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COTTON G46



Cotton is a natural fibre that comes from the seedpod of the cotton plant. The cotton plant is a shrub which is native to tropical and subtropical regions around the world, including the Americas, India, and Africa. Cotton produces fluffy fibres to protect its seeds and help them disperse in the wind (below). It is a member of the mallow family of plants, which includes species such as marsh mallow, hollyhock, hibiscus and lavatera. A cotton flower can be seen above right. There are thirty recognised species of cotton. However, only four are cultivated on any scale commercially. Successful cultivation of cotton requires a long frost-free period and plenty of sunshine. Cotton is also a thirsty crop and needs from 60 to 120cm (24 to 48 inches) of rainfall a year.



There is archaeological evidence from Peru, India and Mexico that cotton has been used for thousands of years. People in Asia and South America realised that the soft white fibres of the wild cotton plant could be useful and started to grow cotton as a crop around 3000BC.

Cotton cloth was known in England in the thirteenth century and is mentioned in an Act of Parliament in 1212, during the reign of King John. At this time no one in Europe had actually seen a cotton plant. Writing in 1350 Sir John Mandeville reported that in India 'there grew there a wonderful tree which bore tiny lambs on the endes of its branches. These branches were so pliable that they bent down to allow the lambs to feed when they are hungrie.' The picture on the right shows Mandeville's lamb-tree! This belief was shared across Europe - the German word for cotton, for example, is *baumwolle*, which translates as 'tree wool'.



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Until around 1800 most British people wore either woollen goods or linen made from the flax plant. Indeed, in 1721 Parliament passed an *a*ct which forbade people from wearing cotton clothes in order to protect the British wool industry. Not that much notice was taken of this law. In the mid-eighteenth century, society ladies seized on the fashion of wearing cotton dressing gowns, called *indiennes*, as at this date most of the cotton in Britain came from India.

When Columbus made landfall on 12 October 1492, he received gifts that included 'balls of cotton thread' from the Arawaks of the island of San Salvador. British settlers intended to send cotton plants to Jamestown in 1607, but the rapid emergence of tobacco as the colony's cash crop doomed early cotton cultivation. The growth of cotton cultivation in the United States, which was the source of the raw material for the British cotton manufacturing industry, was largely a nineteenth century development.



One of the factors laid that the foundations for the nineteenth century British cotton manufacturing industry was the invention of a number of machines. One was the flying shuttle (right), patented in 1733 by John Kay from Lancashire. For centuries handloom weaving had been carried out on the basis of the shuttle, bearing the yarn, being passed slowly and awkwardly from one hand to the other. The flying shuttle caused the shuttle to be knocked back and forth across the loom from one shuttle box to the other. A weaver using Kay's flying shuttle could produce much wider cloth at faster speeds than before. Although Kay's flying shuttle was intended for use with wool it could easily be adapted for other materials, including cotton.



Another important machine was the cotton gin (left), invented by the American Eli Whitney in 1793. The purpose of this machine was to separate cotton fibre from the seeds, a process which had, until the time of its invention, been extremely labour-intensive. The cotton gin was a wooden drum stuck with hooks, which pulled the cotton fibres through a mesh. The cotton seeds would not fit through the mesh and fell outside. Whitney told the story that when he was pondering an improved method of seeding the cotton he was inspired by observing a cat attempting to pull a chicken through a fence, but it could only pull through some of the feathers!

Other inventions which played an important part in making large-scale cotton production viable were the spinning jenny (which allowed one operator to spin eight threads at once) invented by James Hargreaves in 1764; the improved carding machine by Richard Arkwright in 1775; and Edmund Cartwright's power loom in 1785.

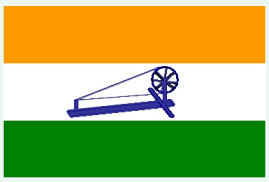
With the development of these machines it became profitable for American farmers to grow cotton. Between 1800 and 1860 cotton farming came to dominate large portions of the American South and was the most lucrative agricultural commodity in the USA. In 1800 the USA produced 36,572,500 lb of cotton, by 1860 this had risen to 1,918,701,000 lb.

Unfortunately cotton plantations required vast labour forces to harvest the crop and this labour was provided by slaves. In 1800 the slave population of the southern states was 851,532, by 1860 it had risen to 3,950,511. For slaves the triumph of 'King Cotton' meant a life of endless toil. The picture on the right shows slaves working a cotton gin.





