about 3.40 % and 21.40 % of total raw cotton respectively.

Cotton is also the source of edible oil, De oiled cake, linters, and hull, huge biomass as dried cotton stalk used as fuel. Its stem can also be used as input for preparation of Particle-board etc.

2.2 Export, Import, Consumption & Cotton balance Sheet:

2.2.1 Export:

India was exporting a negligible quantity (0.84 lakh bales during 2002-03) whereas importing a large quantity (17.67 lakh bales during the same period). But after 2003-04, picture had been changed and import reduced a few lakh bales and export had touched the height of 129.57 lakh bales during 2011-12 (**Table 7**). This is because of increased production & availability of surplus cotton after introduction of Technology Mission on Cotton (TMC) in 1999-2000 and introduction of Bt. cotton cultivation in 2002-03 onwards. The improvement in quality has been a major achievement in recent years and the textile industry has expressed their satisfaction. The increased production after meeting domestic consumption opened the opportunities of export of raw cotton by India. During 2011-12, India was able to export 129.57 lakh bales after meeting domestic consumption. It became possible owing to highest production of cotton during the said year.

The improvement in quality of Indian Cotton established the global export market for cotton since 2006-07 and it reached to 88.50 lakh bales in 2007-08. The cotton production drastically reduced in 2008-09 due to severe drought in major cotton growing states and therefore, the export of cotton was also reduced to 35.00 lakh bales. However in 2009-10 and 2010-11, the export of cotton again maintained a range of 76- 83 lakh bales. During 2012-13, it was 101.43 lakh bales, which increased to 116.96 lakh bales in 2013-14. Further, decreased to 57.72 lakh bales in 2014-15. During 2015-16, the export increased at 69.00 lakh bales and it is expected at 50 lakh bales during 2016-17.

2.2.2 Import:

Despite a bumper crop, the mills were forced to go in for some imports, particularly of extra-long staple cotton (ELS) as there has been a quantitative & qualitative gap in this category. Since the indigenous ELS cottons do not combine all the fibre parameters to yield world class yarn in the superfine count group. Mills have been continuing to import such cotton from Egypt, USA etc. The highest import of cotton was 20.00 lakh bales and minimum was 02.38 lakh bales in 2015-16 and 2010-11 respectively (**Table : 7**).

2.2.3 Consumption & Cotton balance Sheet:

Domestic consumption of cotton in India is also increasing with increase in production but still surplus cotton is available for export. The total demand of raw cotton is ranging between 169.67 to 416.51 Lakh bales during the period from 2002-03 to 2016-17. The year wise details of cotton balance sheet have been shown in **Table:7**.

Table 7: Cotton Balance Sheet (in Lakh Bales of 170 kg each) over the years

Details	02-03	03-04	04-05	05-06	06-07	07-08	08-09
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Opening Stock	40.00	24.00	21.00	72.00	52.00	47.50	35.50
Production	136.00	179.00	243.00	241.00	280.00	307.00	290.00
Import	17.67	7.21	12.17	5.00	5.53	6.38	10.00
Total Supply	193.67	210.21	276.17	318.00	337.53	360.88	335.5
Mill Consumption	142.42	150.39	163.98	180.00	194.89	195.67	190.00
Consumption by SSI units	11.63	13.00	16.57	19.00	21.26	22.08	20.00
Non-Textile consumption	14.78	13.71	14.48	20.00	15.88	19.13	19.00
Exports	0.84	12.11	9.14	47.00	58.00	88.50	35.00
Total Demand	169.67	189.21	204.17	266.00	290.03	325.38	264.0
Closing Stock.	24.00	21.00	72.00	52.00	47.50	35.50	71.50

Table 7: Cotton Balance Sheet (in Lakh Bales of 170 kg each) over the years

Details	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
Opening Stock	71.50	40.50	45.77	40.00	40.00	33.00	66.23	43.00
Production	305.00	339.00	367.00	370.00	398.00	386.00	338.00	351.00
Import	06.00	2.38	07.51	14.59	11.51	14.39	20.00	17.00
Total Supply	382.50	381.88	420.28	424.59	449.51	433.39	424.0	411.00
Mill Consumption	219.50	221.77	223.59	251.74	268.03	278.06	272.00	275.00
Consumption by SSI units	23.00	24.46	22.12	23.59	25.20	26.38	27.00	28.00
Non-Textile consumption	17.00	13.38	05.00	7.83	06.32	5.00	13.00	10.00
Exports	83.00	76.50	129.57	101.43	116.96	57.72	69.00	50.00
Total Demand	342.00	336.11	380.28	384.59	416.51	367.16	381.00	363.00
Closing Stock.	40.50	45.77	40.00	40.00	33.00	66.23	43.00	48.00

Source: Textile Commissioner, Ministry of Textiles, Mumbai.

CHAPTER 03

World Cotton scenario

3. World Cotton scenario

3.1. Cotton is an International crop grown by about 80 countries across the world. On an average, cotton is planted in an area of 329.49 lakh hectares. India is at top with 1st rank by contribution of 33.23 % in total area of the world. China is at 2nd position by contributing 16.02%. The countries of USA, Pakistan, Uzbekistan and Brazil rank 3rd, 4th, 5th & 6th by contribution of 11.27%, 9.01%, 4.06% & 3.09% respectively. The country wise area planted in the world from 2006-07 to 2015-16 is given in **Table 08**.

Table 08: Country wise area planted in the world from 2006-07 to 2015-16.

Country	Area in lakh Hectares											% Con.
	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Average	
India	91.44	94.14	94.06	101.20	105.75	121.78	119.80	119.60	128.19	118.81	109.48	33.23
China	61.43	62.97	61.23	54.19	55.27	55.28	52.51	47.00	43.10	34.70	52.77	16.02
USA	51.52	42.45	30.63	31.12	38.63	38.29	37.73	30.53	37.83	32.62	37.14	11.27
Pakistan	30.75	30.55	28.20	31.10	32.65	28.62	28.79	28.06	29.58	28.69	29.70	9.01
Uzbekistan	14.32	14.50	13.91	13.17	13.30	13.16	12.85	12.75	12.98	12.98	13.39	4.06
Brazil	10.97	10.77	8.43	8.36	9.61	13.93	8.94	11.22	9.76	9.66	10.17	3.09
Burkina Faso	7.16	4.07	4.66	4.20	4.62	4.29	5.91	6.44	6.61	6.63	5.46	1.66
Mali	4.80	2.84	1.97	2.50	2.60	4.78	5.48	4.81	5.70	5.73	4.12	1.25
Turkmenistan	6.00	6.42	6.74	6.07	6.67	5.50	5.50	5.50	5.45	5.34	5.92	1.80
Argentina	4.00	3.04	2.86	4.30	4.52	5.28	3.62	5.06	4.56	4.45	4.17	1.27
Turkey	6.30	5.00	3.30	2.80	3.64	5.42	4.88	4.51	4.68	4.31	4.48	1.36
Cote D'Ivoire	2.26	1.34	1.41	1.87	1.96	2.60	3.40	3.61	4.15	4.02	2.66	0.81
Benin	2.36	2.34	1.99	1.49	2.00	2.03	3.12	3.80	3.79	3.30	2.62	0.80
Tanzania	4.09	4.50	4.03	3.48	3.66	5.68	3.98	4.00	3.50	3.15	4.01	1.22
Zambia	1.80	2.43	2.31	2.54	2.67	5.12	3.30	2.90	3.05	2.98	2.91	0.88
Other Countries	47.36	41.10	38.80	34.63	38.64	49.87	43.65	38.63	38.06	34.24	40.49	12.27
All World	346.56	328.46	304.53	303.02	326.19	361.63	343.46	328.42	340.99	311.61	329.49	100.00

Source: ICAC

Of the total area in the world, about 76% is contributed by the countries of India, China, USA, Pakistan, Uzbekistan & Brazil. During the period in the table above, the highest coverage under cotton was 361.63 lakh hectares in 2011-12 whereas the lowest was 303.02 lakh hectare in 2009-10.

On an average, about 1482.86 lakh bales are received per year as cotton production (**Table: 09**). The highest contribution was of China (28.30%), followed by India (22.67%), USA (13.59%), Pakistan (8.14%), Brazil (5.95%) & Uzbekistan (3.93%).

Table 09: Country wise Production of Cotton in the world from 2006-07 to 2015-16.

Country	Production in lakh bales (170 Kg / bales)										
	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Average
India	280.00	307.00	290.00	300.00	323.47	367.00	370.00	398.00	380.00	345.82	336.13
China	469.11	474.76	472.06	400.00	422.65	435.29	429.40	407.58	381.17	303.88	419.59
USA	276.47	246.00	164.12	155.26	213.06	199.47	221.76	165.35	209.00	164.82	201.53
Pakistan	126.29	111.41	115.29	124.24	128.71	135.94	117.76	122.11	135.58	89.05	120.64
Uzbekistan	68.88	70.94	58.82	52.94	62.59	51.76	58.82	55.29	52.06	50.88	58.30
Brazil	89.64	94.24	71.41	74.94	83.71	110.41	77.06	102.00	91.94	87.11	88.25
Burkina Faso	16.58	8.82	10.71	8.94	10.35	10.24	15.53	16.12	17.52	14.82	12.96
Mali	10.35	5.94	5.00	5.82	6.12	11.00	11.29	10.83	13.70	12.70	9.28
Turkmenistan	15.29	16.47	17.47	14.71	16.24	19.41	21.76	19.70	19.41	17.64	17.81
Argentina	10.29	8.82	6.88	10.65	11.29	12.35	9.24	17.76	14.41	13.70	11.54
Turkey	44.11	36.76	25.88	22.35	28.71	48.71	43.82	42.23	44.35	41.00	37.79
Cote D'Ivoire	3.81	2.94	3.12	4.41	4.41	6.65	8.94	10.18	11.35	10.41	6.62
Benin	6.06	6.65	5.29	4.71	5.76	4.41	6.18	7.29	9.88	8.23	6.45
Tanzania	4.18	7.29	5.24	4.94	5.24	7.06	4.82	4.58	5.00	4.00	5.23
Zambia	2.06	2.65	2.59	2.82	3.00	6.47	2.47	2.35	2.82	2.52	2.97
Other Countries	152.82	131.6	123.29	110.85	133.27	211.35	178.15	161.45	148.51	126.42	147.77
All World	1575.94	1532.29	1377.17	1297.58	1458.58	1637.52	1577.00	1542.82	1536.70	1293.00	1482.86

Source: ICAC

As seen the table above, about 82.57% cotton is produced by India (22.67%), China (28.30%), USA (13.59%), Pakistan ((8.14%), Uzbekistan (3.93%) & Brazil (5.95%). The highest production received at 1637.52 in 2011-12 and minimum at 1293 in 2015-16. India ranked first in Cotton production during 2015-16.

During the period from 2006-07 to 2015-16 (**Table:10**), the highest average productivity achieved was 799 kg / hectare during 2013-14 and minimum was 705 kg / hectare in 2015-16. The average highest productivity was of Brazil (1476 kg/ha) followed by Turkey (1433) & China (1352).

Table 10: Country wise Yield of Cotton in the world from 2006-07 to 2015-16.

Country	Yield in Kg lint / hectare										
	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Ave.
India	521	554	524	504	520	512	525	566	504	495	522
China	1298	1282	1311	1255	1300	1339	1390	1474	1503	1489	1352
USA	912	985	911	848	938	886	999	921	939	859	923
Pakistan	698	620	695	679	670	807	695	740	779	528	691
Uzbekistan	818	832	719	683	800	669	778	737	682	666	740
Brazil	1389	1488	1440	1524	1481	1347	1465	1545	1601	1533	1476
Burkina Faso	394	368	391	362	381	406	447	426	451	380	404
Mali	367	356	431	396	400	391	350	383	409	377	383
Turkmenistan	433	436	441	412	414	600	673	609	605	562	512

Table 10: Country wise Yield of Cotton in the world from 2006-07 to 2015-16.

Country	Yield in Kg lint / hectare										
	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Ave.
Turkey	1190	1250	1333	1357	1341	1528	1527	1592	1611	1617	1433
Cote D'Ivoire	287	373	376	401	383	435	447	479	465	440	423
Benin	436	483	452	537	490	369	337	326	443	424	418
Tanzania	174	275	221	241	243	211	206	195	243	216	222
Zambia	194	185	191	189	191	215	127	138	157	144	174
Other Countries	549	544	540	544	586	720	694	710	663	628	620
All World	773	793	769	728	760	770	781	799	766	705	765

Source: ICAC

3.2 World Cotton Balance sheet:

The world cotton balance sheet for the years from 2006-07 to 2015-16 is given in **Table-11**.

Table 11: World cotton balance sheet (Quantity in Lakh bale 170 kg each)

Particulars	06-07	07-08	08-09	09-10	10-11
Beginning stock : World Total	739.70	764.87	747.29	751.93	617.46
Production : World Total	1575.94	1532.29	1377.17	1297.58	1458.58
Consumption : World Total	1555.88	1552.05	1377.11	1433.35	1458.47
Exports : World Total	476.47	491.70	385.11	438.58	455.82
Imports World Total	481.58	493.88	389.69	439.88	455.82
Ending Stocks: World Total	764.87	747.29	751.93	617.46	617.57

Table 11: World cotton balance sheet (Quantity in Lakh bale 170 kg each)

Particulars	11-12	12-13	13-14	14-15	15-16
Beginning stock : World Total	617.57	912.44	1089.75	1210.76	1310.24
Production : World Total	1637.52	1577.00	1542.82	1536.70	1293.00
Consumption : World Total	1340.23	1386.05	1404.70	1431.64	1396.58
Exports : World Total	577.94	589.52	530.11	453.05	432.58
Imports World Total	575.52	575.88	513.00	447.47	432.58
Ending Stocks: World Total	912.44	1089.75	1210.76	1310.24	1206.66

Source: ICAC

India had occupied top position in the World cotton production since 2015-16. It was already holding first position in cotton coverage in the World.

3.3 Cotlook A Index:

Under this system, the average Cotlook A Index of International prices of cotton ranged from 52.20 -151.29 US Cents per lb during the period from 2004-05 to 2014-15.

The month/year wise details of International prices of cotton from 2004-05 to 2015-16 are given in **table 12**.

Table 12: International prices [(Monthly average Cotlook A index (FE)) of cotton
(Cotlook Index in US Cents per lb.)

Month	04-05	05-06	06-07	07-08	08-09	09-10	10-11
August	51.80	53.55	59.90	66.60	78.04	64.14	90.35
September	55.05	53.95	58.85	68.15	77.09	63.99	104.73
October	50.85	57.75	57.05	68.95	62.30	66.82	125.55
November	47.70	55.85	57.40	69.70	54.96	71.78	155.47
December	47.50	56.10	59.45	69.55	55.47	76.78	168.22
January	50.25	58.36	59.05	73.25	57.71	77.39	178.93
February	51.30	59.65	57.85	75.05	55.21	80.05	213.18
March	55.35	57.60	58.40	80.20	51.50	85.30	229.67
April	56.00	56.25	57.15	75.40	56.78	88.08	216.62
May	54.75	54.35	55.55	74.10	61.95	90.07	165.52
Jun	52.65	55.15	60.60	77.05	61.39	93.04	167.18
July	53.20	55.40	67.85	77.30	64.80	0	0
Average	52.20	56.16	59.09	72.94	61.43	71.45	151.29

Source: Cotton outlook

Table 12: International prices [(Monthly average Cotlook A index (FE)) of cotton
(Cot look Index in US Cents per lb.)

Month	11-12	12-13	13-14	14-15	15-16
August	114.10	84.40	92.71	74.00	71.82
September	116.86	84.15	90.09	73.38	68.74
October	110.61	81.95	89.35	70.34	69.03
November	104.68	80.87	84.65	67.53	
December	95.45	83.37	87.49	68.30	
January	101.11	85.51	90.96	67.35	
February	100.75	89.71	94.05	69.84	
March	99.50	94.45	96.95	69.35	
April	99.94	92.68	94.20	71.70	
May	88.53	92.70	92.71	72.89	
Jun	82.18	93.08	90.90	72.35	
July	83.97	92.62	84.01	72.35	
Average	99.80	87.96	90.67	70.78	

Source: Cotton outlook

The average International price of cotton was 79.43 Cot look Index in US Cents per lb during the period from 2004-05 to 2014-15.

The details of country wise area, production, yield, consumption, import and export of cotton in the World from 2006-07 to 2015-16 are given in **Annexure B**.

CHAPTER 04

Indian cotton scenario

4. Indian cotton scenario

4.1. Cultivated Species:

The scientists have identified 50 species of cotton in the World that includes 45 species of diploid cotton and 5 species of tetraploid cotton. Among these, 46 species are of wild cotton and the other four are cultivated in the World, 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 more than 90% to the global production. Distinguishing morphological features of all the four cultivated species of cotton are given below:

4.2. *Gossypium arboreum*:

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 (**Picture: 1**).

4.3. *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 (**Picture: 2**).



Picture: 1



Picture: 2

4.4. *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 (**Picture: 3**).

4.5. *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 (**Picture: 4**).



Picture: 3



Picture: 4

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.

Intra specific (within species of *G. arboreum* x *G. arboreum*, *G. hirsutum* x *G. hirsutum* and *G. barbadense* x *G. barbadense*) and Interspecific (*G. hirsutum* x *G. barbadense*) hybrids are cultivated. Hybrids made through Cytoplasmic Male Sterility (CMS) and Genetical Male Sterility (GMS), besides transgenics are also cultivated.

The research system of India has also developed some varieties having three basic colours in naturally coloured cotton -brown, grey and green belong to *Gossypium hirsutum* and *Gossypium arboreum* species. Some of the varieties of coloured cotton are- *G. hirsutum*: MSH-53 (Vaidehi 95) Dark brown, JCC 1 (KC 94-2)- Bright Almond brown coloured cotton, NDLH 1, HC 2, DDB 12: Dharwad dark brown, DMB 225 : Dharwad Medium Brown and DGC 78 : Dharwad green and *G. arboreum*: AC 2 Brown, DDCC 1: Brown and DGC 78 : Green lint.

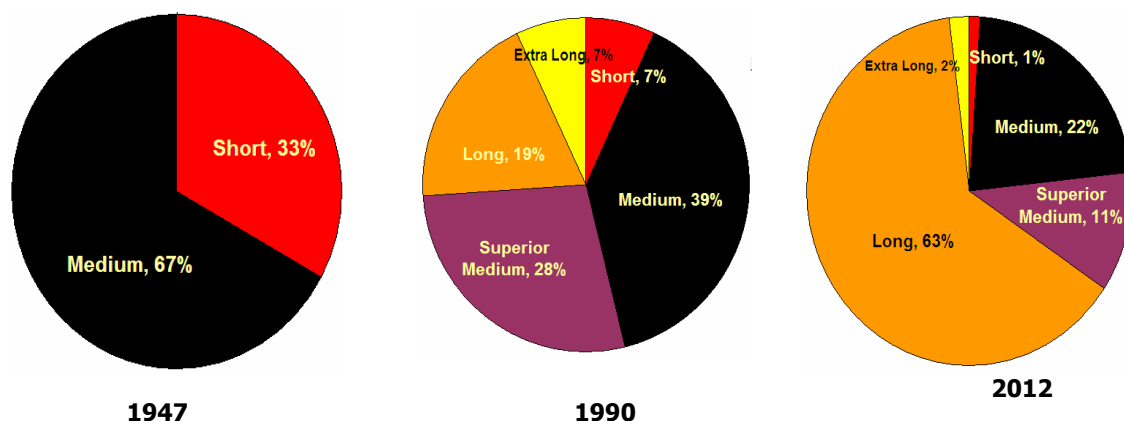
At the time of independence and early fifties mostly short and medium staple cottons were produced in the country and there were no long and extra long staple cottons during 1947-48. It continued up to 1970. After the development of hybrid Cotton in India during 1970, the cultivation of four species was undertaken. Thereafter, India produced the widest range of cottons capable of spinning from 6s to 120s counts. During 1990 also India produced sufficient quantity of all the four species as per the requirement. The import of cotton, particularly of Egyptian and Sudanese long and extra long staple cottons, was a regular phenomenon till 1978-79. Now, import takes place only for extra long staple varieties (ELS). Not only that, India has also emerged as a net exporter of cotton in the mid-1990s. During 2000, *Gossypium hirsutum* represented 69% of the total cotton in India followed by *G. arboreum* (17%), *G. herbaceum* (11%) and *G. barbadense* (3%) (**Table 13**).

After the introduction of Bt hybrids for commercial cultivation in the year 2002-03, the composition of cultivation of species drastically changed. Presently, all the cotton in India is under *hirsutum* group (>95%, 2012) leaving only <5% under *arboreum* & *herbaceum* and negligible area under *barbadense* group (**Picture 5**). As a result, in recent years, shortage of short staple & ELS cotton has been realized by the textile Industries.

Table 13: Species-wise percentage of cotton in India

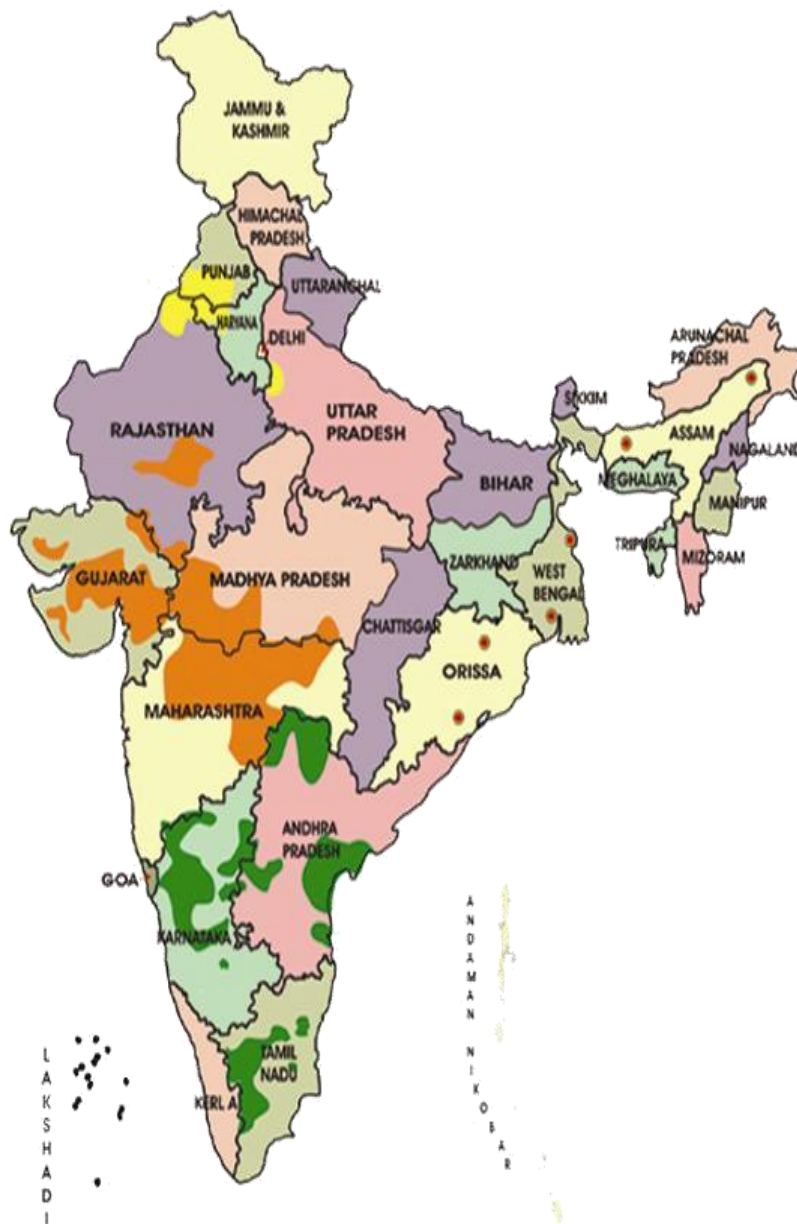
Species	1947	1980	1990	2000	2008	2012
<i>G. arboreum</i>	65	20	30	17	4	3
<i>G. hirsutum</i>	3	54	48	69	90	96
<i>G. herbaceum</i>	32	14	12	11	5	1
<i>G. barbadense</i>	-	11	10	3	1	Neg
Total	100	100	100	100	100	100

Picture 5: Changes in Staple length of Indian Cotton



4.6. Cotton Cultivation in India:

Cotton is the second largest kharif crop of the country, after Rice contributing 6-7% of the net sown area. Cotton is cultivated in Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Telangana, Karnataka & Tamil Nadu, besides, in small areas in non-traditional states like Uttar Pradesh, Orissa, West Bengal, Assam & Tripura (Picture 6). Cotton cultivated in northern zone is almost irrigated, while the percentage of irrigated area in southern zones is about 40% and in the central zone 23%. Central zone has nearly 60% of the cotton area of the country and mostly covered by hybrids, upland cotton and diploid species.



Picture 6:

Cotton Growing Zones in India

NORTHERN: *hirsutum* &
arboreum zone.

CENTRAL: *hirsutum*,
arboreum, *herbaceum* & hybrid
zone .

SOUTHERN: *hirsutum*,
arboreum, *herbaceum*,
barbadense and hybrid zone.

EASTERN :
arboreum ZONE.

4.7. Major Constraints in Cotton Production:

- Nearly 64.00 % cotton area is rainfed (2011-12), mainly in the Central Zone (Madhya Pradesh : 59.7 %, Maharashtra: 97 % and Gujarat: 64 %) and Southern Zone (Tamil Nadu : 64.9 %, Telangana: 81.2 %, Andhra Pradesh : 80 % and Karnataka: 75.4 %).
- Non availability of Canal Water at the optimum sowing time (North Zone)
- Salinity and Water logging in irrigated areas (North Zone).
- Acute Moisture stress during flowering and boll formation mainly in central and south zones.
- Cotton crop is highly prone to insect pests and diseases due to green succulent leaves, Long duration crop, Hot and humid weather, more fruiting bodies, Open flowers and soft Bolls, Nectaries on leaves and fruiting bodies, Indeterminate nature of the plant, Intensive cultivation (North zone) and non judicious use of irrigation, fertilizers and pesticides.
- Inadequate efficient use of irrigation water through Micro irrigation devises.
- Inadequate timely transfer of technology due to shortage of extension staff with cotton producing states.
- More shedding of fruiting bodies like - squares, flowers etc due to longer period of heavy rains, Cloudy weather and lack of sunshine hours.
- Lack of awareness among the farmers about proper spraying of Pesticides / Bio pesticides.
- Non availability of standardized package of practices of Bt. cotton and organic cotton cultivation.
- Non availability of credit to farmers in time as per their requirement, specially Marginal and small farmers for purchase of quality agricultural inputs like Seeds, fertilizers / Bio-fertilizers , pesticides / Bio pesticides, irrigation and other tillage Machines .
- There is no reduction in import of ELS cotton due to not increasing area in potential districts / Blocks of Raichur, Sindhanpur, Manavi in Tungabhadra region, Bhilhongal, Manoli, Yargtti, Saundatti, Nargund, Kittur of Malaprabha region, Halyal, AI Navar, Kirwatti, Mundgod in Uttar Kannada of Karnataka (varieties: DCH 32 and Varalaxmi), Coimbatore, Erode, Dindigal, Theni, Atur, Pollachi /Udumalpet and Dharmapuri (Varieties : DCH 32 / TCHB 213, MRC 6918 Bt., RCHB 708 Bt.), Attur of Salem, Udhamalpet and Pollachi of Coimbatore of Tamil Nadu (Suvini), Jalna, Western tract of Maharashtra (Varieties: Phule 388, Suvini and Varalaxmi), Ganjam, Navarnpur, Koraput and Raigada of Orissa (Varieties: MCU 5), Anand (South Gujarat), Talod (North Gujarat) of Gujarat (Variety: Suvini), Dhar, Jhabua, Ratlam of Madhya Pradesh (Varieties: DCH 32, Varalaxmi) and Warangle, Karim Nagar and Guntur of Telangana/ Andhra Pradesh (MCU 5, MRC 6918 Bt., RCHB 708 Bt. and DCH 32).

- Farmers do not adopt proper crop rotation which leads to multiplicity of pests.
- Being rainfed, farmers do not pay much attention to fertilizers and pesticides in Central and South zones.
- Deep black clay soils unfit for hand weeding during Monsoon season (Central zone)
- Not following of recommended crop rotations.
- Economic status of cotton growers do not match the recommended technology.
- Inadequate efforts in strengthening cotton in nontraditional districts of Major / minor producing states. Presently, most of the cotton is produced by 16 districts of Maharashtra, 10 of Gujarat, 6 of Madhya Pradesh, 5 of Punjab, 6 Rajasthan, 8 of Karnataka, 7 of Telangana / Andhra Pradesh and 6 of Tamil Nadu.
- Inadequate availability of quality Bio agents / Pesticides.
- Inter mixing of different pickings of same variety.
- Excessive use of pesticides and synthetic pyrethroids has also led to development of immunity in insect pests against the pesticides.
- Wide fluctuation in cotton prices, inadequate market infrastructure and cotton export policy.
- High incidence of contamination in cotton / lint [(A. Plant origin, a) Genetic origin: i) Motes : undeveloped seeds having immatured fibres, ii) Ovules: Crushed immatured part in lint , b) Picking practice based : i) Leaf beats (dry and green) - Careless picking, ii) Twigs, iii) All other plant parts, c) Ginning Practice based : i) Cut seeds, ii) Seed coat fragments, iii) Partially ginned seeds, B. Foreign Origin type : a) Storage origin: i) Small stone, ii) Sands, ii) Dusts / Micro dust, b) Transport origin : i) Jute yarn and ii) Grass / dust / others)] due to lack of proper marketing infrastructure (Inadequate Pucca roads, Pucca Platforms, Parking place, Grading Laboratory, Firefighting arrangements, Weigh Bridge, Farmers' information Centre, Farmers' rest house, Canteen for farmers, drinking water, Sanitation, Maintenance of proper records to ensure transparency etc) and lack of modernized ginning/pressing facilities.

4.7 Cotton growing zones:

Cotton is grown in India in three distinct zones viz., North Zone (Punjab, Haryana and Rajasthan), Central Zone (Gujarat, Madhya Pradesh, Maharashtra) and South Zone (Karnataka, Andhra Pradesh, Telangana and Tamil Nadu). Cotton is also grown in small area in the eastern region.

The north zone is characterized by cotton grown totally as an irrigated crop in Kharif season in the Indo-Gangetic alluvial soils. The climate is adverse at sowing season with high temperatures and the growing period is limited to seven months (April-October). With introduction of double cropping of 'Cotton-Wheat' sequence since the last two decades and with limited turnover period for tillage between the two crops and crop duration, the seed cotton yield potential is limited to 1146-2061 kg kapas / ha. Yield has further reduced in recent years due to various reasons, including adverse climate and pests damage. Increasing soil salinity and high water table are becoming problems of north zone cotton. The North zone covers approximately 12% of total cotton area in India.

The Central zone is characterized by hot semi-arid climate with mostly shallow to medium and deep black soils. In parts of Gujarat, sandy coastal alluviums, saline-alkali soils and desert sands are put under cotton cultivation. Under this zone, 41% of area is contributed by Maharashtra, 27% by Gujarat and about 6 % by Madhya Pradesh. The seed cotton yield levels in dry lands are poor ranging from 1300-1461 kg/ha (Kapas: Seed + Lint).

In contrast, the irrigated cotton has high seed cotton yield potential ranging from 2500-4000 kg/ha (western Maharashtra, parts of Madhya Pradesh and Gujarat). In the central zone, added to scanty and ill-distributed monsoon rains in parts of Maharashtra and Madhya Pradesh, there are vast tracts of shallow black soils with poor fertility status and moisture retaining capacity. In these kinds of soils and climate, even the most hardy crops like Sorghum and minor millets are found to be non-remunerative compared to cotton, though the seed cotton yields (500-600 kg/ha) of cotton may be low. The Central zone covers approximately 73% of total cotton area in India. In South zone, cotton is mostly grown in hot semi-arid regions, both as rainfed and irrigated cotton in medium black soil, red and black soils and coastal alluviums. High quality long and extra long staple cotton is grown in this zone.

The agro-climate is more suitable for cotton, especially with bimodal distribution of rainfall in parts of Karnataka, southern Andhra Pradesh / Telangana and Tamil Nadu. The irrigated cotton in the zone yields about 2500-3000 kg/ha seed cotton, while the yield levels range from 1100-1839 kg/ha seed cotton in dry lands. The South zone covers approximately 26% of total cotton area in India.

4.8. Area, Production & Yield of Cotton in India:

4.8.1. Before Bt. Cotton (1990-2000):

Though efforts were being made to improve cotton production and productivity, the scenario did not improve much during this period. Cotton area showed some improvement from 76.66 lakh ha in 1991-92 to 93.42 lakh hectare during 1998-99 (**Table-14**). Cotton production increased from 97.06 lakh bales during 1991-92 to 142.30 lakh bales during 1996-97 and came down to 115.30 lakh bales by the end of the decade. Similarly, cotton productivity also remained around 216- 265 kg per ha.

Table 14: Cotton area, production & yield scenario during 1991-2000.

Year	Area (Lakh ha)	Production (Lakh bales of 170 kg each)	Yield (kg lint / ha)	Area under irrigation %
1991-92	76.66	97.06	216	33.3
1992-93	75.42	114.02	257	34.6
1993-94	73.20	107.41	249	34.7
1994-95	78.71	118.88	257	34.2
1995-96	90.35	128.61	242	35.0
1996-97	91.20	142.30	265	35.8
1997-98	88.68	108.50	208	36.8
1998-99	93.42	122.90	224	34.9
1999-2000	87.10	115.30	225	35.2

Source: DES, DAC & FW, MoA & FW, Krishi Bhavan, New Delhi.

4.5.2 After Bt. Cotton:

The acreage, production and yield of cotton have undergone a sea-change after the cotton development programme was brought under Mini Mission II of Technology Mission on Cotton (TMC) since 1999- 2000. The cultivated area of cotton in the country, which was 93.42 lakh hectares in the Pre- TMC period (1998-99) eventually increased to 101.32 lakh hectares during 2009-10 and reached to 121.78 lakh ha in 2011-12 (**Table15**). This marginally decreased to 119.80 lakh ha in 2012-13. MM II of TMC was merged with National Food Security Mission (NFSM) for implementation from 2014-15. During 2014-15, the area under cotton surpassed the coverage figure of 121.78 lakh ha and touched the figure of 128.19 lakh hectare. The same was all time high area coverage in cotton crop.

Bt. Cotton was released in 2002-03 for commercial cultivation in India. Since the release of Bt. Cotton technology, it has emerged as an effective alternative to traditional cotton varieties by inhibiting bollworm attack, thereby improving yield and income. This has resulted in fast adoption of Bt cotton over conventional cotton. Cotton production in India has accelerated more than 4 times and reached a peak of 359.02 lakh bales during 2013-14 as compared to 86.24 lakh bales in 2002-03. Introduction of Bt cotton has played a catalytic role in enhancing cotton production in India.

Suitable climatic conditions, better farm practices, accelerated transfer of technology under MM-II of TMC has facilitated increase in cotton area, yield and production in the country. However, the production of cotton during 2012-13 declined marginally to 342.20 lakh bales due to delayed /deficient rainfall in the country in the main cotton growing states of Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Rajasthan. During 2013-14, the production of cotton received was 359.02 lakh bales which was all time high in cotton history. In 2014-15 and 2015-16, the cotton production kept reducing to 348.05 and 301.47 lakh bales respectively due to drought condition in Maharashtra in 2014-15 and pest infestation in some of the pockets of cotton producing zones, especially in north zone (Punjab) and drought in Maharashtra in 2015-16. The area under cotton receded drastically to 105 lakh hectares in 2016-17 due to fear of infestation of whitefly in north zone, infestation of pink boll worm in central and south zones including decision of Andhra Pradesh and Telangana states for diversion of cotton area to pulses and oilseeds.

Cotton yield in India has witnessed substantial increase over the years. The average cotton yield increased from 186 kg / ha in 2001-02 to 510 kg / ha in 2013-14, but productivity decreased in 2014-15 and 2015-16 owing to the reasons mentioned above. As per the first advance estimates of DES, the cotton season 2016-17 is likely to provide all time high yield in cotton history. The year wise information on area, Production and Yield of cotton in India is given in **Table 15**.

Table 15: Area, Production & Yield of Cotton in India from 2001-02 to 2016-17

Year	Area (Lakh ha)	Production (Lakh bales)	Yield (Kg/ha)	Area under irrigation %
2001-02	91.30	100.00	186	34.0
2002-03	76.70	86.24	191	33.1
2003-04	76.00	137.29	307	27.1
2004-05	87.90	164.29	318	36.9
2005-06	86.80	185.0	362	36.1
2006-07	91.44	226.32	421	35.0
2007-08	94.10	258.80	467	35.1
2008-09	94.10	222.80	403	35.3
2009-10	101.32	240.22	403	35.3
2010-11	112.40	330.00	499	33.8
2011-12	121.78	352.00	491	35.9
2012-13	119.77	342.20	486	Not Available
2013-14	119.60	359.02	510	Not Available
2014-15	128.19	348.05	462	Not Available
2015-16*	118.72	301.47	432	Not Available
2016-17**	105.00	321.23	520	Not Available

Source: DES, DAC & FW, MoA & FW, Krishi Bhavan, New Delhi, *: Fourth advance Estimates, **: First Advance Estimates.

CHAPTER 05

Cotton Research in India

5. Cotton Research in India

5.1 Launching of AICCIP:

The ICAR launched the All India Coordinated Cotton Improvement Project (AICCIP) in the year 1967 with its Headquarters at Coimbatore (Tamil Nadu) to give new thrust and direction in terms of multidisciplinary and multi-centre approaches with the active involvement of State Agricultural Universities. Currently, the AICCIP Project is in operation with its headquarters at Coimbatore and spread over 21 participating Centres involving 15 State Agricultural Universities. The AICCIP is vested with multi-location and multi-disciplinary research works on Cotton with a nationwide network Centres involving Agricultural Universities of all the major cotton growing States.

The All India Coordinated Cotton Improvement Project (AICCIP) is operating in ten cotton growing states with 10 main centres at Faridkot, Hisar and Sriganganagar in North Zone, Surat, Khandwa, Akola, 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). Central Institute for Cotton Research through its three centres of Coimbatore, Nagpur and Sirsa has offered basic research support in addition to guiding the AICCIP in its programme formulation.

Since the formation of AICCIP in 1967, have led to the release of around 224 Cotton varieties and hybrids for the different cotton growing tracts of the country and development of economical and eco-friendly package of practices for realizing enhanced productivity. World class cotton varieties & hybrids like Suvin, DCH 32, NHH 44, TCHB 213, DHB 105, LHH 144, Shresth, LRA 5166, Anjali, Surabhi, MCU5, MCU 7, MCU 13, HHH 287, Abhadita, HD 324, DHH 11, H4, H6, H8, AAH 1, RG 8, RAJ DH 9, PKV Hy-2 and scores of others with higher yield, special characteristics and suitable to low cost production technologies have all been released over the years suiting to the textile needs and bringing net profit to the farming community in the Country.

During the IX Plan period (1997-2002), 23 hybrids and 40 varieties have been released for commercial cultivation catering to the needs of the various Agro climatic regions of the country. Diversified cropping systems and crop rotations suited to various agro-niches have been identified through AICCIP and are very popular among cotton growing farmers.

With the help of the network programme of entomological trials under AICCIP, elaborate integrated pests management strategies have been evolved using cultural, mechanical and chemical components to reduce the insecticide application and make it more environmental friendly and sustainable. Monitoring of insecticide resistance to *Helicoverpa* in several agro-ecosystems has helped to better manage the pest in the farmer's fields. Besides these, many production technologies were designed and evaluated

The interest in ELS *G.barbadense* was later revived in 1967 with the launching of the All India Coordinated Cotton Improvement Project by the Indian Council of Agricultural Research and Sujata variety was released in 1969 from Coimbatore Regional Station. This was accomplished in variety Suvin released in 1974 and rated equivalent to Giza 45 then imported from Egypt. The textile industry acclaimed Suvin as the pride of India and considered it a suitable substitute for the Egyptian cottons imported during the 1970s.

5.2 Establishment of CICR, Nagpur:

With a view to develop a Centre of excellence for carrying out long term research on fundamental problems limiting cotton production and also to provide basic support to location specific applied research work being carried out in a network of cotton research centres in the country through the AICCIP system, the Indian Council of Agricultural Research had established the Central Institute for Cotton Research at Nagpur in April, 1976. This institute has two regional research stations at Sirsa in Haryana and Coimbatore in Tamil Nadu state. Various Agricultural universities in cotton growing states are also conducting research on various aspects of cotton production.

The varieties / hybrids released by the CICR including its Regional Stations and SAUs are providing the recommendations for cultivation of the released variety / hybrids. All the varieties / hybrids are recommended for specific zone/state. Since its inception, CICR developed many relevant, feasible and economically viable and ecologically friendly production and protection technologies including the development of improved varieties and hybrids and fundamental research pursuits in all the disciplines to further our understanding of the crop vis-à-vis the ambient biotic and abiotic environment.

The Institute has released ten varieties of *G. hirsutum* (MCU 5 VT, LRA 5 166, Supriya, Kanchana, Anjali, CNH36, Arogya, Surabhi, Sumangala and CNH 120 MB), one variety of *G. arboreum* (CISA 310), seven intra-*hirsutum* hybrids (Savitha, Surya, Kirthi, Omshankar, CSHH 198, CSHH 238 and CSHH 243), two *hirsutum* x *barbadense* (inter-specific) hybrids (HB 224 and Shruthi) and one intra *arboreum* (CISAA 2) hybrid. Besides these, many improved crop production and protection technologies were developed for different agro-eco- regions.

Main research activities under taken by CICR for crop improvement are summarized below:

1. Cotton Gene Bank: The National Centre for Cotton Genetic Resources with more than 9000 accessions (Germplasm lines) of the four cultivated species of *Gossypium* and over 100 accessions of perennials including wild species and cytogenetic material (in *situ* in species garden) has been established at CICR, Nagpur.
2. Varietal Improvement: Sumangala and CNH 120 MB, five intra-*hirsutum* hybrids (Savitha, Surya, Kirthi, Omshankar and CSHH 198), two *hirsutum* x *barbadense* (inter- specific) hybrids (HB 224 and Shruthi), and one intra *arboreum* hybrid (CISAA 2).
3. Maintenance of Male sterile lines.
4. Performance of GMS based hybrids CSHG 1862.
5. Development of Early Duration, Compact Genotype.
6. Development of long and Extra-Long Staple *G.hirsutum* cotton.
7. Wild species were used for introgression of useful characters and also for identifying new source of CMS.
8. Biotechnology: Molecular Characterization of cotton germplasm (Core Collection) using DNA markers.
9. Bollworm Resistant Transgenic cotton in Tetraploid and Diploid cotton.
10. Characterization of new transformed events.
11. Pollen tube pathway transformation.
12. Genetic Engineering for Abiotic Stress Tolerance in Crops and identification of new genes for high water use efficiency.
13. Development of diseases resistant transgenic cotton.
14. Cloning of Chitinase genes for fungal resistance.
15. Identification of Molecular markers and tagging genes for Bacterial blight resistance and CLCuV-resistance transgenic cotton.
16. Development of Transgenic Cotton for Cotton Leaf Curl Virus resistance Antisense approach.

17. Improvement of fibre strength.
18. Attempts are being made to clone cellulose synthase gene (AthA and AthAB) from Arabidopsis which brings about rapid conversion of carbon to UDP glucose to facilitate high fibre strength.
19. DNA Finger Printing.
20. Molecular Characterization of cotton Germplasm (Core Collection) using DNA markers: Drought Resistance Genes.
21. Intensive efforts are underway to clone and characterize native genes from cotton viz., protease inhibitor involved in pests resistance and osmotin and dehydrin genes that govern tolerance of cotton to drought.
22. Molecular breeding: Making framework linkage maps in diploid cotton (A genome) and *G. hirsutum* has been initiate Nodule Induction in Cotton
23. Cotton plants were subjected to root nodule induction by *Rhizobium fredii*, Six individual plants of Anjali and two of LRA 5166 produced nodules in their root system.
24. Seed Production and Seed Quality Improvement.
25. Enhancement of seed germination and vigour.
26. Development of efficient agro-techniques for enhancing productivity and seed quality in Cotton.
27. Testing & Documentation of Extant Varieties, hybrids and their Parents for Distinctness, Uniformity& Stability.
28. Film coating of cotton seeds with polymers.

5.3 National Gene Bank of *Gossypium*:

In the World, about 53, 665 accessions are available for undertaking research work to strengthen the cotton development (2015-16). The chief mandate of the Central Institute for Cotton Research at Nagpur when it was established in April 1976 under the Indian Council of Agricultural Research (ICAR) was to establish a National Gene Bank of global wealth in cotton. The task was achieved successfully with the cooperation of the cotton specialists of all the Cotton Research Centres (CRC) in the country, the NBPGR and outside agencies like United States Department of Agriculture (USDA), etc. The present strength of the gene pool at CICR is as in **Table 16**.

Table 16: Present strength of the gene pool at CICR.

Species	No. of accessions
<i>G. arboreum</i>	1867
<i>G. herbaceum</i>	568
<i>G. hirsutum</i>	5990
<i>G. barbadense</i>	1049
Wild species and perennials	173 (some chromosomal races were rejected)
Total	9647

More than 3000 accessions out of these have been deposited with NBPGR for maintenance under long term storage. CICR also maintains all the collections in short and medium storage by periodical replenishment in field, one third of the collections every year, to maintain viability. The CICR has become the National Cotton Gene Bank, from which, all breeders of both Government and private sector R &D centers all over India obtain seeds as per requirement for new variety and hybrid development.

