Subject	Lesson/Chapter Name
Plant Resource Utilization	**Fibers 2 Cotton**

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Learning Outcome

- ✓ What is the source of cotton?
- ✓ How the tetraploid cotton evolved?
- ✓ What is India's status as cultivator and producer of cotton?
- ✓ What are the steps involved in extraction of raw cotton?
- ✓ What make the cotton fibres so important for textile industry?
- ✓ What are the uses of cotton and its various products?

Introduction

Cotton fibre is a surface fibre; it originates from prolongation of epidermal cells of the seed coat. The seeds are present in a capsule called a "ball". Under natural conditions, the role of the fibres is to enhance the dispersal of seed. This vegetable fibre is purely cellulosic (94 %) in nature.

Cotton is one of the world's earliest domesticated plant. It is cultivated as world's major fibre crop; it is important among all natural textile fibres with high commercial value. It was domesticated independently as a source of fibre in both the old world as well as in new world.

Origin of word cotton: Arabic word *al qutn*

Origin of word *Gossypium*: Arabic word *goz* (meaning soft substance)

Botanical name: *Gossypium* species

G. *arboreum* (Old world cotton, section Herbacea, diploid, 2n = 26); A2
G. *herbaceum* (Old world cotton, section Herbacea, diploid, 2n = 26); A1
G. *hirsutum* (New world cotton, section Hirsuta, tetraploid, 2n = 52); (AD)1
G. *barbadense* (New world cotton, section Hirsuta, tetraploid, 2n = 52;*(*AD)2

Systematic Position:

Family:Malvaceae
Tribe: Gossypieae

Vernacular Names: Kapas (in hindi); cotton (in english)

Cotton (*Gossypium* species)

History and Origin

Cotton was probably, first domesticated in old world about 7000 - 5000 years ago. The reference of cotton is found in many religious texts, including Rig Veda that suggests the use of cotton in India by 1000 BC.

Cotton fabric was excavated from Mohenjodaro (Sind, Pakistan) in 3000 BC indicates cotton cultivation (propably *G*. *arboreum*) in ancient India. In fact, *G*. *arboreum* was first cultivated in Indus Valley of India and then it spread to Asia and Africa, whereas *G*. *herbaceum* was initially cultivated in Arabia and Syria.

Among new world species, *G*. *hirsutum* was first cultivated in Mexico and *G*. *barbadense* in Peru.

Taxonomic diversity of cotton:

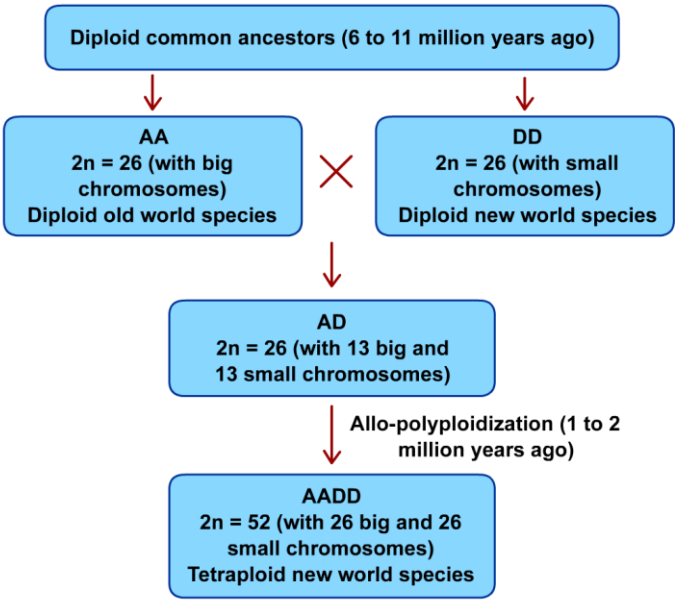
Out of about 50 species of genus *Gossypium*, the word 'cotton' refer to only four species are cultivated and are used for spinnable fibres, rest 46 species distributed world-wide in tropical and sub-subtropical regions are designated as wild species. These wild species are important source of functional traits such as fibre properties, resistance to abiotic and biotic stresses, and cytoplasmic male sterility which can be utilized for improvement of cultivated species through introgressive breeding.

Out of 50 species, 43 diploid species (with 2n = 26) have been grouped into seven genome from A to G, whereas rest of the 7 tetraploid species (with 2n =52) have been designated into genome AD.