The cotton that was grown in the southern states was either sent to the northern states or to England (especially Lancashire) to be woven into cloth. By 1812 there were 100,000 spinners and 250,000 weavers working in the industry. By 1830 more than half the value of British home-produced exports consisted of cotton textiles. Although not slaves, conditions for the workers in British cotton mills were harsh. The photograph on the left shows a Lancashire mill in about 1900.



During the American Civil War (1860-65) the export of cotton from the southern states was blocked. British manufacturers turned to Egypt and India for their raw material. Through tariffs and other restrictions the British government discouraged the production of cotton cloth in India. They preferred the raw fibre to be sent to England for processing. The finished cloth was then exported back to countries like India for sale. This is one of the practices which Ghandi protested against and was why he dressed in simple, homespun cloth. It is also the reason why a spinning wheel was included in the pre-Independence national flag of India (above right)!

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Today the cotton factories of the UK have largely disappeared. This is mostly because manufacturing has moved to poor countries where labour is cheap. Cotton growing is still important in the USA but, as in other areas of agriculture, is now highly mechanised. The photograph on the right shows a modern cotton harvester. In 2007 the seven largest producers of cotton in the world were, in order, China, India, USA, Pakistan, Brazil, Uzbekistan and Turkey.

Growing cotton is often profitable, but it has always had a noticeable impact on the environment in which it is grown. For example, by 1835 the topsoil of eastern Georgia in the USA had become severely eroded after less than 50 years of cotton cultivation. Planters were forced to look westward. This led to the cruel expulsion of the Cherokees and other Indian tribes from the land to 'Indian Territory' west of the Mississippi River. These people had previously made remarkable efforts to adapt their culture and organisation to that of United States, but it was to no avail in the face of 'White Gold'.



As well as draining nutrients from the soil, intensive cotton agriculture demands a lot of water. In many countries this is now obtained not from rainfall, but by draining rivers and wells. Water extraction in order to irrigate cotton is one of the main reasons why in 2000 the Aral Sea had shrunk to less than half the size it was in 1960. The photograph on the left shows an abandoned ship on the now-dried up seabed of the Aral Sea.

Cotton growing uses approximately 25% of the world's insecticides, more than 10% of pesticides and thousands of tons of synthetic fertilizers. In 2000 the World Health Organisation (WHO) estimated that 20,000 deaths occur each year from pesticide poisoning in developing countries, many of these from cotton farming. A more recent development has been the creation of genetically modified cotton. For example, a brand of GM-cotton has been produced which contains a bacteria gene that is toxic to cotton bollworm. However, the long term effects of this are unclear. Some cotton seed has been modified to make it resistant to weedkiller. This means that the field can still be sprayed with weedkiller, killing the weeds but leaving the cotton plants unaffected. In 2003 almost three-quarters of the USA cotton crop was genetically modified.