5.4 CIRCOT, Mumbai:

The Central Institute for Research on Cotton Technology (CIRCOT) was established by the then Indian Central Cotton Committee (ICCC) as its Technological Laboratory in 1924. During the initial period, the objectives of the Institute were to undertake quality evaluation and spinning tests on various cotton strains received from Agricultural Departments in the country and to assess their spinning potential. These activities were carried out by the Institute in close co-ordination with both the Department of Agriculture and the Agricultural Universities located in major cotton producing areas in the country. After the abolition of commodity committees including the ICCC, the administrative control of the Technological Laboratory was transferred to the Indian Council of Agricultural Research (ICAR) in the year 1966 and the name of the Institute was changed to Cotton Technological Research Laboratory (CTRL). Realizing the phenomenal increase in the research component, the Quinquennial Review Team (QRT) recommended changing the name of CTRL to Central Institute for Research on Cotton Technology (CIRCOT). Accordingly, the Institute was rechristened with effect from April 1, 1991.

CIRCOT is one of the Research Institutes under the Engineering Division of the ICAR. The Institute has six quality evaluation units located at Coimbatore, Dharwad, Guntur, Nagpur, Sirsa and Surat. The Ginning Training Centre (GTC) at Nagpur specializes in research on ginning and human resource development for cotton ginning sector. All these Regional units of CIRCOT also serve as windows for transfer of CIRCOT technologies. The Institute has four major divisions – Quality Evaluation and Improvement, Mechanical Processing, Chemical and Biochemical Processing and Transfer of Technology. Over the years, CIRCOT has been modernizing its research facilities to meet the challenges posed by the trade and Industry. The Institute has been expanding and modernizing its research capabilities to meet not only the changing requirements of trade and industry but also venturing into newer areas of research which were not attempted or taken up before.

CIRCOT is a unique Institute which carries out research on cotton, while many industry supported research associations have shifted their interest to man-made fibres.

In the XII Plan, the institute is proposing to take up research in development and application of cotton with other natural fibres and their blends, in newer areas like composites, non-wovens, neon-technology, plasma research and function-oriented blends. During the plan period, the institute proposes to establish two state-of-the-art laboratories - one for Nano technology and the other for Composites. The Institute is trying to forge strong linkages with the farming sector, trade, industry, other research bodies and academic institutions.

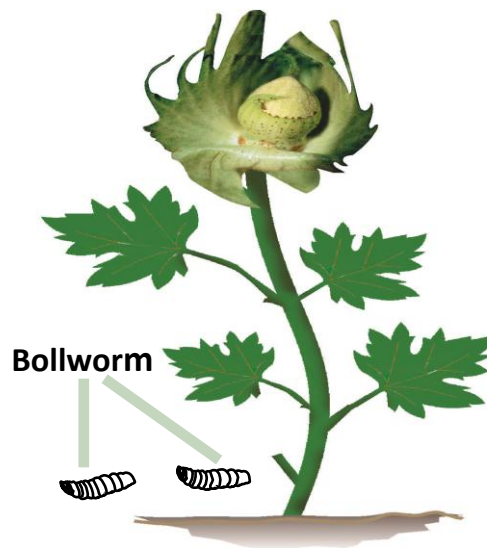
CHAPTER 06

Bt. Cotton in India

6. Bt. Cotton in India

6.1 Development of Bt Cotton In India:

- ✓ 1994 Formation of IBSC & application for seed import.
- ✓ 1995 Permit to import seed (100 gm Coker 312).
- ✓ 1996 Limited field trial -1 Location.
- ✓ 1997-98 Limited field trials-5 Locations.
- ✓ 1998 Ruminant (goat) and Allergenicity studies.
- ✓ 1998-99 Multi centric replicated trials-15+25 Locations.
- ✓ 1999-00 Multi centric replicated trials-11 Locations.
- ✓ 2000-01 Large Scale field Trials & Hybrid Seed Production, Conduction of various Studies.
- ✓ 2002: Approval for commercialization by GEAC for 3 Mahyco Bollgard hybrids in CZ and SZ.
- ✓ 2006 :Approval for commercialization of Bollgard II by GEAC for 3 Mahyco hybrids for CZ and two hybrids for SZ.



6.2 Bt Gene and its incorporation:

- Gene: Cry1A(c).
- Donor: *Bacillus thuringiensis* var kurstaki (B.t.k.) strain HD73.
- *Agro bacterium tumeficiens* mediated transformation used.
- Coker 312 transformed.
- Imported 100 g seed for gene transfer into Indian elite germplasm.

The Government of India through GEAC, Ministry of Environment and Forests considered the proposal for the commercial release of Bt cotton in its meeting held on 26th March, 2002 after the careful and in-depth consideration, accorded approval for release of Bt cotton (with Cry1 Ac gene), which confers resistance to Lepidopteron pests of cotton, was Initially approved only for the Central (Gujarat, Maharashtra & Madhya Pradesh) and South zone states (Tamil Nadu, Andhra Pradesh & Karnataka). GEAC had approved the commercial cultivation of Bt cotton in North Zone from the year 2005-06 and the permission have been given to the four seed companies including Mahyco-Monsanto. During 2007-08, GEAC also approved the Boll Gard II (BG II) of Bt hybrids for its commercial cultivation.

6.3 Bt events in India:

- First event known as Bollgard I (BGI), featuring the Cry1Ac gene was developed by MAHYCO sourced from Monsanto and approved for sale.
- The second event, Bollgard II (BG II with event MON 15985) also developed by MAHYCO and sourced from Monsanto, featured the stacked genes cry 1Ac and cry 2Ab, was approved for sale for the first time in a total of seven hybrids for use in the Central and South regions.
- The third event, known as Event 1 was developed by IIT, Kharagpur, and adopted by JK seeds featuring the cry1 Ac gene, and approved for sale for the first time in a total of four hybrids for use in North, Central and South regions during 2006.
- The fourth and last event, the GFM event was developed by Nath Seeds, sourced from China, featured the fused genes cry 1Ab and cry 1 Ac and approved for sale for the first time in a total of three hybrids, one in each of the three regions of India during 2006.

- Genes utilized for the development of transgenic cotton hybrids in India are represented in **Table 17**.

Table 17: Genes utilized for the development of transgenic cotton hybrids in India.

Name	Gene utilized
Private Companies	cry1Ac, cry1Ac+2Ab, cry1Ab+Ac fusion (China), cry1Ac modified (IIT Khargpur, India), Vip3A+cry1Ab, cry1Ac+ cry1 F, cry1C
ICAR	cry1Aa3, cry1F, cry1Ia5, cry1Ab, cry1Ac,
NBRI	cry1Ec

The transgenic hybrids released in the country can be categorized in different ways on the basis of transgenic involved. They can be categorized in to two groups viz., (i) Bollgard (single gene) (ii) Bollgard II (double gene) and based on species involved these can again be classified into two distinct types (i) Intra-*hirsutum*, and (ii) Inter-specific hybrids (*hirsutumxbarbadense*).

6.4 Committees associated in transgenic crops:

- Genetic Engineering Approval Committee (GEAC).
 - Under Ministry of Environment and Forests.
 - Multi-ministry committee (Health, Agriculture, etc).
 - Senior Scientists from various Govt. Research Institutes.
- Review Committee of Genetic Manipulations (RCGM).
 - Under Ministry of S.&T (DBT).
 - Senior scientists from various Research Institutes.
- Institutional Biosafety Committee (IBSC).
 - Applicant's committee.
 - Includes DBT nominee and external independent members.
- Monitoring and Evaluation Committee (MEC).
- State Biotechnology Co-ordination Committee (SBCC).
 - Headed by the Chief Secretary of the State.
- District Level Committee (DLC).
 - Headed by the District Magistrate.

6.5 Bt cotton coverage:

Bt cotton area, which was hardly 0.29 lakh ha (0.38 %) out of 76.70 lakh in 2002-03, increased to 119.40 lakh ha out of 128.19 lakh hectares in 2014-15 showing more than 93.14 % adoption within a span of thirteen years (**Table 18**)

As on today, more than 2000 Bt hybrids are approved by GEAC for its commercial cultivation in the states of Punjab, Haryana and Rajasthan in north zone; Madhya Pradesh, Maharashtra and Gujarat in central zone and Telangana, Andhra Pradesh, Karnataka and Tamil Nadu in south zone. More than 30 private seed companies are producing & marketing Bt hybrids to fulfill the requirements. It is pertaining to note that BG II i.e. protection from Heliothis and Spodoptera was approved in 2007. In the crop season 2009-10, nearly 25-30% of the total Bt cotton was under BG II version. The farmers are coming forward to adopt BG II instead of BG I. The cost of BG II is slightly higher than BG I. During recent years, BG III will also be available to the farmers which are herbicide resistance and will further increase the seed cost. The performance of Bt. and non Bt. cotton coverage is shown in **Table 18.**

Table 18: Performance of Bt. and non Bt. cotton coverage

State	Area in lakh hectare											
	02-03			03-04			04-05			05-06		
	Bt	Non Bt	Total	Bt	Non Bt	Total	Bt	Non Bt	Total	Bt	Non Bt	Total
An.Prad.	0.038	7.99	8.03	0.05	8.32	8.37	0.71	11.07	11.78	0.90	9.43	10.33
Gujarat	0.091	16.26	16.35	0.42	15.99	16.41	1.26	17.80	19.06	1.49	17.57	19.06
Haryana		5.18	5.18		5.26	5.26		6.21	6.21	0.11	5.72	5.83
Karnataka	0.021	3.91	3.93	0.03	3.14	3.17	0.34	4.87	5.21	0.29	3.84	4.13
M. Pra.	0.014	5.58	5.59	0.13	5.51	5.64	0.86	4.90	5.76	1.36	4.84	6.20
Mahar.	0.120	27.88	28.00	0.22	27.40	27.62	1.62	26.78	28.40	5.09	23.66	28.75
Odisha		0.30	0.30		0.37	0.37		0.46	0.46		0.57	0.57
Punjab		4.49	4.49		4.52	4.52		5.09	5.09	0.70	4.87	5.57
Rajas.		3.86	3.86		3.44	3.44		4.38	4.38	0.02	4.70	4.72
TN	0.003	0.75	0.75	0.08	0.90	0.98	0.12	1.17	1.29	0.17	1.24	1.41
Telangana			0.00			0.00			0.00			0.00
Others		0.22	0.22		0.21	0.21		0.23	0.23		0.20	0.20
All India	0.29	76.42	76.71	0.93	75.06	75.99	4.91	82.96	87.87	10.13	76.64	86.77

Table 18: Performance of Bt. and non Bt. cotton coverage

State	Area in lakh Ha											
	06-07			07-08			08-09			09-10		
	Bt	Non Bt	Total	Bt	Non Bt	Total	Bt	Non Bt	Total	Bt	Non Bt	Total
An. Prad.	6.57	3.15	9.72	10.00	1.34	11.34	11.43	2.56	13.99	12.53	2.14	14.67
Gujarat	4.07	19.83	23.90	13.00	11.22	24.22	14.50	9.04	23.54	15.39	9.25	24.64
Haryana	0.42	4.88	5.30	2.79	2.04	4.83	3.46	1.09	4.55	4.90	0.17	5.07
Karnataka	0.80	2.96	3.76	1.46	2.57	4.03	1.57	2.52	4.09	3.16	1.41	4.57
M. Pra.	3.02	3.37	6.39	4.71	1.59	6.30	5.14	1.11	6.25	6.06	0.04	6.10
Mahar.	16.55	14.52	31.07	25.62	6.33	31.95	25.72	5.74	31.46	30.48	4.47	34.95
Odisha		0.51	0.51		0.50	0.50		0.58	0.58		0.54	0.54
Punjab	2.81	3.26	6.07	5.57	0.47	6.04	4.76	0.51	5.27	4.90	0.21	5.11
Rajas.	0.05	3.44	3.49	0.38	3.31	3.69	1.48	1.55	3.03	2.80	1.64	4.44
TN	0.32	0.68	1.00	0.60	0.39	0.99	0.12	1.03	1.15	0.09	0.95	1.04
Telangana			0.00			0.00			0.00			0.00
Others		0.24	0.24		0.24	0.24		0.17	0.17		0.19	0.19
All India	34.61	56.84	91.45	64.13	30.00	94.13	68.18	25.90	94.08	80.31	21.01	101.32

Table 18: Performance of Bt. and non Bt. cotton coverage

State	2010-11			2011-12			2012-13			2013-14		
	Bt	NonBt	Total	Bt	NonBt	Total	Bt	NonBt	Total	Bt	NonBt	Total
A. Pradesh	17.01	1.78	18.79	18.26	0.53	18.79	19.41	4.59	24.00	23.65	0.24	23.89
Gujarat	20.88	5.45	26.33	26.78	2.84	29.62	23.00	1.97	24.97	21.25	3.94	25.19
Haryana	4.18	0.74	4.92	5.88	0.53	6.41	5.56	0.58	6.14	4.67	0.69	5.36
Karnataka	3.73	1.72	5.45	4.60	0.94	5.54	4.50	0.35	4.85	5.63	0.99	6.62
M. Pradesh	6.00	0.50	6.50	6.35	0.71	7.06	5.75	0.33	6.08	4.40	0.74	5.14
Maharash.	35.43	3.99	39.42	38.95	2.30	41.25	38.47	2.99	41.46	37.72	4.20	41.92
Orissa	0.00	0.74	0.74	0.00	1.02	1.02	0.00	1.19	1.19	0.00	1.24	1.24
Punjab	5.10	0.20	5.30	5.46	0.14	5.60	4.70	0.10	4.80	4.24	0.22	4.46
Rajasthan	2.60	0.75	3.35	4.00	0.70	4.70	2.93	1.57	4.50	2.50	1.43	3.93
Telangana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T. Nadu	0.62	0.60	1.22	1.06	0.27	1.33	1.23	0.05	1.28	1.30	0.22	1.52
Others	0.00	0.33	0.33	0.00	0.46	0.46	0.00	0.50	0.50	0.00	0.33	0.33
All India	95.55	16.80	112.35	111.34	10.44	121.78	105.55	14.22	119.77	105.36	14.24	119.60

Table 18: Performance of Bt. and non Bt. cotton coverage

State	2014-15			2015-16			2016-17		
	Bt	NonBt	Total	Bt	NonBt	Total	Bt	NonBt	Total
A. Pradesh	8.00	0.21	8.21	6.50	0.16	6.66	4.38	0.11	4.49
Gujarat	27.13	0.60	27.73	26.23	0.96	27.19	19.24	4.76	24.00
Haryana	6.31	0.17	6.48	5.27	0.76	6.03	3.77	1.21	4.98
Karnataka	6.97	1.78	8.75	4.87	1.46	6.33	2.85	1.79	4.64
M. Pradesh	5.20	0.27	5.47	5.20	0.27	5.47	5.39	0.60	5.99
Maharash.	40.10	1.80	41.90	34.40	3.87	38.27	32.30	5.79	38.06
Orissa	0.00	1.27	1.27	0.00	1.25	1.25	0.00	01.36	01.36
Punjab	4.08	0.12	4.20	3.29	0.10	3.39	2.43	0.13	2.56
Rajasthan	3.95	0.92	4.87	3.56	0.92	4.48	2.87	1.55	4.42
Telangana	16.08	1.05	17.13	16.61	1.12	17.73	12.27	0.23	12.50
T. Nadu	1.58	0.29	1.87	0.90	0.52	1.42	0.60	0.90	1.50
Others	0.00	0.31	0.31	0.00	0.50	0.50	0.00	0.50	0.50
All India	119.40	8.79	128.19	106.82	11.90	118.72	86.10	18.90	105

The first *hirsutum* group (medium staple) Bt variety (Bikaneri Narma) was released in 2008 and first Bt. hybrid NHH 44 Bt in 2009 by the ICAR, but these did not perform well as compared to popular Bt hybrids. The consistent and perceptible increase in cotton production and productivity during last 3 years, attributed to higher rate of adoption of Bt cotton in the country. Bt-cotton seems to have reduced the overall quantity of insecticides substantially, only in some parts of the country, coupled with spectacular yield increases reported from Gujarat, while rest of the states have been showing mixed results despite increase in the area under Bt-cotton. The response of farmer to these Bt Hybrids were very positive as these hybrids have reduced their plant protection expenditure and saved the crop from the losses due to attack of American bollworm, which resulted in increase in the yield.

6.6 Availability of seed:

At present, about 82 % of cotton area is under Bt hybrids. Remaining area is under deshi variety and very small area is under other hybrids. The Bt hybrids are produced and marketed by private sector. The seed of all the Bt hybrids, which are made available to farmers, are sold through private dealers of seed producing companies. This seed is not subject to certification and it is sold by private traders without certification of government seed certification agency. Farmers are using these seed for cultivation. Some popular / important Bt hybrids cultivated in various cotton growing zones are given in **Table 19** below:

Table 19: Popular / important Bt hybrids cultivated in various cotton growing zones of India.

North Zone	Central Zone	South Zone
MRC-6301	MECH-12	MECH-162
MRC-6304	MECH-162	MECH-184
RCH-134	MECH-184	MRC-6322
RCH-317	MRC-6301	MRC-6918
RCH-308	RCH-2	RCH-2
RCH-314	RCH-118	RCH-20
Ankur-651	RCH-138	RCH-368
Ankur-2534	RCH-144	RCH-371
MRC-6025	Ankur-651	RCH-111
MRC-6029	Ankur-09	RCHB-768
NCS-913	Mallika	NCH-145
NCS-138	Bunny	NCH-207
JKCH-1947	NCS-145	NCH-913
NCEH-6R	NCS-207	Mallika
	GK-205	Bunny

Table 19: Popular / important Bt hybrids cultivated in various cotton growing zones of India.

North Zone	Central Zone	South Zone
	Tulasi-4	Gk-209
	Brahma	GK-207
	VICH-111	PRCH-102
	VICH-5	PRCH-103
	VICH-9	ACH-135-1
	ACH-33-1	PCH-2170
	ACH-155-1	KDCHH-9632
	ACH-11-2	VICH-5
	PRCH-102	MRC-7751
	KDCHH-441	MRC-9207
	MRC-7701	JK-Durga
	MRC-7329	JKCH-99
	MRC-7347	NCEH-3R
	JK-Varun	
	NCEH-2R	

6.7 Benefits of Bt-cotton in India:

- Direct benefits from Bt-cotton in India:
Bt cotton hybrids proved to be the most accepted technology in cotton cultivation. The main purpose of Bt-cotton is to control bollworms.
- Bollworm control:
Bt cotton-effectively controlled bollworms, especially the American Bollworm, *Helicoverpa armigera*, thus preventing yield losses from an estimated damage ranging from 30 to 60 % each year in India from 2002 to 2011.
- Reduction in pesticides use for bollworm control:
Biggest gain from the technology was in the form of reduced insecticides usage from 46 % in 2001 to less than 26 % after 2006 and 21% during the last two years 2009 and 2011. Prior to the introduction of Bt cotton, about 9400 M tonnes of insecticides were used for bollworm control in India, whereas in 2011 only 222 M tonnes were used.
- Reduction in bollworm infestations:
The intensity of bollworms reduced significantly on cotton and also on other host crops.
- Elimination of bollworm threats:
Farmers are no longer scared of impending bollworm infestations and the subsequent stress of using insecticides cocktails.

- **Enhanced seed-cotton quality:**
The quality of seed-cotton from Bt-cotton fields was found to be better than non-Bt cotton because of negligible loculi and fiber damage.
- **Earliness and determinate habit:**
Introduction of Bt gene into the hybrids has added the advantage of protection of early fruiting parts, thus resulting in earliness and determinate habit. The earliness ranged from 15 to 20 days in many hybrids in many parts of the country. This has added several benefits. In North India, farmers were able to take up wheat cultivation immediately after early harvest of cotton. The number of picking reduced and the yield per picking increased. Farmers were able to get remunerative returns because of higher prices generally prevalent early in the market during the initial cotton arrivals.
- **Increased Area:** The Bt cotton area, which was 0.29 lakh ha in 2002-03, increased to 128.19 lakh ha in 2014-15 due to preference by cotton farmers.
- **Increased yields:** The all India level yield of cotton, which was 191 kg lint per ha. in 2002-03, increased to 510 kg per ha. in 2013-14.
- **Increased income of farmers:** The per hectare net income of farmers increased from Rs. 7058/- in 2001 to Rs. 16125/- in 2010 under rainfed conditions and Rs. 25000/- under irrigated conditions.
- **Record export:** A record export of 129.57 lakh bales was in 2011-12 after meeting domestic consumption.
- **Environmental benefits with Bt-cotton:** The greatest environmental benefit with Bt cotton is the reduction in usage of insecticides.

The average insecticide usage for bollworm control over 10 years from 1995 to 2004 was 6767 M tonnes, which reduced to an average of 1089 M tonnes over seven years from 2005 to 2011. However, during the average usage of insecticides for sucking pests control, was 3335 M tonnes during 1995 to 2004, which increased to an average of 4600 M tonnes during 2005 to 2011. Though, this is not directly related to Bt cotton technology. The pesticides scenario could have been very different, at low levels, if care had been taken to ensure that sucking pest resistant hybrids were approved for commercial cultivation.

6.8 Future prospects of Bt Cotton:

- The ICAR's Central Institute of Cotton Research (CICR) Vision 2030 document released in 2011 noted that the development of the first cotton hybrid was one of the most spectacular achievements that had greatly influenced the cotton industry in India (CICR, 2011). Savings in insecticides between 2004 and 2010 coincided with the large scale adoption of Bt cotton. The sharpest decline in insecticides use was from US\$ 160 million in 2004 to US\$ 25 million in 2010 – an 85% decrease equivalent to a saving of US\$ 135 million.
- The quantity of insecticides used to control bollworm reduced by 96 % from 5748 metric tonnes of active ingredients in 2001 to 222 metric tonnes of active ingredients in 2011, when approximately 91.43 % (11.24 million hectare) of the cotton area in 2011 was planted to Bt cotton. With the steep increase in adoption of Bt cotton between 2002 and 2011, the average yield of cotton in India, which used to have one of the lowest yields in the world, increased from 186 kg per hectare in 2001-02 to 510 kg per hectare in 2013-14, cotton production increased from 86.24 Lakh bales in 2002-03 to 359.02Lakh bales in 2013-14. Hence, the Country was transformed from a net importer of raw cotton until 2002-03 to net exporter of cotton. India occupied top position in the World cotton production since 2015-16, it was already holding first rank in cotton coverage in the world.

CHAPTER 07

Approved Package of Practices for Cotton

7. Approved Package of Practices for Cotton:

7.1. Punjab State:

Cotton is an important kharif crop of the Punjab State. It is grown in about 4.49 lakh hectares area, from which 16.64 lakh bales is received with a productivity of 630 kg per hectare (average of 2011-12 +to 2015-2016).

Hints for high yield of cotton:

1. Grow only recommended and early maturing varieties resistant to cotton leaf curl viral disease.
2. Eradicate alternate hosts of cotton leaf curl virus / volunteer cotton plants before sowing, to avoid the multiplication and spread of diseases.
3. Must soak delinted seed in water for 2 – 4 hours.
4. Heavy pre – sowing irrigation is must to obtain good germination and early establishment of plants.
5. Complete the sowing during April. It will help to escape the attack of American bollworm to great extent.
6. Avoid growing bhindi, moong, arhar, castor, dhancha in and around the cotton fields to avoid simultaneous build up and spread of pests and diseases to cotton.
7. Maintain the plant to plant spacings of 60 cm for American cotton varieties and 45 cm for desi cotton varieties through manual thinning after first irrigation.
8. Avoid sowing American cotton in / or near the orchards.
9. The incidence of insect pests increases with excessive use of nitrogenous fertilizers, hence use only recommended dose.
10. Spray to control jassid only when it reaches economic threshold level of second injury grade i.e. marginal cupping of leaves.
11. Give 3 – 4 sprays of 2% potassium nitrate starting at flower initiation.
12. Avoid using synthetic pyrethroids after September 15 to minimize resurgence of whitefly. Prefer to use triazophos and ethion to control whitefly.
13. Avoid tank mixing and use of readymade insecticidal mixtures.
14. Control American bollworm at the initial stages. Use chlorpyrifos / spinosad / acephate / indoxacarb for the control of larvae when their length is more than 1.25 cm.
15. The incidence of insect pests increases with excessive use of nitrogenous fertilizers, hence use only recommended dose.
16. Use chlorpyrifos / thiodicarb / acephate / quinalphos / endosulfan against tobacco caterpillar taking into consideration the pest complex.
17. Follow Insecticide Resistance Management (IRM) strategy for effective management of insect pests.
18. Use fixed type hollowcone nozzle which discharges 600 ml of spray material per minute for efficient pest control.

Important hints for Bt Cotton:

1. Grow only recommended hybrids (RCH 134, RCH 317, MRC 6301, MRC 6304) of Bt Cotton.
2. Avoid sowing Bt Cotton in light sandy soils.
3. Give first irrigation 4 – 6 weeks after sowing depending on soil type.
4. Control sucking pests and tobacco caterpillar as and when situation arises.
5. Grow non Bt – cotton as refuge on the periphery of Bt cotton to prevent development of resistance against Bt in bollworms. If 20 percent area is under refuge then it should be protected against bollworms by using recommended insecticides but if refuge occupies only 5 percent area then it should not be protected.

Climatic Requirements:

A daily minimum temperature of 16 degree C is required for germination and 21 degree C to 27 degree C for proper crop growth. During the fruiting phase, the day temperature ranging from 27 degree C to 32 degree C and cool nights are needed. The cotton – picking period from mid – September to November must have bright sunny days to ensure a good quality of the produce.

Soil Type:

Cotton can be successfully grown on all soils except sandy, saline or waterlogged types. Proper drainage of excess water during rains is essential.

Rotations:

- Cotton – Fallow
- Cotton – Wheat / Barley
- Cotton – Sunflower
- Cotton – Senji / Barseem / Oats
- Cotton – Sunflower – Paddy – Wheat

Agronomic Practices:

Land Preparation:

A fine seed – bed is essential for securing good plant stand.

Varieties/hybrids	Seed rate (kg/acre)
American Cotton	
Hybrids : LHH 144, Ankur 651 and Whitegold	1.5
Varieties : F 1861, F 1378, F 846 and LH 1556	3.5
Desi Cotton	
Hybrids : Moti	1.25
Varieties : LD 694 and LD 327	3.0

Acid Delinting of Cotton Seed:

Mix 400 g commercial grade concentrated sulphuric acid with 4 kg cotton seed for American cotton and mix 300 g commercial grade of sulphuric acid with 3 kg seed of desi cotton in either / plastic container by stirring it vigorously for two to three minutes with a thick wooden or glass rod. As soon as the fuzz gets dissolved, add 10 litres of water, stir well and drain out water through the perforated plastic basket. Repeat these washings three times to make the seed free from sulphuric acid residue. Dip the washed seed for about one minute in sodium bicarbonate solution (50g sodium bicarbonate in 10 litres of water) to neutralize the acid residue on the cotton – seed. Give one more washing with water and remove light, damaged and rotten inviable seeds floating on the surface. Dry the healthy fuzz free seed in the shade by spreading in a thin layer. Treat the dry seed with recommended fungicides.

Precautions:

1. Metal or wood container should not be used.
2. The operator should wear the plastic gloves
3. The water containing acid and alkali residue should be properly disposed off in the waste land.
4. Inadequate washing and delayed washing of the seed after acid treatment and residual acid on the seed if not neutralized may impair the germination of seed.

Seed Treatment:

Add half gram (0.5 g) Emisan – 6 and one fourth gram (0.25 g) of Streptocycline for one kg cotton seed in one litre of water. In case of acid delinted seed soak the seed for 2 – 4 hours and for non – delinted seed 6 – 8 hours. Also add half g succinic acid in 5 litres of water to promote good establishment of plant stand, better early growth and more yield. After this treatment, the cotton seed should be smeared with Gaucho 70 WS (Imidacloprid) @ 5 g/kg seed for preventing damage by cotton jassid. In case undelinted seed is used, rub it with fine earth, cowdung or ash to remove its fuzz and ensure its uniform distribution.

Time of Sowing: Whole of April

Note: Sowing during this period ensures better yield and escapes the attack of insect pests and diseases.

Sowing and Spacing:

Sow in lines 67.5 cm apart with a cotton sowing drill. The plants within rows be kept 60 cm apart at thinning in case of narma and 45 cm in case of desi cotton. However, for hybrid LHH 144, Ankur 651 and Whitegold plant to plant distance should be kept at 75 cm. It may be done after first irrigation or heavy showers. For Moti Hybrid the plant to plant spacing should be kept at 60 cm.

Ridge Sowing:

Sowing of cotton on ridges prepared with cotton planter and irrigating the crop planter and irrigating the crop in furrows saves considerable amount of irrigation water without reduction in seed cotton yield.

Weed Control:

Hoe two or three times. The first hoeing should be done before first irrigation. For hand weeding, use of a weel hoe is recommended. A tractor drawn cultivator or bullock driven Triphali can also be used in the early stages of the crop growth but their use after fruit initiation should be avoided. Chemical weed control in cotton is cheap and efficient. For control of weeds particularly its it (*Trianthema portulacastrum*), Madhana / Makra (*Eleusine spp*), apply Treflan 48 EC, Shaktiman Triflurex 48 EC (trifluralin) @ 1.0 litre / acre on a well prepared seed bed and incorporate these herbicides thoroughly in 3 – 4 cm soil or stomp 30 EC @ 1.0 litre / acre as pre – emergence within 24 hours of sowing. Weeds start emerging at about 5 – 6 weeks after application of herbicide. Give one hoeing / interculture around 45 days after sowing to control these weeds.

Alternatively, in place of hoeing / interculture apply Gramoxone 24 percent WSC (paraquat) 500 ml / acre or Roundup 41% SL / Glycel 41% SL (Glyphosate) 1.0 litre / acre in 100 litres of water (6 – 8 weeks) after sowing when the crop is about 40 – 45 cm in height as a directed spray to control weeds in – between the crop rows. To avoid drift, spray these herbicides on non – windy days. The directed spray can be done using knap – sack sprayer fitted with flat fan nozzle and keeping the boom height low (15 – 20 cm above the ground level) or using a protective hood so that herbicide does not fall on crop leaves. Both paraquat and glyphosate are non – selective herbicides and can cause injury to the crop if it falls on the crop leaves. However, falling of herbicides on stem of the plant is not harmful. In situations where perennial weeds are a problem, glyphosate is more effective and provides long duration control.

In situations where it emerges after first irrigation or with the rain shower Stomp @ 1.0 litre/acre can also be applied as post- emergence after first irrigation to cotton. If the weeds emerge before the application of the herbicide, a light hoeing/interculture may be done as the Stomp does not control the emerged weeds. Dissolve the herbicide thoroughly in 200-250 litres of water/acre and spray it uniformly with a knap sack sprayer fitted with flat fan or flood jet nozzle. The herbicide can also be sprayed with tractor mounted sprayer fitted with flat fan nozzle. For getting good results with the herbicide, following precautions should be taken:

- Prepare a fine seed bed free from plant residues and clods ensure adequate moisture in the field at the time of spray of herbicide.
- Spray of the herbicide should be done either in the morning or evening hours.

Fertilizer Application:

Cotton responds well to the application of nitrogen. In certain areas, the crop shows some response to the application of phosphatic fertilizers.

Drill all phosphorus with the last ploughing. Apply half N at thinning and the remaining half at the appearance of the first flower for all varieties except LH 1556 For LH 1556 the first half dose of N may be applied alongwith phosphorus at sowing and remaining half of N around mid-July.

If the soil is low in fertility, the first half dose of N may be applied at sowing instead of at thinning. Apply 20 kg muriate of potash and 10 kg zinc sulphate per acre to cotton on light soils. To get higher yields, give four sprays of 2% potassium nitrate at weekly interval starting at flower initiation in addition to soil applied fertilizers.

The following fertilizer recommendations are made:

		*Nutrients (kg/acre)		Fertilizers (kg/acre)		
		N	P ₂ O ₅	Urea (46% N)	**DAP (18% N 46% P ₂ O ₅)	SuperPhosphate (16% P ₂ O ₅)
(A)	Varieties	30	12	65	27	75
(B)	Hybrids	60	12	130	27	75

* These nutrients can also be supplied from other fertilizers available in the market.

** Where 27 kg DAP is used, reduce the urea dose 10 kg.

Note: Omit application of phosphorus to cotton when it follows wheat which received recommended dose of phosphorus.

Irrigation and Drainage:

Cotton requires four to six irrigations, depending upon the seasonal rainfall. The first irrigation should be given 4 to 6 weeks after sowing and the subsequent ones at interval of two or three weeks sowing cotton on ridges and irrigation in furrows save considerable amount of water. The crop must not be allowed to suffer for want of water during the flowering and fruiting stages, otherwise a lot of shedding of flowers and bolls will take place resulting in low yield cotton during its early growth is very sensitive to water stagnation. Therefore, drain out the stagnant water, if such a situation arises. To hasten boll opening give the last irrigation by the end of September.

Caution:

On light soils and in crop sown on ridges, the first irrigation may be advanced if necessary.

Hybrid Seed Production:

LHH 144: This is a cross between PIL 43 (Female parent) having okra lobed leaves and PIL 8 Miah (male parent). The hybrid seed is produced by hand emasculation of flower buds of female parent and pollination by flowers of male parent. The seed of parental lines should be purchased from Punjab Agricultural University every year to maintain genetic purity. The emasculated female bud is covered with soda straw pipe and the male flower is tied with a 3" piece of a thread in the evening. The tied male flowers are used for pollinating the emasculated female buds in the morning. A piece of thread is tied to the stalk of the bud after pollination which serves as a marker for crossed boll.

Characteristics of Parents:

PIL 43:

The female parent of LHH 144 has bushy plant habit with 3.4 monopods, okra type narrow lobed green leaves, creamy white flower and pollen. It has bold seeds. It matures in about 185 days.

PIL 48:

The male parent of LHH 144 has compact plant type with 0 – 1 monopod and about 130 cm plant height. It has medium lobed green leaves, creamy white flowers and matures in about 165 days.

Isolation of hybrid seed plot:

The hybrid seed production field should have an isolation of 50 meters from other American cotton varieties and 5 meters between male and female plots to ensure the genetic purity of the seed.

Seed Rate and Spacing in Hybrid Seed Plot:

One acre hybrid seed production plot requires 6 kanal area under female parent and 2 kanal area under male parent with the following seed rate and spacing

<i>Parental lines</i>	<i>Seed rate (kg/acre)</i>	<i>Spacing (cm) LHH 144</i>
Female	3.0	67.5 × 90
Male	1.5	67.5 × 60

The skipping of one row after every two rows in female plot gives better setting of crossed bolls. In LHH 144 hybrid seed production 50 percent of the male parent should be sown along with female parent and the remaining 50 percent 10 – 15 days later to get sufficient number of male flowers for crossing.

Roughing:

Off – type plants based on plant colour, leaf shape, flower colour etc., if any, should be rogued to maintain purity of parental lines.

Seed Production Technique:

The F1 hybrid seed is produced by the placement of functional pollen of the desired male parent on to the receptive stigma of the emasculated female at right time. Emasculation of flowers is done from 3 PM to 6 PM by removing the anthers with thumb nail before maturity (anthesis) and pollinate the next morning from 8 AM to 10 AM when stigma is receptive. Avoid too young or too old buds. The male flowers to be taken for pollination should be selfed the previous evening to avoid contamination by insects. For identification of crossed bolls at maturity the crossed flower buds should be tagged in order to enhance the setting percentage unattempted flowers and naturally formed bolls should be removed. Hybrid seed plot should be kept free from weeds and special care should be taken to prevent damage due to insect pests and diseases.

Picking, Storing and Ginning:

The kapas from crossed healthy and marked bolls should be picked, stored and ginned separately. The cleaned seed should be labeled and stored in a clean dry place. Its genetic purity and germination should be tested before use.

Hybrid Seed Production:

Moti: Desi Cotton Hybrid:

This hybrid is produced by crossing DS – 5 (female parent) with LD 210 (male parent). DS – 5 is a genetic male sterile line and, thus there is no need of emasculating the female flowers. Crossing is accomplished by applying pollen from freshly opened flowers of the male parent on the stigma of the freshly opened flowers of the female parent.

Maintenance of Parental lines:

Female Parent (DS – 5):

The male sterile line is maintained by pollinating the male sterile plants with pollen from male fertile plants of the same line. Since male sterility DS – 5 is controlled by a single recessive nuclear gene, so we always get a mixture of male sterile and male fertile plants in 1: 1 ratio.

The male sterile plants are identified on the basis of their small, whitish and shriveled anthers. The male fertile plants have well developed anthers and after flower opening the anthers are covered with bright yellow pollen grains. Freshly opened flowers on male sterile plants are pollinated with pollen from male fertile plants in the morning (9.00 – 11.00 AM). Pollination is done by rubbing the anthers of fertile flowers in the stigma of male sterile flowers. For identification of cross these artificially pollinated flowers, a thread is tied to the pedicel of the flowers immediately after pollination.

Male Parent (LD 210):

This is a normal male fertile genotype. It is maintained just like other varieties by following normal seed production and certification norms. Care should be taken to maintain maximum genetic purity.

Characteristics of Parents:

DS-5:

It is generic male – sterile line. The male – sterile plants are identified on the basis of their small, shriveled and whitish anthers. It has green plant body with narrow deep cut leaves, creamy white flowers and monopodial plant habit.

LD 210:

Green plant body with narrow lobbed deep cut leaves, white flowers, plant habit semi sympodial.

Production of hybrid seed:

Isolation of hybrid seed plot:

The hybrid seed production plot should have an isolation of 50 meters from other desi cotton varieties and 5 meters between male and female plots to ensure genetic purity of the seed.

Seed rate and Spacing in hybrid seed plot:

One acre hybrid seed production plot requires 6 kanal area under female parent and 2 kanal area under male parent with the following seed rate and spacing.

<i>Parental lines</i>	<i>Seed rate (kg/acre)</i>	<i>Spacing (cm)</i>
DS-5 (Female Parent)	2.0	67.5 × 45
LD 210 (Male Parent)	1.0	67.5 × 45

The skipping of one row after every two rows in female plot gives better setting of crossed bolls.

Roughing:

In the female parent, 50% plants are expected to be male – fertile. These plants are identified by examining the first opened flower and roughed out. This is necessary to obtain a pure stand of the male – sterile plants.

Crossing Procedure:

For production of hybrid seed, freshly opened flowers of the male parent (LD 210) are used as source of pollen. Pollen is applied in the morning (9.00 – 11.00 AM) by rubbing anthers of the male flower on the stigma of freshly opened flowers of female parent (DS – 5). For identification of crossed bolls, threads are tied to the pedicel of cross pollinated flowers. In order to enhance the setting percentage, unpollinated flowers and naturally pollinated bolls should be removed. Hybrid seed plot should be kept free from weeds and special care should be taken to control insects and diseases. The crop should not suffer from moisture stress flowering stage as it will lead to shedding of flowers / bolls.

Picking, Storing and Ginning:

The Kapas from crossed healthy and marked bolls should be picked, stored and ginned separately. The cleaned seed should be labeled and stored in a clean dry place. Its genetic purity and germination should be tested before use.

Plant – Protection Measures:

Insect Pests Management (Bt cotton):

Bt cotton does not provide effective control of sucking pests and tobacco caterpillar. Among sucking pests, jassid, aphid and whitefly are most serious on Bt cotton and they cause maximum damage during July – September. Nymphs and adults of jassid suck sap from leaves and cause shedding in case of severe infestation. Whitefly adults and nymphs suck sap from leaves and excrete honey dew on leaves which become sticky. Affected leaves and seed cotton turn black due to development of sooty mould. Aphids appear sporadically. The nymphs and adults of aphid suck sap and excrete honey dew on leaves on which black fungus develops.

Tobacco caterpillar is a polyphagous pest. The larvae cause serious damage to crop from August to October. The small larvae are black whereas grown up larvae are dark green with black triangular spots on body. Its moths lay eggs in masses covered with brown hairs on the lower side of mature leaves. After hatching, first and second instar larvae feed gregariously and skeletonize the foliage. Later on grown up larvae disperse and feed singly. Besides leaves, they also damage the buds, flowers and green bolls. Spotted, pink and American bollworms may also attack Bt cotton late in the season. Due to attack of these bollworms shedding of flowers and bolls may occur. For effective protection of Bt cotton, it is necessary to adopt the following Integrated Pest Management strategies.

A. Cultural and Mechanical Control:

- i. Grow only recommended Bt cotton hybrids.
- ii. Complete sowing in the April.

- iii. Avoid growing castor, moong, dhaincha and bhindi in and around the Bt cotton. These are the most preferred hosts of tobacco caterpillar, helping the pest to multiply and shift to cotton.
- iv. Keep the fields free from the weed as acts as an alternate host of tobacco caterpillar.
- v. Egg masses and young larvae of tobacco caterpillar feeding gregariously should be collected along with leaves and destroyed.

B. Monitoring of bollworms and tobacco caterpillar with sex pheromones:

The monitoring of bollworms and tobacco caterpillar should be done with the initiation of flowering stage of crop. Observations on moth catch should be recorded on every alternate day. This monitoring strategy will help in making decision for effective management of bollworms and tobacco caterpillar.

Pink bollworm:

Using Sticka / Delta traps with at least 10 micro litre of gossyplure and place it at 15 cm above crop canopy. Replace the lure after 15 days and use 1 trap / ha.

Spotted / Spiny bollworms:

Use Sleeve / Moth catch traps for spotted bollworms and replace the lure at 15 days interval. Place the trap at 15 cm above the crop canopy and use 2 traps / ha.

American bollworm:

Use Sleeve / Moth catch trap with at least 2 mg of pheromone and place it at 15 cm above crop canopy. Replace the lure after 15 days and use 2 traps / ha.

Tobacco Caterpillar:

Use sleeve / moth catch trap for tobacco caterpillar. Replace the lure after every 15 days. Place the trap 15 cm above crop canopy and use 2 traps / ha.

C. Chemical Control

a) Sucking insect pests:

The decision regarding spray of insecticides should be taken based on economic threshold (ETH). Initiate spray against jassid whenever some of the fully formed leaves in the upper canopy show curling and yellowing at the margins on 50 percent of the plants. Sprays against whitefly should be done when population reaches six adults per leaf in the upper canopy of plants before 10 AM or when honey dew appears on 50% of the plants. Spray against aphid should also be done on the appearance of honey dew on 50% plants (**Table 20**).

b) Tobacco Caterpillar:

Bt Cotton does not provide protection against tobacco caterpillar. Tobacco caterpillar can cause severe damage to the Bt crop if not controlled in time. For effective control of this pest, insecticides mentioned in table 2 should be sprayed when the need arises.

c) Bollworms:

Bt cotton provides effective protection against all cotton bollworms. However, regular monitoring should be done at weekly interval during reproductive phase. Farmers should examine their fields twice a week in order to ensure that bollworms damage does not exceed 5 percent in shed flowers and bolls. For this purpose divide the field into four quarters and collect 25 freshly shed flowers and bolls at random in each quarter. The bolls damaged by bollworms will have feeding holes or their larvae. In case the damage exceeds 5 percent, the crop should be sprayed immediately and thereafter spray as when need arises. If at all American bollworms cross ETH level during late crop season, use insecticides as mentioned in **table 21**. Prefer spinosad and indoxacarb for the control of American bollworm during September.

Resistance management:

To avoid the development of resistance in Bt cotton to bollworms, 20 percent area should be sown under non – Bt cotton hybrids around Bt cotton. The non - Bt hybrids should be protected against damage by insect pests as mentioned in case of non – Bt cotton hybrids. Alternatively 5 percent area of non – Bt hybrids can be sown around Bt cotton and this should be kept unsprayed.

Insect Pests Management (Non – Bt Cotton):

Bollworms are the most harmful insects which attack cotton in the Punjab. Spotted bollworms damage growing points during May – June and cause heavy shedding of squares, buds, flowers and bolls during July to October. The American bollworms causes severe shedding of fruiting bodies during September – October especially on American cotton. The colour of its larvae greatly varies. They have one line on upper side and two wavy lines on lateral side of body. Their body also has sparse hairs. Pink bollworm does maximum damage from mid – July to mid – October. Due to severe attack of bollworms, the plants continue to grow without having adequate number of bolls.

Tobacco caterpillar is a polyphagous pest. The larvae cause serious damage to crop from August to October. The small larvae are black whereas grown up larvae are dark green with black triangular spots on body. Its moths lay eggs in masses covered with brown hairs on the lower side of mature leaves. After hatching, first and second instar larvae feed gregariously and skeletonize the foliage. Later on grown up larvae disperse and feed singly. Besides leaves, they also damage the buds, flowers and green bolls.

Amongst sucking pests, jassid and whitefly are most serious on American cotton and they cause maximum damage during July – September. Nymphs and adults of jassid suck sap from leaves and cause shedding in case of severe infestation. Whitefly adults and nymphs suck sap from leaves and excrete honey dew on leaves which become sticky. Affected leaves and seed – cotton turn black due to development of sooty mould. Whitefly also transmits cotton leaf curl virus in American cotton. Aphids appear sporadically. The nymphs and adults of aphid suck sap & excrete honey dew on leaves on which black fungus develops.

The larvae of leaf – roller, semi – loopers, hairy – caterpillars and bud moth may also appear sporadically and damage the crop during July – October.

For effective protection of cotton, it is necessary to adopt the following Integrated Pest Management approach based on cultural, mechanical and chemical control measures.