Origin of Tetraploid cotton:

World's commercially cultivated cotton is obtained from two tetraploid species, *G. hirsutum*, a upland species that contribute 90 per cent of world's plantings, and *G. barbadense*, pima cotton species. Two desi cotton species in India, *G. arboreum* and *G. herbaceum*, are two diploid native species of Asia and Africa. In fact, the various researchers have revealed that new world cottons are natural amphidiploids containing A genome (from Asiatic diploid group) and D genome (from American diploid group). Timings of these crosses is hypothetical. The new world cotton species include *G. hirsutum* (American cotton) and *G. barbadense* (Egyptian). The allotetraploid of these plants contain fifty two chromosomes and AADD genome. The probable sequence in the origin of tetraploid species is summerised as follows (Figure).

Further, *G. hirsutum*, a new world tetraploid cotton, has probably originated from hybridization between *G. herbaceum* (old world diploid cotton) and *G. thurberi* (American upland cotton) as shown schematically (Figure)



Source: Author

Figure: Showing probable origin of tetraploid cotton from hybridization between diploid old world cotton and diploid new world cotton and further allo-polyploidization.

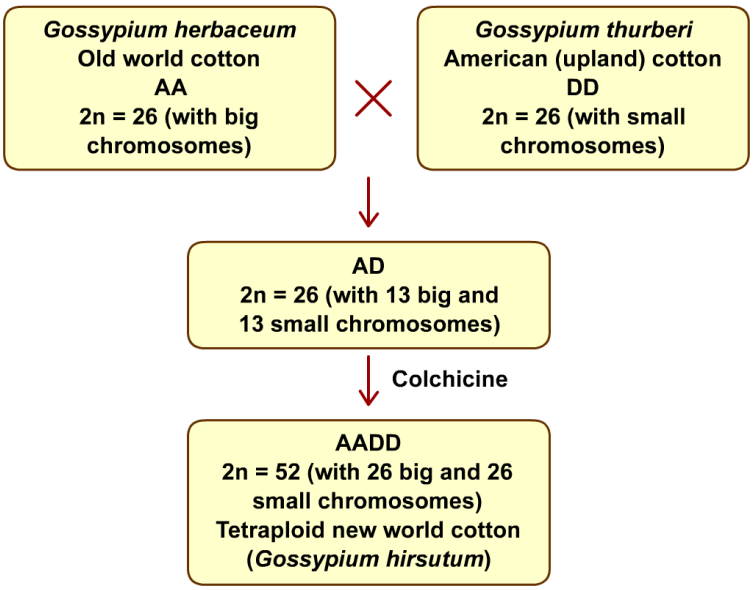


Figure: Schematic presentation of probable origin of *G. hirsutum*, a tetraploid cotton from two diploid species.

Production

Cotton is grown commercially in more than 75 countries. Major cotton producing countries include China, India, USA, Pakistan, brazil, Uzbekistan, Turkey, Australia and Egypt. India contributed 20.5 per cent of total world's cotton production in 2012, and ranked second among cotton producing

countries. India has the largest cotton cultivation area in the world. China is the World's leading cotton producer; it produced 26.3 per cent of total World's cotton in 2012 (Table).

Table: World's Top Six Cotton Producing Countries during 2012

Country	Production in 2012 (*metric tonnes)	Per cent of total world's production
China	6,840,000	26.3
India	5,321,000	20.5
United State	3,598,000	13.8
Pakistan	2,215,000	8.5
Brazil	1,638,103	6.3
Uzbekistan	1,052,000	4.0
World	25,955,096	100

*** 1 metric tonne = 1000 kgs.**

Source: Compiled from FAOSTAST data, 2014)

In India, Gujarat is largest cotton producer state followed by Maharashtra, Andhra Pradesh and Haryana (Table).

Table : Top cotton producing states in India during 2013-14 in the decreasing order of production

State	Area (in lakh hectares)	Production (in lakh *bales)	Yield (Kg/hectare)
Gujarat	26.91	124.00	783
Maharashtra	38.72	84.00	369
Andhra Pradesh	22.69	78.00	584
Haryana	5.66	24.00	721
Karnataka	5.94	23.00	658
Punjab	5.05	21.00	707
Madhya Pradesh	6.21	19.00	520
Rajasthan	3.03	14.00	7785

* 1 bale = 170 kgs.

Source: Data extracted from Cotton Advisory Board, Govt. of India

Cotton Industry In India:

Cotton is one of the important cash crops of India and earn significantly by export. Cotton contributes to around 30 per cent of Indian Agricultural gross domestic product. Indian textile industry constitutes one of the largest organized sector of the country. In India, there are 1500 spinning mills, 250 composite mills and more than 1 lakh handlooms. The power looms and handlooms in decentralized sector, make available employment to over 2.5 million people.