(A) Cultural and Mechanical Control:

- i. Burn all trash collected during the ginning process. Remove all seed from the ginneries by the end of April. Fumigate the seed left uncrushed in the mills before end of May with Celphos / Phostoxin / Delicia @ one 3 – g tablet per cubic metre space, giving an exposure of 48 hours or use two tables with an exposure of 24 hours. No un – fumigated seed should be retained as seed by the ginner is only cotton – seed cake (khal) should be fed to the cattle and no seed should be kept for this purpose.
- ii. The seed meant for sowing should be acid – delinted in the ginneries before it is sold. The acid – treatment kills the larvae of the pink bollworm and the bacterial pathogen of bacterial blight. It also removes fuzz and thereby facilitates mechanical sowing.
- iii. Even the apparently healthy seed – cotton (kapas) may be harbouring larvae of pink bollworm. Hence, kapas retained by the farmers should be ginned by the end of March and seed fed to cattle. If this seed is to be retained for sowing. It should be acid – delinted / fumigated or thoroughly dried in the sun in a thin layer for 3 – 4 consecutive days in April.
- iv. Sow only recommended varieties / hybrids because they are moderately resistant to jassid and due to their early maturity they also escape the late – season attack of bollworms.
- v. Terminate the crop as early as economically feasible. For this purpose give last irrigation by end of September. It would reduce bollworms damage and their carryover.
- vi. After the last picking, allow sheep, goats and other farm animals into cotton fields to feed on plant debris and un – opened bolls.
- vii. Stacking of cotton sticks in a shaded place and in horizontal position favours the survival of the over wintering larvae of pink bollworm. Stacking in the field helps in easier spread of the first brood. Therefore, bundles of sticks should be stacked vertically in the open within the village premises. Before stacking the sticks, dislodge the burs and unopened bolls by beating them against the ground or just pluck them. The burs and bolls so collected should be burnt immediately.
- viii. Uproot and destroy the alternate host plants of spotted bollworms like kanghi buti and peeli buti, growing on field bunds, water channels and waste land in the area during the off – season of cotton. Repeat these operations at monthly interval upto the end of May.
- ix. Avoid growing bhindi, moong and arhar in the cotton crop and as border rows in order to reduce the incidence of Helicoverpa, spotted bollworms, jassid and whitefly. Bhindi, moong, dhaincha and castor are also the most preferred hosts of tobacco caterpillar, helping the pest to multiply and shift to cotton. The above pests on these crops grown in the vicinity of cotton fields, should be properly controlled in order to check their migration to the cotton crop.

x. Egg masses and young larvae of tobacco caterpillar feeding gregariously should be collected along with leaves and destroyed.

(B) Monitoring of bollworms with sex pheromones:

The monitoring of bollworms should be done with the initiation of flowering stage of crop. Observations on moth catch should be recorded on every alternate day. This monitoring strategy will help in making decision for effective management of bollworms.

Pink bollworm:

Use Sticka / Delta trap with at least 10 micro litre of gossyplure and place it at 15 cm above crop canopy. Replace the lure after 15 days and use 1 trap / ha.

Spotted / Spiny bollworms:

Use Sleeve / Moth catch traps for spotted bollworms and replace the lure at 2 weeks interval. Place the trap at 15 cm above the crop canopy and use 2 traps / ha.

American bollworm:

Use Sleeve / Moth catch trap with at least 2 mg of pheromone and place it at 15 cm above crop canopy. Replace the lure after 15 days and use 2 traps / ha.

(c) Chemical Control:

(a) Sucking pests:

The decisions regarding spray of insecticides are taken based on economic threshold (ETH). Initiate spray against jassid whenever some of the fully formed leaves in the upper canopy show curling and yellowing at the margins on 50 percent of the plants. Sprays against whitefly should be done when population reaches six adults per leaf in the upper canopy of plants before 10 AM or when honeydew appears on 50% of the plants. Spray against aphid should also be done on the appearance of honeydew on 50% plants.

Table 20: Insecticides for the control of sucking insect pests

Insecticides	Dose	Brand (s)
Jassid		
(a) Seed treatment: At the time of sowing smear the seed with any of the following insecticides.		
i. Imidacloprid 70 WS	5 g/kg seed	Gaucha
ii. Thiomethoxam 70WS	3 g/kg seed	Cruiser

Table 20: Insecticides for the control of sucking insect pests

Insecticides	Dose	Brand (s)
Jassid		
(b) Spray: Spray any of the following insecticides, if incidence is noticed in standing crop.		
i. (a) Imidacloprid 200 SL	40 ml/acre	Confidor
(b) Imidacloprid 555/	40 ml/acre	Confidence
(c) Imidacloprid 17.8	40 ml/acre	Imidacel
ii. Acetamiprid 20 SP	20 g/acre	Pride/Rapid
iii. Thiomethoxam 25 WG	40 g/acre	Actara/Extra super
Whitefly		
i. Triazophos 40 EC	600 ml/acre	Hostathion
ii. Ethion 50 EC	800 ml/acre	Fosmite/E-mite/ Volthion

Note: Insecticide for jassid control is also effective against aphid

(b) Bollworms:

In order to control bollworms, conduct sprays on different varieties during their effective boll formation period based on economic threshold (ETH). Farmers should examine their fields twice a week in order to ensure that bollworms damage does not exceed 5 percent among the freshly shed fruiting bodies (squares, buds and young bolls). For this purpose divide the field into four quarters and collect 25 freshly shed fruiting bodies at random in each quarter. The fruiting bodies damaged by bollworms will have feeding holes or their larvae. In case the damage exceeds 5 percent, the crop should be sprayed immediately and thereafter spray as when need arises. The effective boll formation period of different varieties / hybrids of American cotton during which spray of insecticides should be done is as follow:

Effective boll formation period in different varieties / hybrids of American Cotton

Variety / hybrid	Effective boll formation period
LH 1556, Ankur 651 and White gold	4 th week of July to mid September
F 1378, F 846, F 1861 and LHH 144	2 nd week of August to 1 st week of October
Long duration under script varieties	3 rd week of August to October

Desi Cotton:

In case of desi cotton, the first spray against bollworms should be done when 25 percent plants start producing squares. Subsequent spray should be need based.

Detopping:

Desi cotton grown on medium to high fertility soils generally attain unmanageable height for effective spraying against bollworms. The top portion of plants with excessive height usually remains unsprayed. Fruiting bodies of these uncovered plant portions contribute very little towards yield but greatly help in bollworms build up. Plants attaining height more than 1.5m should be detopped as and when required by using pruning scatteur / sickle / green mulberry stick.

Insecticide Resistance Management (IRM) Strategy:

IRM is component of Integrated Pest Management (IPM) programme. The adoption of this strategy helps in reducing / delaying the insecticide resistance to insects. It also increases function life of the insecticides.

1. Sucking pests management (Sowing – first week of July):

- Sow recommended varieties which are resistant to sucking pests and cotton leaf curl virus to avoid early sprays.
- Destroy alternate hosts of cotton leaf curl virus and whitefly.
- Timely sowing, judicious use of fertilizers, irrigation, proper spacing and clean cultivation will prevent the early build up of pests and help conserve natural enemies.
- Treat seed with Gaucho / Cruiser to control the cotton jassid in susceptible cultivars. Do not use any insecticide during this period to conserve natural enemies.
- Do not spray against thrips and black semilooper, as they do not cause any economic damage to the crop.

2. Sucking pests and bollworms management (Second week July – first week of August):

- Use endosulfan for bollworms infestation as it is less toxic to natural enemies. It gives moderate control of cotton jassid also.
- Avoid the use of synthetic pyrethroids for the control of spotted bollworms (SBW). Use them only if endosulfan fails to give satisfactory control.
- Avoid the use of nitogvadine compounds against jassid as these are toxic to natural enemies.
- Do not use organophosphates / carbamates against bollworms.

3. Bollworms and tobacco caterpillar management (Mid to end August):

- Use profenophos / quinalphos / carbaryl in alternation with synthetic pyrethroids for the control of bollworms.
- Prefer the use of acephate for the control of grown up larvae of American bollworm. It will also provide effective control of tobacco caterpillar.
- Use spinosad only in case of severe infestation of American bollworm.

4. Bollworms and tobacco caterpillar management (September – October):

- Use profenophos / triazophos / quinalphos / thiodicarb for younger larvae of American bollworm. Prefer chlorpyrifos for grown up larvae. Chlorpyrifos, thiodicarb and quinalphos will also provide effective control of tobacco caterpillar.
- Use indoxacarb / spinosad in case the American bollworm is serious.
- Use triazophos / ethion for the management of whitefly. It will also provide effective control of pink bollworm and spotted bollworms.

Table 21: Insecticide for the control of bollworm in cotton

Insecticides	Dose per acre	Brand (s)
Pink and spotted bollworms		
A. Synthetic Pyrethroids		
i. Alphamethrin 10 EC	100 ml	Fastac/Alphagaurd/Merit Alpha
ii. β -cyfluthrin 0.25 SC	300 ml	Bulldock
iii.(a)Cypermethrin 10EC	200 ml	Ripcord/Bilcyp/Bullet/Ustad/Cypergaurd
(b) Cypermethrin 25EC	80 ml	Cymbush/Cyperkill/Hillcyper/Colt/Basat hrin/ Agrocyper/Cypergaurd
iv. Deltamethrin 2.8 EC	160 ml	Decis/Rukrain/Decicare
v. Fenvalerate 20 EC	100 ml	Sumicidin/Fenval/Agrofen/Fenlik/Trium phcard/ SB
vi. Fenpropathrin10EC	300 ml	Fenvalerate/Milfen/Markfenval Mesthrin
Pink, spotted and younger larvae of American bollworm		
A. Carbamates		
i. Carbaryl 50 W	1 kg	Sevin/Hexavin
ii. Thiodicarb 75 WP	250 g	Larvin
B. Organochlorinate		
iii. Endosulfan 35 EC	1 litre	Thiodan/Endocel
C. Organophosphates		
iv. Profenophos 50 EC	500 ml	Curacron/Carina/Profex/Celcron
v. Monocrotophos 36 SL	500 ml	Corophos/Milphos/Markphos/Nuvacron/ Phoskill/Monocil/ Monolik/Kadett/SB Monocrotophos/ Luphos/Azophos
vi. Quinalphos 25 EC	800 ml	Ekalux/GAIC Quinalphos/Quingaurd
vii. Triazophos 40 EC	600 ml	Hostathion
viii.Ethion 50 EC	800 ml	Fosmite/E-mite/Volthion
Grown up larvae of American bollworm		
A. Organophosphates		
i. Acephate 75 SP	800 g	Orthene/Asataf/Starthene
ii. Chlorpyriphos 20 EC	2 litres	Coroban/Dursban/Durmet/Chlorgaurd/R adar/ Lethal/Force
B. Naturalyte		
iii. Spinosad 48 SC	60 ml	
C. Oxadiazine		
iv. (a) Indoxacarb 15 SC	200 ml	Tracer
(b) Indoxacarb 15 EC	200 ml	Avaunt

Table 21: Insecticide for the control of bollworm in cotton

Insecticides	Dose per acre	Brand (s)
Tobacco caterpillar		
A. Carbamate i. Thiodicarb 75 WP	250 g	Larvin
B. Organochlorinate ii. Endosulfan 35 EC	1 litre	Thiodan/Endocel
C. Organophosphates ii. Acephate 75 SP iv. Chlorpyrifos 20 EC	800 g 2 litres	Orthene/Asataf/Starthene Coroban/Dursban/Durmet/Chlorgaurd/R adar/ Lethal/Force
v. Quinalphos 25 EC	1 litre	Ekalux/GAIC Quinalphos/Quingaurd

Note:

- Regularly monitor the pest population.
- For effective insecticide resistance management do not repeat the insecticide of same group in subsequent sprays.
- Do not use mixtures of insecticides as they will result in faster development of resistance and resurgence of pests.
- Do not use synthetic pyrethroids on cotton for the control of bollworm complex after mid September.
- Repeat the spray immediately if it rains within 24 hours after spray.
- If hairy caterpillars damage cotton crop during June – July use 500 ml endosulfan 35 EC / quinalphos 25 EC or 200 ml of Nuvan / DDVP 100 in 100 litres of water per acre.
- Never follow the wrong advice of the pesticide dealers.
- Cotton is highly sensitive to the 2, 4 – D weedicide. Some farmers spray the ester form of 2, 4 – D for controlling weeds in maize grown near the cotton fields. Owing to the volatile nature of 2, 4 – D ester, its vapours cause serious injury to the cotton crop. Hence avoid the application of this herbicide in maize, if cotton is grown in the adjoining fields. The other precautions are:
 - After using 2, 4 – D on any crop, fill all spraying equipment as well as tubs, buckets, etc. with 0.5 percent washing soda solution (500 g of washing soda in 100 litres of water) in the evening. Next morning, flush all equipment thoroughly with fresh water.
 - To avoid the use of contaminated insecticides on cotton. It is advisable to test two weeks in advance on a few plants. If the insecticide is contaminated with 2, 4 – D the tender leaves and shoots could become distorted and lancolated within 10 days. Reject such an insecticide.

Performance of various insecticides against insect pests and safety to natural enemies of cotton

Insecticides	Insect Pests						Natural enemies	Remarks
	J	W	PBW/ SBW	ABW		TC		
				Young	Grown up			
A. Organochlorinate								
Endosulfan	Good	Good	Good	Good	Poor	Very good	Safe	Safer to the natural enemies, low resistance in American bollworm early in the season
B. Organophosphates								
Monocrotophos	Good	Poor	Good	Poor	Poor	Poor	Highly toxic	Excessive use can cause resurgence of whitefly and American bollworm
Profenophos	Poor	Poor	Good	Good	Poor	Poor	Toxic	-
Quinalphos	Poor	Poor	Good	Good	Poor	Very good	Toxic	Excessive use can cause resurgence of jassid
Chlorpyriphos	Poor	Poor	Good	Very Good	Very good	Very good	Highly toxic	Excessive use can cause resurgence of jassid
Acephate	Good	Poor	Good	Very Good	Very good	Very good	Toxic	Excessive use can cause resurgence of whitefly and American bollworm
Triazophos	Poor	Very good	Good	Good	Poor	Poor	Toxic	-
Ethion	Poor	Very good	Good	Good	Poor	Poor	Toxic	-
C. Synthetic pyrethroids								
Alphamethrin, β -cyfluthrin, cypermethrin, deltamethrin, fenvalerate	Poor	Poor	Very good	Poor	Poor	Poor	Toxic	Excessive use can cause resurgence of whitefly and American bollworm, high level of resistance in American bollworm
D. Carbamates								
Carbaryl	Poor	Poor	Good	Good	Poor	Poor	Toxic	Excessive use can cause resurgence of mite
Thiodicarb	Poor	Poor	Good	Good	Poor	Very good	Toxic	Excessive use can cause resurgence of 18 mite
E. Naturalyte								
Spinosad	Poor	Poor	Good	Very good	Very good	Poor	Safe	Safer to the natural enemies
F. Oxadiazine								
Indoxacarb	Poor	Poor	Poor	Very good	Very good	Poor	Toxic	-

J= Jassid, W = Whitefly, SBW = Spotted bollworm, PBW = Pink bollworm, ABW = American bollworm and TC = Tobacco caterpillar.

Spray Technology:

The insecticides recommended for control of sucking pests bollworms and tobacco caterpillar should be sprayed using 125 – 150 litres spray material per acre with the manually operated knapsack sprayer of 75 litres with the shoulder mounted power sprayer and tractor mounted sprayer. Quantity of spray material may vary with different types of sprayer and nozzles. However, actual amount of insecticide recommended should be reduced.

Making pathways by pressing the branches on both sides helps in efficient spraying. Make such pathways at 2 metres distance for the manually operated knapsack sprayer and at 4 metres for the shoulder – mounted power sprayer.

Tractor mounted sprayer should have 13 triple action nozzles fixed on the boom at 75 cm distance from each other. Each zone should discharge 500 – 600 ml spray material per minute. The tractor should be operated at 4.0 and 2.5 km per hour speed for spraying against sucking pests and bollworms, respectively. Use the same tyre tracks and run the tractor in the same direction for all sprays. Keep the spray boom about 50 cm above the crop canopy. Each run of the tractor should cover about 10 meters width of the crop.

Diseases:

Leaf Curl:

Disease is caused by whitefly transmitted virus. The diseased plants become stunted and have twisted internodes. Leaves remain small, show cupping and curling. Veins on the lower side of the leaves become thickened with netted appearance. Small leaflets (enations) also develop on the under side of the leaves on the main as well as lateral veins. Numbers of fruiting bodies are reduced in the diseased plants.

The disease can be reduced by adopting the following measures:

- i. LHH 144 and desi cotton varieties are resistant to leaf curl virus. LH 1556, Ankur 651, Whitegold and F 1861 are tolerant to this disease.
- ii. Avoid growing American cotton in and around citrus orchards and adjoining bhindi crop.
- iii. In American cotton use 4 kg seed per acre and go on uprooting and destroying the infected plants upto initiation of fruiting phase.
- iv. Protect the crop against whitefly vector at 4 – 5 leaf stage by using recommended insecticides.
- v. Follow clean cultivation and destroy Kanghi buti (*Sida* sp.) and Peeli buti (*Abutilon* sp.) which act as collateral hosts.
- vi. Destroy volunteer / ratoon cotton plants during the off season.

Root rot:

This disease is caused by *Rhizoctonia solani* and *R. bataticola*. The main symptom is sudden and complete wilting of plant. The disease spreads in field in round patches. The affected plants can be pulled out very easily. The disease starts much early but wilting takes place quite late. The bark of the roots is broken into shreds and gives foul smell.

Bacterial blight:

It is caused by *Xanthomonas axonopodis* pv *malvacearum* which survives in seed and plant debris. Lesions on the leaves appear as minute, water – soaked, angular spots, which subsequently turn brown and then are transformed into black angular dead lesions on both sides of the leaf. The bacterium also infects the young developing bolls and causes small, round, water soaked spots depressed in the centre. Spray will Blitox 50 (500g) + Agrimycin (20g) / Streptocycline (3 g) per acre at 15 – 20 days interval starting just after the first shower of rain. Three sprays will be enough. These chemicals can be mixed with the pesticides recommended for the control of insect pests after consulting compatibility chart. The quantity of water will depend upon the crop growth and the spray pump to be used.

Anthracnose:

It is caused by *Glomerella gossypii* which survives on crop debris in the soil. It produces small, round reddish spots on leaves, bracts and bolls. The disease is severe at the seedling stage.

Leaf blight:

The disease is caused by *Helminthosporium speciferum*. The fungus generally attacks the seedling causing pre and post emergence deaths. Light brown spots occur on the leaves. During severe infection, there is shedding of leaves, flowers and bolls.

The fungus *Alternaria gossypina* also causes blighting of the leaves. In the early – stages, the spots have a pale green area with irregular margins. As the spots enlarge, irregular concentric zones are formed. Sometimes severe shedding of leaves occur due to this disease. The plants with low vigour because of drought or deficiency of potash favour the development of this disease.

Leaf spots:

The disease is caused by *Myrothecium roridum* and the symptoms appear on leaves, bracts as well as on bolls. The disease is characterized by circular to semicircular brown coloured spots with broad violet margins. At later stages, shield shaped, small size fruiting bodies appear in the central necrotic portion of the spot. The pathogen is a seed borne and also survives on the dead leaves. High humidity and intermittant rains are congenial for the development of the disease. Another type of leaf spot disease which is caused by *Cercospora* sp. generally appears towards the end of the season. It produces small, circular spot having white purple margin. In advance stages, necrotic central portion may fall out giving shot hole appearance.

To control anthracnose, leaf blights and leaf spots, the crop should be sprayed alternately with Blitox 50 or Captan 83 (500 g in 200 litres of water) at interval of 15 to 20 days starting just after the first shower of rain. Two to three sprays will be enough.

Wilt:

It is a fungal disease caused by *Fusarium oxysporum* f.sp. *vasinfectum*. The pathogen of disease is both soil and seed – borne. In the diseased seedlings and plants, the leaves lose their turgidity, first turn yellow, then brown, start wilting and finally drop off. Discoloration of the leaves start from the margins and spreads towards the mid – ribs. The older leaves are affected first, followed by the younger ones towards the top. Wilting may be complete or partial.

In the later case only one side of the plant is affected while the other remains apparently healthy. In complete wilting, the plant remains stunted, wilt rapidly and dies. The most prominent diagnostic symptom of the disease is browning and blackening of the vascular tissues. Five to six year rotation with non – host crops may help in controlling the disease. In the infested field, sow LD 694 variety of desi cotton since the same is tolerant to wilt. In the highly infested fields grow American cotton because it remains free from this disease. For the chemical control of wilt soak 3 kg seed in 6 litres of water containing 6 g of Bavistin / Derosal for 6 – 8 hrs. (non delinted seed) or 2 – 3 hrs (acid delinted seed).

Grey mildew:

Grey mildew or dahiya disease caused by *Ramularia areola* occurs sporadically during humid weather. It appears on leaves as dull white, irregular, translucent spots bordered by veinlets with frosty growth on the lower surface of the leaves. It may cause defoliation and premature boll opening.

Tirak:

It is a physiological disorder. It is characterized by the yellowing and reddening of leaves, followed by the bad opening of the bolls. The disease appears now and then the attack is more pronounced in the dry belt adjoining Rajasthan and Haryana. It is particularly serious in pockets where cotton suffers from persistent drought, inadequate water supply, nutrient deficiency on light sandy drought, inadequate water supply, nutrient deficiency on light sandy soils, too early sowing or lack of plant protection measures. These factors may operate singly or in different combinations. Spells of high temperature prevailing during the flowering and fruiting further aggravate the intensity of this malady. Judicious fertilization and timely watering particularly during flowering and fruiting stages and the adoption of recommended plant protection schedule help to mitigate the intensity of this disease.

Picking:

Cotton should be picked clean and dry to get a good price in the market. Desi cotton is ready for picking in the third week of September. Picking should be done after every 8 – 10 days to avoid loss because of the Kapas falling to the ground. Do not keep the picked cotton in wet water channels in the field, as this practice impairs the quality of cotton. Store kapas in a dry godown. Keep produce of different varieties separately.

Removal of cotton sticks:

Soon after the last picking, remove the cotton sticks along with the roots from the field and bury the remaining plant debris with furrow turning plough as sanitary measure against pests and diseases. Use or burn cotton sticks by the end of February at the latest.

Use two – row tractor operated Cotton Stalk Uprooter for uprooting of Cotton stalks. The Cotton Stalk Uprooter should be operated at a speed of 7 to 9 km/hr and at a depth of 12 to 15 cm with 45hp tractor for efficient field operation. This equipment will provide 10 to 15% more cotton sticks by weight than conventional manual stalk chopping method with a field capacity of 1.25 to 1.50 acre/hr.

Marketing Hints:

- 1) Kapas should be picked dry, with covered head free from trash, with no dew on it.
- 2) The first and the last picking are usually of low quality and should not be mixed with rest of the produce. High – grade kapas mixed with low grade kapas sells at a relatively low price.
- 3) Store kapas in damp proof and rat – free room.
- 4) Store different varieties separately.

Improved Varieties:

American Cotton:

RCH 134 Bt:

It is high yielding, intra – hirsutum Bt Cotton hybrid resistant to spotted bollworm and American bollworm. It has broad lobed green leaves, 2 – 3 monopods and 25 – 26 sympods. It matures in 160 – 165 days. Its boll size is 3.8 g with good fluffy opening. It gave average yield of 11.5 q/acre seed cotton. It has very good fibre properties with 27.7 mm 2.5% span length, 25.0 g/tex fibre strength and 34.4% ginning outturn.

RCH 317 Bt:

It is high yielding, intra – hirsutum Bt cotton hybrid resistant to spotted bollworm and American bollworm. It has broad lobed green leaves with 2 – 3 monopods and 26 – 27 sympods. It matures in 160 – 165 days. It has boll size of 3.7 g with good fluffy opening. It recorded average yield of 10.5 q/acre. It has 28.6 mm 2.5% span length and 33.9% ginning outturn.

MRC 6301 Bt:

It is high yielding, intra – hirsutum Bt Cotton hybrid resistant to spotted bollworm and American bollworm. It has green broad leaves, 3 – 4 monopods and 24 – 25 sympods. It gave average yield of 10.0 q/acres seed cotton and matures in 160 – 165 days. It has good boll size (4.3g) with good fluffy opening. It has 28.3 mm 2.5% span length and 34.7% ginning outturn.

MRC 6304 Bt:

It is high yielding, intra – hirsutum Bt cotton hybrid resistant to spotted bollworm and American bollworm. It has green broad lobed leaves, 2 – 3 monopods and 26 – 27 sympods. It matures in 160 – 165 days. It has boll size of 3.9g and has good fluffy opening. It gave an average yield of 10.1 q/acre seed cotton. It has good fibre properties with 2.5% span length of 29.0 mm and 35.2 percent ginning outturn.

Ankur 651:

This is an intra – hirsutum leaf curl virus resistant and jassid tolerant hybrid having small leaves with broad lobes. It is short, compact, early and sympodial. It has one monopod and 23 – 25 sympods and of about 97 cm plant height. It matures in about 170 days and is suitable for cotton – wheat rotation. It recorded an average seed cotton yield of 7 q/acre. It has 28 mm medium staple fibre and 32.5% ginning outturn.

Whitegold:

It is an intra – hirsutum hybrid tolerant to leaf curl virus disease with dark green broad lobed leaves. It has 1 – 2 monopods and 20 – 22 sympods with 125 cm plant height. Its maturity period is 180 days. Average seed cotton yield is 6.5 q/acre. It has 29.4 mm staple length and ginning outturn is 30%.

LHH 144:

This is an intra – hirsutum, leaf curl virus resistant hybrid, with semi – okra lobed leaves. It has 3 – 4 monopods, 20 – 25 sympods and about 151 cm plant height. The average boll weight is 5.5 g. Besides its resistance to leaf curl it is also tolerant to jassid and bacterial blight. It matures in about 180 days and is suitable for cotton – wheat rotation. It recorded an average seed cotton yield of 7.6 q/acre. It has 28.8 mm 2.5% span length and 33.0% ginning outturn. LHH 144 has superior medium staple fiber which is suitable for spinning at 40s counts.

F 1861:

It is a cotton leaf curl virus resistant variety recommended for cultivation throughout the Punjab State. The plant of this variety bears 1 – 2 monopods with 13 – 16 sympods and has an average plant height of 135 cm. It has dark green broad lobed leaves with narrow tips slightly curved upwards. Its maturity period is 180 days. It recorded an average seed cotton yield of 6.5 q/acre. It has medium staple with 2.5% span length of 26.3 mm. Its ginning outturn is 33.5% and is spinnable at 30s counts.

F 1378:

It is a high yielding, semi – sympodial variety, the plant bears 0 – 2 monopods with 19 – 20 fruiting branches and has an average plant height of 150 cm. It has light green broad lobed flat leaves and big round bolls with good fluffy opening. Its maturity period is 180 days. It recorded an average seed – cotton yield of 10 q/acre. It has medium staple with 2.5% span length of 26.2 mm. Its ginning outturn is 35.5 percent.

F 846:

This is semi – spreading, high yielding variety. The average plant height of the variety is about 134 cm with strong main stem. The plants bear 2 – 3 monopods with 18 – 20 fruiting branches. It has green broad lobed leaves and big round bolls with good fluffy opening. Its maturity period is about 180 days. The average yield is about 11 quintal kapas/acre. The ginning outturn is 35.3 percent with 2.5% span length of 25.8 mm. It is suitable for spinning at 30s counts.

LH 1556:

It is short duration, early maturing variety of cotton. It is semi – sympodial in growth habit with 1 – 2 monopods and plant height of 140 cm. It has light green medium sized leaves and round bolls with good fluffy opening. Its 2.5 percent span length is 27.7 mm and is suitable for spinning at 40 counts and gins 34.0 percent. It matures in about 165 days. Its seed cotton yield is 8.5 quintal/acre.

Desi Cotton

Moti:

It is a new Fusarium wilt tolerant male sterility based desi cotton hybrid. It has green plant body, semi sympodial, bushy habit of growth, average plant height of 164 cm, narrow leaves with white flowers, large boll size with 4 – locules and good fluffy opening and easy to pick. It matures in 165 days. Its average yield is 8.45 quintal per acre. Its ginning outturn is 38.6% and fibre length is 20.5 mm.

LD 694:

It is a desi cotton variety with dark – red pigmented plant body, narrow lobed leaves, pink flowers and red spot inside the petal. It possesses big bolls with fluffy opening. LD 694 matures in about 170 days and is more synchronous in maturity than other released varieties of desi cotton. It is short staple, coarse fibre variety with ginning outturn of 40.9%. It gave an average seed – cotton yield of 7 q/acre. It is resistant to jassid and more tolerant to Fusarium wilt and bacterial blight.

LD 327:

It is a high yielding and high ginning semi – sympodial variety. The plants are reddish brown with narrow – lobed deep cut leaves and pink flowers. It possesses big bolls usually with 4 loculi, better opening and easy picking. It vacates the field in about 175 days for the timely sowing of wheat. It is relatively tolerant to Fusarium wilt. Its fibre is short, coarse and suitable for export. Its average yield is 11.5 q/acre. Its 2.5% span length is 19.0 mm and ginning percentage is 41.9.

Varieties/hybrids of American and arboreum cotton released by Punjab Agricultural University, Ludhiana

Sr. No.	Variety/hybrid	Parentage	*Year of release	Yield potential (q/ha)	Fibre length (m m)	Ginning outturn (%)	Micronaire value	Fibre strength (g/tex)	Spinnability (s Counts)	Resistance to diseases/ insect pests	Duration (days)
AMERICAN COTTON											
1.	LSS	Selection	1931	15.00	22.4	33.4	4.5	45.0	30		270
2.	320F	Selection	1951	13.70	23.1	34.6	3.2	45.6	30		270
3.	J 34	45F × L 55	1966	14.00	24.3	34.8	4.1	46.6	32	Resistant to Jassid	190
4.	J 205	J 2 × UL 48	1973	15.00	25.1	34.3	3.6	46.1	35	Resistant to Jassid	185
5.	F 414	Selection from B.N	1977	19.00	23.4	34.2	4.4	49.8	30	Resistant to Jassid	180
6.	LH 372	G 67 × Am. Nectriless	1980	16.87	24.2	33.3	4.5	47.7	30	Resistant to Jassid	180
7.	F 286	F 414 × Empire 61	1983	21.00	23.9	33.8	4.6	47.2	30		180
8.	LH 900	LH 223-480 × LH 223-343	1985	27.50	23.1	33.9	4.8	47.7	30	Resistant to bacterial blight	165
9.	F 505	F 414 × A 231	1986	24.00	24.3	34.6	4.6	48.2	30	Tolerant to jassid	180
10.	LH 886	LH 62 × EC 34859	1988	26.10	23.0	35.0	4.5	47.7	30		180
11.	LH 1134	IAN 6074 × LH 96-4	1990	27.00	27.6	35.5	4.5	47.7	40	Tolerant to jassid	175
12.	F 846	F 452 × LH 223-481	1992	27.50	25.8	35.3	4.4	45.6	30		180
13.	F 1054	F 470 × A 258	1992	28.60	26.8	34.6	4.7	48.2	30		160
14.	Fateh	LHH 660 × Suman	1994	29.00	26.0	34.2	4.8	22.6	30		180
15.	LH 1556	(LH 886 × LH 900) × LH 952	1995	24.00	27.7	34.0	4.8	49.8	40	Tolerant to CLCuV	165
16.	F 1378	(SRT 1 × F 413) × CP 32	1997	24.00	26.2	35.5	4.2	45.6	30		180
17.	LHH 144	PIL 43 × PIL 8	1997	19.10	28.8	33.0	4.6	23.1	40	Resistant to CLCuV	180
18.	F 1861	F 505 × F 380	2002	20.10	26.3	33.5	4.6	20.6	30	Resistant to CLCuV	180

ARBOREUM COTTON											
1.	231R	Selection	1959	12.80	15.5	42.0		39.1	6		180
2.	G 27	Selection	1969	15.00	16.0	38.0	7.2	42.9	8-10		180
3.	LD 133	Selection	1978	16.87	16.7	38.9	7.7	37.5	8-10		180
4.	LD 230	G 27 × 231R	1981	26.25	18.0	37.8	7.8	40.7	8-10	Tolerant to fusarium wilt	160
5.	LD 327	G 57 × (G 27 × L 124)	1987	28.50	17.0	41.9	7.4	41.8	10- 12	Tolerant to fusarium wilt	175
6.	LDH 11	G 327 × IC 30839	1994	31.30	21.8	40.1	8.5	40.7	8-10	Tolerant to fusarium wilt	175
7.	LD 491	LD 251 × Gao 20	1995	23.15	19.9	38.9	7.5				
8.	LD 694	LD 260 × LD 360									
9.	Moti	DS 5 × LD 210	2004	21.13	20.5	38.6					

*Punjab Agricultural University, Ludhiana was established during 1962.

Source: CICR, Nagpur.

7.2. Rajasthan State: Recommended Varieties/ Hybrids of Cotton

American Cotton	
Varieties	<ul style="list-style-type: none"> • RS 2013 • RS 810 • RST 9 • RS 875 • Ganganagar Ageti, Bikaneri Narma
Hybrids	<ul style="list-style-type: none"> • Maru Vikas • LHH144
Desi Cotton	
Varieties	<ul style="list-style-type: none"> • RG 8 • RG 18
Hybrids	<ul style="list-style-type: none"> • RAJDH 9

PRODUCTION TECHNOLOGIES

Package	Desi cotton	American cotton
Land & land preparation	<ul style="list-style-type: none"> o Sandy loam to clay loam o One deep ploughing followed by 2-3 harrows 	<ul style="list-style-type: none"> o loam o One deep ploughing followed by 2-3 harrows
Sowing time	1 April to 15 May	1 May To 30 May
Seed rate kg/ha	12.0	16.0 for variety, 4.0 for hybrid
Sowing method Row to row spacing Plant to plant spacing Varieties Hybrids Sowing depth	67.5 cm 30 cm 60cm 4-5 cm	67.5 cm 30 cm 60cm 4-5 cm
Thinning	25-30 DAS to maintain plant to plant distance at 30 cm for varieties and 60 cm for hybrids	25-30 DAS to maintain plant to plant distance at 30 cm for varieties and 60 cm for hybrids
Fertilizer FYM Nitrogen kg /ha Phosphorus kg/ha Potash kg/ha Zn (On soil test basis)	8 tones/ha 20-25 days before sowing 90 (50% basal & remaining in the first fortnight of August along with irrigation) 20 for varieties & 40 for hybrids (Basal) 12 kg/ha ZnSO ₄	8 tones/ha 20-25 days before sowing 80 for varieties & 150 for hybrids (50% basal, 25% at 1 st irrigation and remaining at the time of square formation along with irrigation) 40 (Basal) 20 (basal)

Weeding	First hoeing after first irrigation & thereafter 2-3 interculturing with Triphali/cultivator depending upon growth	First hoeing after first irrigation & thereafter 2-3 interculturing with Triphali/cultivator depending upon growth
Cultural	Pre-plant or pre emergence application of trifluralin @ 1.5kg/ha or pendimethalin @ 1 kg/ha	Pre-plant or pre emergence application of trifluralin @ 1.5kg/ha or pendimethalin @ 1 kg/ha
Chemical		
Irrigations	4 -5 (First at 35-40 DAS and than at the interval of 25-30 days)	5 -6 (First at 35-40 DAS and than at the interval of 25-30 days)

PROTECTION TECHNOLOGIES

Disease Control	American /Desi cotton
Root rot	<ul style="list-style-type: none"> o Summer deep ploughing o Use proper crop rotation o Application of ZnSO₄@24kg/ha helps in combating the root rot disease o Seed treatment with Tricoderma @ 4g/kg seed or Bavistine 0.2% solution or bio-agent Pseudomonas fluorescens @ 10g/ kg seed and chemical Vitavax (carboxin) 200 WP @ 3g/ kg o Soil drenching with Tricoderma@10kg/ha mixing with 50 - 200kg moist FYM (in the fields where root rot is sever)
Root rot	<ul style="list-style-type: none"> o Summer deep ploughing o Use proper crop rotation o Application of ZnSO₄@24kg/ha helps in combating the root rot disease o Seed treatment with Tricoderma @ 4g/kg seed or Bavistine 0.2% solution or bio-agent Pseudomonas fluorescens @ 10g/ kg seed and chemical Vitavax (carboxin) 200 WP @ 3g/ kg o Soil drenching with Tricoderma@10kg/ha mixing with 50 - 200kg moist FYM (in the fields where root rot is sever)
Black arm (in hirsutum cotton)	<ul style="list-style-type: none"> o Seed soaking in the solution of either Streptocyclin @ 1g/liter of water or Plantomycin @ 10g/liter of water for 8-10hrs (not more than 2 hrs in case of delinted seed) o Spray Streptocyclin 5-10 g or Plantomycin 50-100 g or Copper oxy chloride (0.3%) 300 gm in 100 liters of water
Cotton leaf curl Virus (in hirsutum cotton)	<ul style="list-style-type: none"> o Use resistant varieties RS 2013, RS 810, all the varieties of desi cotton are free from CLCV disease
Insect control	American /Desi cotton
Termites	<ul style="list-style-type: none"> o Soil treatment with 24 kg /ha dust of either <ul style="list-style-type: none"> • Quinalphos 1.5% or • Methyl parathion 2% or • Endosulphan 4%

PROTECTION TECHNOLOGIES

Insect Control	American /Desi cotton
Jassids ETL (2-3 nymph/leaf) Cultural control Biological control Chemical control	<ul style="list-style-type: none"> • Use of resistant varieties RS 2013, RS 810, BN, RST 9 • Use Chrysopa predator @ 40000/ha and repeat it at flowering stage(ETL) if required • Seed treatment with Imidacloprid 70WS @5g/kg or thiomithoxam 70WS @4g/kg delinted seed • Foliar spray of either <ul style="list-style-type: none"> • Imidacloprid 200 SL @ 0.2 ml/ l water or • Monocrotophos 36SL @ 2.0 ml/ l water or • Acephate 70SP @ 2.0 ml/ l water or • Dimethioate 30EC @ 2.0 ml/ l water or • Thiomthoxam 25WG @0.5ml/l water
White fly ETL (6-8 adults/leaf) Cultural control Biological control Chemical control	<ul style="list-style-type: none"> • Early sowing(15 April – 15May) harbored less population • Use of resistant varieties RS 2013, RS 810, BN, • Use Crysopa predator @ 40000/ha and repeat it at flowering stage if required • Seed treatment with Imidacloprid 70WS 5g/kg or thiomithoxam 70WS @4g/kg delinted seed • Foliar spray of either <ul style="list-style-type: none"> • Neem oil + liquid soap @ (5ml+1ml) l of water or • Trizophos 40EC @ 2.5 ml/ l water or • Imidaclorpid 200SL @ 0.3 ml/ l water or • Methyl demeton @ 2.0 ml/ l water or • Acetamiprid 20SP @ 0.4 ml/ l water or • Thiochloprid @ 1.0 ml/ l water or • Thiomithoxam 25WG @ 0.5 ml/ l water
Spotted boll worm ETL (1 boll worm/plant) Biological control Chemical control	<ul style="list-style-type: none"> • Use 5-7 pheromone traps/ha to catch male moths • Use Crysopa predator @ 50000/ha and repeat it at flowering stage if required • Use Tricogramma parasitoid @ 160000/ha in the evening time and repeat it 3 times at the interval of 7 days • Foliar spray of either <ul style="list-style-type: none"> • Monocrotophos 36 SL @ 2.0 ml/ l water or • Fenvalarate 20EC @ 1.0 ml/ l water or • Endosulphan 35 EC @ 2.5 ml/ l water or • Chlorpyriphos 20EC @ 5.0 ml/ l water or • Deltamethrin 2.8 EC @ 1.0 ml/ l water or • Quinalphos 25EC @ 2.0 ml/ l water or • Indoxocarb 14.5SC @ 1.0 ml/ l water

PROTECTION TECHNOLOGIES

Insect Control	American /Desi cotton
American boll worm ETL (5% floral damage) Biological control Chemical control	<ul style="list-style-type: none"> • Use 5 pheromone traps/ha to catch male moths • Use Crysopa predator @ 50000/ha and repeat it, if required, at the flowering stage • Use Tricogramma parasitoid @ 160000/ha in the evening time on the appearance of eggs on the crop • Use of NPV @0.75ml(LE)/lit of water <ul style="list-style-type: none"> • Alphamethrin 10EC @ 0.5 ml/lit of water or • Thiodicarb 75 SC @ 1.75g/ lit of water • Quinalphos 25 EC @ 0.5 ml/ lit of water or • Endosulphan 35 EC @ 2.5 ml/ lit of water or • Deltamethrin 2.8 EC @ 1.0 ml/ lit of water or • Ethion 50 EC @ 3.0 ml/ lit of water or • Beta syfluthrin 2.5 EC @ 0.75 ml/ lit of water or • Chlorpyrifos 20EC @ 5.0 ml/ lit of water or • Alfamethrin 10 EC @ 0.5 ml/ lit of water or • Spinosed 45 EC @ 0.33 ml/ lit of water or • Indoxacarb 14.5 SC @ 1.0 ml/ lit of water
Pink boll worm ETL (1 larva/plant or 10% floral damage) Chemical control	<ul style="list-style-type: none"> • Use 5 pheromone traps/ha to catch male moths • Seed fumigation with either Aluminum Phosphide • EDB ampule @ 3g/40 kg seed • Foliar spray of either • Cypermethrin 10EC @ 1.0 ml/ lit of water or • Cypermethrin 25EC @ 0.4 ml/ lit of water or • Carbaryl 50WP @ 4.5g/ lit of water or • Trizophos 40 EC @ 2.5 ml/ lit of water or • Endosulphan 35 EC @ 2.5 ml/ lit of water or • Deltamethrin 2.8 EC @ 1.0 ml/ lit of water

INTEGRATED PEST MANAGEMENT IN COTTON (IPM):-

An IPM Module was developed at Agriculture Research station, Sriganaganagar for this zone. The components of module are

- Deep summer ploughing,
- Use crop rotation
- Use of tolerant varieties,
- Planting of bio-agents conservation crop (maize + cowpea + bajra) two rows around the field at the time of first irrigation,
- Remove weeds in and around the field
- Excess use of nitrogenous fertilizers should be avoided
- Use of chemicals should strictly on the basis of ETL
- Use of pheromone traps
- Hand picking & killing of larvae of Heliothis and Spodoptera
- First two spray of neem based insecticide should be done
- One spray of each Trizophos and Indoxacarb at boll formation stage
- Use of synthetic parathyroid for the control of whitefly and American bollworm should be avoided

INSECTICIDE RESISTANCE MANAGEMENT:-

Insecticide resistance management is a component of integrated pest management. By following IRM activities, building of resistance in the insects against insecticides can be checked and insecticides can be made effective against insects for longer period. Following recommendations (window system) were included in package and practices.

S.N.	Days after sowing/Insects	Strategy	Rationale
1.	Up to 60 days for sucking pests	Sowing sucking pests resistance varieties Use the Thiomethoxam /Imidacloprid for seed treatment. Spray the Neem insecticide or Endosulfan	To avoid early sprays. To avoid disturbing beneficial insects (predator and parasite).
2.	60-90 days bollworm management	On the basis of ETL, spray of Endosulfan. Use Ha NPV/ NSKE at ETL basis.	Safe for beneficial and low initial resistance. Early broods are young & uniform and can be controlled with biorationals.
3.	90-110 days bollworm management	Use the Organophosphates/ Carbamates on ETL basis. Use any of the following : (Quinolphos or Chlorpyrifos or Profenophos or Thiodicarb or Spinosad) spray once if ETL is reached	Natural enemies population declines after 90 DAS. Resistance to Organophosphates/ Carbamates is very low at this stage.
4.	110-140 days bollworm management	Pyrethroids can be used for spotted & pink bollworms. New Chemical: Indoxacarb and Spinosad once at ETL basis. Whitefly Management: Use Trizophos or Ethion or Thiomethoxam.	Pyrethroid work best against bollworms. Indoxacarb works best on Pyrethroids resistant larvae. Never mix Indoxacarb with Organophosphates.

Characteristics of prominent cultivars:

AMERICAN COTTON:

RS 2013:

The average plant height of this variety is 125-130 cm. Flowers are of yellow in color and bolls are of medium size. Mean fiber length of this variety is 25 mm and ginning out turn 35 per cent. It matures in 165-170 days and gives 22-24 q seed cotton yield. The variety is resistant to cotton leaf curl virus disease and moderately tolerant to Jassids and American boll worms.

RS 810:

The average plant height of this variety is 130-140 cm. Flowers are of yellow in color. Bolls are of medium size, mean fiber length of 27mm and ginning out turn 35 per cent. It matures in 170-180 days and gives 22-24 q seed cotton yield. The variety is resistant to cotton leaf curl virus disease.

RST 9:

The average plant height of this variety is 130-140 cm. Foliage color is light green with light yellow flower. Number of monopods per plant varies from 4-6. The average boll weight in this variety is 3.5 g. It matures in 160 -200 days. Loss due to jassids on this variety is comparatively less and it has high ginning per cent. In this variety Ist irrigation can be delayed upto 50 days.

RS 875:

The average plant height of this variety is 100-110 cm. Number of monopods per plant varies from 0-1. Bolls are of medium size (average boll weight 3.5 g). Mean fiber length in this variety is 27mm and oil content 27 per cent, which is higher than the other recommended varieties. It matures in 150-160 days so that normal sown crop of wheat can be taken after cotton.

Ganganagar Ageti:

The average plant height of this variety is 120-150 cm. Leaves are of medium size with dark green in color. Flowers are of light yellow color. Number of monopods per plant varies from 2-3. Bolls are of medium size (average boll weight 2.5 g). It matures in 170-180 days so that normal sown crop of wheat can be taken after cotton

Bikaneri Narma:

The average plant height of this variety is 135-165 cm. Foliage color is light green with light yellow flower. Number of monopods per plant varies from 4-6. Bolls are of medium size (Average boll weight 2.0 gms). It matures in 160 -200 days.