Morphology of Plant

The cotton plant is shrub or a small tree. The main stem is monopodial in growth and hold spirally arranged leaves and branches. Plant shows dimorphic branching- (i) vegetative branches exhibits monopodial pattern that arises from the axillary buds of the lower nodes of main shoot, (ii) fruiting branches shows sympodial pattern that arises from extra-axillary buds. Leaves are palmately lobed (3-, 5- or 7), large and covered with multicellular hairs. Flowers are showy, large and terminal in position. Flowers are enclosed by an involucre of bracts (epicalyx) that remains persistent in some species.

The fruit i.e. boll is spherical to ovoid, leathery capsule developed from tri-penta carpellary (3-5 loculer) ovary having 6 to 9 seeds in each locule/chamber. The seed surface is covered with hairs of varying length that yield fibre.

A

ning,

C

Figure : Morphology of all the four cultivated species of *Gossypium*

Source:

http://www.prota4u.org/plantphotos/Gossypium%20barbadense.full.08.jpg

http://www.prota4u.org/plantphotos/Gossypium%20hirsutum.full.08.jpg

http://www.prota4u.org/plantphotos/Gossypium%20herbaceum.full.06.jpg

http://www.prota4u.org/plantphotos/Gossypium%20arboreum.full.03.jpg

Table: Distinguishing features of all the four cultivated species of cotton.

Chacteristics	***G. herbaceum***	***G.arboreum***	***G.hirsutum***	***G.barbadense***
Common Name	Levant cotton	Tree cotton	Upland cotton	Extra-long staple cotton
Genome	A1, 2n = 26	A2, 2n = 26	(AD)1, 2n = 52	(AD)2, 2n = 52

	Diploid	Diploid	Tetraploid	Tetraploid
Distribution	Afghanistan	Indo-Burma, China and Arab	America	America
Habit	Annual	Perennial	Annual	Perennial/Annual
Stem	Green, hairy	Green to brown, hairy	Green, hairy	Green, glabrous
Leaves	1/2 cut or less, 5-7 lobes	2/3 to 4/5 cut, 5-7 lobed	Large cordate, 1/2 cut or less, 3-5 lobes	2/3 cut, 3-5 lobes
Bracteole	Flaring widely form the flower bud, 6-8 teethed	Closely invested to bud, 3-4 teethed	4-12 teethed triangular	Fused at base, 8-13 teethed
Flowers	Yellow, petal spot as bright eye rays	pink, petal spot as purplish red	Flower yellow, petal spot absent	yellow with petal spot
Fruit (Boll)	Small with 3-4 loculi, round, pitted	Round to tapering with 3-4 loculi, smooth to pitted	Round to elongated with 3-5 loculi, pitted	Pointed with 2-4 loculi, deeply pitted
Seeds	8-10 medium	6-7 medium	5-11 large	5-8 large

Fibre	Short to medium	Short to medium	Moderate to long	Longest

Source: Author

Figure : Cotton crop (*G. hirsutum*) field before picked up mechanically during mid September

Source:

http://www.forestryimages.org/browse/detail.cfm?imgnum=5520052

Ecology and Cultivation

Diversity in agro-climatic zones in India is much larger than any of cotton growing countries in the world. India is the only country where all four cotton species along with their hybrids are cultivated.

Cotton is primarily a tropical crop that grows in the region between 40° north and 30° south of the equator. It requires frost free, sufficient sunshine, temperature ranging from 21°C to 27°C and moderate rainfall (150 - 175 mm) for proper growth. Relatively drier season (no rainfall) is necessary during flowering, fruiting, and particularly during ripening and picking of cotton to ensure high yield and better quality. Cotton is grown on various soil types, but humus rich, well drained, fertile and deep soil is preferred. Fertilizers and pesticides are needed in some of the areas.

In India, the growing season varies significantly from region to region. Seeds are sown from April to May in northern India whereas May to June in southern India. It is mostly a monsoon crop except in southern India where it is a late monsoon or early winter crop. Picking period varies from September to November depending upon the time of sowing the crop. Crop is ready for picking fibres after a minimum of 200 days.

Insect Pests and Diseases of Cotton

In cotton production, Insect pests are one of the limiting factor. About 1300 species of insects have been reported globally, out of which caterpillars of six lepidopteran species causes most damage. In India, about 162 species of insect pests attack different stages of cotton crop. Most of these species can be efficiently contained by conventional practices of chemical, cultural and biological and host resistance way but the major challenge is bollworms, most important tissue feeders and highly damaging ones. In fact, three type of bollworms namely American bollworm (*Helicoverpa armigera*), Spotted

bollworm (*Earias vitella*) and Pink bollworm (*Pectinophora gossypiella*) are most damaging pests of cotton (Figure). Out of these, *Helicoverpa armigera* alone cause 80% loss in cotton crop in India. **Currently, Bt cotton, genetically modified (GM) seeds are preferred over normal cotton seed to reduce losses and damages due to infestations of various insect bollworm.**

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Source:

http://www.forestryimages.org/browse/detail.cfm?imgnum=5082068

http://agropedia.iitk.ac.in/content/spotted-bollworm-cotton

http://www.forestryimages.org/browse/detail.cfm?imgnum=1321029

Figure: Major Insect pests of cotton: American bollworm (*Helicoverpa armigera*), Spotted bollworm (*Earias vitella*) and Pink bollworm (*Pectinophora gossypiella*)

What is Bt?

- *Bacillus thuringiensis*, commonly known as Bt, is a positive and spore forming soil bacterium that forms parasporal crystals during stationary growth phase of its growth cycle. The crystalline proteins synthesized by this bacterium constitute about 20 -30% of dry weight of sporulated cultures, called 'endotoxins' are highly toxic to certain insects.
- Bt was first discovered by a Japanese Scientist Ishiwata in 1901. It has been used to control insect pests in stored grains since 1938 in France and from 1961 in USA.
- The Bt strains produce three types of insecticidal toxins, crystal (Cry) toxins, cytolytic (Cyt) toxins and vegetatively expressed insecticidal proteins (vip). These toxins are extremely specific to certain insects.

Did You Know about Bt Cotton?

- Bt cotton is a GM crop that expresses an insecticidal protein whose gene has been derived from a soil bacterium *Bacillus thuringiensis*, commonly known as Bt.
- The first Bt cotton was developed in 1987 in U.S.A. by Monsanto, Delta and Pine companies. The Bt gene *cry 1Ac* was used to develop first Bt cotton using *Agrobacterium tumefasciens* mediated gene transfer technique. Cry1Ac toxins are extremely specific to insects at species level, and are not cause any harm to non- target organisms such as beneficial insects, .
- Currently, Cry1Ac, Cry2Ab and Cry1C have been approved for commercial cultivation in India. These endotoxins belong to the class 'Bt-delta-endotoxins' which act as oral toxins. The toxins kill the insect by acting on the epithelium tissues of midgut of caterpillars.
- The Cry1Ac is most toxic to the all three major bollworms, semiloopers and hairy caterpillars.

What are the Benefits of Bt Cotton?

Bt technology has boost up the global cotton industry not only by enhancement in the productivity and benefit the growers, but also society as whole on various levels- economic, social and environmental. The major direct and indirect advantages are as follows:

Direct Benefits:

- Increased yield at least by 30.0%
- Bollworm control
- Reduction in pesticide use
- Enhanced seed cotton quality

Indirect Benefits:

- Improved population of beneficial insects in cotton fields
- Reduced pesticides runoff
- Improved farmer safety
- Reduction in labour costs

Figure : Bt cotton on the left, next to a conventional cotton variety on the right which is showing the damage crop due to insect feeding.

Source: SEEK PERMISSION

http://theconversation.com/genetically-modified-crops-shrink-farmings-pesticide-footprint-3004

Harvesting

Harvesting or picking the cotton from ripened fruit (open boll) is a highly labour intensive practice, and starts after six months of sowing the seeds. As all fruits do not ripen at the same time, hand-picking the cotton continues for a period of two months. Although hand-picking method needs much labour but produces cleaner and better quality fibres in comparison to mechanical harvesting (a cheaper option).

In western countries, where availability of labour is a concern, mechanical harvesters are preferred. As these harvesters are suction based, some chemicals (e.g. calcium cyanamide) are sprayed to defoliate the plants and to induce the ripening of all the fruits simultaneously.

Seed Anatomy and location of fibre

Cotton is a surface fibre i.e. borne on the surface of seed. It is derived from epidermal prolongation of seed coat cells. These fibres are also referred to as ultimate fibres, as they are free of any irrelevant plant tissue. Fibres are long, slender and unicellular; in the cultivated species following two types of fibers occur:

Lint Fibre: These hairs are moderately long (upto 45 mm) with hollow lumen due to reduced internal cellulose deposition, and are readily detachable and can be spun. The cellulose is deposited spirally that gives characteristic convolutions and fibre shape is twisted like ribbon after maturity (Figure).

Fuzz/linter Fibre: It consists of short hairs (10 mm). These hairs are solid, due to internal cellulose deposits, and are so firmly attached to the seed that it can not be spun.