Maru Vikas:

It is hybrid variety of American cotton. The average plant height of this variety is 135-145 cm. Leaves are of medium size with light green in color and flowers are of light yellow color. Bolls are of medium size (average weight 4.5g), mean fiber length of 27mm and ginning out turn 40 per cent. It matures in 170-180 days.

DESI COTTON

RG 8:

In this variety leaves are narrow and deeply loved. Flower are of light yellow in color with red spots on the inner side of petals. Boll are oblong in shape. This variety is comparatively early in maturity, average seed cotton yield is 20-25 q/ha and has high ginning percent.

RG 18:

It is a medium maturing (160-170 days) variety having sympodial branches. The average plant height of this variety is 130-140 cm. Leaves are violet in color with narrow loved. Flowers are of pink color with dark red spots. Boll are medium in size (average weight 2.20 g). Ginning out turn in this variety is 38 per cent and average seed cotton yield is 24-26 q/ha. This variety is tolerant to root rot disease.

RAJDH 9:

RAJDH 9 is genetically male sterility based hybrid of arboreum cotton released in the state in 2005. The height of plants is 140-145 cm and leaves are of green color. Flowers are yellow in colour with red spots on petals in side. Bolls are oblong in shape. Average seed cotton yield is 26-27 q/ha and ginning percent 39.0. The hybrid matures in 160-170 days.

Source: CICR, Nagpur.

7.3. Haryana State:

Cotton agronomy research is oriented to develop best agro technique for attaining maximum yield potential from cotton varieties and very useful recommendation for cotton production technology have been evolved under prevailing agro-climate of the State.

Time of sowing:

Cotton is grown in Kharif season in the State. Time of sowing spread over a period of April to first fortnight of June. However, in case of American cotton optimum time of sowing is May for better yields. Delay in sowing results in yield reduction. For all desi cotton varieties/hybrids, best sowing time is mid April to 1st week of May, while during May & June burning of seedling is very high. In case of American cotton variety H 1117 and hybrid HHH 223, recommended sowing time is mid April to 10th May and for H 1226 & hybrid HHH 287, the sowing time is mid May for normal hirsutum genotypes and third week of May to first week of June for compact type.

Method of Sowing:

- Before sowing seeds should be dipped in water upto 5-6 hours for better germination.
- Sowing in 4-5 cm depth.
- Seeds treated with 5 gm Emisan, 1 gm streptocyclin and 1 gm succinic acid in 10 litres of water.
- In termites affected areas seeds treated with 10 ml chlorpyrifos apart from above mentioned chemicals.
- Seed treated with carbendazim @2 gm /kg in the root rot affected areas.
- Seed treated with Imidacloprid @ 7.5 gm / kg seed to escape the crops from sucking pests upto 40-60 days.

Plant population and Geometry:

On the basis of large number of trials on different varieties following recommendation for seed rate, spacing and plant population are finalized for our state and are adopted by the farmer's of the state.

Varieties	Seed rate (kg/ha)	Spacing (cm)	Plant population per ha.
American cotton	15-20	100x20, 67.5x30	50000 49380
Desi cotton	10-12	67.5x30 67.5x60	49380 24690
Hybrid	3-5	100x40	25000

Fertilizers:

For obtaining high yield in cotton, 80-100 Kg N per ha for American Cotton and 50 kg N for desi cotton along with 30 kg P₂O₅/ha and in case of hybrid cotton, 150 kg N, 60 kg P₂O₅, 60 kg K₂O and 25 kg Zn SO₄/ha has been recommended. However, the nitrogenous fertilizer application, half quantity at squaring and half at flowering gave highest seed cotton yields. In case of hybrid split the N dose in three parts i.e. sowing, squaring and flowering stage. In sandy soil the research results have revealed that 90 per cent dose of fertilizer through soil application and 10 per cent through foliage spray at the boll development stage gave the highest seed cotton yields. Inoculation of cotton seed with C₂, M₄ and Azospirillum culture resulted into saving of 25-27 kg N/ha.

Tillage and Weed control:

Pre-planting deep ploughing every year or alternate year was found to be effective for better root development and optimum vegetative growth resulting in higher seed cotton.

Interculture through mechanical methods is a usual practice for controlling the weeds in cotton crop. However, combination of weeding with interculture gave better results over the years. Pre-emergence application of stomp @ 1.5 litre a.i./ha and post emergence application of diuron 0.5 kg + grammaxone @ 1.5 litre/ha gave better results for effectively controlling the weeds.

Integrated Weed Management:

Use of tractor drawn harrows for interculture and weeding is common in Haryana. Pendimethalin @ 1.5 Kg ai/ha + one hoeing at 35 DAS

- Before 1st irrigation 1 or 2 dry hoeing should be done.
- After first irrigation 2-3 hoeing by kasola
- Deep hoeing by tractor mounted cultivator till the crop reaches one feet height.
- The spray of basalin @ 800 ml/ acre dissolved in 200 litre water before sowing or Treflan @ 800ml/acre before germination or Stamp @ 1.0-1.5 l/acre dissolved in 200-250 litre water after sowing or Duron @ 200 gm/acres or gramaxon @ 600 ml/ acre or to be used after germination.

Irrigation:

Cotton requires 800-1000 mm water during crop period. In Haryana, though the cultivation is under irrigation condition, but normal rainfall is very helpful for obtaining optimum yields of cotton. About 4 irrigation supplying 240 mm amount of water are needed and rest of the water is fulfilled through rains during the season. The main requirement of irrigation is in the month of April, May, August and September (to avoid water stress during critical stages i.e. flowering and fruiting). Last irrigation should not be given after the opening of about 1/3rd bolls.

It is revealed from the studies that irrigation applied in furrows rather than flooding resulted in 25% saving of water and also the utilization of nutrients was more efficient.

Cropping system:

Cotton - Wheat, Cotton - Mustard, Cotton - berseem

Use of defoliant:

Some times the delayed opening of bolls resulted in low yield and little time is left for field preparation of taking next rabi crop in rotation. Defoliant hastens the boll opening. Application of Dropp @ 200 g/ha at the time of 60 per cent boll opening stage contributed significantly for increasing the effective number of bolls opening and thus seed cotton yield.

Shedding of fruiting bodies in cotton:

Studies revealed that in cotton 7-35 per cent of floral buds and 2-64 per cent of bolls shedding are due to physiological disorders and remaining shedding is attributed to insect infestation. Plant capacity to induce nitrate reductase and ethylene biosynthesis is diminished with the lowering of metabolic energy available in the abscising plant part. Such parts face internal water stress even under normal conditions and nutrients such as N and P and carbohydrates are drained out and shedding of fruiting bodies is caused.

Method of P₂O₅ application:

If Phosphorous fertilizer is not applied at the time of sowing due to any reason, then it should be applied after 1st irrigation (45-50 DAS) from DAP fertilizer through pora method. It should be 10 cm away from the cotton plants on both side.

Foliar application of nutrients:

Application of MgSO₄ +DAP (1+2%) as a foliar spray has increased 15% to 21% higher seed cotton yield over control. Three sprays would be carried out with an interval of 25 days. Spray schedule should be started at 75 days old crop. This recommendation has been accepted at the national level and at state level spray of urea @ 2% is recommended.

Pest Management:

- Avoid growing bhindi, moong and arhar in the cotton crop and as border row in order to reduce the incidence of Helicoverpa and spotted bollworms, jassids and whitefly. Bhindi, moong, daincha and castor are also the most preferred hosts of tobacco caterpillar, helping the pest to multiply and shift to cotton.
- Monitor insect pests regularly every week during vegetative phase and twice a week during reproductive phase. Use pheromone traps for monitoring bollworms.
- For whitefly control, use systemic insecticides or neem formulations. Use of yellow sticky traps or yellow sheet with greese helps in mass trapping of whitefly adults.

Disease Management:

- Application of *Trichoderma harzianum*, *Trichoderma viride* and *Gliocladium virens* in soil @0.33% (w/w basis) were effective in reducing root rot of cotton.
- Coating of seeds with bioagents @ 1.0% showed root rot reduction and yield improvement.
- Spray of Plantomycin (30-40g per acre) or Streptocyclin (6-8g per acre) and copper oxychloride (600-800 g per acre) in 150-200 litre water is recommended for the management of foliar diseases.
- In order to control boll rot, copper oxychloride or carbendazim @ 2g per litre may be added to any insecticide recommended for bollworm control.

List of released cotton cultivars released from HAU:

American Cotton Varieties (*G.hirsutum* L.):

H 777:

This variety was developed through selection of plants (Mass selection) from Bikaneri Narma (unspecified strain popular with farmer) and released for general cultivation in 1978. The release of H 777 brought a revolution for cotton cultivation in the State. Extra ordinary feature of this variety was its early maturing shorter duration habit. Its crop duration is 180 days when planted in the month of May, then crop is terminated by middle of November. Because of its early maturing habits, the farmers in the State adopted cotton-wheat rotation very successfully. This variety remained on the cotton map of the state for more than a decade. It was resistant to jassids and escape spotted as well as pink boll worm considerably by virtue of its being early in maturity and synchronous in production of flowers and fruiting bodies, and completes its life cycle before the onset of frost

Its plant grows upto 120-150 cm, bears 3-6 strong monopods, semi spreading, stem and leaves covered with hairs, flowers and pollens of cream colour and boll shape is oblong with pointed tip. Its average yield is 18 q/ha.

H 655 c:

Another American cotton variety H 655c also released at the same time in 1978. It was developed through hybridization, following pedigree method of breeding, from a cross of "02982 x PRS-74". Its boll weight was 3.2 g and far superior in fibre length and fibre properties, spinnable at 40's. The duration of the variety was 210 days, more than the other early maturing varieties. Due to this reason the farmers for cultivation under double cropping system did not prefer this variety. Its average yield is 15 q/ha.

HS 45:

It was released for early sowings (before middle of May) in the State. It was developed through hybridization involving 'H 777x M8', having 2-5 monopods, spreading, leaves medium in size, hairs on stem and leaves, flower and pollen of cream colour. Crop maturity period is 185-190 days and average kapas yield is 16 q/ha. This variety is not under seed chain presently.

HS-6:

High yielding medium maturing Narma variety HS 6 was released in 1992. It was bred through pedigree method attempting three way cross “(Bikaneri Narma x K3199) x Bikaneri Narma” after extensive testing in research and farmers trials over several locations and years. It was recommended both for early and normal planting (upto 15 May). Its plant height is 150-160 cm. It has 2-5 strong monopods, light green medium size leaves and round boll shape. Being synchronous in flowering and boll opening, less number of pickings are needed. Boll opening is fluffy and clean cotton is picked up with low trash content. Last picking is completed by the end of November vacating the fields for timely sowings of wheat. Its average yield is 20 qt./ha. It has field resistance against insect-pests and diseases (Except cotton leaf curl virus).

H 974:

Another American Narma variety, suitable for normal and late planting from second fortnight of May to 10th of June was released in 1992. Plant is bushy with 2-3 monopods, green and medium broad and flat leaf raised in the center is a distinguishing character of this variety with cream corolla and pollen. It is fairly resistant to bollworms (Pink and Spotted), jassids and tolerant to partial intermittent drought conditions. Its average yield is 1861 kg/ha. This is now not in seed chain.

H 1098:

This is the first sympodial variety released for cultivation in 1995 for Haryana State. It was bred through ‘Pedigree’ method involving three way-cross-‘(LH 354 xSBI 71) x H 777’ as parents. It is high yielding and early maturing having 165 days crop duration suitable for late sowing i.e. 10th May to 10 June, Plant is sympodial with 0-1 monopodia (can be more due to early detopping of growing shoot tip) green and broad flat leaf raised in the center, cream anther and flower. Its average yield is 1943 kg/ha.

H 1117:

It is the first cotton leaf curl viral disease tolerant variety released for cultivation in the Haryana State. This variety was developed through pedigree method from cross (H777x Ac 134) x (H 777 x GS 21). Its plants are having 4-6 strong monopods, small size cup shape hairy green leaves, cream flower and anther with pointed round bolls. This variety matures in 185 days and suitable for early and normal sowing i.e. 15 April to 15th May. Its average yield is 1918 kg/ha and potential yield is 3704 kg/ha.

H 1226:

It is the first cotton leaf curl virus disease resistant variety recommended for release for cultivation in the Haryana State. This variety was developed through Mass-pedigree method through the cross RS 2013 x H777. Its plants are having 2-3 strong monopodia, small size cup shape hairy light green leaves, yellow flower and dull creamish anther with pointed round bolls. Its petal are dark yellow at the base and light yellow at the periphery/tips. This variety matures in 170-175 days and suitable for normal sowing i.e. around 15th May. Its average yield is 2151 kg/ha and potential yield is 4292 kg/ha.

American Cotton Hybrid:

HHH 81 (Dhan Luxmi):

This is the first intra-hirsutum cotton hybrid released in Haryana in 1995. Its plants attain 150 cm. height, having 4-6 strong monopods, leaves green with hairy surface, corolla cream, yellow pollen and big boll with pointed apex. It is fairly resistant to spotted as well as Pink boll worm and other insect-pests and diseases, resistant to lodging and non-shedding, and picking is over before the onset of frost. Its average yield is 2251 kg/ha. It takes 185 days in maturity therefore sowing should be completed before 15 May. It spins at 40's.

HHH 223:

This is first cotton leaf curl virus disease resistant cotton hybrid released in 2001 for cultivation in Haryana State. Plants is tall and erect growing, leaves green, hairy, medium in size, flower colour yellowish with anthers creamy. It can be sown from 15th April to 20th May as this hybrid matures in 180 days. The average yield of this hybrid is 2124 kg/ha and potential yield is 3933 kg/ha and ginning out turn is 35.2 per cent.

HHH 287:

HHH 287 is first genetic male sterility based intra hirsutum hybrid released by State Variety Release Committee in 2005 for irrigated conditions of Haryana State. Medium height (150-160 cm) erect growing, leaves green, hairy, medium in size, corolla and anthers cream in colour, close bearing, medium boll wt. (0.4 g.). It matures in 160-170 days and farmer can plant wheat crop in time. It is resistant to leaf curl virus disease. Hybrid seed production is easy and cheap (Rs. 125/kg) in comparasion to conventional hybrids (Rs. 700/kg). This hybrid possesses ginning percent (34.2), 2.5% span length (27.8 mm), strength (22.4) and spins at 40 count. The yield potential of this hybrid is 3285 kg/ha. and average kapas yield is 2045 kg/ha.

Desi Cotton varieties (*G. arboreum* L.)

DS-1:

Desi cotton variety DS-1, developed through mutation breeding (gamma Radiation) from variety G 27 and was released in 1983. It replaced the very old desi cotton variety G 27. It is tall growing (150-190 cm) and has tendency to go taller in humid and fertile soil conditions. Its plants body colour is red. Several monopods at the base, leaves medium in size, broad, 3 to 6 lobed, outer margin of petals pink, which gives an impression of pink flower with dark red petal spot at the base or "red eyes" and yellow pollen. It is highly resistant to jassids and bacterial blights. Crop is resistant to lodging and drought, escapes from bollworms due to early maturing habits. Its fibre is coarse and short, not suitable for mill consumption, however it is quite suitable for domestic use, medical dressing and for the non-spinning purpose.

DS-5:

High yielding early maturing short staple desi cotton variety developed through hybridization (Shamli x S-44-4) was released in 1987. It has green plant body and foliage. 150 cm tall, having several monopods at the base, leaves medium size-narrow 3-5 lobed, flower (corolla) white, dark red 'eye' at the base, yellow pollen with medium size bolls.

The variety is resistant to bacterial blight and highly resistant to jassids. Its early maturing and synchronous flowering habit helps in escaping from pink boll worm damage to a greater extent. DS-5 is tolerant to shattering of seed cotton at the time of boll opening, which is an extra-ordinary feature of this variety against most of desi cotton varieties. Due to this character of the variety frequent pickings are not required and this reduces the cost of cotton pickings. Its mean yield is 2238 kg/ha.

HD 107:

HD 107 was released in 1995. It gave stable performance for seed cotton yield over varying environmental fluctuations. Its plant is semi-determinate, bears 2-3 monopods and 12-15 short sympods. Leaf lobe is narrow with deep cut, small and green leaves, cream corolla colour with yellow pollens and small light red spot on petals inside at the base. Crop duration is 170 days with last pickings in second fortnight of October. It is resistant to Jassids and fairly escape boll worms damages. It has short and coarse fibre suitable for non-spinable purposes. Mean seed cotton yield is 22 quintals per hectares. It possess 38.5% lint and 15.0 mm fibre length.

HD 123:

This variety is suitable for cotton-wheat/cotton-Raya rotation as its picking is finished about 10 days earlier than old desi cotton varieties. It matures in about 160-165 days. Its average yield is 23 q/ha. It possesses 39.5% lint and 15 mm fibre length. The stem and leaves of HD-123 are of green colour. The leaves are okra type. The flower is white and small. The height of plants is 150 cm with round bolls.

HD 324:

The state variety release committee has released new desi cotton variety, HD 324 in 2004. The average yield of this variety is 2200 kg/ha against 1719 kg/ha of HD 123 (Local check). The plant of this variety is of red colour. It possesses 3-4 monopods; small leaves with deep lobes, pink coloured flower with spotted red eyes. It is suitable for normal planting and can tolerate drought conditions. It is tolerant to insect pest and diseases. It possesses 42% lint and mean fibre length is 15.0 mm. Crop duration of this variety is 180 days. This can be planted in April and will vacate the field by the end of October

Desi cotton hybrid:

AAH-1:

The first GMS based hybrid of desi cotton and released at national level for cultivation in north zone during 1999. Its major advantage is that its seed production is cheaper because of its female parent has genetic male sterility (GMS) system. The female parent is DS-5 and the male parent is HD 266. The Hybrid plant is 150 cm in height with dark green coloured leaves having red mid rib and veins and stem. It is sown in April and cotton picking can be done by October. Its average production is 25 q/ha. Its male and female can be obtained from CCS HAU, Hisar.

Source: CICR, Nagpur.

7.4. Gujarat State:

Preparation of land:

In case of normal monsoon, the land should be prepared with 1-2 cross harrowing. This may help in conservation of moisture in the soil. If monsoon receives late, the land should be prepared with one ploughing. Deep ploughing after 2-3 years with tractor drawn implements may reduce the problem of perennial weeds in the field.

Time of sowing:

Normally, the crop is sown with the onset of monsoon in the last week of June to first week of July. Where irrigation facility is available, the crop may be sown little earlier i.e. in the first week of June. Advance sowing of the crop will give higher yield than normally sown crop.

Seed rate and spacing:

The seed requirement of the variety mainly depends upon the size of the seed and method of distance of sowing. Spacing mainly depends on the growth habit of a variety and in which condition it is to be sown i.e. irrigated or rainfed. The details of seed rate and spacing of different cotton varieties is given in **table 22**. Normally, seed should be sown at a depth of 4-6 cm according to availability of moisture in the soil.

Selection of variety:

In Gujarat, following varieties have been recommended to grow in different cotton zones

Zone	Recommended varieties/ hybrids
South Gujarat Cotton Zone	Digvijay
Middle Gujarat Cotton Zone	Digvijay , G.Cot-16, G.Cot-17 and G.Cot-23
Wagad Cotton Zone	V-797, G.Cot-13, G.Cot-21, G.Cot-12 (Surendranagar dist.), G.Cot-18 (Junagadh)
Mathio Cotton Zone	G.Cot.15 and G.Cot-19

All hybrids like Hybrid-4, G.Cot.Hy-6, G.Cot.Hy-8, G.Cot.Hy-10, G.Cot.Hy-12, G.Cot.DH-7, G.Cot.DH-9 and G.Cot.MDH-11 and hirsutum varieties like Deviraj and G.Cot.10 are recommended for whole state. The economic characters of different varieties are given in **Table 23**.

Thinning and gap filling:

To harvest good yield one should maintain proper plant population in unit area. For the purpose one should carry out operation like thinning and gap filling as and when required.

Fertilizer:

The organic manure@ 10 tonnes/ha should be applied as this will help in conservation of moisture, increase in aeration, soil drainage, microbial activity and availability of nutrients. This will also help in improvement of soil structure. The recommended doses of inorganic fertilizers for different varieties are given in **Table 22**.

Weeding and inter-culturing:

The operation of interculturing and weeding may be followed as per one's requirement. The weed should be removed by following deep ploughing in earlier stage of the crop whereas shallow ploughing in later stage of the crop. This is to avoid damage to root.

In case of chemical weed control, the field should be sprayed with 2.8 litre/ha Fluchloralin in 600 litres of water. If spraying is to be done only on the rows of the crop, the quantity of the weedicide will be lesser i.e. 1 litre/ha or 50 ml in 10 litres of water.

Irrigation:

Where irrigation facility is available, irrigation should be given 3-4 weeks after last effective rainfall. In black soils, generally irrigation should be given at an interval of 20-25 days. Where as, in sandy loam soils (GORADU), it should be given at 15 days interval; irrigation water can be saved by irrigating the crop with alternate furrow method without decreasing in the yield as compared to flood irrigated area.

In rainfed cultivation, when shortage of rainfall occurs, crop should be irrigated with one or two life saving irrigations.

Intercropping:

In cotton various intercrops like soybean, tur, urid and mung can be taken up. The recommendations emerged in Gujarat are given in **Table 22**.

Plant Protection:

Entomology:		
No	Pest/disease	Measures to be taken
1.	Bollworm complex*	Cypermethrin 10EC @ 50g ai/ha Decamethrin 2.8 EC @ 15g ai/ha Fenvalerate 20 EC @ 100 g ai/ha Alphamethrin 10 EC @ 25 g ai/ha Endosulfan 35 EC @ 875 g ai/ha Profenphos 50 EC @ 1.0 kg ai/ha Quinalphos 20 AF @ 2.5 l/ha Polytrin C 44 EC @ 1.0 l/ha Spinosad 48 SC @ 75g ai/ha Bulldock 2.5 SC@ 18g ai/ha
	*Synthetic pyrethroids should be sprayed twice @ 15-20 days interval at the peak flowering stage alternated with conventional pesticides.	
2.	<i>Helicoverpa armigera</i> **	Rimon 10 EC @ 100g ai/ha
	** The IGR is sprayed when pest crosses the ETL	
3.	Pink bollworm	Decis tablet 25% @ 10 g ai/ha (20 tab/ha), Betacyfluthrin 2.5 SC@ 18g ai/ha Spinosad 48 SC@ 50 g ai/h, Methylo-demeton @ 1.0 l/ha

Plant Protection:

Entomology:		
No	Pest/disease	Measures to be taken
4.	Aphids, Jassids, Thrips and White flies***	Imidacloprid 200 SL@ 20g ai/ha, Acetamiprid 20 SP @ 10g ai/ha, Thiamethoxam 25 WG @ 25g ai/ha, Seed treatment : Imidacloprid 70 WS @ 7.5 g/kg seed or Thiamethoxam 70 WS @ 2.8g ai/kg seed or Imidacloprid 600 FS @ 9ml/kg seed.
	***Need based application of any of the insecticides is recommended.	
5.	White flies	Triazophos 40 EC @ 0.75 Kg ai/ha
6.	Cotton pest complex	IPM strategy : <ul style="list-style-type: none"> o Seed treatment with Imidacloprid @ 7.5 g/kg seeds. o Hand collection of infected shoots with spotted bollworms in the early stage. o Planting of Maize as a inter crop (10:1), Marigold and Castor as trap crops in and around the cotton. o Installation of pheromone trap @ 5/ha. One week after germination. o Early release of Chrysoperla @ 10000 eggs or larva /ha (2 release) o Spraying of Neem form. or Neem seed kernel suspension @ 5%. o Release of Trichogramma @ 1.5 lakh/ha (3 releases). o Spraying of HNPV @ 450 LE/ha for Helicoverpa and SNPV @ 250 LE/ha for Spodoptera. o Hand collection of eggs and larva of Helicoverpa and eggs and larval masses of spodoptera from main and trap crops. o Need based application of insecticides for pests based on ETL.
Plant Pathology		
1	Seedborne diseases #	Delinting with sulphuric acid @100 ml/kg seed and seed dressing with mercuric fungicide @2-3 g/kg of seed
	# Wash the seeds thoroughly after acid delinting dry it in shade before seed dressing	

Plant Protection:

Pathology:		
No	Pest/disease	Measures to be taken
2.	Bacterial blight \$	Streptomycin sulphate @0.005% + copper oxychloride 0.2% spray Bacterial blight (<i>Xanthomonas axonopodis</i> P.v. <i>malvacearum</i>) disease of cotton causes 11.95, 11.14 and 9.26% avoidable loss in seed cotton yield of cultivars LRA-5166, G.Cot.Hy-10 and BC-68-2, respectively.
	\$ Two to three sprays at 15 days interval after disease initiation	
3.	Wilt and Root rot	Follow cultural practices like long term crop rotation, balanced application of NPK, organic manure, mixed cropping of Moth or Urid, irrigation at short intervals, green manuring and destruction of infected debris. Farmers of Gujarat growing cotton are advised to follow soil amendment with farm yard manure @ 20 tons/ha or pressmud or poultry manure @ 2 tons/ha for effective and economical management of root rot disease. Farmers of Gujarat growing cotton recommended to following seed treatment with commercially available biocontrol agent <i>Tricoderma viride</i> @ 5g/kg seed for safer, effective and economical management of root rot disease.
4	Alternaria leaf spot ®	Captafol or Mancozeb @ 0.2% spray
	® Four sprays at 20 days interval after disease initiation	

Plant Physiology:

- Seed germination (one month after processing) is not affected by picking or position of boll. Other seed quality parameters are not adversely affected by either picking or position of boll. Therefore, it is recommended to the seed producers of American cotton (e.g. G.Cot.10) that all pickings and positions are alike with respect to fulfilling certification standards of germination (65%).
- It is recommended to the cotton growing farmers especially seed producers of desi cotton that seed germination is not affected by either picking or position of boll. Therefore, all picking are alike and can be used for seed purpose.
- Under specific conditions, defoliant like Ethrel 2000 ppm or NaCl 10% solution can be used at 50% boll bursting stage for hastening maturity of crop by about a week. This would also help in getting cleaner kapas.
- Seed producers of desi cotton hybrid G.Cot.DH-9 are advised to give two sprays of 1 mM Sodium benzoate (1.44 g/10 L. @ 400 L/ha) on female parent at the initiation of crossing programme and twenty days later to get higher seed yield (F1) and economic gain (Rs. 11,065/ha) (ICBR 1:300).
- Farmers of South Gujarat growing hybrid cottons (G.Cot.Hy-6 and G.Cot.DH-9) are advised to spray the crop with 30 % or 20 % Methanol at 65 and 85 days of the germination (@ 300 L/ha and 400 L/ha to realize higher yield and better economic returns (Net profit being Rs. 3802 and Rs. 2412 and ICBR being 1:1.51 and 1:1.44, respectively for the two treatments)-Recommendation put in abeyance due to ban on Methanol.

- Acid delinting of cotton seed does not improve or advance the germination. Hence it is advised that the practice of acid delinting parent/breeder seed may be discontinued.
- Chemical defoliant thiadizuron @ 50 gm/ha at 50 percent boll bursting stage gave maximum yield of cotton without impairing the quality.

TABLE 22: RECOMMENDATION FOR COTTON CULTIVATION:

A: Agronomic Practices on cotton

[illegible]

TABLE 22: RECOMMENDATION FOR COTTON CULTIVATION:

A: Agronomic Practices on cotton

Sr No	Varieties/ hybrids	Seed rate (Kg/ha)		Spacing in cms.		Fertilizer (Kg/ha)			
1	2	3	4	5	6	7	8	9	10
20.	Intercropping of Urid and Mung with G.Cot.Hy.6	For securing higher net profit, farmers of South Gujarat Zone-II growing irrigated cotton G.Cot.Hy.6 at a distance of 120 cm between rows are advised to intercrop one row of soyabean (Gujarat-1) or Urid (Zandewal) or Mung (Gujarat- 2) between the rows(Surat).							
21.	Double cropping with G.Cot.Hy-6 and G.Cot Hy-8 and Wheat and Groundnut	For securing higher net monetary returns, farmers of South Gujarat Zone-II growing irrigated cotton G.Cot-Hy.6 and G.Cot.Hy-8 are advised to grow wheat (Lok-1) or Groundnut (GG-2) as second crops.							

Note:

SRT = Surat, BCH= Bharuch, ACH=Achhalia, VIR= Viramgam, TLD= Talod, KHB= Khedbraham, JND= Janagadh

* through two equal splits

** through three equal splits

Table 23: List of released cotton cultivars from SAU, Surat Station with Characteristics and Economic characters

Sr. No.	Varieties	Type	Year of release	Maturity days	Seed cotton yield kg/h.	2.5 % span length (mm)	G.P. (%)	Fibre fineness (mv)	LUR	Fibre strength (g/tex)	Maturity Coefficient	Spinning count
1	Digvijay	Herbaceum	1956	260	663	23.1	39.0	4.4	50	9.5(PSI)	0.75	40
2	G.Cot.17	Herbaceum	1995	200-230	1375	22.5	40.5	4.1	51	47.1(0mm)	0.79	--
3	G.Cot.23	Herbaceum	2000	190-210	1300	22.4	39.1	4.2	52	22.9(3.2mm)	0.81	16-20
4	G.Cot.16	Hirsutum	1995	135-140	1606	26.8	36.7	4.2	49	47.9(0mm)	0.83	40
5	V-797	Herbaceum	1966	260-300	787	22.6	39.9	3.9	47	7.7(PSI)	0.82	31
6	G.Cot.13	Herbaceum	1981	245-280	887	23.2	39.4	4.3	48	45.1(0mm)	0.74	30
7	G.Cot.12	Hirsutum	1981	210-220	600	24.3	36.0	4.3	46	8.4(PSI)	0.80	23
8	G.Cot.21	Herbaceum	1998	215-225	1129	23.6	42.1	5.3	48	52.8(0mm)	--	20
9	G.Cot.18	Hirsutum	1999	175-180	1535	27.4	34.0	3.6	48	17.6(0 mm)	0.85	--
10	G.Cot.15	Arboreum	1989	120-150	1108	21.1(MFL)	32.8	5.7	50	47.2(0mm)	0.78	--
11	G.Cot.19	Arboreum	1997	110-120	1101	25.4	34.5	4.4	50	50.8(0mm)	0.76	--
12	Deviraj	Hirsutum	1951	290	1250	27.4	36.3	3.7	45	7.2(PSI)	0.77	43
13	G.Cot.10	Hirsutum	1974	180	1350	24.3	35.7	4.2	48	8.9(PSI)	0.72	40
14	Hybrid-4	Hirsutum Hybrid	1971	210-230	2103 3400*	26.7	33.4	3.5	40-51	7.5-8.5(PSI)	0.70-0.80	40-60
15	G.Cot.Hy-6	Hirsutum hybrid	1980	190-210	1305 3800*	27.5(MFL)	33.6	4.2	48	8.7(PSI)	0.77	60-70
16	G.Cot.DH-7	Desi hybrid	1984	180-200	1808 2600*	21.8(MFL)	37.5	5.6	49	9.4(PSI)	0.76	28-30
17	G.Cot.Hy-8	Hirsutum hybrid	1988	170-190	1824 3775*	25.8	36.5	4.5	50	47.8(0mm)	0.83	40-50
18	G.Cot.DH-9	Desi hybrid	1989	180-200	2108	28.4	34.1	4.7	47	49.2(0mm)	0.80	40-50
19	G.Cot.Hy-10	Hirsutum hybrid	1995	190-210	1837 3805*	28.9	34.6	4.3	48	43.7(0mm)	0.83	40-50
20	G.Cot.MDH-11	Male sterility	2002	120-140	1307 2727*	23.8	36.5	5.7	51	19.0(0mm)	0.83	20-30
21	G.Cot.Hy-102	Hir x Barb.	2002	220-230	1967	34.0	33.4	3.6	48	25.3(3.2mm)	0.76	60-80
22	G.Cot.Hy-12	Intra- hirsutum	2005	175-190	1829	26.6	34.2	4.2	51	22.9(3.2mm)	0.80	40-50

*Under high care condition

Source: CICR, Nagpur.

7.5. Maharashtra State:

I. Major cropping system in the region (crop rotation / intercropping)

A. Intercropping:

- i. Cotton + Green gram / Black gram (1:1 row proportion)
- ii. Cotton + Sorghum + pigeon Pea + Sorghum (6:1:2:1 row proportion)

II. Crop season: Kharif (June to February)

III. Land preparation:

Rainfed: Ploughing once after three years

Irrigated: Ploughing every year

Harrowing: Two harrowing after Ploughing and third harrowing before sowing after receipt of monsoon rains to reduce the weed infestation

IV. Method of sowing:

A. Drilling method: For straight varieties

B. Dibbling method: For hybrids (wider spacing)

V. Soil, Seed rate and spacing:

- Normal as well as paired row cropping pattern of sowing for cotton gave similar yields hence either planting pattern can be adopted. Spacing depending upon the hybrids / variety of cotton to be sown.
- For rainfed intra-hirsutum hybrids two plants per hill produced significantly higher kapas yield than one plant per hill.
- Sowing of deshi and American cotton to the direction of North-south or EastWest was not found beneficial in increasing the yield of seed cotton under rainfed condition.

Situation	Soil type	Spacing	Density (plant /ha)
A) Irrigated cotton			
1. Hybrid	Heavy soil	150 x 90 cm	7,407
	Medium soil	120 x 90 cm, 120 x 60 cm	9,259 13,888
2. Variety	Heavy soil	90 x 60 cm	18,518
	Medium soil	120 x 60 cm or 120 x 30 cm	13,888 27,777
B) Rainfed cotton			
i) American varieties	Heavy soil	60 x 60 cm	27,777
	Medium soil	60 x 30 cm	55,555
	Medium soil	90 x 90 cm	12,345
ii) American hybrids	Heavy soil	90 x 60 cm	18,518
	Medium soil	60 x 60 cm	27,777
iii) Deshi varieties	Heavy soil	60 x 15 cm	1,11,111
	Medium soil	45 x 22.5 cm	98,765

Sr.	Particular	Seed rate (kg/ha-1)	Spacing (cm)
A	G. hirsutum		
I	PKV RAJAT	10-12	60 X 30
Ii	AKH-8828	10-12	60 X 30
Iii	AKH-081	15-20	60 X 15
Iv	DHY-286	15-20	60 X 30
B	G. arboreum		
I	AKA-5/AKA-7/AKA-8	12-15	60 X 15
Ii	AKA-8401	09-10	60 X 30
C	Hybrids		
I	PKV HY-2 AND 3	3.5-4.0	90 X 60
Ii	PKV HY-4 AND 5	4.5-5.0	60 X 60
	IRRIGATED	2.5-2.5	120 X 90
D	Arboreum hybrids		
I	PKV DH-1	3.0-3.5	60 X 45
Ii	AKDH-5	3.0-3.5	60 X 45

VI. Fertilizer:

- Cotton crop should be manured with FYM or compost at least once in 3 years at the rate of 12 to 15 tons/ha.
- The fertilizer dose of 100:50:50 (NPK) kg/ha for irrigated cotton; 80:40:40 (NPK) kg/ha for rainfed cotton hybrids and 50:25:25 NPK kg/ha both for desi and hirsutum varieties are recommended. Nitrogen should be in two splits for rainfed cotton crop i.e. 50% at sowing time and 50% at square formation stage and three split for irrigated cotton i.e. 1/3rd at sowing time, 1/3rd at one month after sowing and remaining 1/3rd at 60 DAS. While whole P and K should be applied as basal dose for both rainfed and irrigated cotton.
- The application of basal dose of fertilizer to dibbled cotton crop should be given at the time of sowing by ring method 5 to 6 cm away from dibbled seed. Delay application of basal dose of fertilizers reduces the yield of seed cotton to the tune of 10 to 40% with in late duration period of 10 to 30 DAS.
- Spraying of DAP at the rate of 2% at the time of flowering and boll development stage gave 10 to 20% higher seed cotton yield as well as avoid the redding of cotton.
- Seed treatment with azatobactor was found beneficial for cotton crop for reducing the nitrogen dose to the tune of 20 to 25 %.

Sr.	Particulars	RDF NPK (kg/ha-1)	Time of application	Method of application
A i	Hybrids Irrigated	100:50:50	1/3rd N and full P ₂ O ₅ and K ₂ O as basal, 1/3rd N after 30 DAE and 1/3rd N after 60 DAE	Ring method / Spot application
ii	Rainfed	50:25:25	1/2 N and full P ₂ O ₅ and K ₂ O as basal, 1/2 N after 30 DAE	Ring method / Spot application
B	Improved varieties of Hirsutum	50:25:0	1/2 N and full P ₂ O ₅ as basal, 1/2 N after 30 DAE	Broadcasting followed by hoeing
C	Improved varieties of arboreum	30:15:0	1/2 N and full P ₂ O ₅ as basal, 1/2 N after 30 DAE	Broadcasting followed by hoeing
D	Arboreum hybrids	50:25:25	1/2 N and full P ₂ O ₅ and K ₂ O as basal, 1/2 N after 30 DAE	Spot application / Broadcasting

Application of chemical fertilizers should be as per soil test report.

VII. Integrated Nutrient Management:

- A. Application of FYM / compost 5 t per hectare every year + 50 % RDF
- B. For Hirsutum varieties / hybrids apply 50 % RDF as basal and 4.5 t/ha lucerna topping 30 and 40 days after sowing. This INM not only save fertilizer but improve soil fertility.
- C. Application of 50 % RDF (25 + 12.5 kg ha⁻¹ N and P₂O₅) before sowing or glyricidia green foliage topping at 30 DAE @ 5 t/ha is recommended to get higher seed cotton yield and net monetary returns with the added benefit of improving physico-chemical soil properties under rainfed condition.
- D. Application of FYM @ 5 t/ha along with low fertilizer dose of 25 + 12.5 kg/ha N and P₂O₅ is recommended for cotton variety AKH-081 grown under shallow soil (less than 25 cm) to get maximum monetary benefit in rainfed condition.
- E. For cotton crop 4.5 ppm available iron content in soil and 281 ppm in youngest mature leaf at square initiation stage be considered as critical level for application of iron.
- F. Use of bio-fertilizers:
 - a. Azotobactor @ 25 gm/kg seed
 - b. PSB @ 20 gm/kg seed

VIII. Water management:

- i. Source of irrigation: Well
- ii. Method of irrigation:
 - a. Spot application for pre-monsoon cotton by crow bar method
 - b. Drip irrigation for irrigated cotton

- c. Furrow irrigation to irrigated cotton
- d. Protective irrigation by alternate furrow at critical growth stages

iii. Irrigation scheduling:

- a. Peak flowering: If there is necessity
- b. Boll development: If there is necessity
- c. Stop irrigation after boll bursting

iv. Intercultural operations:

- a. Three to four hoeing at an 15 to 20 days interval by bullock drawn implements for removing weeds, aeration and to check evaporation
- b. At last hoeing open the furrow between two rows of cotton by tying the ropes to hoe for conservation of rains

Water management for rainfed cotton:

- Sowing of cotton crop on contour ridges resulted in to good crop growth and optimum plant population both in high rainfall and low rainfall situation under rainfed condition.
- Dry sowing of cotton on flat bed or top of the ridges or by crow bar method gave higher seed cotton yield than normal sowing of cotton.
- Normal sowing of cotton on flat beds followed by earthingup at the time of each hoeing and opening of ridges and furrows at last hoeing across the slope produced maximum seed cotton yield. Hence, this practice is recommended for rainfed cotton for rain water conservation in cotton crop.

Water management for irrigated cotton:

- For irrigated cotton, irrigation at 10 to 12 days interval till the on set of monsoon is advocated. If there is a dry spell of 3 weeks or more in monsoon, gave protective irrigation to cotton crop. Use of irrigation water to cotton crop at 75-150 CPE ratio was found equally effective. Application of irrigation water at 125 IW/CPE ratio recorded higher seed cotton yield of hybrids than no irrigation and irrigation at 250 IW/CPE ratio.
- H-4 under irrigation at 125 mm CPE ratio recorded significantly higher seed cotton yield over 100mm CPE ratio and irrigations given at critical stages of growth were found more effective for producing more yield.

IX. Weed management:

- a. Keep the field weed free up to 60 days after sowing (9 weeks) by adopting three to four hoeing followed by 2 to 3 manual weedings.
- b. If labourers are problem in that area use any one herbicides from following table for control of weeds

Sr.	Common name	Trade name	Dose kg a.i. /ha	Time of application
1	Fluchlorin	Basalin 45 EC	0.75 to 1.0	Pre sowing
2	Trifluralin	Treflon 48 EC	1.0	Pre sowing
3	Pendamethalin	Stomp30 EC	1.0 to 1.5	Pre emergence
4	Diuron	Class 80 % WP	0.5 to 1.0	Pre emergence
5	Oxadizone	Ronstar 25 EC	0.5 to 0.75	Pre emergence
6	Alachlore	Lasso 50 E C	1.0 to 1.5	Pre emergence

- i. Out of these, use any one herbicide to control the weeds
- ii. Hoeing and weeding should be undertaken 30 to 45 days after sowing

X. Cotton based cropping systems:

- Normal as well as paired row sowing of cotton gives similar yields, hence either planting pattern can be adopted. Spacing depending upon the hybrid/ variety of cotton. Intercropping of urd (T9) in general (solid or paired row planting) should be adopted for getting maximum monetary returns.
- In sequence cropping system, the sequence of cotton followed by summer groundnut and cotton followed by summer sunflower were found more remunerative than other sequences.
- Cropping system of cotton intercropped with pigeon pea (6:2) gave significantly higher gross monetary returns. The next best cropping systems was cotton intercropped with soybean.

XI. Plant Protection Technology:

General behavior insect pest of cotton:

In Maharashtra state cotton crop is heavily damaged by almost 21 insect pests. Out of these at seedling stage sucking pests viz. jassids (*Amrasca biguttulla biguttulla*), Aphids (*Aphis gossypii*), Thrips (*Thrips tabaci*) cause serious damage to cotton crop. From 1985-86 onwards-white fly (*Bemica tabaci*) has also become an important sucking pest. After square formation, bollworms viz. Spotted bollworm (*Earias insulana* and *Earias fabea*), American bollworm (*Helicoverpa armigera*) and Pink bollworm (*Pectinophora gossypiella*) found to cause heavy losses in cotton crop. Occasionally red cotton bug (*Dysdercus cingulatus*) and dusky cotton bug (*Oxycarenus hyalinipennis*) found infesting cotton bolls. Incidence of leaf defoliator's viz. Tobacco leaf eating caterpillar (*Spodoptera litura*), Cotton leaf roller (*Sylepta derogata*) etc occur very rarely. Since last 10 years incidence of leaf miner (*Bacculatrix thuribiella*) is also noticed.

A) Chemical Insecticides and their doses recommended:

a) Sucking pests: (Aphids, jassids and thrips)

- Soil application of phorate 10 G @ 10 kg/ha or Imidacloprid 70 ws seed treatment @ 10gm/kg seed or Thiomethoxam 70ws seed treatment @ 4.28 gm/kg seed
- Spraying of methyl demeton 25 EC @ 8m /10lit. of water or

- Spraying of dimethoate 30 EC @ 10ml/ 10 lit of water or
- Spraying of acetamiprid 20 sp @ 15 g.a. % /ha

b) For White fly:

- Methyl demeton 25EC @ 40 ml /10 lit of water or
- Dimethoate 30 EC @ 33 ml/10lit of water or
- Trizophos 25 EC @ 10 ML /10 lit of water or
- Monocrotophos 36 WSC @ 28 ML/10 lit of water or
- Fenpropethrin 50 EC @ 10ml/10 lit. of water

c) For Bollworms:

- Endosulfan 35 /Ec @ 17 ml /10 lit of water or
- Quinalphos 25 EC @ 20 ml /10 lit of water or
- Carbaryl 50 wp @ 40 gms/10 lit of water or
- Monocrotophos 36 WSC @ 17 ml/10 lit of water or
- Phosalone 35 /ec @ 14 ml/10 lit of water or
- Spinosad 45 /sc @ 0.01 % particularly for American and spotted bollworm
- Beta-cyfluttrin 2.5 EC @ 0.0025 % particularly for pink bollworm

d) Synthetic pyrethroids recommended for bollworms:

- Cypermethrin 10 EC @ 7.5ml/10lit of water or
- Cypermethrin 25 EC @ 3.0 ml/10 lit of water or
- Fenvalerate 20 EC @ 6 ml/10 lit of water or
- Decamethrin 2.8 EC @ 9ml/10lit of water or
- Fluvalinate 20 EC @ 4.5 ml / 10 lit of water

B) Biological Agents Recommended:

- Release of Trichogramma chilonis egg parasitoid @ 1.5 lakh/ha
- Release of chrysoperla carnea eggs @ 10000/ha
- Spray of HaNPV @ 250-500 LE/ha for H. armigera

C) Botanicals Recommended:

- Neem seed extract 5 %
- Spray of azadiractin 300 ppm @ 5 ml/L of water
- Spray of azadiractin 10000 ppm @ 1 ml/lit or azadiractin 1500 ppm @ 2.5 ml/L

D) IPM:

Economic threshold levels for major pests of cotton

Sucking pests:

- Aphids - 10 aphid nymphs/plant or 15-20 % aphid infested plants
- Jassids - 2 to 3 / leaf

- Thrips - 10 thrips/leaf
- Whitefly – 8 to 10 adults or 20 bthrips/leaf
- Aphids, Jassids and thrips together- 10 insects/leaf

A) Bollworms :

- American bollworm: one egg or larva/plant or 5 to 10 % damage in green fruiting bodies (squares, flowers and green bolls)
- Spotted bollworm: 5 to 10 % damage in green fruiting bodies (squares, flowers & green bolls)
- Pink bollworm: 5 to 10 % green boll damage
- Bollworm complex: 5 to 10 % damage in green in green fruiting bodies (squares, flowers and green bolls)

COTTON PATHOLOGY:

- All most all arboreum cotton varieties were found disease resistant to Para wilt (New wilt) of cotton.
- The fungicide calixin 0.1% (N-tridecyl-1,2, 6 dimethyl morpholin) was found most effective to control the gray mildew of cotton.
- Copper oxy-chloride 0.25% + Agrimycin-100 ppm recommended for control of bacterial blight of cotton.
- Carbendazim 0.1% found most effective to control the boll rot of cotton.
- Seed delinting with sulphuric acid + seed treatment with thairum 2-3 gram/ kg seed Found most effective in reducing the seedling mortality of cotton.
- The crops of Bhendi, Brinjal and Tomato acts as alternate host for the fungus Alternaria so it is suggested that these host plants should not be planted near the cotton crop for minimize the Alternaria leaf spot incidence on the cotton crop
- Identification of races of *Xanthomonas compastris* PV. *Malvaceum*. In this trial the race No. 10 was identified from NH-452, NHH-44, NHH-302 and PH-93 cotton varieties / hybrids.

PROFORMA FOR VARIETY/ HYBRID RELEASED FOR CROPS

S.N.	University	Name of variety/ Hybrid		Year of release		Duration			Yield (kg / Ha)	Recom- mende d state	Disease reaction	Insect Pest reaction	Salient features
		Variety	Hybrid	Center	State	Early	Medium	Late					
1	C.R.S., Nanded M.A.U., Parbhani		NHH-44	CRS, Nanded	M.S. 1983		150-160 days		1200	Mahara shtra	Rasistant to Bacterial blight, Alternaria leaf spot	Tolerant to sucking pests	Good rejunvation capacity, wider adaptability
2			PHH-316	CRS, Parbhani	M.S. 1999		150-160		1400	Mahara shtra	-“-	-“-	Semi- erect, open plant type ,High GOT(38%)
3		NH-452		CRS, Nanded	M.S. 1995		150-160		1500	Mahara shtra	-“-	-“-	Resistant to sucking pests, tolerant to drought
4		NH-545		CRS, Nadned	M.S. 2002		150-160		1600	Mahara shtra	-“-	-“-	-“-
5		PA-255		CRS, MB Farm, Parbhani	M.S. 2002		150	15 00		Mahara shtra	-“-	-“-	Good fibre properties long staple arboreum

Source: CICR, Nagpur.

7.6. Andhra Pradesh:

Recommended Cultivars:

Varieties (hirsutum) : MCU 5, LRA 5166, Kanchana (LPS -141), L 389, L 603, L 604 & NA 1325(Narasimha)

Desi : Aravinda, MDL 1875 (Veena)

Hybrids: H 6, JKHyl, H 8, LAHH 4, NHH 44, Savitha, DCH 32 and NSPHH 5

Prominent cultivars in cultivation:

Varieties:

Variety/ Hybrid	Year of Release	Yield (q/ha)	Duration (days)	Ginning percentage	2.5 Span Length (mm)	Cou nts	Remarks
LK 861	1993	25-26	170	34	29	50	Immune to whitefly
LPS141	1987	24-25	170	34	26	40	Resistant to whitefly
L 389	1993	25-30	160-170	35.5	29	50	Resistant to whitefly
L603	1997	25-30	150-160	35	28	40	Resistant to whitefly
L604	1997	25-30	150-160	36	27	40	Resistant to whitefly
MCU 5	1968	28	160-180	34	30	60	Tolerant to jassids
LRA 5166		26	160-180	35	24	40	Tolerant to jassids
NA 1325 (Narasi mha)		18	160	36.2	25.6	30- 40	Tolerant to jassids

Hybrids:

Variety / Hybrid	Year of Release	Yield (q/ha)	Duration (days)	Ginning percentage	2.5 Span Length (mm)	Counts	Remarks
LAHH4	1997	35	160-170	35	27	40	Wider Adaptability
NSPHH 5	2002	32-35	160-165	35	29	40	Resistant to BLB, Cercospora
NSPHH 7	2006	34-35	160-170	36	32	40	Resistant to jassids (Pre released)
H 6	1979	35	180	36	27	50	Long staple cotton
JKHy 1	1976	34	180	36	26	40	
H 8	1988	35	165	34	25	40	Superior medium staple
LAHH 4	1997	35	160-170	35	27	40	Wider adaptability
NHH 44	1983	34	160	34	25	40	Suitable for delayed sowing
Savitha	1987	34	170	34	28	50	-
DCH 32	-	35	200	31	33	80	Superior long staple

Soil / Areas: Deep black soils and Red soils with irrigation

Land preparation: For rainfed cotton, deep ploughing or sub soiling once in 3 to 4 years with disc or mould board plough facilitates deep infiltration of water and charging of soil profile with large quantities of water. The land has to be ploughed 2 to 3 times and work with harrow to bring the soil to good tilth. Seeds can be dibbled at the intersecting points of lines made with markers. For irrigated crop ridges and furrows are to be formed at recommended spacings after deep ploughing.

Seed and Planting method and time:

Region	Seeding time	Seed rate	Spacing (cm)		Method
			Row to row	Plant to plant	
Desi cotton					
Mungari Rayalaseema	Last week of May to first week of June	4-5	60	22	Drilling
Hingari Rayalaseema	Mid August to mid September	4-5	60	22	Drilling

Seed and Planting method and time:

Region	Seeding time	Seed rate	Spacing (cm)		Method
			Row to row	Plant to plant	
Western Rayalaseema	Mid September	4-5	60	22	Drilling
Adilabad Gaurani tract	June to July	4-5	60	30	Drilling
American varieties					
Red soils of costal AP	Mid June	3-4	90-105	45-60	Dibbling
Black soils of costal AP	July to August	3-4	90-105	45-60	Dibbling
Hingari region of Rayalaseema	August to September	4-5	60	30	Drilling
Hill slops of Telangana	June to July	4-5	75	30	Drilling
Shriramsagar area of Telangana	June to July	3-4	90-105	45-60	Dibbling
Nellore and Prakasham district	February	3-4	60-75	45-60	Dibbling on Ridges and furrows
Hybrids					
Red soils of costal AP	Mid June	0.75-1	120	60	Dibbling
Black soils of costal AP	July to August	0.75-1	120	60	Dibbling
Black soils of Rayalaseema	July to August	0.75-1	120-150	45-60	Dibbling
Telangana	June to July	0.75-1	90-120	60-90	Dibbling

Seed treatment:

For acid delinting seed should be treated with 80-100 ml H₂ SO₄ per 1kg of seed for 2-3 minutes followed by thorough washing with water 2-3 times and to remove the acid, it should be washed with lime to neutralize. Seed dressing with appropriate insecticide, Imidachloprid 70 WS @ 5 g/Kg or Thiomethoxam 70 WS @ 4g/kg or Carbofuran SD @ 40 g/kg of seed. Seed treatment with Paushamycin/Plantomycin 100 mg + Carboxin 1 g/lit of water and allow to soak for 6-8 hrs and then shade dry.

Inter cropping:

Monocropping of cotton and heavy dependence on chemical fertilizers should be avoided in order to maintain stability of cotton production. Some suggested inter crops in cotton and black gram / green gram / soybean in 1:2 ratio.

Thinning and gap filling:

Gap filling should be done 10 days after sowing. Excess seedlings should be removed within three weeks, retaining 2 plants per hill in case of varieties, one plant per hill in case of hybrids.

Cropping systems:

Cotton-soybean-groundnut system has been found more remunerative than cotton monocropping. Cotton-groundnut intercropping in 1:2 ratio is more profitable than sole crop of cotton.

Fertilizers recommended for different regions of Andhra Pradesh

Region	Recommended dose (kg / acre)			Method
	N	P	K	
Costal AP				Phosphorus fertilizer must be applied as basal dose. Nitrogen and potash should be applied in three equal splits at 30, 60, 90 days after sowing, 7-10 cms away from plants in Rayalaseema for American varieties under hybrid conditions only Nitrogen should be applied in two splits i.e. 30 and 60 days after sowing
American varieties	36	18	18	
Hybrids	48	24	24	
Rayalaseema				
Desi cotton	8	8	-	
American rain fed	16	8	8	
American irrigated	36	18	18	
Hybrids	48	24	24	
Telangana				
Desi cotton	16	8	8	
American	36	18	18	
Hybrids	48	24	24	
Rice fallows				
American	54	18	18	
Hybrids	60	24	24	

Micronutrients Deficiencies:

In case of Magnesium deficiency spray 10 g Magnesium sulphate litre water at 45 days and 70 days after sowing. In case of zinc deficiency spray 2-3 times at interval of 5-6 days 2 g

Zinc sulphate litre and apply 20 kg zinc sulphate acre⁻¹ once in three years as prophylactic measure. Boll drying is common due to B deficiency for controlling boron deficiency spray 1-1.5 g borax litre water at 60-90 DAS twice at the interval of one week.

Intercultivation and other Management Practices:

Rainfed crop must be kept weed free by harrowing 2-3 times within the first 30-60 days of crop growth. In case of irrigated cotton crop, earthing up should be done with the help of a plough or blade harrow after fertilizer application and irrigation. Topping (i.e., nipping the terminal bud) should be done after emergence of 15 to 16 sympodial branches at the age of 90- 100 days crop.

Irrigation:

- Generally irrigated crop requires 2-3 irrigations depending upon soil type.
- Cotton cannot tolerate excess water, therefore drainage is very essential, depend upon available soil moisture (ASM), irrigation may be given at the interval of 20-25 days. Generally after fertilizer application, flowering and boll development stage are critical for irrigation. The irrigation requirement in kharif is 2-3 irrigations and in Rabi 6 irrigations.
- Water logging condition and prolonged drought spells leading to soil moisture stress. Adequate drainage provision is a must, especially for vertisols during periods of continuous rains (September).
- In the case of irrigated cotton, earthing up should be done with blade harrows after fertilizer application to provide adequate drainage and to facilitate water application. In all, about 3 irrigations may be optimum for vertisols and five for alfisols during kharif.

Pest Management:

Sucking pests (Jassids, aphids, thrips, whitefly): Seed treatment with imidacloprid 70WS 5g/Kg or thiomethoxam 4g/Kg or carbosulfan 40-50g/Kg. Stem application with monocrotophos/ methyl demeton 1:4 or imidacloprid 200SL in 1:20 dilution with water at 20, 40, 60 DAS or spraying of monocrotophos 1.5ml/lit or methyl demeton 2ml/lit or imidacloprid 200 SL 0.2ml/lit or acetamiprid 0.1g/lit or thiomethoxam 0.2g/lit or acephate 1.5g/lit was also equally effective in controlling sucking pests.

Whitefly: triazophos /profenophos 2ml/lit+5ml neem oil.

Mealy bug: 1. Stem application; 2. 1ml dichlorovas + 2ml methyl parathion/malathion or 3ml quinalphos/lit.

Bollworms:

- Spotted bollworm, American Bollworm, Tobacco cut worm and pink bollworm : monocrotophos 2 ml/lit or quinalphos 3 ml/lit or chlorpyrifos 2.5 ml/lit or endosulfan 2 ml/lit or carbaryl 3 g/lit or acephate 1 g/lit or indoxacarb 1 ml/l or thiodicarb 1.5g/lit or spinosad (Tracer) 0.6ml/lit or emamectin benzoate 0.45g /lit.
- Bollworms attack cotton from 50-60 DAS such as Heliothis, tobacco budworm, spotted bollworm and pink bollworms which requires integrated management techniques (IPM).
- The ETL for boll worms is 10% losses, 1 larvae, or egg of heliothis plant⁻¹ or one group of eggs of semilooper per 10 plants or 10 % bolls/ locules affected by pink boll worms.

INTEGRATED PEST MANAGEMENT IN COTTON:

1. Growing cotton as a rotation crop rather than a continuous crop year after year to restore the phenomenon of polyculture in the system.
2. Application of chemical fertilizer as supplement to organic or biological fertilizers as per the recommended doses.
3. Growing intercrops/strip crops/barrier crops. Crops like, Cowpea, Groundnut, Greengram, Soybean, Clusterbean were found better intercrops in increasing the effectiveness of natural enemies like coccinellids, syrphids, chrysopids, spiders, Trichogrammids, Apanteles etc. Growing fodder jowar or maize as barrier crops around cotton and castor and marigold as trap crop was also found more advantageous to manage pests of cotton.
4. Using delinted seed to take up seed dressing with imidacloprid/ carbosulfan and mancozeb before sowing crop. Replacement of sprayable insecticides in the initial stages of crop would help to preserve the populations of natural enemies of cotton pests.

Recently, stem application with monocrotophos or imidacloprid at 1:4 or 1:20 dilution at 20,40 and 60 DAS was found effective in controlling the sucking pest like aphids, leafhoppers etc., in initial stages of crop growth.

5. Monitoring pests by using sticky, pheromone and light traps. The adult monitoring should be supported by egg and larval monitoring following sequential sampling technique at frequent intervals in case of boll worm. Bird perches should be arranged @ 10 to 20 per acre for encouraging bird predation on bollworm larvae.
6. The build up of broad spectrum predators-spiders, coccinellids and chrysopids should be synchronised in other cultural operations. Release of Trichogramma egg parasite @ 50000/ha and Chrysopa egg larval predator @ 100000/ha, should be done as soon as the first brood of bollworms are noticed.
7. Removal of top leaves by topping of cotton plants when maximum egg laying of *Helicoverpa armigera* is noticed formation of 16 to 18 sympodial branches.
8. Application of Helio NPV @ 500 LE/ha or Neem seed kernel extract (5%) in synchrony with early larvae of Heliothis. Neem oil formulation to manage whitefly initially.
9. Resorting to chemical insecticides - Need based application of recommended insecticides Endosulfan 2ml or Quinalphos 2.5ml or Chlorpyrifos 3ml or Acephate 1.5g, Triazophos 2ml or Thiodicarb 1.5g/lit. For eggs control profenophos 2ml or Thiodicarb 1.5g or Triazophos 2ml/lit. In case of more incidence Indoxacarb(Avaunt) 1ml or Spinosad (Tracer) 0.3ml or Emamectin Benzoate(Proclaim 5% SG) 0.5g /lit. For managing red spider mites application of water soluble sulphur (3g/lit) or dicofol (5ml/lit) must be done. Similarly if mealy bugs spread in patches to alarming level methyl parathion (3ml/lit) or triazophos (3.0ml/lit) may be used by mixing with sandovit or teepol.
10. Removal of cotton stubbles after last picking, without opting for ratoon crop or prolonging the crop growth with irrigations and fertilizer applications. This is essential to break the cycles of problem pests in the system as a whole.

Management Strategy for Pink Bollworm:

Since eggs are mostly protected by calyx and the newly hatched larvae bore into the bolls immediately, it is difficult to manage this pest with insecticides. Therefore, hygienic methods are more important than chemical control. However, from the available literature the following integrated methods to control this insect can be suggested.

- 1). Grow early maturing varieties so that the cotton bolls mature before the heavy population of pink bollworm builds up.
- 2). Avoid staggered sowing in an area and take up timely sowings.
- 3). Use of acid delinted seed only.
- 4). Adopting efficient and timely agronomic practices such as use of organic manures and recommended doses of 'N' fertilizers only.
- 5). Keep the crop free from weeds.
- 6). Regular monitoring for pest builds up with field scouting and pheromone traps.
- 7). Destroy pink bollworm larvae in rosette flowers and also through periodical removal of dropped squares, dried flowers and pre-matured bolls, to suppress pest population in the initial stage.
- 8). Avoid ratooning and summer cotton.
- 9). Allow cattle, sheep and goats to graze upon immature green bolls and attacked bolls after final picking to prevent carry-over of the pest to the next season.
- 10). Prompt removal and destruction of cotton stubbles to prevent carry over of pest to next season.
- 11). Restrict the movement of cotton seed from other areas/states
- 12). Need based use of insecticides.
 - a). Seed fumigation with methyl bromide at 0.4 kg/1000 cuft/ phostoxin 50 tablets/1000 cuft for 24 hours.
 - b). Spraying of persistent insecticides like quinalphos/chlorpyrifos at 2.5 ml/l lt at 15 days interval on need basis.
- 13). Even at the ginning mills burning the stained kapas have to be advised regularly.

Disease Management:

Blackarm: Seed treatment with 80-100 ml concentrated sulphuric acid. Use of resistant varieties like L-389. Removal and destruction of infected seedlings. Seed soaking in antioibotic (Paushamycin/Agrimycin 100 mg/ltr) solution along with vitavax 1 g for 6-8 hours will eliminate seed borne diseases. Agrimycin 0.01% + copper oxychloride 0.3% at fortnightly intervals for 3 rounds.

Root rot: Seed treatment with Carbendazim 2 g/kg of seed. Drenching with copper oxychloride @ 3 g/ltr of water around the base of affected plants.

Leaf spots: Mancozeb 0.25% or Copper oxychloride 0.3% for 4-5 times at 15 days interval.

Greymidew: Wettable sulphur at 3 g/ltr or Carbendazim 1 g/ltr of water for 2-3 rounds at 7 day interval.

Bollrots: Commonly used conventional insecticides along with fungicides and antibiotics.

Harvesting and Post Harvesting Technology:

Kapas from fully opened bolls should be collected during cooler times of the day. Kapas picked should be free from debris like dried leaves; dried bracts etc., Kapas from the first and last pickings should not be mixed with middle pickings, which are of better quality. Kapas damaged by bollworms should be picked separately. The cleaned kapas is to be graded and stored in heaps or in gunny boras in dry and well ventilated godowns.

Source: CICR, Nagpur.

7.7. Karnataka State:

Cotton is a major commercial crop grown in almost all the Agro-climatic zones of Karnataka. All the four cultivated species of cotton viz, *Gossypium arboreum*, *G. herbaceum*, *G. barbadense*, and *G. hirsutum* are grown in the state where in *Gossypium hirsutum* has the major share of the hybrid cotton grown. The package of practices developed for different species of cotton and agro-climatic situations is summarized as below.

1. CROP IMPROVEMENT:

1.1 Cotton varieties / hybrids released for cultivation in the state

Varieties/ hybrids	Zone and situation	Crop duration (days)	Time of sowing	Special characters	Yield (q/ha)	
					Irrigate d	Rainfed
Inter specific hybrids						
Varalaxmi	2, 3, 8, 9 Irrigated / rainfed	190	May –15 th July	Extra long staple (ELS) cotton	15 – 20	12 – 15
DCH – 32	2, 3, 8, 9 Irrigated / rainfed	190	May –15 th July	Extra long staple (ELS) cotton	15 – 20	12 – 15
DHB- 105	2, 3, 8, 9 Irrigated/ rainfed	180	May –15 th July	Long staple cotton and tolerant to leaf reddening	20 – 25	15 – 18
Intra hirsutum hybrids						
NHH – 44	2, 3, 8, Irrigated / rainfed	160	May –15 th July	Having better regenerative character	18 – 20	12 – 15
DHH – 11	2, 3, 8, Irrigated / rainfed	160	May –15 th July Feb-Mar	Bigger boll size and good boll opening	20 – 25	15 – 18
Suvida (DHH – 543)	2, 3, 8, Irrigated / rainfed	160	May –15 th July	Average boll size good boll opening	20 – 25	15 – 18
Bunny (NCH – 145)	2, 3, Irrigated / rainfed	165	May –15 th July	Bigger boll size and good boll opening	20 – 25	15-- 18
Hirsutum varieties						
Abadhita	2, 3, 8, Rainfed	160	May –15 th July	Tolerant to bollworm		15 – 18
RAMPBS 155	2, Irrigated	170	May –15 th July	Round boll shape, Tolerant to leaf reddening	18 – 20	--
Sahana	2, 3, 8, Irrigated / rainfed	160	May –15 th July Feb-Mar	Tolerant to bollworm	18 – 22	15 – 18

1.1 Cotton varieties / hybrids released for cultivation in the state

Varieties/ hybrids	Zone and situation	Crop duration (days)	Time of sowing	Special characters	Yield (q/ha)	
					Irrigated	Rainfed
LRA - 5166	3, Irrigated	160	Feb-Mar	Suitable for summer season also.	15 – 18	--
Ganesh - (ACP – 71)	3, Irrigated	170	Feb-Mar	Suitable for intercropping with maize	18 – 20	--
Gouri – (AH - 107)	3, Irrigated	160	Feb-Mar	Suitable for double cropping system	18 – 20	--
RAH – 100	2, 3, Irrigated	165	May – 15 th July	--	18 – 20	--
Desi cotton varieties						
Jayadhar	2, 3, 8 Rainfed	200	July – Sept.	Resistant to pest and diseases. Suitable for intercropping under rainfed conditions	--	08 – 12
Renuka	2, 3, Rainfed	190	July – Sept	--	--	08 – 12
DDHC – 11	2, 3, 8 Rainfed	180	July – Sept	--	--	10 – 12
RAHS – 14	2, 3, Rainfed	180	July – Sept	Suitable for saline soils	--	10 – 12
DLSA – 17	2, 3, 8 Rainfed	160	May – 15 th July	Long Staple cotton with good boll opening	--	12 – 15

2. CROP PRODUCTION:

2.1 Seed, seed treatment:

Use delinted seeds for uniform and higher germination. Adopt the following method for delinting of cotton seeds.

- Soak 1 kg of cotton seeds in 100 ml commercial grade Sulphuric acid (H₂SO₄) for ten minutes.
- Wash the acid treated seeds with 2% Calcium Chloride (CaCl₂), then with clean water and dry the seeds under sunlight and use for sowing after recommended seed treatment.
- Treat the seeds required for one hectare area with 500g Azospirillum and 500g Phosphorous Solubilising Bacteria (PSB) before sowing which can save 20 kg N and 10 P₂O₅ /ha.
- Treat the seeds with 10 g Imidacloprid 70WS or 5 g Thiomethaxam 70 WS to reduce the sucking pest incidence up to 35-40 days of sowing.

2.2 Seed rate and methods of sowing

Methods of sowing	Seed rate (kg / ha)	
	Varieties	Hybrids
Drill sown	7.5 – 10	--
Hand dibbling	5 – 6	2.5 – 3

2.3 Time of sowing:

- Early sowing in the season is recommended for higher yields.

Situation	Time of sowing
I. Rainfed	
a. Herbaceum varieties (Jayadhar/DDHC-11 etc.)	July - September
b. Arboreum varieties (DLSa-17)S	May – July
c. Hirsutum varieties/hybrids (Inter specific and Intra hirsutum)	May – 15th July
II. Irrigated	
a. Hybrids	May – 15th July
b. Summer cotton	February – March

2.4 Planting geometry:

Planting geometry can be modified and adopted based on soil type and fertility. Following planting geometries have been recommended under different soils and various growing situations.

1. Rainfed situation (For varieties)	60cm x 30 cm or 90cm x 20 cm
2. Irrigated (For varieties and summer cotton)	75 cm X 30 cm (Average soils) 90 cm x 30 cm (Fertile soils)
3. Transitional Zone (Zone-8, Assured rainfall areas for Hybrids) a. Interspecific hybrids b. Intra hirsutum hybrids	90 cm x 60 cm 90 cm x 60 cm or 90 cm x 30 cm
4. Heavy rainfall tract (zone 9 - Malanad) and Irrigated areas a. Interspecific hybrids b. Intra hirsutum hybrids	90 cm x 60 cm (Average fertility soils) 90 cm x 60 cm or 90 cm x 30 cm 120 cm x 60 cm (Fertile soils)

2.5 Integrated Nutrient Management (INM):

2.5.1 Organic Fertilizer:

- Apply FYM/Compost @ 10 t/ha and 5 t/ha under irrigated and rainfed conditions respectively
- Apply Poultry manure @ 2t/ha instead of FYM under irrigated conditions only.
- Incorporate cotton stalks (Crop residues) @ 2 t/ha along with FYM @ 3 t/ha and Vermicompost @ 1 t/ha. 2-3 weeks before sowing under irrigated conditions.
- Grow sunhemp (as green manure) between two rows of cotton and incorporate in situ after 30 DAS in .irrigated and assured rainfall areas which helps in increasing the soil fertility and reducing weed population.
- Incorporate FYM @ 3 t/ha along with green leaf manures @ 2t/ha (Ex situ), 2 to 3 weeks before sowing in irrigated and assured rainfall areas

2.5.2 Bio fertilisers:

Treat the seeds required for one hectare area with 500 g Azospirillum and 500 g Phosphorous Solubilising Bacteria (PSB) before sowing which can save 20 kg N and 10 kg P_2O_5 /ha.

2.5.3 Inorganic fertilizers

Zones/ Varieties/Hybrids	Recommended quantity nutrients (kg/ha)		
I. Rainfed (varieties)	Nitrogen	Phosphorus	Potash
1. Northern dry tract (zone 1, 3)	30	15	15
2. Transitional tract (zone 8)	40	25	25
II. Rainfed (hybrids)			
1. Malanad tract (zone 9)	100	100	100
2. Transitional tract (zone 8)	80	40	40
III. a. Irrigated (varieties)			
In all zones	80	40	40
III. a. Irrigated (hybrids)			
1. Inter specific hybrids	150	75	75
2. Intra hirsutum hybrids	120	60	60
IV. Summer cotton			
1. Varieties	80	40	40
2. Intra hirsutum hybrids	120	60	60

2.5.4 Split application of fertilisers:

- Incorporate organics (FYM/Compost/Crop residues) into the soil 2-3 weeks before sowing.
- For rainfed cotton apply entire recommended nutrients as basal at the time of sowing.
- Under assured rainfall conditions apply 50% N, entire dose of P_2O_5 and K_2O as basal at the time of sowing and top dress remaining 50% N at 60 DAS.
- Under irrigated conditions, apply 50 % N & K_2O and entire P_2O_5 as basal at sowing and top dress 50 % N & K_2O at 30 DAS and remaining 25% N & K_2O at 60 DAS.
- Under irrigated conditions in Zone -3 apply 25 % N & K_2O and entire P_2O_5 as basal at sowing and top dress 50 % N & K_2O in three equal splits at 50, 80 and 110 DAS.
- Under heavy rainfall areas (Malanad), apply N, P_2O_5 and K_2O in three equal splits i.e Basal, 60 and 90 DAS.
- In all the situations give foliar sprays of 2% Urea or DAP + 1% MOP at 80, 100 & 120 DAS

2.6. Post sowing operations and weed management:

- Keep the plots weed free up to 60 days as the crop growth is slow during this period and this is the critical crop growth stage for crop weed competition.
- Three – four intercultivations at an interval of 15 days after 30 DAS helps in controlling weeds and acts as dust mulch in conserving the available soil moisture.
- In rainfed situations weeds can be managed effectively by 2-3 intercultivations followed by hand weeding.
- In transitional and irrigated areas integrated weed management proved effective in controlling the weeds. Pre emergent application of Diuron (80%) @ 1.25 kg/ha or Pendimethalin (30 EC) @ 3 lit/ha in 500-750 lits of water, immediately after sowing (with sufficient soil moisture) coupled with one hand weeding and intercultivation is recommended.

2.7 Irrigation

2.7.1 Water requirement and number of irrigations.

Soil type	Crop duration	Irrigation interval	No. of irrigations	Depth of each irrigation (cm)	Total crop water requirement (cm)
Black soils	180 days	20 days	5 – 6	6 cm	80 – 90 cm
Light/red/sandy loam soils	170-180 days	15 days	8 – 10	5 cm	80 – 90 cm

- Schedule irrigation at 0.6 IW/CPE through out the crop growth.

2.7.2 Methods of irrigation

- Adopt **furrow method** of irrigation with following specifications.
- Adopt **Alternatively Alternate Furrow Irrigation (AAFI)** in heavy soils (Vertisols), which saves time, labour, irrigation water (to the extent of 30%) and minimizes the long term ill effects of irrigation on soil properties.

Particulars	In heavy or black soils	In light or red soils or sandy loam soils
Furrow length	100-150 m	60-90 m
Slope in furrows	0.1 – 0.2 %	0.2 - 0.4%
Stream size	2 – 3 lit/sec	3 – 4 lit/sec

2.7.3 Critical stages of irrigation

Critical Stages of crop growth	Days after sowing (DAS)
Sympodial branching and square formation stage	45 – 50
Flowering and fruiting stage	75 – 85
Peak boll formation	95 – 105
Boll development and boll opening stage	115- 125

- Heavy and frequent irrigation enhances the vegetative growth leading to ineffectiveness of plant protection measures, resulting in higher incidence of pest/diseases
- Provide drainage in heavy soils to avoid water logging due to low infiltration rate

- Under canal command areas where in the canal opening is not assured at scheduled time, ensure early sowing with protective irrigation by open/bore well water.
- Under constraints of irrigation water, foliar spray of Kaolin (60 g/lit) with 1 g teepol or soap, at 3 days after last irrigation reduces transpiration losses from the crop canopy, thus helps the crop to utilize the available soil moisture efficiently.

2.8 Drip irrigation in cotton:

- Drip irrigation can be a viable option under constraints of irrigation water in zone 3 and 8 for hybrid cotton cultivation.
- It can save electricity, labour and 50% of irrigation water as against the surface furrow irrigation
- Planting geometry of 90 cm x 60 cm (Normal planting) can be adopted under drip irrigation, but paired row planting at 60 cm – 120 cm – 60 cm can save 50% laterals as against the normal planting
- Operate drip system daily or once in three days and replenish 75 per cent cumulative ET of corresponding days by drip for hybrid cotton and 50 percent for hirsutum varieties (Table.24).

Table. 24: Time schedule of drip operation based on daily ET (Zone 3 and 8)

Month	Evaporation(mm/day)		*Time of drip operation based on ET (Minutes)			
			Zone 3		Zone 8	
	Zone 3	Zone 8	Hybrids	Varieties	Hybrids	Varieties
January	6.1	5.1	16	10	13	9
February	6.3	6.2	17	11	16	11
March	8.1	7.3	21	14	19	12
April	9.7	7.2	25	17	19	12
May	10.1	5.9	26	17	15	10
June	7.4	3.1	19	13	8	5
July	5.2	1.9	13	9	5	3
August	4.7	1.7	12	8	5	3
September	4.8	2.3	12	8	6	4
October	5.2	2.8	13	9	8	5
November	4.7	3.4	12	8	9	6
December	4.5	4.3	11	8	11	7

- Replenishing 75% and 50% daily ET for hybrids and varieties respectively.
- Drippers having discharge capacity of 4 lit/sec to be used.
- Laterals to be placed at 90 cm apart and drippers at 60 cm under normal planting
- In case of paired row planting (60 cm – 120 cm – 60 cm) the above time of drip operation has to be doubled as the number of laterals and drippers are reduced to 50 % as compared to normal planting of 90 cm x 60 cm

2.8.1 Fertilizer management in drip irrigation system:

- Apply 10 percent of recommended fertilizers as basal at the time of sowing and apply remaining fertilizers in equal splits through fertigation between 30 to 120 DAS at six days interval.
- Urea, MOP and DAP can be used for fertigation instead of costly liquid fertilisers.
- Follow weed, pest and diseases management practices as mentioned in irrigated cotton

2.9 Cotton based cropping systems:

2.9.1 Crop rotations

I year	II- Year	III-Year
Cotton	Groundnut – Rabi Jowar or wheat	Cotton
Cotton	Green gram – Rabi Jowar or Wheat	Cotton
Cotton	Soyabean – Wheat or Rabi Jowar	Cotton
Cotton	Maize – Chickpea	Cotton
Cotton	Sunflower – Chickpea	Cotton

2.9.2 Intercropping and mixed/relay cropping systems:

In rainfed situations cotton based intercropping and mixed cropping systems are remunerative and act as insurance against the risk of erratic rainfall.

- Under rainfed conditions adopt the following intercropping systems.
 1. Cotton + onion (1: 5)
 2. Cotton + chilli (1: 1)
 3. Cotton + groundnut (1: 3)
 4. Cotton + green gram (1: 3)
 5. Cotton + soybean (1: 3)
 6. Cotton + peas (1: 2)
- Under irrigated conditions following inter cropping systems are recommended.
 1. Cotton + chilli (1: 1)
 2. Cotton + onion (1: 5)
 3. Cotton + soybean (1: 2).
 4. Cotton + Sunhemp (As green manure) (1: 2)
 5. In black soils of Tung Bhadra Project (TBP area), Cotton + onion (1: 2) and Cotton + chilli (1: 1) are recommended.
- Under low rainfall areas Cotton (desi) + Onion + Coriander, Cotton (desi) + onion + chilli mixed/relay cropping systems are recommended.
- In heavy rainfall areas (Malanad) (zone-9), Cotton + paddy (1:6) intercropping system is recommended.

2.10 Physiological disorders in cotton:

Square drying, flowers and premature boll dropping and leaf reddening are the major Physiological disorders in cotton. These can be effectively managed and minimized by the following measures.

- Squares, flowers and boll dropping can be minimized by foliar sprays of Planofix @ 0.25ml/lit of water during pre flowering (55-60 DAS) and peak flowering stage (80-90 DAS) of the crop.
- Twice foliar sprays of 1% MgSO₄ or 2% urea or DAP at 90 DAS and 110 DAS reduces the leaf reddening during winter season.

3 CROP PROTECTION:

3.1 Major diseases, symptoms and their control measures.

Sl No.	Name of the disease	Symptoms of the disease	Suggested control measures
1.	Seedling rot	Decay of the seedlings before emergence, girdling of the seedling stems and root rot. Some times mustard like seeds appear on the roots.	Drenching of Thiram @ 2 g/litre of water around the diseased seedlings.
2	Grey mildew / areolate mildew	A whitish mycelial growth appears chiefly on the under surface of the leaves. Under congenial conditions defoliation is observed in diploid cottons.	Foliar sprays of Carbendazim @ 1g /litre of water as and when symptoms seen.
3	Bacterial blight	Water soaked angular leaf spots appear on the leaves, later spread to the veins and vein lets	Foliar sprays of Streptocycline Sulphate @ 0.5 gm/litre and Copper-Oxychlode @ 3 g / litre of water as and when symptoms seen
4	Rust	Circular brown to reddish pustules appear during boll maturation stage on lower surface of leaves and later on they coalesce in to large spots lowering photosynthesis, affecting nutrient supply from source to sink thus affecting the yields..	Foliar sprays of CopperOxychloride @ 3g/litre or Mancozeb @ 2gm/litre of water, as and when symptoms are seen.
5	Wilt	Adult plants become weak coupled with yellowing of leaves with senescence and drying	Drenching of Carbendazim @ 2g/litre of water around the diseased plants
6	Boll rot	The bolls nearer to the ground becomes decay, with mycelial growth and some times bacterial ooze comes out of the bolls	Efficient pest management is the best method to control the boll rot. Yet, foliar sprays of Copperoxychlode @ 3g/litre and Streptocycline Sulphate @ 0.5 gm/litre or Mancozeb @ 2g /litre and Chlorothalonil @ 2g/litre of water at boll initiation stage and a second need based spray after 10-12 days in heavy rainfall /irrigated areas on interspecific hybrids

3.2 Major insect Pests, symptoms and their control measures.

Sl. No	Pests	Damage Symptoms	Management strategies
I. Sucking Pests			
1.	Jassids	Yellowing, reddening along the leaf margin and complete drying of leaves	* Treat the seeds with 10 g Imidacloprid 70WS or 5 g Thiomethaxam 70 WS * Foliar application if needed further with NSKE(5%) or 0.5 ml Imidacloprid 17.8 SL or 1.5ml Oxydemton methyl 25EC or 2.0ml Dimethoate 30 EC or 1.0 ml Monochrotophos 36 SL or 0.2 g Thiomethoxam 25WG or 0.2g Acetamiprid 20 SP per liter of water OR * Smear with 1.0 ml Imidacloprid 17.8 SL in 20 ml water approximately to a length of an inch at top tender green portion of the stem.
2.	Thrips	White streaks on leaves and complete dr[y]ing of leaves	
3.	Aphids	Yellowing, crinkling and development of black sooty mildew on leaves	
II. Other Sucking pests			
4.	Serpentine leaf miner	Makes zig zag tunnels or mines on leaves. Infestation starts at very early stage of plant growth (two leaf stage)	Spraying of any systemic insecticides mentioned above.
5.	White flies	Yellowing, crinkling and development of black sooty mold on leaves. Premature dropping of squares and bolls	Erection of yellow sticky traps @ 50 /ha, Foliar sprays of NSKE @ 5.0% or 1.5 ml Triazophos 40 EC per liter of water.
6.	Mites	White streaks on leaves, yellow spots on lower side of the leaves.	Sprays of water soluble sulphur @ 5 g or 2.5 ml Dicofol 20 EC per liter of water
7.	Dusky cotton bugs	Bad boll opening and deterioration of seed quality	Any contact insecticides
8.	Red cotton bugs	Suck the sap from the matured bolls. Quality of the lint deteriorates.	

3.2 Major insect Pests, symptoms and their control measures.

Sl. No	Pests	Damage Symptoms	Management strategies
III. Bollworms			
1.	Spotted bollworm	Feeds on squares, flowers and bolls. Flaring up of squares and damage holes on bolls	<ul style="list-style-type: none"> * Installation of pheromone traps @ 5/ha for monitoring of bollworm moths activity. Use separate traps for each kind of boll bollworms. Change the lure at every 15-20 days. * Release egg parasitoid i.e. <i>Trichogramma chilonis</i> @ 2.5 lakh/ha (Tricho card) twice a week at 45-50 DAS * Spraying of neem based insecticides or Endosulfon 35 EC @ 2.75 ml/liter after 5-7 days of T.chilonis release. * If T.chilonis is not available pray ovicides like Profenophos 50 EC @ 2.5ml/lit or Thiodicarb 75WP @ 1.0 g/lit. * Under irrigated situations spray Methomyl 40 SP @ 0.6g/lit. * Spray Ha NPV @ 500 LE/ha + 5 % jaggery water + 0.1% Boric acid (Spray during morning or evening hours) at 60-70 DAS * Nipping and disposal of terminal shoots at 70-90 DAS to reduce egg laying by bollworm moths and to prevent aphid breeding. * Selective use of following insecticides based on incidence of bollworms: Emamectin benzoate 5 SG @ 0.25g/lit or Indoxcarb 14.5 SC @ 0.5 ml/lit or Spinosad 48 SC @ 0.2 ml/lit or Carbaryl 50% WP @ 3.0 g/lit or Quinolpho 25 EC @ 2.0 ml/lit or Cholrpyrphos 20 EC @ 2.5 ml/lit.water * Spray with recommended synthetic pyrethroids in severe cases of bollworm incidence (0.5ml of Decamethtrin 2.8 EC or Cypermethrin 10 EC or Fenvalrate 10 EC or β- Cyfluthrin 25 SC or 0.25ml/lit Alphamethrin 10 EC, however its use should be avoided or restricted to one or two spays after 100 days of sowing alternating with Insecticides of other groups. <p><u>Specific recommendations for Pink Boll Worm (PBW) management:</u></p> <ul style="list-style-type: none"> * Use delta traps (5.0/ha) for monitoring PBW activities * Twist tying of PB Ropel sticks @ 200/ha at 30-40 DAS Or Mass trapping and killing of moths through pheromone traps @ 30/ha * Supervisory control by spraying recommended Pyrethroides or Profenophos or thiodicarb in addition to regular boll management activity.
2.	American bollworm	Feeds on squares, flowers and small as well as big sized bolls. Flaring up symptoms and dropping of squares. Bored entry holes on boll.	
3.	Pink bollworm	Feeds on squares, flowers and developing bolls. Rosetted flowers. No damage symptoms on bolls as it feeds inside.	

3.3 Integrated Pest Management in Bt- Cotton under Irrigated conditions:

- Seed treatment with 0.5ml Imidacloprid 17.8SL or 0.2 g Thiomethaxam 25WG or 0.2g Acetamiprid 20 SP per lit. of water for sucking pest management. OR Stem smearing with 1ml Imidacloprid 17.8 SL in 20ml water.
- Monitoring bollworm moth activity with pheromone traps @ 5.0/ha
- Erecting of bird perches @ 20-25/ha to sustain insectivorous birds in the field.
- Hand collection and disposal of grownup larvae.
- Spry Ha NPV @ 500 LE/ha+5% jaggery in water+ 0.1% Boric acid (Spray in morning or evening hours) when early stage larval incidence is persisting.
- Apply stomach and contact insecticide when larval incidence cross ETL.
- Apply recommended synthetic parathyroids at 110-130 days after sowing for Bt resistant population of American bollworm and pink boll worms.
- Erection of yellow sticky traps @ 50 /ha and application of NSKE 5.0% or 1.5 ml Triazophos 40EC per liter of water for whitefly management
- Manage mite, dusky cotton and red cotton bugs with application of suitable insecticide/acaricide
- Conservation of soil moisture till boll opening stage is essential.

Economic Threshold Level for Chemical Application.

Insect Pests	ETL
Jassids	2.0 nymphs/leaf
Aphids	10 aphids/leaf
Thrips	10 thirps/leaf
Whitefly	5 whiteflies/leaf
American bollworm	1.0 larvae/plant
Spotted bollworm	5.0% damage
Pink bollworm	10 % damage

4. Economics of cotton cultivation:

1.1 The details on cost of cultivation, gross and net returns of hybrid cotton-Non Bt are given in the following table.

Cost of cultivation of Hybrid cotton - Non Bt. (Per Acre) -2007-08

Sl. No	Particulars	Physical unit		Unit cost (Rs)		Total cost per Acre (Rs/acre)	
		Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
1	Tractor ploughing	5hrs	5hrs	750	750	750	750
2	Tractor cultivator	2hrs	2hrs	300	300	300	300
3	Twice harrowing (by bullocks)	1 pair	1 pair	300	300	300	300
4	FYM application	6 L	4 L	50	50	300	200
5	Opening seed line (by bullocks)	0.5 pair	0.5 pair	300	300	150	150
6	Seed dibbling	5 L	5 L	50	50	250	250
7	Weedicide application (Optional)	-	-	-	-	-	-
8	Fertiliser application	5 L	5 L	50	50	250	250
9	Thinning	2 L	2 L	50	50	100	100
10	Twice intercultivation	1 pair	1 pair	300	300	300	300
11	Twice hand weeding	15 L	10 L	50	50	750	500
12	Irrigation (4-5 times)	12 L	-	50	-	600	-
13	Spraying(6-Irri, 5-rainfed)	18 L	15 L	50	50	900	750
A. Total cost of cultural operations (Rs).						4950	3850
1	* Kapas picking	1500	1000	Rs.2 /kg	Rs.2 /kg	3000	2000
B. Total cost of kapas picking (Rs)						3000	2000
1	Cost of seed	0.75 kg	0.75 kg	Rs.800 /kg	Rs.800 /kg	600	600
2	N: P: K(Basal + Top dress + Rec. Foliar sprays of DAP, MgSO ₄ , planofix)	60:30: 30 N : P: K (kg/ac)	32:16 :16 N : P: K (kg/ac)	N-Rs. 11/kg P- Rs. 24/kg K-Rs. 8 /kg	N-Rs. 11/kg P- Rs. 24/kg K-Rs. 8 /kg	1800	1100
3	Weedicide cost (optional)	-	-	-	-	-	-
4	Additional micronutrient Foliar sprays(Optional)	-	-	-	-	-	-
5	FYM	4 tons	4 tons	Rs.300/t	Rs.300/t	1200	1200
6	PPchemicals	6 sprays	5 sprays	-	-	2150	1750
C. Total cost of inputs (Rs).						5750	4650
1	Grading& kapas packing in docras/ transportation to market	-	-	800	500	800	500
2	Land rent	-	-	1500	1000	1500	1000
D. Total post harvest management cost (Rs)						2300	1500
E. Total cost of cultivation (Rs)/acre						16,000	12,000

- * Varies as per the actual quantity of kapas obtained from an acre.
- Total cost of cultivation: Irrigated -- Rs. 16,000 per acre. (Rs.40,000 per hectare)
Rainfed -- Rs. 12,000 per acre. (Rs.30,000 per hectare)
- Gross returns: Irrigated -- 15q/ac kapas @ Rs.2000/q = Rs.30,000/ac (Rs.75,000/ha)
Rainfed -- 10q/ac kapas @ Rs.2000/q = Rs.20,000/ac (Rs. 50,000/ha)
- Net returns: Irrigated: (30,000 – 16,000) = Rs. 14000/ac (Rs. 35,000/ha)
Rainfed: (20,000 – 12,000) = Rs. 8000/ac (Rs. 20,000/ha)

4.2 The details on cost of cultivation, gross and net returns of hybrid cotton- Bt are given in the following table.

Cost of cultivation of Hybrid cotton - Bt. (Per Acre) - 2007-08.