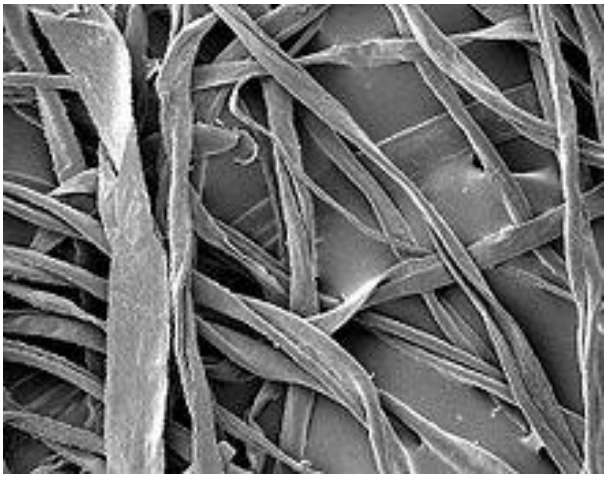


Figure : Lint cotton fibre under scanning electron microscope

Source: http://en.wikipedia.org/wiki/Cotton#mediaviewer/File:C21a.jpg

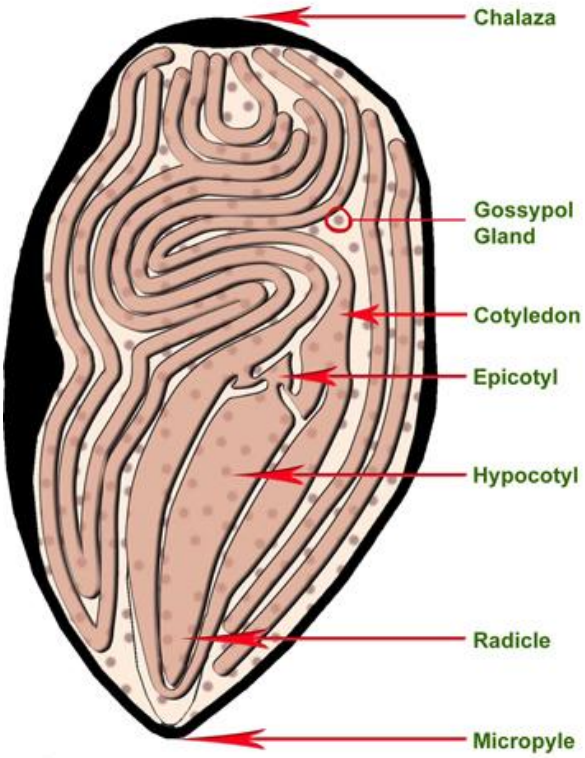


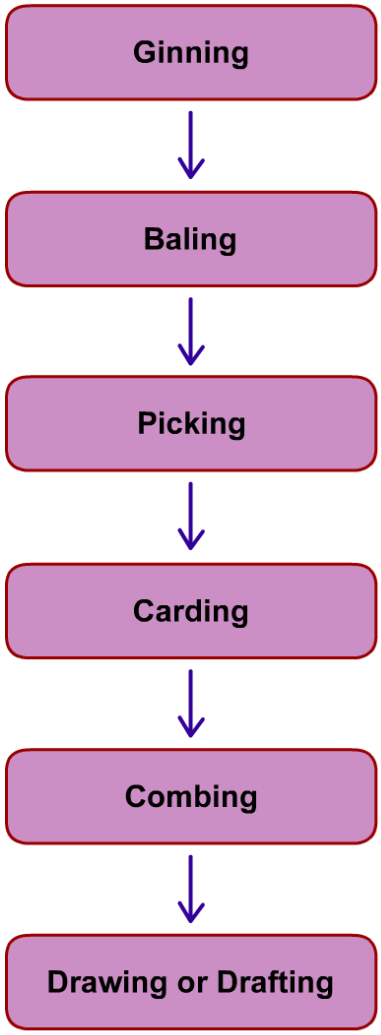
Figure : L.S. of cotton seed showing radicle, intricate folds of the cotyledons

Figure : L.S. of cotton seed showing radicle, intricate folds of the cotyledons

Source:
http://www.soilcropandmore.info/crops/CottonInformation/B1252/b1252.htm

Processing of Cotton (Extraction of Fibres)

After picking the cotton from the field, it pass through a number of steps such as ginning, baling, grading, marketing, opening, picking, carding, combing, and drawing (Figure).



Source: Author

Figure: Flow chart showing steps involved in extraction of fibre and processing to obtain raw cotton fibre.

Ginning: The cotton gin was invented in 1793 that revolutionized the textile industry; prior to that hand separation was done for removal of fibres from seed. Ginning is the process of separation of the fibres from the seeds in which the raw cotton pass on to hoppers of a gin machine. The gin machine may be roller type or saw type.

Raw cotton get across through a series of rollers and toothed wheels, and then conveyed to gin stand, which removes the lint fibres from the seeds. In India, a small amount of raw cotton is ginned by the use of charkha gin in villages.

Baling: After ginning, the fibers are hydraulically pressed into bales. These bales are wrapped in jute or hessian, bag and tied with iron bands. Now, baled cotton is ready for marketing.

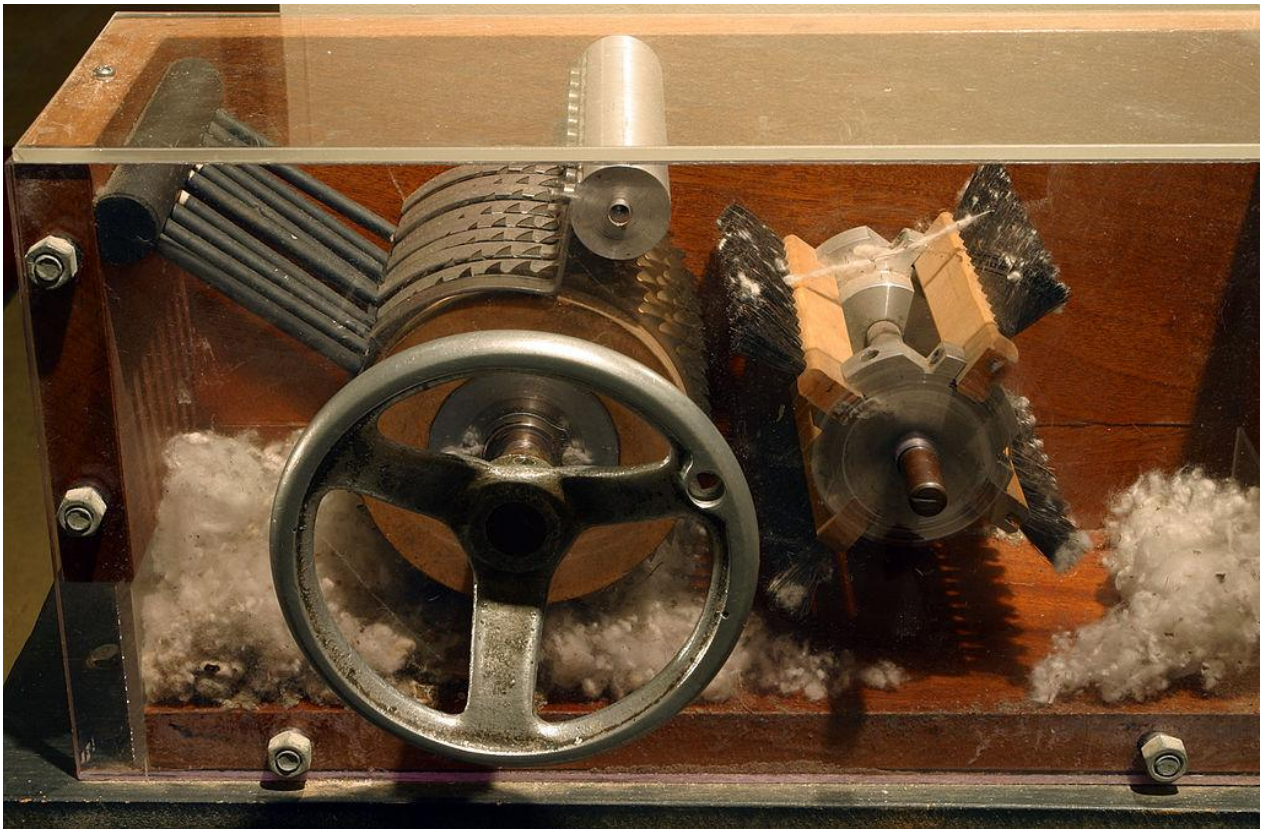
Picking: After opening the bales, the fibers are beaten, shaken and rolled by passing through a scutcher to remove the foreign matter. Now, the uniform layers are condensed into sheet (lap) using picking machines.

Carding: The carding machine, further separates the lumps of fibres into individual fibres, and removes impurities and immature fibres, if any.

Combing: The combing used to remove short fibres.

Drawing or Drafting: In this process the fibres are straightened, evenly distributed and are aligned parallel to one another. Generally, two drawing act after carding and two after combing is common.

The fibers are then spun into a untwisted rope or a 'silver'. The 'silvers' is further drawn out and twisted into a fine yarn through spinning process. Now, the finished yarn is wound on spools or bobbins and then goes for weaving.