Sl. No	Particulars	Physical unit per acre		Unit cost (Rs)		Total cost per Acre (Rs/acre)	
		Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
1	Tractor ploughing	5hrs	5hrs	750	750	750	750
2	Tractor cultivator	2hrs	2hrs	300	300	300	300
3	Twice harrowing (by bullocks)	1 pair	1 pair	300	300	300	300
4	FYM application	6 L	4 L	50	50	300	200
5	Opening seed line (by bullocks)	0.5 pair	0.5 pair	300	300	150	150
6	Seed dibbling	5 L	5 L	50	50	250	250
7	Weedicide application (Optional)	-	-	-	-	-	-
8	Fertiliser application	5 L	5 L	50	50	250	250
9	Thinning	2 L	2 L	50	50	100	100
10	Twice intercultivation	1 pair	1 pair	300	300	300	300
11	Twice hand weeding	15 L	10 L	50	50	750	500
12	Irrigation (4-5 times)	12 L	-	50	-	600	-
13	Spraying(4-Irri, 3-rainfed)	12 L	9 L	50	50	600	450
A. Total cost of cultural operations (Rs).						4650	3550
1	* Kapas picking	1500	1000	Rs.2 /kg	Rs.2 /kg	3000	2000
B. Total cost of kapas picking (Rs)						3000	2000
1	Cost of seed	0.75 kg	0.75 kg	Rs.1500/kg	Rs.1500/kg	1125	1125
2	N: P: K(Basal + Top dress + Rec. Foliar sprays of DAP, MgSO ₄ , planofix)	60:30:30 N : P: K (kg/ac)	32:16:1 6 N : P: K (kg/ac)	N-Rs. 11/kg P-Rs. 24/kg K-Rs. 8 /kg	N-Rs. 11/kg P- Rs. 24/kg K-Rs. 8 /kg	1800	1100
3	Weedicide cost (optional)	-	-	-	-	-	-
4	Additional micronutrient Foliar sprays(Optional)	-	-	-	-	-	-
5	FYM	4 tons	4 tons	Rs.300/t	Rs.300/t	1200	1200
6	PPchemicals	4 sprays	3 sprays	-	-	1450	1050
C. Total cost of inputs (Rs).						5575	4475
1	Grading& kapas packing in docras/ transportation to market	-	-	800	500	800	500
2	Land rent	-	-	1500	1000	1500	1000
D. Total post harvest management cost (Rs)						2300	1500
E. Total cost of cultivation (Rs)/acre						15,525	11,525

- * Varies as per the actual quantity of kapas obtained from an acre.
- Total cost of cultivation: Irrigated -- Rs. 15,525 per acre. (Rs. 38,813 per hectare)
Rainfed -- Rs. 11,525 per acre. (Rs. 28,813 per hectare)
- Gross returns: Irrigated -- 15q/ac kapas @ Rs.2000/q = Rs.30,000/ac (Rs.75,000/ha)
Rainfed -- 10q/ac kapas @ Rs.2000/q = Rs.20,000/ac (Rs. 50,000/ha)
- Net returns: Irrigated: (30,000 – 15,525) = Rs. 14,475/ac (Rs. 36,188/ha)
Rainfed: (20,000 – 11,525) = Rs. 8475/ac (Rs. 21,188/ha)

4.3 The details on cost of cultivation, gross and net returns of desi cotton are given in the following table

Cost of cultivation of desi (Herbaceum/Arboreum) Cotton (Per Acre) – 2007-08.

Sl. No	Particulars	Physical unit per acre	Unit cost (Rs)	Total cost per Acre (Rs/acre)
1	Tractor cultivator*	2 hrs	300	300
2	Twice harrowing (by bullocks)	1 pair	300	300
3	FYM application	2 L	50	100
4	Opening seed line (by bullocks)	0.5 pair	300	150
5	Seed dibbling	5 L	50	250
6	Fertiliser application	2 L	50	100
7	Intercultivation	1 pair	200	200
8	Hand weeding	5 L	50	250
9	Spraying(One spray)	3 L	50	150
A. Total cost of cultural operations (Rs).				1800
1	* Kapas picking	400	Rs.2 /kg	800
B. Total cost of kapas picking (Rs)				800
1	Cost of seed	2 /kg	Rs.40 /kg	80
2	N: P: K(kg/ac)	16:10:10 N : P: K (kg/ac)	N-Rs. 11/kg P-Rs. 24/kg K-Rs. 8 /kg	500
3	FYM	2 tons/ha	Rs.300/t	600
4	PPchemicals	1 spray	1 spray	250
C. Total cost of inputs (Rs).				1430
1	Grading & kapas packing in docras/ transportation to market	-	250	250
2	Land rent	-	1000	1000
D. Total post harvest management cost (Rs)				1250
E. Total cost of cultivation (Rs)/acre				5280

*Ploughing once in 3 years

** Picking cost varies as per kapas picked from the area.

Total cost of cultivation: Rs. 5280 per acre (Rs. 13,200 per hectare)

Gross returns: 4q/ac kapas @ Rs.1700/q = Rs.6,800/ac (Rs.17,000/ha)

Net returns : (6,800 – 5280) = Rs 1520 / ac (Rs 3,800/ha)

Source: CICR, Nagpur.

7.8. Tamil Nadu State:

CROP IMPROVEMENT SEASON AND VARIETIES

District/Season	Varieties/Hybrids
Irrigated (Main) Winter Irrigated (Aug – Sep)	
Coimbatore, Erode, Madurai, Dindigul, Theni	MCU 5, MCU 5 VT, Suvin, TCHB 213*, MCU 12, MCU 13, Surabhi, Sumangala, Sruthi
Dharmapuri	MCU 5, TCHB 213*, MCU 12, MCU 13, Suvin
Salem, Namakkal	MCU 5, Suvin, TCHB 213*, MCU 12, MCU 13, Sumangala
Cuddalore, Villupuram	MCU 5, MCU 12, MCU13, LRA 5166, TCHB 213*, SVPR 2, Surabhi
Summer – Irrigated (Feb – Mar)	
Erode	MCU 5, MCU 5 VT, SVPR 2, Supriya, MCU 12, MCU 13, TCHB 213
Madurai, Dindigul, Theni	MCU 5, MCU 5 VT, MCU 12, MCU 13, SVPR 2, Supriya.
Ramanathapuram, Virudhunagar, Srivangai, Tirunelveli, Thoothukudi	MCU 5, MCU 5 VT, SVPR 2, MCU 12, MCU 13
Rainfed (Sep – Oct)	
Madurai, Dindigul, Theni	LRA 5166, K 11, KC 2, SVPR 2
Ramanathapuram, Virudhunagar, Sivagangai	LRA 5166, K 11, KC 2, SVPR 2
Tirunelveli, Thoothukudi, Dharmapuri	LRA 5166, K 11, KC 2, SVPR 2
Rice Fallow	
Thanjavur, Tiruvarur, Nagapattinam, Parts of Trichirapalli, Perambalur, Karur, Cuddalore and Villupuram	MCU 7, SVPR 3, Anjali

* = Hybrid

PARTICULARS OF COTTON VARIETIES/HYBRIDS

Varieties/ Hybrids	Parentage	Season	Irrigated/ Rainfed	Mean Yield of seed (kg/ha)	Special features
MCU 5	Mutiple cross	Aug-Oct Feb- Mar	Irrigated	1850	Extra long staple (29 mm MHL), Can spun upto 70s, ginning 34%
MCU 7	X ray irradiation of X L 1143 EE	Jan-Feb	Rice fallow	1330	Medium staple (23.7 mm MHL), Can spun upto 30s, early maturing with 33.2% ginning outturn. Tolerant to Balck arm
MCU 12	Derivative from the cross LRA 5166 x MCU 11	Aug-Oct	Irrigated	2000	Shorter in duration than MCU 5, GOT 34.8% Can spun upto 50s
MCU 13	It is a multiple cross derivative involving the parents of [(TCH 665 x LS 149) x(TCH 665 x TCH 21)] x (TCH 21 x EECH) x (TCH 92- 7 x EECH)	Aug-Oct Jan- Feb	Irrigated	2200	Early duration Can spun upto 50s
LRA 5166	Laxmi x Reba B.50 x AC 122	Aug-Oct Jan- Feb	Irrigated Rainfed	1800 725	Medium staple (29 mm), Can spun upto 40s, ginning 36.2%
MCU 5 VT	Reselection from MCU 5	Aug-Oct Jan- Feb	Irrigated	2000	Extra long staple Verticillium wilt tolerant
Supriya	MCU 5 x C 1998	Aug-Oct Jan- Feb	Irrigated	2000	White fly tolerant
Anjali	LRA 5166 x (Khandwa 2 x Reba B 50) BC 2	Jan-Feb	Irrigated (Rice fallow)	1800	Dwarf, semi compact plant type
Surabhi	MCU 5 VT (MCU 5 x G.mexicanum)	Aug-Oct	Irrigated	2200	Extra long staple Verticillium wilt resistant
Sumangala	CW 134 x Reba B 50 x Khandwa 2	Sept-Oct Jan- Feb	Irrigated Rainfed	2000 1200	Suitable for rainfed tract
Sruthi	70 E x RSP 4	Sept-Oct	Rainfed	2500	Early duration
K 11	(0794-1-DX H 876) x (0794- 1-DX H 450) Multiple Hybrid derivate	Sept-Oct	Rainfed	1100	Better fibre properties with lesser pest incidence than K 10
Suvin	Hybrid derivative from the cross Sujatha x St. Vincent	Aug-Oct	Irrigated	1020	Extra long staple cotton with 28% ginning outturn and 32 mm MHL, spins 100s
TCHB 213	Interspecific Hybrid of TCH 1218 (G.hirsutum) and TCB 209 (G.barbadense)	Aug-Sep	Irrigated	2215	High yielding, early maturing, Tolerant to leaf spot diseases
SVPR 2	TSDT 22 x JR 36	Feb_Mar Sep- Oct	Irrigated Rainfed	2000	High ginning out turn of 36.4%, medium staple (24.3 mm), can spin 30's, suited to summer irrigated, winter rainfed and tankfed rice fallow tracts of Tamil Nadu
SVPR 3	Selection from L.H 900 x 1301 D.D	Jan-Feb	Rice fallow	1800	Suitable for rice fallow tract. Early duration (135- 140 days). Tolerant to drought leafhopper, alternaria spot, black arm Disease
KC 2	MCU 10 x KC 1	Sep-Oct	Rainfed	1000	High ginning out turn of 37.5% medium staple cotton – 24.4 mm, Suited for rainfed black cotton soil of Tirunelveli, Thoothukudi and Virudhunagar Districts

CROP MANAGEMENT

PREPARATION OF FIELD FOR IRRIGATED COTTON CROP

PREPARATION OF THE FIELD:

- Prepare the field to get a fine tilth.
- Chiselling for soils with hard pen: Chisel the soils having hard pen formation at shallow depths with chisel plough at 0.5 M interval, first in one direction and then in the direction perpendicular to the previous one, once in three years. Apply 12.5 farm yard manure or composted coir pith/ha besides chiseling to get increased yield
- If intercropping of Greengram/Soyabean is proposed, prepare the main field, so as to provide ridges and furrows to take up sowing 20 days prior to cotton sowing.

APPLICATION OF FYM OR COMPOST:

Spread 12.5 t of FYM or compost or 2.5 t of vermicompost per ha if available, uniformly on the unploughed soil.

APPLICATION OF BIOFERTTLIZER:

Seed treatment with 3 packets of Azospirillum (600 g/ha) and 3 packets (600 g/ha) of Phosphobacteria or 6 packets of Azophost (1200 g/ha). In addition apply 10 packets of Azospirillum (2000 g/ha) and 10 packets (2000 g/ha) of Phosphobacteria or 20 packets of Azophos (4000 g/ha) mixed with 25 kg FYM and 25 kg of soil on the seed line. This save 25% nitrogen besides increasing yield.

FORMATION OF RIDGES AND FURROWS:

- Form ridges and furrows 10 m long with appropriate spacing depending upon the variety.
- Use ridge plough or bund former to form ridges so as to economic on cost of cultivation.
- In fields with ragi stubbles, just dibble cotton seeds at the specified spacings.
- Adopt the following spacing between ridges for different varieties/hybrids.

Varieties/Hybrids	Spacing between ridges(cm)
MCU 5, SVPR 2, LRA 5166, MCU 12, MCU 13	75
TCHB 213	120
Suin	90
MCU 7	60

NOTE: Adopt higher spacing rows in fertile soils by 15 to 30 cm.

APPLICATION OF INORGANIC FERTILIZERS:

- Apply NPK fertilizers as per soil test recommendations
- If soil test recommendations are not available follow the blanket recommendation for the different varieties.

Varieties/Hybrids	Quantity of fertilizers (Kg/ha)		
	N	P ₂ O ₅	K ₂ O
K20 MCU 7, SVPR 3	60	30	30
MCU 5, MCU 5 VT, MCU 12, MCU 13, Suvin, SVPR 2	80	40	40
TCHB 213.	120	60	60

- If basal application could not be done apply the 25th day after sowing.
- Apply 50 per cent of N and K full dose of P₂O₅ as basal and remaining ½ N and K at 40 – 45 DAS for varieties. For hybrids apply N in three splits viz., basal, 45 and 65 DAS
- Foliar application of 2% DAP + 1% KCI will improve kapas yield.
- Apply the fertilizers in a band, two thirds of the distance from the top of the ridge, and incorporate.

APPLICATION OF MICRONUTRIENT MIXTURE:

Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture. Tamil Nadu with enough sand to make a total quantity of 50 kg for one ha.

NUTRITIONAL DISORDERS' CORRECTION:

- In the cross of Zinc deficient soils ZnSO₄ @ 50 kg/ha as basal or ZnSO₄ 0.5% spray thrice at 45, 60 and 75 DAS.
- When reddening occurs in leaves apply 5% MgSO₄, Urea (1.0%) and ZnSO₄ (0.10%) as foliar spray on 50th and 80th day to correct this malady. In Mg deficient areas apply MgSO₄ @ 20 kg/ha basally.

MANAGEMENT OF MAIN FIELD OPERATIONS:

SEED RATE:

Adopt the following seed rates for different varieties/hybrids

Varieties/Hybrids	Quantity of seed (Kg/ha)		
	With fuzz	Delinted	Naked
MCU 5, MCU 5 VT, MCU 12, MCU 13,	15.00	7.50	---
SVPR 2	15.00	--	--
KC 2	20.00	15.00	---
SUVIN	---	---	6.00
TCHB 213	2.5	2.0	---

SPACING:

In a pure crop of cotton, adopt the spacing as below for the different varieties.

Varieties/Hybrids	Spacing (cm)	
	Between rows	Between plants
MCU 5, MCU 5 VT, MCU 12, MCU 13	75	30
LRA 5166, SVPR 2		
KC 2	45	15
SUVIN	90	45
TCHB 213	120	60
MCU 7, SVPR 3	60 or 75*	30

* Fertile soils

- a. If cotton intercropped with other crops, one paired row of cotton is alternated with three rows of intercrop and the total population of cotton crop is maintained at the same level as in the case of pure crop.
- b. For intercropping with Greengram/ Soyabean, complete the sowing and irrigation 20 days prior to cotton sowing on one side of the ridge.

Varieties/Hybrids	Spacing for cotton crop (cm)		
	With in Paired row	Between Paired rows	Between plants
MCU 5, MCU 5 VT, MCU 12, MCU 13	60	90	30
SUVIN	80	100	45
TCHB 213	100	140	60

Plant two rows of intercrop between each paired row of cotton

Intercrop	Seed rate (kg/ha)	Spacing (cm)	
		Rows	Plants
Blackgram	12.5	30	10
Greengram	12.5	30	10
Cowpea	7.5	30	20
Soyabean	20.0	30	10

For higher returns, advance sowing of either greengram or soyabean 20 days before sowing of cotton in winter season.

ACID – DELINTING OF COTTON SEEDS:

- Choose plastic bucket for acid delinting of seeds.
- Do not use earthen wares, metal vessels, porcelain wares or wooden drum for acid delinting as concentrated sulphuric acid will corrode them.
- Put the required quantity of seeds in the container and add commercial concentrated sulphuric acid at the rate of 100 ml per kg of fuzzy seed.
- Stir vigorously and continuously with a wooden stick for 2 to 3 minutes till the fuzz sticking to the seeds is completely digested and the seed coat attains a dark brown colour of coffee powder.
- Add water to fill the container. Drain the acid water and repeat the washing 4 or 5 times to remove any trace of acid.
- Remove the floating, ill-filled and damaged seeds while retaining the healthy and good seeds which remain at the bottom.
- Drain the water completely and dry the delinted seeds in shade.

NOTE: Acid delinting has the following advantages:

- Eliminate some externally seed borne pathogenic organisms.
- Kills eggs, larvae and pupae of pink boll worm
- Helps to remove immature, ill-filled, cut and damaged seeds.
- Makes seed dressing more effective and easy.
- Facilitates easy sowing and good germination.

PRE-TREATMENT OF ACID DELINTED SEEDS WITH FUNGICIDES:

- Treat the delinted seeds with talc formulation of *Trichoderma viride* @ 4g/kg of seed or with Carbendazim (or) Thiram @ 2g/kg of seed Biocontrol agents are compatible with biofertilizers. First treat the seeds with biocontrol agents and then with biofertilizers. Fungicides and biocontrol agents are incompatible.
- Treat the delinted fungicide treated seeds with 3 packets (600 g) of Azospirillum and 3 packets of phosphobacteria 600g (or) 6 packets of Azophos (1200 g) and sow immediately.

SEED HARDENING:

Soak the seeds in equal volume of Pungam leaf extract (1%) for 8 hours and dry back to original moisture to increase germination and vigour. Dry the seeds in shade.

Seed pelleting: Seeds coated with arappu leaf powder (100 g/kg) along with DAP (40 g/kg), micronutrient mixture (15 g/kg) and Azospirillum (200 g/kg) phosphobacteria (200 g/ha) or Azophos (400 g/ha) using 5% maida solution or gruel as adhesive (300 m/kg) to increase the germination and vigour.

SOWING:

- Dibble the seeds at a depth of 3-5 cm on the side of the ridge 2/3 height from the top and above the band where fertilizers and insecticides are applied, maintaining the correct spacing and then cover seeds with soil.
- In the case of intercropping, sow the seeds of the intercrop in between the paired rows of cotton in a row of 5 cm apart and cover the seeds.
- Sow the required number of seeds in each hole.

Varieties/hybrids	No. of seeds / hole	
	Fuzzy seeds	Delinted seeds
Hybrids	2	1
Varieties	3	2

WEED MANAGEMENT:

- Apply Pendimethalin @ 3.3 l/ha three days sowing using a hand operated sprayer fitted with deflecting or fan type nozzle. Sufficient moisture should be present in the soil at the time of herbicide application. This will ensure weed free condition upto 40 days.
- One hand weeding on 45 DAS will keep weed free environment upto 60 DAS.
- Hoe and hand weed between 18th to 20th days of sowing, if herbicide is not applied at the time of sowing.

GAP FILLING:

- a. Take up gap filling on the 10th day of sowing.
 - In the case of TCHB 213, raise seedlings in polythene bags of size 15 x 10 cm.
 - Fill the polythene bags with a mixture of FYM and soil in the ratio 1:3.
 - Dibble one seed per bag on the same day when sowing is taken up in the field.
 - Pot water and maintain.
 - On the 10th day of sowing, plant seedlings maintained in the polythene bags, one in each of the gaps in the field by cutting open the polythene bag and planting the seedling along with the soil intact and then pot water.
- b. In the case of all other varieties, dibble 3 to 4 seeds in each gap and pot water.

THINNING:

Thin out the seedlings on the 15th day of sowing. In the case of fertile soils, allow only one seedling per hole, whereas in poor soil two seedlings per hole.

TOP DRESSING:

- Top dress 50% of the recommended dose of N and K on 40 – 45 DAS for varieties.
- Top dress 1/3rd of recommended dose of N on 40 – 45 DAS and the remaining 1/3rd on 60 – 65th DAS for hybrids.

RECTIFICATION OF RIDGES AND FURROWS:

Reform the ridges and furrows after first top dressing in such a way that the plants are on the top of the ridges and well supported by soil.

SPRAYING OF NAPHTHALENE ACETIC ACID (NAA):

Spray 40 ppm NAA at 60 and 90 days sowing on the crop to prevent early shedding of buds and squares and to increase the yield.

MANAGEMENT STRATEGIES FOR DELAYED UMMER IRRIGATED COTTON SOWING:

KCI 1% spray, twice on 50 and 70 DAS for delayed sowing (first fortnight of March) of summer irrigated cotton in rice-cotton cropping system for Srivilliputhur region.

ARRESTING TERMINAL GROWTH:

Nip the terminal portion of the main stem as indicated below: For varieties having less than 160 days duration nip the terminal portion of the main stem beyond the 15th node (75 to 80 DAS) and for varieties and hybrids having more than 160 days duration beyond the 20th node (85 – 90 DAS).

WATER MANAGEMENT:

Regulate irrigation according to the following growth phases of the crop.

Stages	No. of Irrigations	Days after dibbling seeds	
		Light soil	Heavy soil
Germination Phase (1 – 15 days)			
Irrigate for germination and	1	Immediately after sowing	Immediately after sowing
Establishment	2	Give a life irrigation on	Give a life irrigation on
		5th day of sowing to	5th day of sowing to
		facilitate the seedlings	facilitate the seedlings
		to emerge out	to emerge out
Vegetative phase (16 – 44 days)			
Regulate	1	Irrigate on the 20th or	Irrigate on the 20th or
		21st day of sowing three	21st day of sowing three
		Days after hoeing and	Days after hoeing and
		weeding	weeding
	2	Irrigate again on	Irrigate again on
		the 35th or 36th	the 40th day of
		day of sowing	Sowing
Flowering phase (45 – 100 days for hybrids and 87 days for varieties)			
Irrigate copiously	1	48th day	55th day
	2	60th day	70th day
	3	72nd day	85th day
	4	84th day	100th day
	5	96th day	**

** For TCHB 213 and Suvin only.

Maturity phase (beyond 100 days for hybrids and 88 days for varieties)		For all varieties other than Suvin, and TCHB 213	
Control irrigation	1	108th day	115th day
during maturity	2	120th day	130th day
Phase	3	130th day	
	4	144th day	
Stop Irrigation after 150th day			
For Suvin, TCHB 213			
	1	108th day	115th day
	2	120th day	130th day
	3	132nd day	145th day
	4	144th day	150th day
	5	158th day	
Stop Irrigation after 160th day			
NOTE i.	If irrigation is given on climatological approach. Schedule the irrigation at 0.40 and 0.60 IW/CPE ratio during vegetative and reproductive phases respectively.		
Ii	Depending upon the prevailing weather condition and receipt of rains.		
Iii	Adopt alternate furrow or skip furrow irrigation to save irrigation water.		

The futures of the methods are furnished below:

Skip furrow irrigation:

- Suited to heavy soils like clay and loam
- Alternate furrows should be skipped and may be converted to ridges having a wide bed formation
- Short term crops like pulses may be raised in wider bed without exclusive irrigation.
- Water saving is 50% when compared to control.

Alternate furrow irrigation:

- During any one run of irrigation a particular set of alternate furrows is irrigated.
- The interval of irrigation should be shortened when compared to the conventional furrows.
- During the next run, the left over furrows be irrigated.
- Suited to heavy soils like clay and loam.

HARVESTING:

- Harvest at frequent intervals, at less than 7 days interval.
- Harvest in the morning hours upto 10 to 11 a.m only when there is moisture so that dry leaves and bracts do not stick to the kapas and lower than market value.
- Pick kapas from well burst boll only.
- Remove only the kapas from the bolls and leaves the bracts on the plants.
- After kapas is picked, sort out good puffy ones and keep separately.
- Keep stained, discoloured and insect damaged kapas with good kapas, as they will spoil the good kapas also and lower the market value of the produce.

NOTE: Do not mix stained, discoloured and insect damaged kapas with good kapas, as they will spoil the good kapas also and lower the market value of the produce.

POST HARVEST OPERATIONS:

- Immediately after picking, dry the kapas in shade. If it is not dried immediately the colour will change which will lower than market value.
- Do not dry the kapas under direct sun as the fibre strength and luster will be lost.
- Grade the kapas into good and second quality ones, if it is not sorted out at the time of picking.
- Spread a thin layer of dry sand on the ground and keep the kapas over it.

RICE FALLOW COTTON - MANAGEMENT OF FILED OPERATIONS:

PREPARATION OF THE FIELD:

- If the seed is in waxy condition, instead of Zero tillage, the seed rows may be tilled and the seed dibbled in Virudhunagar district.
- If the soil is dry and not in condition to take up sowing, let in water and then allow the soil to dry till soil comes to waxy condition.
- At the lower level of the field dig a trench 15 cm wide and connect the trench to the outside channel to drain off the excess water.

PRE – TREATMENT OF ACID DELINTED SEEDS WITH FUNGICIDES:

- Same as for the irrigated crop.
- Treat the acid delinted and fungicide treated seeds with 3 packets (600 g) of Azosprillum and sow immediately.

SOWING THE SEEDS:

Particulars	MCU 7	SVPR 3
a) Seed rate (kg/ha)		
• Fuzzy seed	15.0	15
• Acid delinted	7.5	7.5
b) Spacing (cm)		
• Between rows	60	60 or 75*
• Between plants	30	30
c) Number of seeds / hole		
• Fuzzy seeds	4	4
• Acid delinted	22	
d) Depth of sowing (cm)	3	3
* In fertile soils		

FILLING UP GAP:

- Fill up gaps on the 10th day of sowing
- Dibble 2 to 3 acid delinted seeds or 4 to 5 fuzzy seeds in the gaps in the case of MCU 7 and SVPR 3

THINNING SEEDLINGS:

- Thin out seedlings on the 20th day of sowing
- Leave only one healthy and vigorous seedling per hill.

WEED MANAGEMENT:

- Pre-emergence application of Pendimethalin 3.3 l/ha ensures weed free condition for 40 – 45 days. This should be followed by one hand weeding and earthing up during 40 – 45 days.
- Take up hoeing and weeding 20 days after sowing.
- Take up this operation when the top soil dries up comes to proper condition.

APPLICATION OF FERTILIZERS:

- Apply NPK fertilizers as per soil test recommendations. If soil test is not done follow the blanket recommendation of 60:30:30 kg NPK/ha.
- Apply half the dose of N and K full dose of P_2O_5 at 35th day in old delta and balance in 55 days the rows of cotton plants. In the case New delta apply full P and 1/3 of N and K at 20 DAS and 2/3 N and K at 40 DAS.

APPLICATION OF MICRONUTRIENTS:

Apply basally 12.5 kg/ha micronutrient mixture prepared by Department of Agriculture. Apply MgSO_4 basally @ 20 kg/ha to prevent reddening.

FORMATION OF RIDGES:

Old delta:

- If soil in condition give a hoeing with mammutti and form ridges and incorporate the fertilizer in the soil around the plants between 30th to 35th days of sowing.
- If soil is not in condition, give one hoeing and weeding and cover the fertilizers.
- Form long ridges and furrows from one end of the field to the other without forming any separate channels for carrying water to prevent excessive soaking of water.
- Form ridges and furrows on alternate rows of plants. Skip furrow method of irrigation to prevent excessive irrigation.

New delta:

- Give a hoeing with mummitti and form ridges and incorporate the fertilizer in the soil around the plants on the 40th day of sowing.
- If soil is not in condition give one hoeing and weeding and cover the fertilizers.
- Form long ridges & furrows on alternate rows of plants to adopt skip furrow irrigation.

Note: In case of Zinc deficient soils, apply 50 kg ZnSO_4 /ha

APPLYING OF NAA:

Spray 40 ppm of NAA (40 mg of NAA dissolved in one litre of water) at 40/45th day using high volume spray. Repeat the same dose after 15 days of first spraying.

TOPPING:

Arrest terminal growth by nipping the terminal 15th node for controlling excessive vegetative growth (70 – 75 DAS)

WATER MANAGEMENT:

Regular irrigation according to the growth phases of the crops.

Stages	No. of Irrigations	Days after dibbling seeds	
		Old delta	New delta
1. Vegetative Phase			
Regulate irrigation during the germination phase	1	One wetting on the 30 th to 35 th day of sowing after the application of fertilizers	One irrigation on the 20 th day after the application of fertilizers
	2	-----	One irrigation on the 40 th day after the application of N
2. Flowering Phase			
Irrigate more frequently	1	45 th day of sowing after the application of 2 nd dose of N	45 th day
	2	55 th day	51 st day
	3	65 th day	56 th day
	4	75 th day	61 st day
	5	85 th day	66 th day
	6	---	71 st day
	7	---	76 th day
	8	---	81 st day
	9	---	86 th day
	10	---	91 st day
3. Control Irrigation during maturity Phase	1	99 th day	98 th day
	2	113 th day	105 th day
	3	---	112 th day

Stop irrigation from the 113th day onwards.

Note: 1) The irrigation schedule given above is only a guideline and regulates irrigation depending upon the prevailing weather conditions and receipt of rains.

2) Observe the crop and if the plants show wilting symptoms in the afternoon and in the evening hours, give an additional irrigation.

HARVESTING:

POST HARVESTING OPERATION: As that of the irrigated cotton.

PEST AND DISEASE MANAGEMENT:

RAINFED COTTON

Follow water harvesting techniques and raise a successful crop of cotton.

SEASON AND VARIETIES:

For Thirumangalam in Madurai district, Sattur in Virudhunagar district and parts of Kovillipatti in Thoothukudi district, where the seasonal rainfall is 375 mm and most of it is received during September of first week of October, select LRA 5166 (or) SVPR 2 (or) KC 2.

In places where rains are received during October or November. Select K 11 for Ramanathapuram, Virudhunagar, Tirunelveli and Thoothukkudi districts.

PREPARATION OF LAND FOR RAINFED COTTON:

PREPARATION OF FIELD:

- Start preparation of the land immediately after harvest of the previous crop.
- Adopt permanent broad ridges system.

APPLICATION OF FYM OR COMPOST:

- Spread 12.5 t of FYM or compost or composted coir pith or 2.5t of vermicompost per ha uniformly on the unploughed soil.
- Incorporate the manure in the soil by working the multipurpose implement or country plough.

APPLICATION OF INORGANIC FERTILIZERS:

- Apply NPK fertilizers as per soil test recommendations as far as possible.
- If soil tests are not done, follow the blanket recommendations for the different varieties.

Varieties	Quantity of fertilizers (Kg/ha)		
	N	P ₂ O ₅	K ₂ O
K 11	20	0	0
SVPR 2	40	20	40
KC 2	40	20	40

APPLICATION OF MICRONUTRIENT MIXTURE:

- Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture. Tamil Nadu with enough sand to make a total quantity of 50 kg.
- Apply uniformly over the furrows after sowing and cover the seeds
- Do not incorporate in the soil.

SEEDS AND SOWING:

- Adopt the following seed rates for different varieties/hybrids

Varieties	Quantity of seeds (kg/ha)	
	Fuzzy seeds	Delinted seeds
K 11	20	---
LRA 5166, SVPR 2	20	15

Note: Delint only LRA 5166 and SVPR 2 seeds. Do not delint seed of K 9, K10 & K 11

- In the case of mixed crop of cotton, maintaining the same seed rates as for a pure crop and adopt the following seed rate for the pulses crop

Blackgram / greengram	10 kg/ha
Cowpea	7.5 kg/ha

SPACING:

- In the case of pure crop of varieties/hybrids, a spacing of 45 cm between rows and 15 cm between plants may be adopted
- In the case of cotton, intercropped with pulses, one paired row of cotton is alternated with tow rows of pulses and the total population of cotton is maintained at the same line as that for a pure crop of cotton.

Varieties	Spacing for cotton crop (cm)			
	Within row	Paired	Between rows	Between plants
K 11, LRA 5166, SVPR 2	30		60	15

- Adopt a spacing of 30 x 10 cm for the pulse crop in between each paired row of cotton. APK 1 Blackgram is best suited for this situation.

ACID DELINTING:

- Adopt procedure for acid delinting as for an irrigated crop

PRETREATMENT OF ACID DELINTED SEEDS WITH FUNGICIDES:

Same as for the irrigated crop

SOWING:

- Use the multipurpose farming implement to sow the seeds and to apply basat fertilizers simultaneously.
- Fill the hopper in the implement with the fertilizer mixtures and work the implement.
- Engage 3 persons for dropping the seeds, 2 for cotton and one for pulses.

In one operation, placement of fertilizer, sowing of seeds and covering will be completed.

NOTE: Cotton and pulses can be sown at a depth of 5 cm in black cotton soil even before the onset of monsoon rains in dry bed sowing. When light rains are received, the moisture will not penetrate deeper and the seeds will not germinate and die away. Only when good rains are received, the moisture level will be sufficient to penetrate to the level of the seed and facilitate germination and proper establishment.

WEED MANAGEMENT:

- Pre-emergence application of Pendimethalin 3.3 l/ha followed by one hand weeding on 40 days after crop emergence. At the time of herbicide application sufficient soil moisture must be there.
- Insufficient soil moisture is not available for applying herbicides hand weeding may be given at 10 – 20 days after crop emergence.

GAP FILLING:

- Dibble 3 to 4 seeds gap if sufficient moisture is available.

THINNING SEEDLINGS:

- Allow two seedlings per hole and thin out on 15th day of sowing, adopting proper spacing between plants.
- Thin the pulse crop on the 20th day of sowing, adopting a spacing of 15 cm between plants for cowpea and 10 cm for other pulse crop.

FOLIAR FERTILIZATION:

Spray 0.5% urea and 1% KCI on the 45th and 65th day of sowing if sufficient moisture is available.

INTERCULTIVATION WITH DHANTHULU/BLADE HARROW:

Work dhanthulu or blade harrow on the 30th and 45th day of sowing.

NOTE: Other cultivation practices, plant protection measures, harvest etc., are the same as for the irrigated crop.

CROP PROTECTION:

Irrigated Cotton:

Pest Management:

- Remove the cotton crop dispose off the crop residues as soon as harvest is over
- Avoid stacking of stalks in the field
- Avoid ratoon and double cotton crop
- Adopt proper crop rotation
- Use optimum irrigation and fertilizers
- Grow one variety throughout the village as far as possible
- Treat the seeds with imidacloprid or use designer seed (Delinted seed + polykote @ 3 g/kg + carbendazim @ 2 g/kg + imidacloprid @ 7 g/kg + *Pseudomonas fluorescens* 10 g/kg + Azophos 40 g/kg. When the treated seeds are used, it protects against sucking pests upto 45 days after sowing and promotes early vigour of the crop.
- Synchronise the sowing time in the villages and complete the sowing within 10 to 15 days.
- Avoid other Malvaceous crops in the vicinity of cotton crop
- Timely earthing up and other agronomic practices should be done.
- Hand pick and burn periodically egg masses, visible larvae, affected and dropped squares, flowers and fruits and squash pink bollworm in the rosettes.
- Use locally fabricated light traps (modified Robinson type) with 125 Watt mercury lamps to determine the prevalence and insect population fluctuations.
- The magnitude of the activity of the moths of the cotton pink bolloworm, the cutworm (*Spodoptera litura*) and the American bollworm can be assessed by setting up the species-specific sex pheromone trap each all the rate of 12 per ha.
- Apply insecticides only where it is absolutely necessary when pest population or damage reaches ET level.
- Intercropping with pulses viz., cowpea, greengram, balckgram, soybean and maize reduces the bollworm incidence and population of sucking pests of cotton viz., aphid and leafhopper with the highest activity of natural enemies viz., spiders and predatory lady bird beetles.

Economic threshold level for important pests

Pests	ETL
Thrips	50 nymphs or adults / 50 leaves
Aphids	15% of infested plant
Leafhopper	50 nymphs or adults / 50 leaves
Mite	10 mites / cm ² leaf area
Spotted Boll-worms	10% infested shoots / squares / bolls
Spiny Boll-worms	10% infested shoots / squares / bolls
Pink Boll-worms	10% infested fruiting parts
Helicoverpa	One egg or one larva / plant
Whiteflies	5 – 10 leaf
Stem weevil	10% infestation
Tobacco cutworm	8 egg masses / 100 m row

Pest management strategies:

Pests	Management strategies
American bollworm	Monitoring:
<i>Helicoverpa armigera</i>	Pest monitoring through light traps, pheromone traps and in situ assessments by roving and fixed plot surveys has to be intensified at farm, village block, regional and State levels. For management an action threshold of one egg per plant or 1 larva / plant may be adopted
	Cultural practices:
	1. Synchronised sowing of cotton preferably with short duration varieties in each cotton ecosystem.
	2. Avoid continuous cropping of cotton both during winter and summer seasons in the same area as well as rationing.
	3. Avoid monocropping. Growing of less preferred crops like greengram, balckgram, soybean, castor, sorghum etc., along with the cotton as intercrop or border crop or alternate crop to reduce the pest infestation.
	4. Remove and destruction of crop residues to avoid carry over of the pest to the next season, and avoiding extended period of crop growth by continuous irrigation.
	5. Optimising the use of nitrogenous fertilizers which will not favour the multiplication of the pest.
	6. Judicious water management for the crop to prevent excessive vegetative growth and larval harbourage.

Pest management strategies:

Pests	Management strategies
	Biological control:
	1. Application of Nuclear Polyhedrosis Virus (NPV) at 3×10^{12} . POB /ha in evening hours at 7th and 12th week after sowing
	2. Conservation and augmentation of natural predators and parasitoids for effective control of the pest.
	3. Inundative release of egg parasitoid, Trichogramma spp., at 6.25 cc/ha at 15 days interval 3 times from 45 DAS
	4. Egg larval parasitoid. <i>Chelonus blackburnii</i> and
	5. Predator Chrysoperia carnea at 1,00,000/ha at 6 th , 13 th and 14 th week after sowing.
	6. ULV spray of NPV at 3×10^{12} POB/ha with 10% cotton seed kernel extract, 10% crude sugar, 0.1% each of Tinopal and Teepol for effective control of Helicoverpa. Note: Dicofol, endosulfan, methyl demeton, monocrotophos and phosalone are comparatively safer to Chrysoperia larva recording low egg mortality.

Pest management strategies:

Pests	Management strategies
	Chemical Control:
	1. Discourage the indiscriminate use of insecticides, particularly synthetic pyrethroids
	2. Use of proper insecticides which are comparatively safer to natural enemies such as endosulfan, phosalone etc., at the correct dosage and alternating different groups of insecticides for each round of spray.
	3. Avoid combination of insecticides as tank mix.
	4. Adopt proper delivery system using spraying equipments like hand compression sprayer, knapsack sprayer and mist blower to ensure proper coverage with required quantity of spray fluid and avoid ULV applications or Akela spray applications.
	5. Proper mixing and preparation of spray formation apply endosulfan 35 EC s l/ha

Pest management strategies:

Pests	Management strategies
	Chemical Control:
	6. During bolling and maturation stage, apply any one of the following insecticide (1000 l of spray fluid/ha); Phosalone 35 EC 2.5 l/ha Quinalphos 25 EC 2.0 l/ha Carbaryl 50 WP 2.5 kg/ha Pyraclofos 50 EC 1.5 l/ha
Pink bollworm (<i>Pectinophora gossypiell</i>)	1. Use pheromone trap to monitor the adult moth activity 2. Spray triazophos 40 EC 2.5 l/ha and endosulfan 35 EC 2.0 l/ha in alternation even after 100 DAS.
Tobacco cutworm (<i>Spodoptera litura</i>)	1. Use of light trap to monitor and kill the attracted adult moths. Set up the sex pheromone trap Pherodin S.L. at 12/ha to monitor the activity of the pest and to synchronise the pesticide application. If need be, at the maximum activity stage.
	2. Growing castor along border and irrigation bunds.
	3. Removal and destruction of early stage larvae found in clusters which can be located easily even from a distance.
	4. Collection and destruction of shed materials
	5. Hand picking and destruction of growth up caterpillars.
	6. Spray any one of the following insecticides per ha using a high volume sprayer covering the foliage and soil surface: Chlorpyrifos 20 EC 2.0 l Dichlorvos 76 WSC 1.0 l Phenthoate 50 EC 2.0 l Chlorpyrifos 20 EC 1.25 l Fenitrothion 50 EC 6.25 l
	7. Spraying nuclear polyhedrosis virus at 1.5×10^{12} POB per ha
	8. Spraying of insecticides should be done either in the early morning or in the evening and virus in the evening
	9. Use of poison bait pellets prepared with rice bran 12.5 kg, jaggery 1.25 kg, carbaryl 50% WP 1.25 kg and water 7.5 litres. This bait can be spread in the fields in the evening hours so that the caterpillars coming out of the soil, feed and get killed.

Pests	Management strategies
Stem weevil (<i>Pempherulus affinis</i>)	1. Soil application of carbofuran 3 G 30 kg/ha on 20 days after sowing and earthing up on 45th day.
	2. Basal application of FYM 25 t/ha and 250 kg/ha of neem cake.
Whitefly (<i>Bemisia tabaci</i>)	1. Avoid the alternate, cultivated host crops of the whitefly in the vicinity of cotton crop
	2. Growing cotton crop once a year either in winter or summer season in any cotton tract.
	3. Adopting crop rotation with non-preferred hosts such as sorghum, ragi, maize etc. for the white fly to check the build up of the pest.
	4. Removal and destruction of alternate weed hosts like <i>Abutilon indicum</i> , <i>Chrozophore rottlari</i> , <i>Solanum nigrum</i> and <i>Hibiscus ficulensus</i> from the fields and neighbouring areas and maintaining field sanitation.
	5. Timely sowing with recommended spacing, preferably wider spacing and judicious application of recommended dose of fertilizers, particularly nitrogenous and irrigation management is essential to arrest the excessive vegetative growth and pest build up. Late sowing may be avoided and the crop growth should not be extended beyond its normal duration.
	6. Field sanitation may be given proper attention.
	7. Cultivars of most preferred alternate host crops like brinjal, bhendi, tomato, tobacco and sunflower may be avoided. In case their cultivation is unavoidable, plant protection measures should be extended to these crops also.
	8. Monitoring the activities of the adult white files by setting up yellow pan traps and sticky traps at 1 foot height above the plant canopy and also in situ counts
	9. Collection and removal of whitefly infested leaves from the plants and those which were shed due to the attack of the pest and destroying them

Pests	Management strategies
	Chemical Control:
	1. Spray any one of the following plant products along or in combination with the recommended dose of insecticide (at 2 ml/l or water) Neem seed kernel extract 5% (50 kg) and neem oil at 5 ml/l of water Fish oil rosin soap 25 kg at 1 kg in 40 lit of water Notchi leaves 5% extract Catharanthus rosea extract 5%
	2. Spray any one of the following in early stage (500 l of spray fluid/ha) Methyl demeton 25 EC 500 ml Phosphamidon 40 SL 600 ml/ha
	3. Spray any one of the following in mid and late stages (1000 l spray liquid /ha) Phosalone 35 EC at 2.5 l/ha Quinalphos 25 EC at 2.0 l/ha Ethion 50 EC 1.0 l/ha Monocrotophos 36 SL 1.25 l/ha Triazophos 40 EC 2.0 l/ha Acephate 75 SP 1.30 kg/ha
	4. In the early stages with high volume sprayer, use a goose neck nozzle to cover the under surface of the foliage to get good control of the pest. If high volume sprayers are not available, 375 litres of spray fluid may be used per hectare for application in the low volume motorized knapsack mist blower.
	5. The use of synthetic pyrethroids should be discouraged in cotton to avoid the problem of whitefly. Cypermethrin, fenvalerte and delamethrin cause resurgence of whiteflies. So avoid repeated spraying of pyrethroids.
	6. The plant protection measures should be adopted on a community basis in a specified cotton area.
Thrips <i>Thrips tabaci</i>	1. Seed treatment with imidacloprid 70 WS at 7 g/kg protect the crop from aphids, leafhoppers and thrips upto 8 weeks.
Aphids <i>Aphids gossypii</i>	Spray any one of the following insecticides (500 l spray fluid /ha) Imidacloprid 200 SL at 100 ml/ha
Leafhopper <i>Amrasca devastans</i>	Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha Phosphamidon 40 SL 600 ml/ha Monocrotophos 36 SL 1000 ml/ha NSKE 5% 25 kg/ha
	2. Where the leafhopper is a big menace apply Neem oil formulation 0.5% or neem oil 3% thrice a fortnightly intervals
Red spider mite <i>Tetranychus cinnabarinus</i>	Apply any one of the following; Wettable sulphur 1.25 kg/ha Dicofol 1.10 l/ha

Insecticide resistance:

In case of control failures monitor the insecticides with following discriminating dose screen.

A. <i>Helicoverpa armigera</i> (Topical assay with III instar larva weighing 30 – 40 mg)		
1. Cypermethrin		0.1
2. Cypermethrin		0.1
3. Fenvalerate		0.2
4. Endosulfan		10
5. Quinalphos		0.75
6. Chlorpyrifos		1.0
B. Tobacco caterpillar – <i>Spodoptera litura</i> (early III instar 8 day old larva weighing 30 – 40 mg and measuring 12 + 0.5 mm length)		
1. Endosulfan topical		2.0
2. Profenofos topical		3.0
3. Chlorpyrifos topical		0.15
4. Fenvalerate topical		0.2
C. Cotton leafhopper – <i>Amrasca devastans</i> (Distant) (III instar larva of 0.14 mg weight, 1.30 mm length)		
1. Dimethoate	IRAC method VIII (leaf disc)	400 ppm
2. Methyl demeton	IRAC method VIII (leaf disc)	800 ppm
3. Acephate	IRAC method VIII (leaf disc)	850 ppm

Resurgence:

Repeated application of the following insecticides can cause resurgence of the insect pest of cotton

- *Aphis gossypii*: Carbaryl, cypermethrin, deltamethrin, endosulfan, fenpropathrin, fenvalerate, flucythrinate, fluvalinate, monocrotophos, permethrin, phorate
- *Amrasca devastans*: Deltamethrin, dimethoate, disulfoton, methylparathion, phorate
- *Bemisia tabaci*: Cypermethrin, deltamethrin, dimethoate, endosulfan, fenvalerate, monodrotophos, phosalone
- *Ferrisia virgata*: Cypermethrin, deltamethrin, fenvalerate, permethrin
- *Tetranychus cinnabarinus*: Acephate, carbaryl, cypermethrin, deltamethrin, endosulfan, fenvalerate, fluvalinate, phosphamidon.