Source:
http://en.wikipedia.org/wiki/Portal:Cotton/Selected_article#mediaviewer/File:Cotton_gin_EWM_2007.jpg

Figure : Ginning machine used for separation of cotton fibre from seed

Characterization and Composition of Fibres

Cotton fibres ranging from 2.5 cm to 5.0 cm in length. Fibre is composed of cellulose more than 90% and water, pectins and fractions of waxes, fatty substances and mineral salts. Unlike other fibres, absence of lignin make this fibre more stronger and durable.

Composition of Cotton Fibre

Cellulose = 94 %; Protein = 1.3 %; Pectic Substances = 0.9 %; Ash = 1.2%; Wax = 0.6%; sugar = 0.3%

Table 4: Showing Physical and Chemical Properties of Cotton fibre

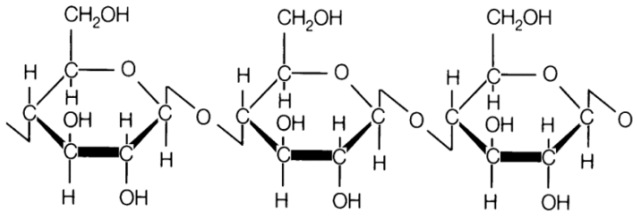
Physical Properties	Assessment
Color	White, creamy white, yellowish white or grey
Tensile strength	Moderately strong fiber that increases on wet
Dimensional stability	Cotton is the resistant to permanent change in its length. It is rigid and inelastic fiber.
Effects of Heat	Resistant to degradation by heat
Sun light	Prolonged exposure weakens fibres
Age	Very small loss of strength on storing the fibre
Chemical Properties	
Effect of Acids	Disintigrate, weakening the fibre
Alkalies	Resistance
Solvents	High resistance to mostly organic solvents

Source: Author

structural formula taken from net has to be modified

Interesting facts about cellulose

- Cellulose is an organic compound made up of a linear chain of 100 to ten 1000 D glucose units linked with β (1- 4) glycosidic linkage.



- About 33 per cent of all plant matter is cellulose.

Cotton Fibres: Tests for cellulose

Burn tests:

- Cotton fibre flare up when lit but no melted bead is left.
- Continue to glow after burning.
- The smoke colour is white or gray.
- Smell of burning fibre is like that of burning paper.

Chemical tests:

- Cotton fibre + Schultze's solution (Chor-zinc-iodide) = Fibres turns blue
- Cotton fibre + Few drops of iodine solution = Fibres turns yellow

- Cotton fibres + Few drops of conc. H_2SO_4 + Iodine solution = Fibres turn blue

Explaination: Cellulose is first hydrolysed by conc. H_2SO_4 into a colloidal hydrocellulose which forms a blue compound on reaction with iodine solution.

Utilization of Cotton fibres and its products:

Cotton is a very important crop of India. Each and every part of the cotton plant is economically important. Seed fibre is processed into yarn and fabric, the seeds are crushed to yield oil or cattle feed, stem and leaves are also used (Table). Cotton fibers are used for various purposes as given below:

Table : Various Parts of Cotton Plant and their utilization

Cotton Plant Parts	Utilization
Root	Drugs
Stem	Bast fibre, Paper pulp
Leaves	Fodder
Fibre: Lint	Clothing, household, industrial fibres
Fuzz/linter	Cellulose pulp, Making rayon, Filling material
Seed: Oil	Valuable used as food and non food purposes
Meal or Cake	Livestock feed, Fertilizer
Hull	Fibre board, Roughage material

Source: Author

- Fibre is very valuable to textile industry due to it is almost composed of cellulose that make it soft and supple.
- Clothing articles include underwear, outwear, gloves, shirts and hosiery.

- Household articles include towel, table cloths, bed sheets, bed cover, pillow covers, blankets etc.
- Industrial articles includes belts, bags, tents, insulation, tarpaulin, industrial threads etc. Due to its long life, the fiber is also used for making tyre and machinery belt.
- Linters are used for making cellulose pulp, rayon, paper, plastics etc. Linters are also used as a filling material in bedding and furniture.
- Cotton can be modified chemically into a variety of products such as mercerised cotton, water repellent cotton, absorbent cotton and flame-proofed cotton.

Regulatory Mechanism for Cotton In India

Ministry of Textiles, Government of India deals with all regulatory organizations in India related to cotton sector **(For detail visit: http://texmin.nic.in/)**. There are also Public Sector Undertakings and some other organizations supported by Ministry of Textiles in India.

Cotton Advisory Board (CAB): CAB is a advisory board under Ministry of Textiles.

Cotton Corporation of India, Limited:

It was established in 1970 as an agency in Public Sector and was responsible of equitable distribution of cotton among the different constituents of the industry, and serving as vehicle for canalization of imports of cotton.

The role and functions of the Corporation were revised with the changing scenario and in 1955, the corporation was nominated as the Nodal Agency of

Government of India, for undertaking Price Support Operations. According Textile Policy 1985, the following role has been assigned to CCI:

- To undertake price support operations, whenever the market prices of kapas touch the support prices announced by the Government of India.
- To purchase kapas to fulfill the export commitments.
- To undertake commercial operations only at CCI's own risk, and
- To act as implementing agency for Mini Mission III and IV of Technology Mission on Cotton.

(For detail visit http://cotcorp.gov.in/index.aspx)

Central Institute of Cotton Research (CICR), Nagpur

It was established in 1976 by ICAR at Nagpur with the objective to carry out long term research on problems limiting cotton production and also to provide support to location specific applied research work through All India Coordinated Cotton Improvement Project (AICCIP). There are two regional stations: (i) The regional station at Coimbatore (Tamil Nadu) to provide the needs of Southern cotton zone, and (ii) the regional station at Sirsa (Haryana) for the irrigated northern zone.

(For detail visit http://www.cicr.org.in/)

Summary

- Fibre satisfied the one of the three basic needs (food, cloth and shelter) of human lives.
- Cotton is one of the earliest domesticated crops, yield the most important textile fibre among all the natural fibres of the world.
- India has largest cultivation area among world's cotton growing countries. India is the only country where all the four species along with their hybrids cultivate.
- India contribute 20.5 per cent of total world's cotton production in 2012, and rank second among cotton producing countries, whereas India has largest cotton cultivation area in the world.
- *G. hirsutum*, a new world tetraploid cotton, has probably originated from hybridization between *G. herbaceum* (old world diploid cotton) and *G. thurberi* (American upland cotton).
- World's the majority commercially cultivated cotton is obtained from two tetraploid species, *G. hirsutum*, a upland species that contribute 90 per cent of world's plantings, and *G. barbadense*, pima cotton species. Two desi cotton species in India, *G. arboreum* and *G. herbaceum*, are two diploid species are also important commercially.
- Cotton is primarily a tropical crop that grows in the region between 40° north and 30° south of the equator. In India, the growing season varies significantly from region to region. Seed are sown from April to May in northern India whereas May to June in southern India.
- In fact, three type of bollworms namely American bollworm (*Helicoverpa armigera*), Spotted bollworm (*Earias vitella*) and Pink bollworm (*Pectinophora gossypiella*) are most damaging pests of

cotton. Out of these, *Helicoverpa armigera* alone cause 80% loss in cotton crop in India.

- Bt cotton, genetically modified (GM) seeds are preferred over normal cotton seed to reduce losses and damages due to infestations of various insect bollworm and also environmental friendly.
- Cotton fibre originates as epidermal prolongation of seed coat cells and is categorized as surface fibre.
- Fibres can be separated from cotton seed by a machine called gin, and the process is known as ginning. Ginned fiber need baling, picking, cording, combing and drawing before it is spun into yarn and woven into cloth.
- Lint fibers are used for making clothing articles, household articles and industrial articles, whereas fuzz or linter fibres are used for filler material.
- Seed oil is also economically important product of crop.

Exercise/Practice

Write the botanical name, family and plant part that yield cotton. Also describe briefly the processes involved in cotton fibre extraction.

Differentiate between the followings:

- Lint fibre and fuzz fibre
- Cotton fibre and Jute fibre

Draw labeled diagram of:

- L.S. of Cotton Seed
- Lint fibre

Write short notes on the followings:

- Origin of tetraploid cotton
- Extraction of cotton fibre
- Utilization of cotton fibre
- Benefits of Bt-cotton

Define the followings:

- Ginning
- Surface fibre
- Bt
- Mercerised cotton

Expand the followings: CAB, CICR.

Glossary

fuzz fibre: These are the short cotton seed fibers, almost solid due to internal cellulose deposits, attached firmly to the seed. Also called as linter and used as filler material.

Ginning: It is the process of separation of fibre from the seeds by using a gin (a machine).

lint fibre: These fibres are long staple cotton fibres, easily detachable, hollow lumen with spiral internal cellulose deposits. Fibre can be spun and is important for textile industry.

Mercerised cotton: It is a chemically modified product in which cotton yarn or cloth is treated with NaOH.

Refugia: It is a method in which non-Bt crop is planted in the neighborhood of the Bt-crop area. This area planted with non- Bt crop serve as hosts of the target Bt susceptible insect pests to multiply.

Silver: It is continuous untwisted rope that can be drawn into desired thickness for twisting into yarn.

References/ Bibliography/ Further Readings

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