CROP PROTECTION:

Rainfed Cotton:

Pest management:

- The control measures recommended for irrigated cotton will hold good.
- When water is not available, use any one of the following insecticides for the control of bollworms at 25 kg/ha:

Endosulfan 4 D

Carbaryl 5 D

Phosalone 4 D

Disease Management:

Name of the Disease	Management
Bacterial blight <i>Xanthomonas axonopodis</i> <i>pv. Malvacearum</i>	1. Avoid stacking of infected plants 2. Spray Streptomycin sulphate + Tetracycline mixture 100g + Copper oxychloride 1250 g/ha 3. Repeat spraying at 10 days interval twice or thrice if drizzling continues.
Alternate leaf spot <i>Alternaria macrospora</i>	Spray any one of the following: 1. Copper Oxychloride 1250g 2. Mancozeb 1000g 3. Chlorothalonil 5000 g/ha
Grey Mildew <i>Ramularia areola</i>	Spray Carbendazum 250 g/ha
Boll rot <i>Fusarium monilifrone</i> , <i>Collectorichum capsici</i> , <i>Aspergillus flavus</i> , <i>A. niger</i> , <i>Rhizopus</i> <i>nigricans</i> , <i>Nematospora</i> , <i>Botryodiplodia</i>	Spray any one of the following 1. Spray Carbendazim 500 g. 2. Mancozeb 2000 g. 3. Copper oxychloride 2500 g/ha along with an insecticide recommended for bollworm from 45th day at fortnightly interval.
Root rot <i>Macrophomina phaseolina</i> <i>Rhizoctonia bataticola</i>	Cultural Method Apply Neem cake @ 150 kg/ha to the soil and treat the seeds with talc based T viride @ 4 g/kg to reduce the root rot incidence. Biological Control Seed treatment with T. viride @ 4 g/kg followed by basal application of zinc sulphate @ 50 kg/ha Chemical Control Spot drench Carbendazim @ 1 g/lit at the base of affected plants as well as surrounding healthy plants.

Source: CICR, Nagpur.

7.9. Uttar Pradesh:

1. Brief History / Introduction:

Cotton is the most important commercial crop and known as white gold. The cultivation of cotton and its manufacture into textile has been practiced in India pre-historic times. It is also used for several other purposes like making threads for mixing in other fibre and extraction of oil from the seed. The oil content in the cotton seed ranges from 15-25 percent. American cotton contains more percentage of oil. Cotton seed cake after extraction of oil is a good organic manure. Cotton seed, cotton linters and pulp obtained during oil extraction and cotton meal are good concentrated feed for cattle. Cotton is grown in almost all parts of the country.

In Uttar Pradesh, cultivated area under cotton crop is 14 thousands hectare. Major growing districts are Agra, Aligarh, Hathras, Mathura and Meerut.

The average demand of lint in the state is 5 lakhs per year. Cotton belongs to the Malvaceae family and the genus *Gossypium*. Cotton plants are shrubby herbaceous or tree like cotton fruits are called Bolls.

Classification:

(a) *Deshi*:

- (i) *Gossypium arboreum* (n=13)
- (ii) *Gossypium herbaceum* (n=13)

(b) *American*:

- (i) *Gossypium hirsutum* (n=26)
- (ii) *Gossypium barbadense* (n=26)

Gossypium arboreum:

This is properly known as Indian cotton, plants are perennial, much branched shrubs up to 2 metres. Twigs and leaves are pubescent, leaves are more hairy and have five to seven lobes. The fibers are coarse and short their length being mostly from 1.25 to 2.10 cm.

Gossypium herbaceum:

This species of cotton is found throughout India. The plants are shrubby, leaves and twigs sparsely hairy, leaves are flat with three to seven lobes. 60-130 cm tall with few or no vegetative branches and thick and rigid stems. Seeds are small fuzzy and lint. Fibre length is mostly 1.25 to 2.30 cm.

Gossypium hirsutum:

This is commonly known as American cotton plants are about 1.5 metre. Stem is usually green or brown leaves and twigs are densely hairy. The flowers have large pale yellow. The bolls are large rounded, with few inconspicuous oil glands. Comprising 3-5 locules, each locule contain up to 11 seeds. The fibre are fine to medium to long staple length.

Gossypium barbadense:

This group of cotton commonly known as Egyptian cotton. This gives very fine, silky and longest staple of 3.7 to 4.5 cm length, flowers are usually yellow in colour with purple spots. Area under this species is only few thousand hectares.

2. Soil Requirements:

Cotton can be successfully grown on all soils except the sandy saline soils. It is grown on all types of soil sandy loam, clay loams, loam, alluvial soil, black cotton soils, red sandy loams to loams and lateritic soil. Cotton needs a fertile soil with good moisture holding capacity.

3. Preparation of Land:

Two pre-sowing irrigations at short intervals. One ploughing by rotavator or one ploughing by soil turning plough and 2-3 ploughing by cultivator.

4. Method & Time of sowing / spacing:

S.N.	District	Varieties	Time of sowing
1	Mathura, Agra	Indian (Desi)	1 st Fortnight of April
2	Mathura, Agra	American	Mid April to Mid May
3	Other Districts	Indian (Desi)	1 st & 2 nd Fortnight of April
4	Other Districts	American	Mid April to 1 st week of May

Spacing between Plants and Rows: Depends on the type of cotton to be grown. The **Indian (Desi)** Varieties sown in line with seed- drill spacing 45-50cm x 50-60cm and **American cotton** is sown at 50-75cm x 60-90cm. Appropriate depth is 4-5cm and properly covered with moist soil. This spacing, however, can be reduced if the sowing is delayed or the soil is poor in fertility.

5. Varieties:

Desi Varieties: Lohit, RG-8, CAD-4.

American Varieties: HS-6, Vikas, H-777, F-846, RS-810, RS-2013.

6. Seeds Rate and plant population:

Deshi Varieties: 15kg/ha. (without fibre)

American Varieties: 20kg/ha

Plant Population should be between 50,000 to 80,000 plants per hectare.

7. Fertilizer Management:

Nitrogen: 60kg/ha

Phosphorus: 30kg/ha

Potash: 30kg/ha

Half quantity of Nitrogen and full quantity of Phosphorus should be given before sowing.

Top dressing: It has been observed that basal fertilization with full dose of P&K followed by N-half just after thinning and rest half near flowering phase of the plants has given the best results.

8. Nutrient Management:

In case of Alkali soil the crop must be supplied with Zinc (Zn), Boron and sulphur (S) after three years for better production of cotton.

9. Interculture operations & weed control:

Weed Control:

(a) Mechanical:

The cotton crop needs weed free field up to 30-40 days after sowing for good yield. Hence control of weeds either by manual labour or by weedicides. Hoeing with a hand hoe / khurpi 30 to 35 days after sowing of crops.

(b) Chemical Control:

Spray pre-emergence Pendimethalin 30% EC@3.3 Ltrs. per hectare after sowing and before germination of seeds.

10. Water Management:

The first irrigation should be given 30-35 days after sowing. The subsequent irrigation should be light and given at an interval of two to three weeks. The crop must not be allowed to suffer from water stress during flowering and fruiting stage, otherwise excessive shedding of flowers buds and young bolls may occur resulting in loss of yield, drain away the excess water of rain and irrigation.

11. Plant Protection Measures:

Pest Control Through:

IPM (Integrated Pest management) and Chemical Control.

(a) Insect / pests:

Pink Boll worm / American Boll worm:

Control: Quinalphos 25% AF 2 ltrs or Monocrotophos 36% SL 1.5 ltrs or Chlorpyrifos 20% EC, 1.5 ltrs/hectare.

Jassids, Aphids, Thrips and Whitefly:

These small insects suck the sap of leaves. The leaves of infected plants curl down wards and turn pale yellow or bronze when severe attacks by these insects may lead to complete withering of the plants.

Control: (i) Monocrotophos 36% SL@500ml/hectare or
(ii) Imidacloprid 17.8% SL@125ml/hectare

(b) Diseases:

Root Rot: This is soil borne disease causal organism *Rhizoctonia bataticola* and *R.solani*

Control: (i) Soil Treatment
(ii) Adopt crop-rotation for three or four years.

Bacterial Blight:

Control:
Seed treatment by Carboxin 37.5% @2.5gm and Thiram 37.5% ws @3.5gm / kg seed

12. Picking:

Cotton is harvested three to four times by hand picking when bolls matured. The number of picking varies with the maturing habit of the variety. The season of harvesting varies with the sowing and the duration. The picking of American cotton 15-20 days and Deshi cotton at 8-10 days intervals.

Picking should be done when bolls begin to fully burst and when Kapas being to hang down and should be spread in the sun to shine dry for two to four hours on a clean surface.

13. Yield:

Deshi: 15 Quintals per hectare

American: 20 Quintals per hectare

Source: State Department of Agriculture, Uttar Pradesh.

7.10 Kerala:

Cotton grown from sea level to moderate elevations not exceeding 1000 m where the climate is tropical with rainfall 500 to 750 mm. Excessive rain at any stage is harmful to the crop. It can be grown in a wide variety of soils. A deep homogeneous fertile soil is desirable.

Seasons

Winter crop: August – September

Summer crop: February – March

Table 25: Cotton varieties, spacing and duration

Variety	Spacing (cm)	Duration (days)	Season
MCU 5 / MCU 5 VT	75 x 45	175	Irrigated crop (Aug.-Sep.)
TCHB 213 (hybrid)	120 x 60	190	Irrigated crop (Aug.-Sep.)
Savita (hybrid)	90 x 60	165	Irrigated crop (Aug.-Sep.)
LRA 5166	60 x 30	150	Irrigated crop (Aug.-Sep.)

Table 26: Seed rate for cotton

	Variety	Delinted seeds	Fuzzy seeds
Irrigated	MCU 5 / MCU 5 VT	5.0 kg	8.0 kg
	TCHB 213	2.5 kg	-
	Savita	3-4 kg	-
Rainfed	LRA 5166	8-10 kg	10-12 kg

Preparation of land and sowing

Plough the land three to four times and form ridges and furrows. Dibble the seeds on the sides of the furrows. Use basalin at the rate of 2.5 l/ha before irrigating the field to control the weeds.

Note: Treat the seeds with carbendazim 50 WP (2 g/kg) or *Trichoderma viride* talc preparation (4 g/kg) before sowing.

Manuring

Apply FYM or compost @12.5 t/ha for rainfed crop and 25 t/ha for irrigated crop. Apply N:P₂O₅:K₂O each @35 kg/ha as basal dressing. Top dress with 35 kg N per ha about 45 days after sowing.

After cultivation

Thin the crop when the plants are 15 to 20 cm high retaining two seedlings per hill. Retain only one seedling per hill in the case of hybrids. Timely weeding and hoeing will ensure good crop growth.

Irrigation

In the case of irrigated crop, irrigate the plants once in two weeks. Copious irrigation during flowering will ensure good pod setting and good fibre quality.

Plant Protection:

Against sucking pests like jassids, aphids and thrips, spray methyl-O-demeton (500 ml/ha) or imidacloprid (100 ml/ha) on 20th day and 40th day.

To control whitefly, use neem oil (3.0 l/ha) or phosalone (2.5-3.0 l/ha).

For bollworm, spray monocrotophos or quinalphos or chlorpyrifos (2-3 l/ha), starting from 55th day of sowing at 15 days interval or more depending on the pest prevalence.

For bacterial blight disease, use streptocycline (50 g/ha + copper oxychloride 1.5 kg/ha). For grey mildew, carbendazim @ 250 g/ha may be used. For *Alternaria* leaf spot, use copper oxychloride @ 1.5 kg/ha.

Harvesting:

The bolls start bursting 100-120 days after sowing and will be ready for harvest at this stage.

Source: Department of Agriculture, Kerala.

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CHAPTER 08

Marketing & MSP

8. Marketing & MSP

8.1 Marketing of cotton:

Marketing of crop produce is a very important activity under which the price of produce is decided. In India, farmer collects the cotton after picking in his house or under shade in heap. When he collects sufficient quantity which he can take to market for sale. He carries the produce in gunny bags or if quantity is enough in open tractor trolleys, truck, etc. Sale of cotton takes place in three ways i) to private trader: about 70 to 75% of cotton is marketed through this channel. It includes private trader, commission agent, representative of ginning pressing mills, etc., ii) Govt. Sector: Government agency like CCI, NAFED, NTC,STC, are procuring produce from farmers, at competitive rate in open auction along with traders for their marketing or consumption in mill or for export purpose, etc. CCI is specially designated agency for purchasing the cotton from farmers directly at Minimum support price. Share of Govt. Sector in the marketing of cotton may be around 10 % and, iii) Co-operative Sector: this sector include Co-operative Marketing Federations of state, Co-operative Mills, Co-operative Marketing Institution, etc.

Existing marketing channels in cotton are:

Farmer → Village Trader → Moving Traders → Whole Sale Trader

Farmer → Commission Agent → Mill Owner → Whole Sale Market

Farmer → Co-operative Marketing Institution → Cotton Trading Market

Farmer → State Co-operative Marketing Institution → Cotton Trading Market

Farmer → Traders → Export Market

The market yard of regulated market under APMC act is available for marketing activity. The market committee provides clean, *paccka* floor, qualified grader, auctioners, weighing and storage facility. Auctioneer an employee of market committee takes up auction of various lots of cotton in presence of farmer or his representative. The prices are quoted by Trader / buyer / authorized commission agent, after examining the quality of cotton. Market committees are supposed to grade the quality of cotton and put for auction, so that producer can receive reasonable, competitive price in market.

Normally, Fiber Length , Strength, Fineness and Maturity, the Inherent Characters and Colour, Contamination & trash contain and Moisture % are the factor which decide the price of produce.

Experienced buyer by visual and physical examination can only judge these factors for deciding proper price. For perfect estimation of the quality factors of cotton fibre, laboratory tests are required. This facility is available in HVI lab of CIRCOT, Mumbai. They also take the testing of cotton yarn, fabric, and made up for textile industry. Cotton Association of India, a traders' association also prepares sample of 'Grade Standards'. These sample are used for determining the correct price of lint cotton.

In order to enable the farmers to fetch remunerative prices with the quality of the produce, the Government of India established Cotton Corporation of India (CCI) in 1970. Initially, the CCI was mostly engaged in imports of cotton and its distribution among the needy Mills. From 1971-72 onwards it was entered in domestic market and has been purchasing raw cotton both under Minimum Support Price (MSP) and at the ruling market prices. The Corporation has gradually increased its purchases and market interventions for export, import & commercial purchase. In addition to CCI, the State Marketing Federations particularly Punjab, Haryana, Rajasthan, Gujarat are also providing price support to the farmers. In Maharashtra, the monopoly procurement by Maharashtra State Cooperative Marketing Federation was in vogue under monopoly procurement scheme of state but it is discontinued and presently trading is open for all.

CCI has been actively involving in the Cotton Development Programme since 1994-95 by way of production of quality certified seeds of desired varieties in collaboration with various State Seed Corporations, Village adoption programme (one village one variety) to avoid varietal mixing, on farm demonstration of IPM, crop surveillance & extension services to boost the productivity, field days, Seminar/workshop on post-harvest management of fibre quality, financial support to R&D projects to SAUs for specific need, promotion of cotton in non-traditional states etc.

8.2 Constraints in marketing:

- I. Due to lack of storage facility with farmer, he is deprived of better price for his produce. Market committee or any government agency shall provide the facility to farmers for storage of cotton, on rental basis, till his produce is sold.

- II. Credit facility should be made available to farmers by banking sector / marketing federations, Government agencies, etc. against the produce to fulfill farmers' immediate need of finance. This will prevent distress sale by farmer and he will get better price for his produce.
- III. Facility of small market yard may be provided in nearby area for cotton growing farmers with adequate facilities at their market yard so that, sale of cotton to village merchants by farmers at lower rate could be avoided.

8.3 Minimum Support Price (MSP):

The Government of India, Ministry of Agriculture and Farmers Welfare, New Delhi fixes Minimum Support Price (MSP) for basic varieties of cotton on the recommendation of Commission for Agriculture Costs and Price (CACP). Government of India taking up this activity to protect the interest of farmers. When prices of agriculture produce fall in market below the declared MSP level, then Government intervene in the market and CCI / notified agency undertake Price Support Operations under Price Support Scheme.

The MSP influenced the farmer's decision to undertake the cultivation of cotton. The MSP of cotton was increased by 40% during 2008-09 compared to 2007-08 and the same was maintained during 2009-10 to protect the farmers' interests. Initially, increased MSP & lower demand for export resulted in less procurement by the private traders in open market. Prices in market had gone below MSP, therefore GOI purchased large quantity of raw cotton under MSP through CCI & NAFED during 2008-09. But the trend was reversed during 2009-10 i.e. CCI & NAFED purchased minimum quantity of cotton and the majority was procured by private traders at price over & above MSP. There was demand of raw cotton from China etc. which resulted in the price hike.

The minimum support price declared by Government for cotton from 2004-05 to 2016-17 and cotton purchased by CCI under MSP and CP purchase from 2004-05 to 2016-17 are given in **Table 27** and **Table 28** respectively.

Variety	Staple Length in mm	Miconn aire value	Prices in Rs. Per Quintal								
			04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13
A: Short Staple (20mm & below):											
Assam Comilla	-	7.0-8.0	310	1310	1410	1440	2000	2000	2000	2300	3100
Bengal Desi	-	6.8-7.2	1400	1410	1320	1350	2000	2000	2000	2300	3100
B: Medium staple (20.5mm to 24.5mm):											
V-797/G-Cot-13/G-Cot-21	21.5-23.5	4.2-6.0	1560	1560	1665	1700	2300	2300	2300	2600	3400
Jayadhar	21.5-22.5	4.8-5.8	1640	1640	1650	1680	2250	2250	2250	2550	3350
AK/Y-1(MAH/MP)	23.5-24.5	3.4-5.5	1675	1675	1685	1735	2350	2350	2350	2650	3450
PCO-2 AP/KAR/k-11(TN)	23.5-24.5		1650	1650	1660	1690	2350				
Mcu-7(TN)	23.5-24.5		1675	1675	1685	1735	2350				
SYPR-2(TN)	23.5-24.5		1700	1700	1710	1760	2350				
C: Medium long staple (25.0mm to 27.0mm):											
F-414/H-777/J-34 Raj	24.5-25.5	4.3-5.1	1760	1760	1770	1800	2500	2500	2500	2800	3600
LRA-5166/KC-2(TN)	26.0-26.5	3.4-4.9	1835	1835	1835	1900	2600	2600	2600	2900	3700
F-414/H-777/J-34 Hyb Rajasthan	26.5-27.0	3.8-4.8	-	-	-	1850	2600	2750	2750	3050	3750
F414/H-777/J-34 Hybrid (Haryana)	26.5-27.0	3.8-4.8	1785	1800	1850	1900	2700				
D: Long Staple (27.5 to 32.0mm):											
F414/H-777/J-34 Hybrid (Punjab)	27.5-28.5	4.0-4.8	1815	1835	1890	1950	2800	2800	2800	3100	3800
H-4/H-6/MECH	27.5-28.5	3.5-4.7	1960	1980	1990	2030	2850	2850	2850	3150	3800
RCH-2	27.5-28.5	3.5-4.7	-	1990	2000	2040	2850	2850	2850	3150	3800
SANKAR-6 Gujarat/10	27.5-29.0	3.6-4.8	1960	1985	2005	2055	2850	2850	2850	3150	3850
Bunny	29.5-30.5	3.5-4.3	2010	2010	2020	2070	3000	3000	3000	3300	3900
Brahma	29.5-30.5	3.5-4.3	-	-	2010	2050	3000	3000	3000	3300	3900
E: Extra Long staple (32.5mm & above):											
MCU-5/Surabhi	32.5-33.5	3.2-4.3	2035	2055	2150	2300	3200	3200	3200	3500	4100
DCH-32(South)	34.0-36.0	3.0-3.5	2065		2430	2700	3400	3400	3400	3700	4300
DCH-32(MP)	34.0-36.0	3.0-3.5	2200	2100	2350	2600	3400	3400	3400	3700	4300
Suvin	37.0-39.0	3.2-3.6	3135	3135	3400	3800	4200	4200	4200	4500	5100
Note: In addition to the aforesaid MSP, the Government of India has approved the payment of Special Drought Relief Prices (SDRP) in respect of cotton (kapas) 2002-03. The SDRP would not become part of MSP and this would be provided by way of special relief and not by way of any bonus. The approved SDRP is of Rs.20/- per quintal and would be payable in all cotton growing States and for all varieties of cotton irrespective of their quality and grade. The SDRP would be payable whenever price support operations are undertaken by Cotton Corporation of India (CCI).											
Source: Office of the Textiles Commissioner, Mumbai.											

Table 27: Minimum Support Prices (MSP) for varieties of kapas of fair average (FAQ)

Variety	Staple Length in mm	Miconnaire value	Prices in Rs. Per Quintal			
			13-14	14-15	15-16	16-17
A: Short Staple (20mm & below):						
Assam Comilla	-	7.0-8.0	3200	3250	3300	3360
Bengal Deshi	-	6.8-7.2	3200	3250	3300	3360
B: Medium staple (20.5mm to 24.5mm):						
Jayadhar	21.5-22.5	4.8-5.8	3450	3500	3550	3610
V-797/G-Cot-13/G-Cot-21	21.5-23.5	4.2-6.0	3500	3550	3600	3610
AK/Y-1(MAH/MP),MCU-7(TN)/SVPR 2(TN)/PCO 2(AP & Kar)/K11 (TN)	23.5-24.5	3.4-5.5	3550	3600	3650	3710
C: Medium long staple (25.0mm to 27.0mm):						
J-34 (Raj)	24.5-25.5	4.3-5.1	3700	3750	3800	3860
LRA 5166/KC 2 (TN)	26.0-26.5	3.4-4.9	3800	3850	3900	3960
F 414/H 777/J 34 Hybrid	26.5-27.0	3.8-4.8	3850	3900	3950	4010
D: Long Staple (27.5 to 32.0mm):						
F-41/h-777/J-34 Hybrid	27.5-28.5	4.0-4.8	3900	3950	4000	4060
H-4/H-6/MECH/RCH-2	27.5-28.5	3.5-4.7	3900	3950	4000	4060
Shankar-6/10	27.5-29.0	3.6-4.8	3950	4000	4050	4110
Bunny/Brahma	29.5-30.5	3.5-4.3	4000	4050	4100	4160
E: Extra Long staple (32.5mm & above):						
MCU-5/Surabhi	32.5-33.5	3.2-4.3	4200	4250	4300	4360
DCH-32	34.0-36.0	3.0-3.5	4400	4450	4500	4560
Suvin	37.0-39.0	3.2-3.6	5200	5250	5300	5360

Source: Office of the Textile Commissioner, Mumbai

Table 28: State-wise purchases of cotton by CCI under MSP and Commercial purchase

(Qty: Bales)

State (1)	2004-05			2005-06			2006-07			2007-08			2008-09			2009-10		
	(2)			(3)			(4)			(5)			(6)			(7)		
	MSP	CP	Total	MSP	CP	Total	MSP	CP	Total	MSP	CP	Total	MSP	CP	Total	MSP	CP	Total
Punjab	143018	8472	151490	52389	5779	58168	0	43201	43201	0	78976	78976	1043814	1604	1045418	86597	9731	96328
Haryana	162917	3318	166235	4429	12549	16978	0	45010	45010	0	19441	19441	255342	3124	258466	21763	10009	31772
Rajasthan	259815	20917	280732	70159	1526	71685	0	60153	60153	0	69653	69653	155217	0	155217	4495	24397	28892
Gujarat	482556	6895	489451	293167	45400	338567	0	144764	144764	0	130058	130058	1236114	0	1236114	162	22912	23074
Maharashtra	234408	1896	236304	295206	29883	325089	539754	3990	543744	0	379320	379320	1997091	0	1997091	509	104062	104571
MP	86266	1868	88134	118267	2361	120628	89844	1209	91053	0	37935	37935	736526	0	736526	0	5221	5221
AP	1210635	63	1210698	350058	489	350547	527646		527646	218694	29882	248576	3275754	0	3275754	445589	0	445589
Karnataka	146533	150	146683	62564	1879	64443	4954	7271	12225	0	17854	17854	163123	202	163325	4763	2448	7211
Tamil Nadu	478	0	478	0	0	0	0	0	0	0	119	119		0				
West Bengal	228	0	228	248	0	248	0	238	238	4611	6288	10899	132	0	132	137	0	137
Orissa	23611	0	23611	6064	0	6064	16257	489	16746	0	0	0	71717	0	71717	16581	0	16581
Total	2750465	43579	2794044	1252551	99866	1352417	1178455	276325	1454780	223305	769526	992831	8934830	4930	8939760	580596	178780	759376

Table 28: State-wise purchases of cotton by CCI under MSP and Commercial purchase

(Qty: Bales)

State	2010-11			2011-12			2012-13			2013-14			2014-15		
	(8)			(9)			(10)			(11)			(12)		
	MSP	CP	Total	MSP	CP	Total	MSP	CP	Total	MSP	CP	Total	MSP	CP	Total
Punjab	0	100784	100784	0	11755	11755	0	18436	18436	0	70267	70267	126690		126690
Haryana	0	72601	72601	0	0	0	0	6824	6824	0	11842	11842	76459		76459
Rajasthan	0	97626	97626	0	4882	4882	0	20797	20797	0	16690	16690	87219		87219
Gujarat	0	234410	234410	0	217443	217443	0	1846	1846	0	75476	75476	603407		603407
Maharashtra	0	427378	427378	0	54998	54998	41572	0	41572	0	85744	85744	1674087		1674087
MP	0	51852	51852	0	885	885	3551	54	3605	0	1999	1999	264977		264977
AP	0	0	0	0	0	0	0	0	0	0	0	0	3366096		3366096
Karnataka	0	341406	341406	7570	49313	49313	2174886	0	2174886	40813	130389	171202	1509590		1509590
Tamil Nadu	0	21331	21331	0	3956	3956	16363	0	16363	0	6685	6685	103307		103307
West Bengal	152	0	0	124	124	124	262	0	262	0	185	185	0		0
Orissa	0	18697	18697	0	4959	4959	50051	0	50051	0	4583	4583	94813		94813
Total	152	1365985	1365985	7704	348315	348315	2286685	47957	2334642	40813	402060	442873	7906645		7906645

Source: CCI, Mumbai

Table 28: State-wise purchases of cotton by CCI under MSP and Commercial purchase

(Quantity: Bales)

State (1)	2015-16			2016-17		
	(2)			(3)		
	MSP	CP	Total	MSP	CP	Total
Punjab	00		00	Not started so far		
Haryana	00		00			
Rajasthan	00		00			
Gujarat	51501	No commercial purchase	51501			
Maharashtra	116799		116799			
MP	29104		29104			
Telangana	595159		595159			
AP	39967		39967			
Karnataka	00		00			
Tamil Nadu	00		00			
West Bengal	0311		0311			
Orissa	11633		11633			
Total	844474		844474			

8.4 Improvement in cotton quality:

Mission III of TMC was set up to setting up of new Market Yard (MY), Improvement of existing MY and activation of dormant MY. Market Yards were developed where maximum contamination of cotton occur. The sources of contamination were plugged so that cotton remain clean. Therefore, MM III intended to achieve by providing essential civil infrastructure and by insisting on best management Practices. A total of 246 Market Yards against the target of 250 were improved. The state wise details are presented in **Table 29**: below:

Table 29 : State wise details of Market Yards

State	Sanctioned	Completed
Punjab	19	19
Haryana	20	20
Rajasthan	14	14
Madhya Pradesh	28	28
Gujarat	45	42
Andhra Pradesh	48	48
Karnataka	13	13
Tamil Nadu	4	4
Odisha	9	9
Maharashtra	50	49
Total	250	246

Modernization of G & P factories, up gradation of G & P factories, installation of bale press and installation of testing laboratories in Ginning & Pressing Factories of the country were addressed by Mini Mission IV of TMC. The implementation Strategies including replacing old, inefficient & poorly maintained G & P Factories, reducing the handling of human labour, Introduction of cotton cleaning machines and Establishing composite units both ginning & bale press were undertaken . Against the 1011 sanctioned G & P Factories modernization was done of 859 in eleven states and India is now capable to produce uniform bales with International quality. The state wise details of sanctioned and completed G & P Factories are given in **table 30**.

Table 30: Improved G & P Factories

State	Sanctioned	Completed
Punjab	19	11
Haryana	7	5
Rajasthan	2	0

Madhya Pradesh	53	46
Gujarat	557	506
Andhra Pradesh	34	22
Karnataka	15	13
Tamil Nadu	2	1
Odisha	8	6
Maharashtra	313	248
Total	1011	859

Further, it is added the factory owners in other states either given poor response or no response to avail the opportunities of MM IV. The activities of MM IV was able to reduce trash content from 6-7% to 1-2%.

CHAPTER 09

Mechanical Harvesting of Cotton

9. Mechanical Harvesting of Cotton

Cotton is completely machine-picked in Australia, Israel and U.S.A. Over 90 % of production is machine-picked in Greece, Mexico and Spain. Almost 75 % of total production is picked by machines in Brazil. In most of other countries including China, India and Pakistan cotton pickings are done manually. In India, harvesting of cotton is done manually by hand picking. Normally, farmers will go for 2 to 5 pickings of cotton till the final stage of harvesting of crop. It is expected that 85 percent of the seed cotton (**Kapas**) is picked during the initial three pickings and the subsequent pickings sometimes may not be economical even by manual labour. Cotton picking operation is a tedious hard work and ten times costlier than irrigation and twice of weeding operation. The cost of picking accounts for 30 to 35 % of total cost of cultivation. Availability of labour for cotton picking is scarce during peak season and its require skilled persons. Therefore, need for indigenization of cotton pickers were realized recently. All commercial cotton pickers are spindle type, only imported machines are available but not popular under Indian conditions due to high initial cost and not economical for Indian plant type. The concept of cotton picking aid by suction valve Pneumatic Cotton Picker, Power Tiller operated cotton picker and Tractor Operated Cotton Picker as developed by ICAR are under field test conditions.

In India, cotton, whether it is rainfed or irrigated, is handpicked by human labourers. Manual picking is not only tedious hard work but also costlier than other agricultural operations. Manual picking of cotton requires around 465 labour-hours per hectare. Due to non-availability of labourers in time, cotton picking get delayed causing yield loss which may be up to 15 per cent and affecting the overall quality of cotton lint. The change in weather forces, the farmers have to harvest cotton quickly and non-availability of labour and less available time makes it expensive & complex. The cost of manual picking operation now a days is as high as Rs. 9/- per kg seed cotton in Tamil Nadu and minimum of Rs. 4-5/- per kg seed cotton in other states.

The cotton area of the country is in increasing trend in recent years with increased crop size. Farmers are finding difficulties to operate picking operation in time even by spending more money. Therefore, considering the constraint of availability of labourers during peak season, the adoption of mechanical cotton picking is very necessary at present in Indian context. The use of mechanical picking machine is, therefore, considered necessary in minimizing drudgery involved in hand picking as well as enhancing production of cleaner grade of seed cotton. The mechanical cotton picking system will also be helpful in achieving timeliness of operation for the next crop.

9.1 Efforts on Mechanical Cotton Picking:

Mechanical picking is not found suitable for hybrids / varieties because of the staggered blooming characteristics of Indian cotton plants and hence, mechanical pickers were not considered suitable for Indian conditions. Consequently, this area of research and development was not taken up extensively anywhere in the country.

Presently, the scientists are gearing up to develop suitable plant type amenable to mechanical picking and Development / identification of a mechanical picker suitable for Indian conditions is given due consideration to coincide with the advent of such a plant type. The cost of operation for mechanical picking is high because of the large initial cost of the imported cotton picker. If a cotton picker could be designed & produced in India through combined efforts of R&D organizations, users & manufacturers, then the cost of the machine might be reduced. However, the higher trash content in cotton picked by spindle type cotton pickers and lack of pre and post cleaning equipment in Indian gins, prohibits the popularization of spindle type pickers in India. Before picking, defoliation has to be done, for which additional cost is involved. Another issue is the inherent huge size of the spindle type pickers which have huge horse power requirement and pose operational difficulties on Indian farms of small holdings.

9.2 Research Efforts:

Efforts were made by CCSHAU, Hisar during 1972-77 to develop a knapsack vacuum cotton picker. A laboratory model of blower fan for creating vacuum in the picking zone for the development of a pneumatic cotton picker was fabricated. However, further work could not be taken up.

PAU, Ludhiana reported the studies on the use of an industrial type vacuum cleaner for picking cotton in the field. Initial trials showed higher labour requirement in mechanical picking in comparison to manual picking. Similar studies were also under taken by TNAU, Coimbatore.

PAU, Ludhiana also reported the basic studies related to development of a Tractor mounted vacuum type cotton picker. Cotton was picked with the Machine from the defoliated crop and the picking efficiency of the cotton picker, was in the range of 70- 75 percent. However, the output of the suction type machine was very low.

Under TMC: MM-I Project on “Identification of G. Italics genotypes suitable for machine picking and development of agronomic package” since 2007, breeders have developed / identified genotypes which may suit machine picking.

9.3 Experience of Imported Cotton Picker:

Initial efforts to introduce mechanical cotton picking system in India were undertaken during 1986-87 by PAU (Uzbekistan model) and later on by CICR, Nagpur (USA model). Initial trials revealed encouraging results, however, it was considered appropriate to develop smaller equipment suitable for mounting on Indian Tractor and to evolve appropriate cotton varieties and agronomical practices as well as cleaning equipment particularly prior to ginning.

The overall development of cotton picker stops with the spindle type of cotton picker. The pickers, being used all over the World mostly, have spindle type of cotton picking mechanism. The same pickers are being tested in India but suitability of these cotton pickers is questionable as trash percentage in seed cotton is in the range of 20-30 %.

9.4 Performance of John Deere Cotton Picker:

Recently John Deere India Private limited & New Holland India are demonstrating their cotton picker under Indian conditions. The performance of John Deere 9935 cotton picker (two-row self-propelled cotton picker) was evaluated at PAU, Ludhiana and CICR, Nagpur. The mean values of forward speed, effective field capacity, total harvesting loss, mechanical picking efficiency and picker efficiency were 2.62 kmph, 0.28 ha / h, 23.62 %, 75.7 % and 76.4 %, respectively.

The field evaluation of cotton picker at CICR, Nagpur recorded mean values of forward speed, effective field capacity, fuel consumption, total harvesting loss, mechanical picking efficiency and picker efficiency were 2.20-3.38 kmph, 0.278-0.563 ha / h, 22.0 - 24.0 l / h, 14.29-31.74 %, 55.6 - 83.1 % and 68.3-85.7 %, respectively. Trash content in the machine picked cotton was found to be 22-26 %.

CHAPTER 10

Cotton Byproducts and utilization

10. Cotton Byproducts and utilization

Cotton plant not only provides the fibre for making cloth to protect the human body but also edible oil for consumption & also excellent cattle, poultry & fish feed. The raw cotton seed consists of lint which is approximately 1 / 3 portion and 2 / 3 portion is of seed. The seed contains about 18 % edible oil & meal is used as animal feed.

Cotton is not grown exclusively for production of oil but for lint having worldwide demand. Cotton seed yields about 13 lakh tonnes of precious cotton seed oil turned as heart oils. Cottonseed oil is third largest in quantity after rape & mustard and soybean. This oil is major contributor to the supply of vegetable oil in India. As indicated above, Cotton is also the source of deoiled cake, linters, and hull, huge biomass as dried cotton stalk used as fuel. Its stem can also be used as input for preparation of particle boards.

i) Cottonseed oil:

Cottonseed contains about 18 % oil. Cotton seed oil is termed as “Heart oil” since it contains about 50 % essential poly- unsaturated fatty acids against 30% in traditional oil, which prevents coronary arteries from hardening. It is one of the few oils in American Heart Association’s list of “O.K. Food”. Cottonseed oil has 2:1 ratio of polyunsaturated to saturated fatty acid. It is also rich in tocopherol, its having long self-life. Cottonseed oil is light non oily consistency and high smoke point make its most desirable for cooking. Qualities of cottonseed oil does not appear to have been known to general consumer in India. This needs adequate publicity. The details of availability of cotton seed and cotton seed processed scientifically are presented in **Table 31**.

Table 31: Availability of cotton seed and cotton seed processed scientifically

(In lakh tonnes)				
Sl.	Particulars	2012-13	2011-12	2010-11
1.	Availability of cottonseed for processing	108.22	113.22	107.89
2.	Cottonseed processed scientifically	6.00	5.44	5.34
3.	Percentage of quantity processed scientifically to the total availability of cottonseed for processing	5.54	4.80	4.9

In India, cottonseed oil is processed unscientifically, which, results in losses in various ways that is loss in oil production, linters, hulls and soap stuck.

The estimated annual loss due to cottonseed by products to traditional processing is shown in **Table 32**.

Table 32: Estimated annual loss

(Quantity: Lakh Tonne, Rs. in lakh)

Particulars	2012-13		2011-12		2010-11	
	Qty	Value	Qty	Value	Qty	Value
1. Cottonseed oil (7%)	6.92	410466.72	7.56	466414.20	7.15	409659.25
2. Linters (4 %)	3.96	68385.24	4.32	89640.00	4.09	172213.54
3. Hulls (27 %)	26.70	118254.30	29.15	184816.08	27.60	140152.80
4. Soap stock hard (0.8 %)	0.79	4254.15	0.86	5055.94	0.82	3735.92
Total	38.37	601360.41	41.90	745926.22	39.66	725761.51

Source: AICSCA, Mumbai

The above table indicates that scientific processing of cottonseed for extraction of oil is must and need attention on priority basis.

ii) Linter:

Cotton linter is one of the important item of export. It is also used for making absorbent cotton, which is very much in demand in public health domain. Linter is vital product for our defence. It is used as propellant for manufacture of ammunition.

iii) Hull:

This item whose potential for use in drilling operation is not exploited so far. There is some demand for this product from abroad.

iv) Deoiled cake:

It is very good cattle feed containing 40 to 42 % protein. But so far, it is not popular among dairies. This can very well used in poultry and fish feed also. Now, there is a technology developed to reduce the gossypol content and making it safe for animal feed.

v) Absorbent cotton / Surgical Cotton:

Cotton fibres are unicellular, flattened tubular structures. The short staple fibre, which is not used in spinning, can be used for making absorbent / surgical cotton. For making the absorbent cotton, it is treated with sodium hydroxide. This process is called scoring.

vi) Pulp paper and corrugated boxes from cotton stalks:

It is estimated that around 15 million tonnes of cotton plant stalk is generated annually. At present, it is used as fuel by farmers and rural people. Sometimes, it is burned in the field to avoid further growth of insect pests etc.

These stalk can be converted into pulp and good quality craft paper and corrugated boxes etc. can be made out of pulp. The making of packing material from cotton stalk is not only the best use of cotton stalk but also saves losses of fruit and vegetable in transition and saves valuable horticultural produce. This also reduces the use of wood material for packing and saving the trees from cutting for making pulp.

vii) Production of compost from ginnery waste:

While ginning i.e. removing lint from seed in machinery waste is created which contains finer fibre pieces. The waste generated during processing can be used for preparation of compost. Loss incurred during processing i.e. short fibre and trash can be used to make value addition.

viii) Production of biogas from willow dust:

Willow dust is waste material from textile mills. It is rich in cellulose, hemicellulose and lignin. Cellulosic substance with carbon-nitrogen ratio 25:1 can be used for biogas production. CN ratio of willow dust is about 28-30:1 is optimum and suitable for biogas production.

ix) Edible oyster mushrooms production on cotton stalks:

Pieces of Cotton stalk of 3-4 cm size can be used as substrate for growing oyster mushrooms, as other media paddy straw, cotton stalk also be used for successful production of mushrooms.

x) Preparation of particle board:

This is one of the important use of cotton stalks. The average area under cultivation of cotton during last three years, (117.9 lakh ha) yields about 470 lakh tonnes of biomass, which is now used as fuel in rural areas. This quantity is huge and even if used partially for making particle board will help farmer to increase his income from cotton cultivation, saving forest wood by providing alternative to wood which is used for this activity, and helping in reducing environmental pollution due to burning. Central Institute for Research on Cotton Technology (CIRCOT), Mumbai has developed the full process of making particle board from cotton stalk. A crop yielding 650 kg of cotton lint also results in 1300 kg of cotton seeds and 4000 to 5000 kg of biomass in the form of cotton stalks, besides adding other forms of the plant to serve as organic material to the soil.

Utilization of cotton stalks in the production of particle boards, which are being used for making furniture, wall paneling, floor & ceiling tiles. The stalks are abundant and under used in India. The major challenges for its use was high transport costs of the bulky stalks. The project funded by CFC, Netherland enabled to establish effective raw material collection, chipping, compacting and supply to factory.

A demonstration plant for particle board manufacture has been developed at Nagpur, India and standardized technical & economical viable agro based industries in rural areas. The return on investment in a 10 tonnes per day capacity are estimated at 20%. The small farmers can earn Rs.1200 per ha additional income by selling cotton stalk.

CHAPTER 11

Prospects of Organic Cotton

11. Prospect of Organic cotton

Organic cotton supposed to provide all the quality and texture expected from the cotton product. It feels good on skin and do not have any type of problem to the skin which may be experienced in man- made- fibre or non-organic cotton.

Cotton grown without use of chemicals for plant protection, fertilizers, weedicides etc.is called clean, natural green or organic cotton.The FYM, organic manure and green manuring, bio fertilizers, bio agents and bio pesticides for production of cotton. Farmers are producing organic cotton or normally a member of some organization association who are interested in production of organic cotton. A few certifying agencies are functioning who certify the products as organic cotton. Farmers producers making agreement with certifying organization to produce organic cotton have to stop use of synthetic fertilizers and pesticides and other chemicals prohibited by registering organization. The period of three years from last application of prohibited inputs will make them eligible to obtain organic certification. The produce during their first and second year of adopting organic cultivation is called transitional organic (certification pending). The produce of third year will be certified as organic cotton. The organization will guide the farmers regarding production practice for certification as organic cotton. They will give 10 to 15 % incentives to farmers over market price of cotton. Organic cotton offers a healthy and sustainable farming future for farmers, their family and the environment. A number of countries in the World like Turkey, Peru, Egypt, Israel, Syria, China, USA & India are involved in cultivating organic cotton, but India is leading in organic cotton production in the word. The states of Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan & Tamil Nadu are involved in organic cotton production in India. The details of area under crops including cotton in India under organic certification (including wild harvest) is shown in **table: 33**.

**Table 33: Area under crops including cotton in India under organic certification
(Including wild harvest) Area: Ha**

States	2009-10	2010-11	2011-12	2012-13	2014-15
Andhra Pradesh	44395.67	14350.72	47456.77	5909.13	100623.81
Arunachal Pradesh	1897.27	243	520.43	231.49	3688.61
Assam	6223.12	2047.33	2048.27	2299.21	16258.02
Andman	0	334.68	0	321.28	321.28
Bihar	1096.3	1303.62	188.6	9351.95	247.10
Chhattisgarh	29084.97	8448.94	299970.6	1887.64	32405.10
Delhi	12734.36	265.82	100238.7	58.4	69.13
Goa	13175.72	13303.7	153684.6	8290.6	15621.24
Gujarat	102488.4	48518.91	41978.94	45275.62	49862.00
Haryana	21951.6	14763.61	17442.36	7532.62	6783.21
Himachal Pradesh	683697.85	631901.99	933798.2	3965.38	1370744.04
Jammu & Kashmir	32687.11	776.48	26834.26	5121.14	50111.22
Jharkhand	100	24300	29794.42	254.94	71383.80
Karnataka	121507.56	88728.64	118739.7	27191.27	92157.09
Kerala	15372.62	6597.65	15790.49	10568.40	23123.00
Lakshadweep	0	12.13	891.93	350.68	895.52
Madhya Pradesh	2829249	2866571.88	432129.5	144239.75	1926369.01
Maharashtra	35449.98	177345.48	245339.3	66504.92	217649.19
Manipur	10871.3	2792.03	1296.91	11.25	168.20
Meghalaya	2254.12	2419.67	288.23	1780.49	4489.29
Mizoram	38674.62	12544.13	7023.97	1182.00	764.24
Nagaland	29715.28	1603.54	7762.6	2916.96	8362.43
Odisha	92452.47	24417.55	43868.18	18186.40	91056.40
Punjab	5264.23	6025.78	927.28	1601.47	19293.58
Rajasthan	260827.88	217712.19	222319.1	38289.04	483090.67
Sikkim	7393.09	1726.34	25716.55	43107.74	76392.38
Tamil Nadu	78442.9	34878.09	38554.33	3066.97	12536.97
Tripura	281.06	348.39	4.05	209.72	203.56
Uttar Pradesh	26567.68	111644.83	2593821	32889.85	107529.11
Uttarakhand	33181.3	105465.98	122880.6	20563.75	92480.23
West Bengal	14861.22	6125.72	19095.55	1279.41	16266.61
Total	4551899	4427519	5550405	504439	4893851.70
Wild Harvest	0	0	0	4706702	0
Grand Total	45, 51, 899	44, 27, 519	55,50, 405	52,11,141	48, 93, 851.70

Source: Agricultural & Processed Food Products Export Development Authority (APEDA).

11.1 Organic Certification in India:

Organic cotton has been produced for centuries, but it was first officially certified in 1989 / 90 by Turkey, followed by the USA. Other common names used for organic cotton, particularly at the beginning of production, are green cotton, biological cotton and environment-friendly cotton. There are places where no insecticides or synthetic fertilizers are used to grow cotton, but production is not sold as organic because it lacks certification. In order to claim that cotton is organic and receive a premium price, cotton production must be recognized as organic by a certifying organization.

Certification of organic cotton production adds credibility to the final product, assures the buyer of the organic status of the product and encourages payment of premium prices to farmers who engage in organic practices. When a grower or processor is certified organic, an independent organization has verified that the company meets or exceeds defined organic standards. Certified organic farms are inspected regularly and must maintain comprehensive records of their production methods. Certification Programmes and standards vary, especially in response to regional differences, although there are general underlying concepts. However, most Organic Cotton certifications ensure two basic facts. First, that all fibres must be natural and grown organically. Second, every step in the process of cotton production (spinning, weaving, washing, etc.) has to meet certain criteria of environmental responsibility. There are many certification agencies worldwide for organic cotton production.

Agricultural and Processed Food Products Export Development Authority (APEDA) has been actively involved in promoting organic farming, through its certification programme. An agricultural product will be allowed to be exported as organic product only if it is produced, processed and packed under a valid certificate issued by a certifying agency duly accredited by the National Steering Committee for Organic Product (NSCOP) set up by the Ministry of Commerce & Industry. At present, accreditation of inspection and certification agency is being done by APEDA, Ministry of Commerce & Industry, Govt. of India, under the National Programme for Organic Production (NPOP). The NPOP was notified in Sept., 2001 by the Govt. of India which contains the standards for the organic production of all crops, including cotton and has the procedures for the accreditation of the Certifying Bodies (CBs) in India. NPOP has been accepted to be equivalent to the organic regulations in EU and Switzerland and the NPOP accredited CBs are recognized by the USDA for certification using the NPOP standards of USA. Currently, there are 16 NPOP accredited CBs in India and many crops, including cotton, are certified by these CBs.

Individual exporter has to first certify the product as organic cotton from any of the private certifying agencies like Control Union Certification, Bengaluru; Organic Exchange, Chennai; etc., who in turn forward the said data of export of organic cotton to APEDA for compilation.

11.2 Organic Process in practice:

Pre-requisite for organic cotton farming:

- Synthetic Fertilizers like Urea, DAP, NPK can not be used.
- Synthetic pesticides like - herbicides, insecticides, fungicides etc are not to be used.
- Prevent spray drift from the surrounding fields - use border framing.
- No use of genetically modifies organisms such as BT Cotton.
- Crop rotation is a must - No repeat crop in the same field for 2 subsequent years and or intercropping.
- Proper maintenance of records and documents for certification.

11.3 Conversion to Organic Farming:

The farm needs to undergo a conversion period before product can be sold as organic cotton. The period of conversation starts with the contract signing with the certifying agency. Once the contract is signed, all the organic standards must be followed strictly as agreed. After one year of the signing in date, the products can be sold with a label - in conversation to organic agriculture. Annual crop can be sold as organic after 24 months and perennial crop after 36 months.

The systemic approach aims to establish a diverse and balanced farming ecosystem which ideally includes all types of crops and farm activities. Soil fertility management and crop nutrition are based on crop diversification and organic inputs such as compost, mulch and manures. Pest management measures focus essentially on pest prevention and the stimulation of a balanced agro-ecosystem through crop rotation, mixed cultivation, trap crops, and the use of natural pesticides when pest infestation rises above the economic threshold.

- Composting transforms organic material from the farm, such as crop and fodder residues, weeds, leaves, dung or kitchen waste, into high-value natural manure.

- Integrating animal husbandry into cotton production provides the farm with high-quality manure.
- Crop rotation and mixed cropping are essential elements in organic cotton production in order to maintain soil fertility and ensure balanced nutrient content in the soil.
- Mixed cultivation: similar effect as crop rotation but on smaller area within the same cultivation period and field.
- Promotion of natural enemies: Not using pesticides and diversifying crops benefits natural enemies of cotton pests such as birds, ladybirds, beetles, spiders, parasitic wasps, bugs and ants etc.
- Trap crops: Some cotton pests prefer crops like maize, sunflower, okra (lady finger), sorghum, pigeonpea or hibiscus to cotton. By growing these crops alongwith cotton as a trap crop, the cotton crop is spared.
- Natural pesticides: If preventive measures are not sufficiently efficient and pest populations exceed the economic threshold, a number of natural pesticides can be used in organic cotton cultivation.

11.4 Harvest and post-harvest quality management:

Usually, the cotton price is fixed according to the quality of the seed cotton (**Kapas**). The most important measures to improve organic cotton quality during and after harvest are as follows:

- ❖ Remove leaves, capsules and damaged bolls from the cotton harvest.
- ❖ Pick and transport harvested cotton in clean cotton cloth material, never in nylon or other synthetic fabrics in order to avoid contamination with foreign fibres (from clothes, human hair, packaging material, etc.).

- ❖ Pick only mature cotton. Unripe cotton fibres do not absorb dyes well enough.
- ❖ Keep the cotton harvest dry. It should be picked in dry conditions, avoiding harvesting when there is morning dew or after rainfall. Storage also needs to be in a dry place.
- ❖ Prevent cotton from becoming contaminated with dust or chemicals, especially fertilizers, pesticides and petroleum.
- ❖ The use of any storage pest control (e.g. DDT) on harvest cotton is prohibited.
- ❖ Clearly separate organic cotton from non-organic cotton or cotton in conversion in order to avoid mixing.

11.5. Constraints in adoption of organic farming:

1. Farmers experience reduction in yield as he is not allowed to use chemical fertilizers.
2. Sufficient quantity of organic manure to substitute to chemical fertilizers is not easily available at many places.
3. Farmers are getting 5-15% incentive for their produce but it is meager and not attracting farmers who are cultivating cotton with chemical fertilizers and pesticides etc.
4. The final product i.e. fabric /clothes prepared out of organic cotton is sold at high premium prices by textiles industry but benefit is not percolated to farmers level.
5. Except certificate by some agency, there is no laboratory test is developed so far to verify whether cotton is organic or not organic?

CHAPTER 12

Cotton in other Countries of the World

12. Cotton in other Countries of the World

12.1. AUSTRALIA

- In New South Wales – Valleys of Macquarine, Namoi, Gwaydir and Macintyre.
- In Queensland – Six tracts located mainly by river valley areas and with Good underground water.

These two provinces mainly grow cotton.

- Annual precipitation is around 500 – 550 mm and disturbances like excess rains do not usually occur.
- Large size farm holdings i.e. 400 – 1000 hectares. In New South Wales, 107 of the farms have sizes over 1000 hectares.
- Cotton crop is revised by cooperatives and private firms with all modern techniques and mechanisation right from sowing to harvesting.
- Irrigation is scheduled through neutron probe.
- Computer programme for interpreting pest scouting results. 80% of pesticide application is through aerial spraying.
- Raw cotton processing is done by modern machinery incorporating state of the art technology for conveyance, moisture regulation, cleaning, processing and packaging. The intrinsic fibre properties of each variety are maintained.
- Cotton period: NSW – Sept. – May, Queensland – Sept. – Nov. – July
- In cotton research – farmers also contribute funds.
- Acala and Deltapine upland cottons from USA are improved upon for characteristics like reduced duration, better fibre strength, fineness and length and higher productivities. The fibre length of leading varieties is 29 – 30 pmm, micronaire value ranges from 3.8 – 4.1 and bundle strength 27 – 37 g / tex – HVI.
- Ingard, counterpart of Bollgard transgenic cotton with Bt gene of USA is now under cultivation.

12.2. ISRAEL:

- Only 15, 000 hectare is under cotton cultivation.
- Mainly grown in green houses.
- Drip Irrigation with fertigation.
- Low chances of pest problem due to controlled cultivation and no major rainy season.

12.3. CHINA:

- Major cotton producing tracts:
 - a) Huang Ho9 river valley – Rainfall of 400 – 740 mm and a medium frost free period of 165 – 230 days.
 - b) The Yangtze river valley – Rainfall of 750 – 1400 mm and longer frost free period of 230 – 300 days which permits double cropping.
 - c) North – west – Short frost – free period of 150-200 days. Rainfall – less than 200 mm.
 - d) North – East – Frost free period of 150 – 170 days. Rainfall – 600 – 800 mm.
- 90% of the production comes from the first two tracts.
- Smaller size of farm holding 1.5 hectare but larger areas are attained when a few households pool their production effort.
- Highly labour intensive cotton cultivation.
- 60% of the total area under cotton is sown by transplantation.
- Relay or inter-cropping is followed mostly.
- About 75% of the cotton crop is irrigated through buckets.
- Area wise Pest Management (APM) system in which the pest problem is tackled at area / regional level instead of at the field level.
- Cotton is handpicked.
- Cotton period – mid April – August / September.
- Research priority on – earliness (to facilitate double cropping) tolerance to drought / salinity, pest resistance, high productivity with desirable fibre traits.
- 2-3 % cotton area only is grown with hybrids.
- *G. hirsutum* : 94% of the cotton area.
- *G. arboreum*
G. barbadense & hybrids } – 2% each.
- Present day varieties having high ginning outturn.
- Features of leading varieties: staple length – 28 – 31 mm, Micronaire value – 3.7 – 4.4, Bundle strength – 19.0 – 29.0 g/ tex.
- New hybrid cottons yield is 1250 – 1450 kg/ha
- CR – 129 Hb cotton carries Bt gene and is pest resistant.
- Raw cotton is processed by saw gins.
- Raised cotton procurement prices lead to larger imports.

12.4. BRAZIL:

- Cotton is growing in south eastern region: Average rainfall: 1200 – 1500 mm. Mainly American upland cottons are grown. North-eastern region: Average rainfall: 600-800 mm. Mainly perennial / tree cottons are grown.
- Cotton is grown mostly in rainfed conditions.
- In south eastern region: annual cotton is grown in rotation with paddy, maize and soybean in relatively scientific method.
- Seeds are treated mechanically planted.
- sprays of pesticide application is given manually.
- In north-eastern region: Annual cotton is grown at low level. All operations are done manually. Farm size is small and yield is also low.
- Cotton is handpicked.
- Cotton period range from September to November – February to May in South Eastern Region. January to June – August to January in North eastern region.
- Research focus on varietal improvement, Agronomic, Plant Protection, resistant / tolerant varieties to fusarium wilt and boll weevil.
- Fibre characteristics of leading varieties are :
 - i) Ginning outturn 33-39%,
 - ii) 2.5% span length 30-34 mm
 - iii) Pressley strength 22-24.5 (3 mm – g/tex)
 - iv) Micronaire value 3.8-4.2
- During 90's the cotton as well as textile product imports were high. But due to efforts from Govt., cotton farmers and textile industry the production has risen to 23.5 lakh bales in 1997-98 from 16.8 lakh bales in 1996-97. The industry has created a fund for research towards the development of more production and better quality cottons.

12.5. UZBEKISTAN:

- Cotton is grown in a belt of sub-mountain plains and foot hills with numerous canals among east, central and western parts of Uzbekistan. Also grown in north-west where a large stretch of fertile land constituting the delta region of Amu Dariya river.
- Large variation on with warm days followed by 20°C temperature contributes to higher productivity of cotton.
- Annual RF about 70 mm – 200mm, so disturbances of heavy rainfall are not there.

- Major portion of soils are saline but overcome by draining out the salts and green manuring.
- 30% of the total area under irrigation where cotton is grown.
- Farm size holdings are 23-24 ha.
- Large state farms are predominant slowly transition is taking place from State ownership to private ownership of land.
- Cotton cultivation is fully mechanized.
- High plant population i.e. over 1 lakh / ha. which is one of the reasons for higher productivity.
- Seed is chemically treated.
- High fertiliser doses: 180 kg.N, 45 kg. P/ha. and fractional application of fertiliser is a common practice. All cotton is irrigated and furrow method is followed.
- Except for wilt, there is no other serious infestation of pests and diseases due to severe winter.
- Normally, 2 sprays of pesticides are given., Ginning takes about 8 – 11 months.
- Cotton is sown during March – April when soil temperature is 12 – 14°C at 10 cm depth and harvesting is done during September to October.
- The directions and priorities for cotton research are decided by 3 bodies viz.,-
 - 1) State Committee of Science and Technology (SCST)
 - 2) Academy of Sciences of the Republic of Uzbekistan.
 - 3) Uzbek Academy of Agricultural Sciences (UAAS)
- Uzbek Central Cotton Station of Seed Control conducts Research on Seed Production and Controls all seed producing collective farms.
- Varieties are of short duration (135-145days).
- Characteristics of leading varieties: staple length – 27 – 29 mm, Micronaire value – 42 – 51 and Bundle strength – 23.8 – 30.8 of flex.
- To preserve priority and quality, production of foundation seed is organized on special collective farms.

12.6. USA:

- Farmers will support payments from the Govt. when they follow legislated farm programme by planting only certain crops over certain areas to maintain soil fertility.

- Cotton producing areas are-
 - a) South eastern region.
 - b) Delta or Mid south region.
 - c) South-western region.
 - d) Western region.
- All the zones have sufficiently long frost free period of at least 200 days.
- The average cotton farm holding size is around 550 – 570 ha.
- The number of cotton farmers are around 45,000 only.
- Cotton cultivation is fully mechanised.
- All methods / practices are scientifically followed.
- Furrow irrigation is adopted, only 12-15 % area under sprinkler irrigation.
- Pest problems are there like in any other country.
- Developed transgenic cottons to combat boll worms.
- Spraying is done mostly by aerial spraying / tractor mounted spraying.
- Extra care is taken during ginning and storage.
- Crop period is March – mid June to late July to December – January.
- 60% research is handled by USDA and over 30% by State Agriculture Experimental Stations
- About 5% is contributed by cotton corporation which is an organization funded by growers.
- Research priorities are – plant protection, plant breeding, cultural practices and mechanization, fibre quality, seed quality, ginning, health and safety, economics and marketing.
- 98% cotton area under *G.hirsutum* & 2 % under *G.barbadense*.
- The characteristics of leading varieties:
 - Fibre length – 25-38
 - Fibre strength – 22 – 41 g/tex
 - Micronaire value – 3.0 – 5.0
- Developed weed resistant transgenic cotton viz. Round up and Budril.
- A well organized and time tested system to make forecasts / estimates of cotton area and production. The estimates are made by two organizations (i) National Agriculture Statistics Service (NASS) under USDA (ii) World Agriculture Outlook Board (WAOB).
- There are around 18 cotton centres in cotton growing belt operated by USDA.
- All USA cotton is HVI (High Volume Instrument) class. Each bale is provided with details like (i) fibre length, (ii) fibre length uniformity, (iii) micronaire value, (iv) fibre strength, (v) colour and (vi) trash (leaf) content.

- Different methods and standards are followed for upland and pierna cottons.
- Marketing is very well organised.
- Former members of Internet Networking Risk Management Programme can look up spot and mill delivered prices, world price data, historic price data, the marketing loom and information about options in New York Cotton Exchange.
- A farm model which is in pipeline allow farmers to select the best crop and the number of ha. to be devoted to each crop based on price expectations, production costs and yields.
- National Cotton Council (NCC) plays major role in keeping cotton strong in the highly competitive fibre market. Members are from producers, ginner, warehousemen, merchants, oil crushers, cooperatives and textile manufacturers financed by voluntary contributions from the seven segments on a per bale or per tonne of seed basis through a finance plan approved by the delegates.

12.7. PAKISTAN:

- Cotton is grown mainly in Punjab and Sind provinces. A small area is grown in the North-West Frontier Province also.
Punjab Province: Hot summer and cold winter prevails. Very fertile soils but varying degrees of salt content in some tracts. Annual Rainfall: 250 – 300 mm.
- All the cotton is grown under irrigated conditions.
- Average cotton farm holding size is 1.5 ha. About 25-50% of the farms have large size of 5-12 ha.
- 30% of the cotton area is under certified seed.
- The seed rate is 18 kg / ha. in Punjab, 10 kg / ha. is in Sindh.
- Irrigation is given through flooding method.
- 50% chemical applications through knapsack sprayers and rest is by motorized / tractor mounted sprayers.
- Cotton is ginned by saw-gins.
- Cotton period is from mid April (Sindh) to early May (Punjab), June – September-November (Sindh), December (Punjab).
- Research priorities: Breeding new varieties, seed quality, agronomy, pest and disease control varieties tolerant to high temperature, resistance against diseases, especially CLCV and biological control, economic research, marketing investigations, studies related to production, consumption on, exports etc.
- Majority cotton area is under American upland cottons, around 2-3% is under deshi cotton

- Characteristics of leading varieties:
Staple length – 15.8 – 31.8 mm
Micronaire value: 3.9 – 8.0
Bundle strength – 80,900 – 1,000, 3000 PSI.
- CIM – 1100 & CIM – 448 are new tolerant varieties to leaf virus and whitefly.
- Minimum guaranteed prices of seed cotton and lint are announced by Govt. at appropriate time.
- Cotton Export Corporation (CEC) a public sector agency purchasing seed cotton at the support prices whenever market prices fall below them.
- Grading is done on a limited scale.

The area, production & yield of cotton in some countries of the world are given at Annexure B: a), b) & c).

CHAPTER 13

Other Information

13. Other Information

13.1. Researchable Issues:

- i) Development of transgenic cotton varieties having multi- resistance to insect pests, diseases, weeds and drought with wide adaptability.
- ii) Development of varieties suitable for Machine picking or Design and development of economically viable picking Machine for picking of cultivated Bt. hybrids / non Bt. hybrids/ varieties.
- iii) Development of inter specific hybrids of Extra Long Staple (ELS) having fibre free from Neps and motes.
- iv) Development of naturally coloured cotton varieties free of neps and motes having high yield and good fibre quality as per demand of Textile Industry.
- v) Development of area specific Integrated Plant Nutrient Supply System.
- vi) Development of area specific standard package of practices for cultivation of organic and Bt. cottons.
- vii) Association of resistance / tolerance with plant Characters and undesirable traits like-
Development of

Character	Tolerance / Resistance observed	Undesirable traits association.
Hairiness	Jassids	Susceptible to Bollworms and Mites.
Bud Gossypol	Bollworms, hoppers and fusarium.	-
Frego Bracts	Bollworms, Boll weevil, Bollrot	Fewer and smaller bolls.
Okra leaf	Boll worms, Jassids	Less productivity.
Glabrous	Aphids, Mites	Susceptible to Jassids
Red Plant body	Bollworms	General weakness in vigour, less production.
Nectariless.	Plant bug and Bollworms	-
Glandless	Bollworms, Budworm and Hoppers.	-

13.2. Important websites:

- i) www.cottonusa.org
- ii) www.catlook.com (cotton outlook)
- iii) www.caionline.in (Cotton Association of India)
- iv) www.aicosca.com (All India Cotton Seed Crushers' Association)
- v) www.cotton247.com (Cotton International)
- vi) www.circot.res.in (CIRCOT)
- vii) www.cicr.org.in
- viii) www.bettercotton.org
- ix) www.cci.org.
- x) Website- CCI, Mumbai
- xi) Website- Textile Commissioner, Mumbai

13.3. References

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2. ICAC cotton Outlook
3. Handbook of Cotton in India.
4. RBI Bulletin June 2012.
5. AICOSCA News Letter July 2013
6. Agricultural statics at a glance 2012
7. Annual Report of DOCD, Mumbai
8. Annual Report of CICR, Nagpur
9. Annual Report of CIRCOT, Mumbai
10. Annual Report of AICCIP, Coimbatore
11. Cotton in India 2012-ICF, Coimbatore
12. Textile Times April 2013 – CITI
13. DES, Ministry of Agriculture
14. State Departments of Agriculture

13.4. Abbreviations:

ICC	Indian Cotton Committee
ICCC	Indian Central Cotton Committee
ELS	Extra Long Staple
ICAR	Indian Council of Agricultural Research
DCD	Directorate of Cotton Development
AICCIP	All India Coordinated Cotton Improvement Project
SAUs	State Agriculture Universities
CICR	Central Institute for Cotton Research
ICDP	Intensive Cotton Development Programme
CCI	Cotton Corporation of India
MSP	Minimum Support Price
CIRCOT	Central Institute Research on Cotton Technology
BWC	Boll Worm Complex
GDP	Gross Domestic Product
TMC	Technology Mission on Cotton
USA	United States of America
SSI	Small Scale Industries
CAB	Cotton Advisory Board
ICAC	International Cotton Advisory Committee
DES	Directorate of Economics & Statistics
CLCuV	Cotton Leaf Curl Virus
DNA	Deoxyribose Nucleic Acid
CRC	Cotton Research Centre
USDA	United States Department of Agriculture
NBPGR	National Bureau of Plant Genetic Resources
CTRL	Cotton Technological Research Laboratory
QRT	Quinquennial Review Team
GTC	Ginning Training Centre
GEAC	Genetic Engineering Approval Committee
RCGM	Review Committee of Genetic Manipulations
IBSC	Institutional Biosafety Committee
MEC	Monitoring and Evaluation Committee
SBCC	State Biotechnology Co-ordination Committee
DLC	District Level Committee
INM	Integrated Nutrient Management
FYM	Farm Yard Manure
ETL	Economic Threshold Level
IRM	Insecticide Resistance Management
IPM	Integrated Pest Management
KVK	Krishi Vigyan Kendra
NZ	NZ: North Zone, CZ : Central Zone and SZ :South Zone

ANNEXURE

Annexure A: All India area, Production & Yield of Cotton alongwith coverage under irrigation

Year	Area (Lakh ha)	Production (Lakh bales)	Yield (kg lint / ha)	Area under Irrigation (%)
1950-51	58.80	30.40	88	8.2
1951-52	65.60	32.80	85	9.1
1952-53	63.6	33.4	89	8.5
1953-54	69.9	41.3	100	8.4
1954-55	75.5	44.5	100	9.8
1955-56	80.9	41.8	88	10.0
1956-57	80.2	49.2	104	11.0
1957-58	80.1	49.6	105	12.7
1958-59	79.6	48.8	104	12.5
1959-60	73.0	36.8	86	12.9
1960-61	76.1	56.0	125	12.7
1961-62	79.8	48.5	103	13.0
1962-63	77.3	55.4	122	14.1
1963-64	82.2	57.5	119	15.3
1964-65	83.7	60.1	122	15.5
1965-66	79.6	48.5	104	15.9
1966-67	78.4	52.7	114	16.1
1967-68	80.0	57.8	123	16.7
1968-69	76.0	54.5	122	16.5
1969-70	77.3	55.6	122	16.4
1970-71	76.1	47.6	106	17.3
1971-72	78.0	69.50	151	20.3
1972-73	76.80	57.40	127	21.0
1973-74	75.70	63.10	142	22.1
1974-75	75.60	71.60	161	22.9
1975-76	73.50	59.50	138	23.5
1976-77	68.90	58.40	144	24.6
1977-78	78.70	72.40	157	26.2
1978-79	81.20	79.60	167	27.2
1979-80	81.30	76.50	160	27.5
1980-81	78.20	70.10	152	27.3
1981-82	80.60	78.80	166	27.7
1982-83	78.70	75.30	163	29.0
1983-84	77.20	63.90	141	29.9
1984-85	73.80	85.10	196	28.5
1985-86	75.30	87.30	197	30.2
1986-87	69.50	69.10	169	31.1

(Continued on page ----2)

Annexure A: All India area, Production & Yield of Cotton alongwith coverage under Irrigation

Year	Area (Lakh ha)	Production (Lakh bales)	Yield (kg lint / ha)	Area under Irrigation (%)
1987-88	64.60	63.80	168	32.0
1988-89	73.40	87.40	202	33.0
1989-90	76.90	114.20	252	34.2
1990-91	74.40	98.40	225	32.9
1991-92	76.60	97.10	216	33.3
1992-93	75.40	114.03	257	34.6
1993-94	73.20	107.40	249	34.7
1994-95	78.70	118.90	257	34.2
1995-96	90.40	128.61	242	35.0
1996-97	91.20	142.30	265	35.8
1997-98	88.70	108.50	208	36.8
1998-99	93.40	122.90	224	34.9
1999-00	87.10	115.30	225	35.2
2000-01	85.30	95.20	190	34.3
2001-02	91.30	100.0	186	34.0
2002-03	76.70	86.24	191	33.1
2003-04	76.00	137.30	307	27.1
2004-05	87.90	164.30	318	36.9
2005-06	86.80	185.00	362	36.1
2006-07	91.45	226.32	421	35.0
2007-08	94.14	258.84	467	35.1
2008-09	94.10	222.80	403	35.3
2009-10	101.32	240.22	403	35.3
2010-11	112.40	330.00	499	33.8
2011-12	121.80	352.00	491	35.9
2012-13	119.77	342.20	486	Not available
2013-14	119.60	359.02	510	Not available
2014-15	128.19	348.05	462	Not available
2015-16*	118.72	301.47	432	Not available
2016-17**	105.00	321.23	520	Not available

Source: Directorate of Economics and Statistics, DAC & FW, Ministry of Agriculture and Farmers Welfare, GOI, Krishi Bhavan, New Delhi, *: Fourth advance Estimates, **: First Advance Estimates.

Annexure B: Country wise area, production, yield, import, export and consumption of cotton in the world.

a) Area : Lakh Hectare

Country	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Average
India	91.44	94.14	94.06	101.20	105.75	121.78	119.80	119.60	128.19	118.81	109.47
China	61.43	62.97	61.23	54.19	55.27	55.28	52.51	47.00	43.10	34.70	52.76
USA	51.52	42.45	30.63	31.12	38.63	38.29	37.73	30.53	37.83	32.62	37.13
Pakistan	30.75	30.55	28.20	31.10	32.65	28.62	28.79	28.06	29.58	28.69	29.69
Uzbekistan	14.32	14.50	13.91	13.17	13.30	13.16	12.85	12.75	12.98	12.98	13.39
Brazil	10.97	10.77	8.43	8.36	9.61	13.93	8.94	11.22	9.76	9.66	10.16
Burkina Faso	7.16	4.07	4.66	4.20	4.62	4.29	5.91	6.44	6.61	6.63	5.459
Mali	4.80	2.84	1.97	2.50	2.60	4.78	5.48	4.81	5.70	5.73	4.121
Turkmenistan	6.00	6.42	6.74	6.07	6.67	5.50	5.50	5.50	5.45	5.34	5.919
Argentina	4.00	3.04	2.86	4.30	4.52	5.28	3.62	5.06	4.56	4.45	4.169
Turkey	6.30	5.00	3.30	2.80	3.64	5.42	4.88	4.51	4.68	4.31	4.484
Cote D'Ivoire	2.26	1.34	1.41	1.87	1.96	2.60	3.40	3.61	4.15	4.02	2.662
Benin	2.36	2.34	1.99	1.49	2.00	2.03	3.12	3.80	3.79	3.30	2.622
Tanzania	4.09	4.50	4.03	3.48	3.66	5.68	3.98	4.00	3.50	3.15	4.007
Zambia	1.80	2.43	2.31	2.54	2.67	5.12	3.30	2.90	3.05	2.98	2.91
Chad	2.46	2.03	1.64	0.98	0.79	1.72	2.70	2.05	2.56	2.91	1.984
Australia	1.42	0.63	1.64	1.95	2.50	6.00	4.42	3.92	1.97	2.70	2.715
Greece	3.00	3.00	2.50	2.34	2.81	3.00	2.79	2.49	2.71	2.60	2.724
Nigeria	3.63	3.00	2.61	2.48	2.60	3.50	3.15	2.84	2.98	2.53	2.932
Cameroon	2.02	1.11	1.47	1.33	1.46	1.49	1.94	2.08	2.27	2.22	1.739
Zimbabwe	4.00	3.08	3.25	3.40	3.91	4.50	2.95	2.50	2.30	2.07	3.196
Tajikistan	2.60	2.50	2.23	1.70	1.80	2.01	0.31	1.89	1.75	1.54	1.833
Kazakhstan	1.96	2.00	1.75	1.40	1.40	1.40	1.33	1.40	1.29	1.03	1.496
Mozambique	1.90	1.76	1.65	1.56	1.64	1.89	1.50	1.57	1.20	1.10	1.577
Uganda	1.50	1.01	1.25	0.70	1.00	1.00	0.74	0.53	0.61	0.61	0.895
Ethiopia	1.08	0.98	0.81	0.75	0.79	1.36	1.29	1.23	0.99	0.66	0.994
Sudan	1.60	0.52	0.85	0.34	0.80	1.27	0.45	0.62	0.89	0.50	0.784
Egypt	2.31	2.46	1.33	1.21	1.57	2.21	1.43	1.22	1.58	1.05	1.637
Mexico	1.14	1.03	1.01	0.69	0.96	1.95	1.53	1.19	1.81	1.30	1.261
Paraguay	1.00	0.70	0.50	0.20	0.40	0.56	0.70	0.25	0.12	0.12	0.455
Myanmar	3.10	3.10	3.10	3.10	3.10	3.49	3.49	2.99	2.99	2.39	3.085
Syria	2.16	1.90	1.90	1.81	1.99	1.86	1.37	1.03	0.72	0.44	1.518
Iran	1.16	1.20	1.30	1.05	1.20	1.17	1.10	0.91	0.91	0.91	1.091
Other country	9.32	9.09	8.01	7.64	7.92	9.49	10.46	7.92	8.41	7.56	8.582
Total	346.56	328.46	304.53	303.02	326.19	361.63	343.46	328.42	340.99	311.61	329.49

Source: ICAC

Annexure B: Country wise area, production, yield, import, export and consumption of cotton in the world.

b) Production: Lakh Bales (One bale=170Kg.)

Country	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Average
India	280.00	307.00	290.00	300.00	323.47	367.00	370.00	398.00	380.00	345.82	336.12
China	469.11	474.76	472.06	400.00	422.65	435.29	429.40	407.58	381.17	303.88	419.59
USA	276.47	246.00	164.12	155.26	213.06	199.47	221.76	165.35	209.00	164.82	201.51
Pakistan	126.29	111.41	115.29	124.24	128.71	135.94	117.76	122.11	135.58	89.05	120.63
Uzbekistan	68.88	70.94	58.82	52.94	62.59	51.76	58.82	55.29	52.06	50.88	58.29
Brazil	89.64	94.24	71.41	74.94	83.71	110.41	77.06	102.00	91.94	87.11	88.24
Burkina Faso	16.58	8.82	10.71	8.94	10.35	10.24	15.53	16.12	17.52	14.82	12.96
Mali	10.35	5.94	5.00	5.82	6.12	11.00	11.29	10.83	13.70	12.70	9.27
Turkmenistan	15.29	16.47	17.47	14.71	16.24	19.41	21.76	19.70	19.41	17.64	17.81
Argentina	10.29	8.82	6.88	10.65	11.29	12.35	9.24	17.76	14.41	13.70	11.53
Turkey	44.11	36.76	25.88	22.35	28.71	48.71	43.82	42.23	44.35	41.00	37.79
Cote D'Ivoire	3.81	2.94	3.12	4.41	4.41	6.65	8.94	10.18	11.35	10.41	6.62
Benin	6.06	6.65	5.29	4.71	5.76	4.41	6.18	7.29	9.88	8.23	6.44
Tanzania	4.18	7.29	5.24	4.94	5.24	7.06	4.82	4.58	5.00	4.00	5.23
Zambia	2.06	2.65	2.59	2.82	3.00	6.47	2.47	2.35	2.82	2.52	2.97
Chad	2.35	2.88	1.71	0.94	0.76	1.88	2.00	1.88	3.41	4.29	2.21
Australia	17.35	7.41	19.35	20.06	29.06	72.06	59.88	52.05	30.35	32.11	33.96
Greece	18.82	16.76	14.12	12.65	15.18	16.47	14.59	17.41	16.05	12.82	15.48
Nigeria	3.82	4.06	3.53	3.41	3.59	3.71	3.65	3.36	3.58	3.05	3.57
Cameroon	4.53	2.70	3.53	2.88	3.47	4.59	6.47	5.88	7.15	6.70	4.79
Zimbabwe	6.12	5.41	5.10	5.64	6.52	8.47	3.47	3.29	2.41	1.47	4.77
Tajikistan	8.23	7.64	6.29	5.23	5.52	7.05	1.58	6.17	5.52	4.82	5.80
Kazakhstan	7.94	7.05	5.29	3.88	4.11	4.70	5.29	4.35	3.23	2.64	4.84
Mozambique	1.53	1.47	1.41	1.41	1.47	3.58	2.18	1.82	1.58	1.17	1.77
Uganda	1.47	0.71	1.35	1.11	1.76	2.82	1.11	0.88	1.00	1.00	1.32
Ethiopia	2.76	2.23	1.88	1.05	1.12	2.00	1.76	2.23	2.76	2.47	2.02
Sudan	3.58	1.29	1.70	0.88	1.88	2.52	0.94	1.47	2.70	1.64	1.86
Egypt	12.35	13.05	6.18	5.88	7.88	10.88	6.47	5.52	6.41	5.00	7.96
Mexico	8.35	8.05	7.35	5.47	7.35	16.11	13.58	11.35	17.76	11.05	10.64
Paraguay	2.17	1.23	1.00	0.41	0.82	1.64	1.52	0.64	0.41	0.41	1.05
Myanmar	3.77	3.76	3.76	3.82	3.82	11.94	12.00	11.41	11.47	9.17	7.49
Syria	13.23	14.70	14.11	12.82	14.47	12.47	8.82	5.88	4.11	2.29	10.29
Iran	5.28	4.94	4.94	3.82	4.41	3.47	3.29	3.82	3.88	3.88	4.13
Other country	29.17	26.26	20.69	19.49	20.08	24.99	29.56	22.04	24.73	20.44	23.74
Total	1575.94	1532.29	1377.17	1297.58	1458.58	1637.52	1577.00	1542.82	1536.70	1293.0	1482.9

Source: ICAC

Annexure B: Country wise area, production, yield, import, export and consumption of cotton in the world.

c) Yield: Kg. per Ha.

Country	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Average
India	521	554	524	504	520	512	525	566	503	495	522
China	1298	1282	1311	1255	1300	1339	1390	1474	1503	1489	1352
USA	912	985	911	848	938	886	999	921	939	859	923
Pakistan	698	620	695	679	670	807	695	740	779	528	691
Uzbekistan	818	832	719	683	800	669	778	737	682	666	740
Brazil	1389	1488	1440	1524	1481	1347	1465	1545	1601	1533	1476
Burkina Faso	394	368	391	362	381	406	447	426	451	380	404
Mali	367	356	431	396	400	391	350	383	409	377	383
Turkmenistan	433	436	441	412	414	600	673	609	605	562	512
Argentina	437	493	409	421	425	398	434	597	537	523	471
Turkey	1190	1250	1333	1357	1341	1528	1527	1592	1611	1617	1433
Cote D'Ivoire	287	373	376	401	383	435	447	479	465	440	423
Benin	436	483	452	537	490	369	337	326	443	424	418
Tanzania	174	275	221	241	243	211	206	195	243	216	222
Zambia	194	185	191	189	191	215	127	138	157	144	174
Chad	163	241	177	163	164	186	126	156	226	251	189
Australia	2077	2000	2006	1749	1976	2042	2303	2257	2619	2022	2127
Greece	1066	950	960	919	918	933	889	1189	1007	838	967
Nigeria	179	230	230	234	235	180	197	201	204	205	207
Cameroon	381	414	408	368	404	524	567	481	535	513	468
Zimbabwe	260	299	267	282	283	320	200	224	178	121	255
Tajikistan	538	520	480	523	521	596	866	555	536	532	538
Kazakhstan	689	599	514	471	499	571	676	528	426	436	551
Mozambique	137	142	145	154	152	322	247	197	224	181	190
Uganda	167	119	184	270	299	479	255	282	279	279	251
Ethiopia	434	387	395	238	240	250	232	308	474	636	346
Sudan	380	422	340	440	400	337	355	403	516	558	403
Egypt	909	902	790	826	853	837	769	769	690	810	827
Mexico	1245	1329	1237	1348	1302	1404	1509	1621	1668	1445	1435
Paraguay	369	299	340	349	349	498	369	435	581	581	383
Myanmar	207	206	206	209	209	582	585	649	652	652	413
Syria	1041	1315	1262	1204	1236	1140	1094	970	970	885	1152
Iran	774	700	646	618	625	504	508	714	725	725	650
Other Country	532	491	439	434	431	448	480	473	500	460	470
Total	773	793	769	728	760	770	781	799	766	705	765

Source: ICAC

Annexure B: Country wise area, production, yield, import, export and consumption of cotton in the world.

d) Import: Lakh bales (170 Kg. each)

Country	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Average
India	5.59	6.47	10.00	7.05	7.64	9.00	15.17	8.64	15.70	14.11	9.94
China	135.64	147.70	89.58	123.52	152.41	314.23	260.35	180.88	106.11	63.41	157.38
USA	0.24	0.17	0.00	0.00	0.00	0.23	0.10	0.17	0.17	0.52	0.16
Pakistan	29.52	50.05	27.00	26.27	24.58	11.17	24.17	14.52	11.64	29.11	24.80
Uzbekistan	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Brazil	6.59	2.11	0.64	1.76	1.52	0.35	0.82	1.88	0.29	0.23	1.62
Burkina Faso	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mali	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turkmenistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01
Argentina	2.35	2.35	1.52	0.88	0.88	1.14	0.35	0.17	0.10	0.00	0.97
Turkey	51.35	41.82	37.35	47.05	39.05	30.52	47.23	54.35	47.05	43.52	43.93
Cote D'Ivoire	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tanzania	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zambia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chad	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.29	0.29	0.23	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.20
Nigeria	0.88	0.82	0.76	0.70	0.64	0.05	0.05	0.05	0.05	0.05	0.41
Cameroon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zimbabwe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tajikistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kazakhstan	0.29	0.29	0.29	0.29	0.29	0.05	0.00	0.00	0.00	0.00	0.15
Mozambique	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Uganda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethiopia	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.35	0.88	1.47	0.30
Sudan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Egypt	6.41	5.29	5.58	7.05	7.05	2.41	2.47	5.11	4.00	3.29	4.87
Mexico	17.70	19.58	16.76	19.41	15.52	13.00	12.64	13.70	12.41	12.88	15.36
Paraguay	0.11	0.00	0.00	0.00	0.00	0.10	0.05	0.00	0.05	0.00	0.03
Myanmar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	3.00	0.36
Syria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iran	3.23	2.35	3.52	3.70	3.52	3.94	2.88	3.58	4.05	3.88	3.47
Other Country	221.34	214.54	196.41	201.98	202.50	188.94	209.21	229.38	244.11	256.84	216.53
Total	481.58	493.88	389.69	439.88	455.82	575.52	575.88	513.00	447.47	432.58	480.53

Source: ICAC

Annexure B: Country wise area, production, yield, import, export and consumption of cotton in the world.

e) Export: Lakh bales (170 Kg each)

Country	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Average
India	56.47	90.00	30.29	75.00	72.58	127.00	99.11	118.47	53.76	70.35	79.30
China	1.12	0.82	1.11	1.17	0.58	0.70	0.58	0.35	0.23	0.23	0.69
USA	166.64	174.88	170.00	156.23	165.29	148.58	166.82	134.88	144.05	121.47	154.88
Pakistan	2.76	3.47	4.82	9.41	5.88	14.88	5.70	6.52	5.76	3.47	6.27
Uzbekistan	57.64	52.17	32.94	47.82	50.58	32.35	38.41	38.23	34.94	31.05	41.61
Brazil	16.64	28.58	35.05	24.11	26.58	61.35	55.17	28.52	50.05	54.41	38.05
Burkina Faso	18.82	11.05	9.47	10.05	9.76	8.94	14.52	16.11	12.52	15.58	12.68
Mali	12.47	6.52	4.94	5.35	0.00	7.64	10.11	11.70	10.29	12.82	8.18
Turkmenistan	9.82	10.88	5.29	10.29	12.47	8.88	11.41	19.82	18.05	4.64	11.16
Argentina	0.41	0.17	1.29	0.64	3.05	5.29	3.23	2.52	4.94	7.05	2.86
Turkey	2.64	3.35	0.64	0.76	0.76	3.64	2.76	2.58	3.00	2.58	2.27
Cote D'Ivoire	4.29	3.00	2.64	3.76	4.23	6.17	8.00	10.64	11.05	8.94	6.27
Benin	6.70	6.11	4.76	5.29	5.29	3.52	5.47	8.23	6.58	7.82	5.98
Tanzania	1.35	1.94	3.35	3.52	2.35	2.11	3.82	3.05	2.17	3.17	2.68
Zambia	3.11	2.29	2.58	2.64	2.94	3.05	4.94	2.23	2.29	2.35	2.84
Chad	3.29	2.41	1.47	1.29	1.00	1.82	2.00	1.94	2.76	3.88	2.19
Australia	27.35	15.58	15.35	20.00	24.23	59.41	79.00	62.17	30.58	29.00	36.27
Greece	15.82	13.76	12.94	11.11	13.29	14.00	13.94	16.47	14.94	11.88	13.82
Nigeria	1.94	1.52	1.58	2.17	1.88	1.88	2.35	2.76	2.52	2.17	2.08
Cameroon	5.29	3.20	2.64	3.29	3.17	4.05	4.82	5.94	5.23	6.64	4.43
Zimbabwe	4.64	4.82	4.47	4.88	5.35	7.88	5.00	3.47	2.76	1.82	4.51
Tajikistan	7.05	6.36	4.00	6.47	5.29	6.94	8.00	4.88	5.11	4.41	5.85
Kazakhstan	7.35	7.17	5.00	3.47	3.76	3.64	2.64	3.58	2.58	2.82	4.20
Mozambique	2.05	1.47	1.41	1.39	1.41	2.11	3.11	2.17	1.82	1.41	1.84
Uganda	1.41	0.88	1.00	1.05	1.41	1.82	1.05	0.82	1.00	1.29	1.17
Ethiopia	0.52	0.70	0.11	0.10	0.10	0.05	0.05	0.05	0.00	0.00	0.17
Sudan	2.82	3.11	1.00	1.76	1.70	0.23	1.41	0.88	0.17	0.11	1.32
Egypt	4.23	7.70	2.35	4.47	3.41	4.29	3.05	1.52	3.23	2.10	3.64
Mexico	2.47	3.00	2.05	0.88	0.82	4.35	2.88	1.70	2.11	1.17	2.14
Paraguay	2.29	0.76	0.76	0.52	0.23	1.17	1.17	0.29	0.17	0.11	0.75
Myanmar	1.00	1.00	1.00	1.00	1.05	0.00	0.00	0.00	0.00	0.00	0.51
Syria	4.11	3.23	2.64	2.94	3.58	0.17	0.41	0.10	3.00	0.29	2.05
Iran	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Country	21.96	19.80	16.17	15.75	21.80	30.03	28.59	17.52	15.39	17.55	20.46
Total	476.47	491.70	385.11	438.58	455.82	577.94	589.52	530.11	453.05	432.58	483.09

Source: ICAC

Annexure B: Country wise area, production, yield, import, export and consumption of cotton in the world.

F) Consumption: Lakh bales (170 Kg each)

Country	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	Average
China	623.52	641.17	538.58	570.88	580.88	507.94	487.64	442.18	439.94	417.94	525.07
India	229.88	238.23	227.23	244.29	254.05	248.88	280.11	305.05	317.47	309.52	265.47
Pakistan	154.88	148.29	141.17	145.41	148.29	124.76	130.35	145.29	146.58	129.00	141.40
Turkey	91.17	77.94	67.05	67.64	67.64	76.47	80.00	82.35	87.41	88.23	78.59
USA	63.17	58.76	45.94	43.52	41.35	42.23	44.82	45.47	45.76	46.11	47.71
Brazil	58.35	59.23	57.29	57.17	58.58	52.76	53.52	50.70	46.88	44.52	53.90
Bangladesh	33.82	39.70	43.52	44.82	47.05	41.17	45.00	51.76	55.11	62.00	46.40
Thailand	25.29	25.00	21.64	22.70	23.64	15.88	21.17	19.82	19.41	16.88	21.14
Russia	16.70	13.94	12.11	11.52	10.70	4.41	4.11	4.23	3.17	3.05	8.39
Taiwan	15.00	12.94	10.88	10.70	10.17	10.88	12.00	11.35	10.76	9.70	11.44
Indonesia	28.23	7.35	25.58	26.58	27.41	31.76	39.52	40.17	41.82	42.23	31.07
Maxico	26.23	25.58	23.52	24.00	24.00	22.94	23.41	24.23	23.82	24.05	24.18
Egypt	12.35	12.05	8.82	11.17	11.52	7.17	7.58	8.35	7.82	6.64	9.35
Argentina	10.00	10.58	9.11	9.11	9.11	10.05	8.23	7.94	8.35	8.47	9.10
Colombia	5.76	5.17	5.00	5.00	5.00	3.64	3.11	3.58	3.05	3.23	4.25
Peru	7.05	7.05	5.88	5.29	5.05	5.52	5.41	5.41	4.82	4.82	5.63
Uzbekistan	13.52	15.29	14.11	14.11	14.23	17.35	19.11	20.29	20.29	19.88	16.82
Greece	4.05	3.29	2.52	2.35	2.29	1.47	1.23	1.17	1.11	1.11	2.06
Italy	8.11	6.17	3.35	3.23	2.11	2.94	2.82	2.64	2.82	2.82	3.70
Japan	7.64	7.35	6.05	3.82	3.64	3.94	4.05	4.05	3.82	3.94	4.83
Korea Rep.	13.64	12.58	12.64	12.00	11.29	14.52	16.00	16.00	17.05	16.52	14.22
Vietnam	12.35	14.41	15.47	19.11	21.05	24.11	28.94	40.82	53.11	64.76	29.41
Syria	11.17	11.17	8.82	10.88	10.88	7.94	5.17	5.88	5.58	5.05	8.25
Iran	7.64	7.94	7.94	7.94	7.94	7.64	5.35	7.70	7.70	7.70	7.55
Others	76.36	90.87	62.89	60.11	60.60	53.86	57.40	58.27	57.99	58.41	63.68
Total	1555.88	1552.05	1377.11	1433.35	1458.47	1340.23	1386.05	1404.70	1431.64	1396.58	1433.61

Source: ICAC