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Cotton Seeds & Boll

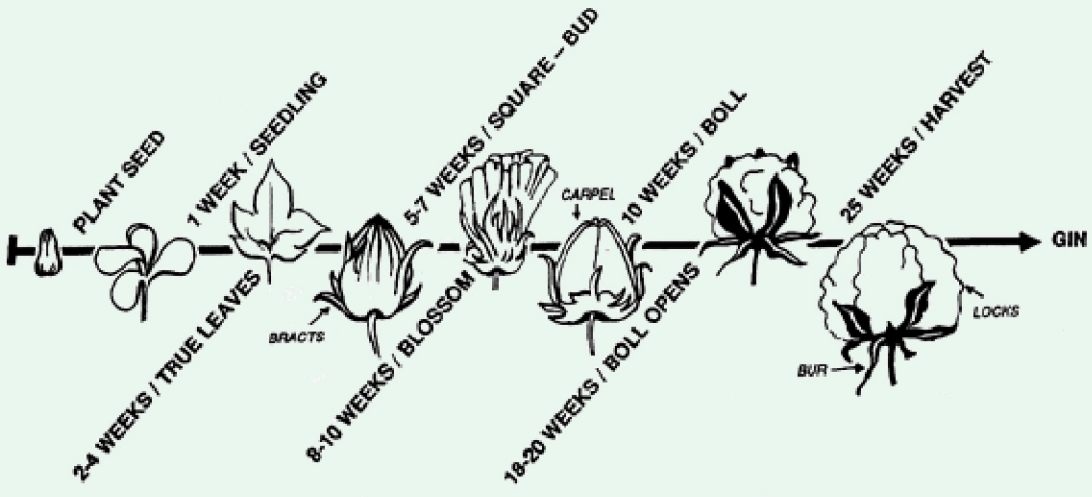




A cotton boll is the segmented pod containing 32 immature seeds embedded in cotton fibre. The chart below shows the time-scale of modern commercially grown cotton, from planting to harvesting. About 140 days after planting or 45 days after bolls appear, the cotton boll will begin to naturally split open along the boll's segments and dry out, exposing the underlying locks of cotton. An average boll will contain nearly 500,000 cotton fibres and each plant may bear up to 100 bolls.



The cotton seed which remains after the cotton is pressed is used to produce cotton seed oil, which can be refined and consumed by humans like any other vegetable oil. The cotton seed meal that is left after the seeds have been crushed is fed to livestock. The stems of the plants are sometimes used to make paper.



Three Cotton Varieties







There are three basic cotton varieties - fine, medium and coarse. The term **fine** refers to a high lustre fibre with a length of over 3cm. In the cotton industry the length of a fibre is referred to as its 'staple'. This is the best quality cotton and includes varieties such as Sea Island cotton (grown in the West Indies, Central America, Mexico), Egyptian, Sudanese and Peruvian. **Medium** refers to cotton with a staple of 2-3cm. This includes most of the cotton grown in the USA. **Coarse** cotton has a staple of 1-2cm. Indian and Chinese varieties belong to this category. The staple length determines a thread's strength - the longer the staple, the stronger the thread.

Cleaned Cotton



After the seeds are separated from the fibre in the cotton gin - which is usually carried out in the country of origin - the raw cotton is then compressed into bales weighing 200kg (500lb) each or more, and transported to a spinning mill. Here the first job is to clean the cotton. Commonly, 2.5% to 9.0% of the bale weight may consist of impurities, depending on the grade of cotton. Impurities are removed by a combination of mechanical and pneumatic methods. This reduces the large agglomerations of ginned cotton fibre size to small tufts. Sometimes this is followed by blending, in which batches of fibres from a number of similar types of bale are mixed together. Blending serves to minimise the effect on the raw material of slight variations between the bales.



Left: Modern factory cotton cleaning machines.

Carding Waste & Three Slivers



After the cotton has been cleaned it is necessary to separate the fibres from each other and to remove as much as possible of the remaining impurities. This process is called carding. Traditionally wool, cotton and other fibres were carded using two hand-held brushes similar to dog brushes (right). Using such brushes was a time-consuming business.









In the mid-eighteenth century various British inventors designed machines to replace hand-held brushes. In carding machines the fibres are passed between closely spaced rollers that are spiked with sharp wire teeth. The teeth comb the fibres into rows that are joined as a soft sheet, or web, and are then formed into loose untwisted rope known as a **card sliver**. Any remaining dirty or matted material is disposed of at this point.

Next, the fibrous slivers are drawn by passing them between a series of pairs of rollers spinning at different speeds. This lines up the fibres parallel to each other and causes them to overlap, randomly, along the length of the strand. This overlapping gives the thread its strength. The strand of cotton is reduced in thickness in preparation for the final conversion of the fibres into yarn form. The card sliver is narrowed into a **slubbing sliver** and then, when this is narrowed even further and is given a slight twist, it becomes a **roving sliver**.

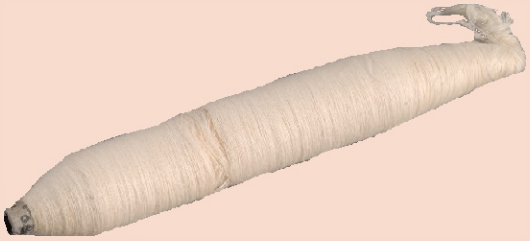


A nineteenth century carding machine from Quarry Bank Mill, Cheshire.

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The simplest and oldest method of transforming wool or cotton fibre into a thread is to use a spindle (right). A lady from South America can be seen using one on the left - the spindle is twisted by hand and the fibre is in turn twisted into a simple thread.



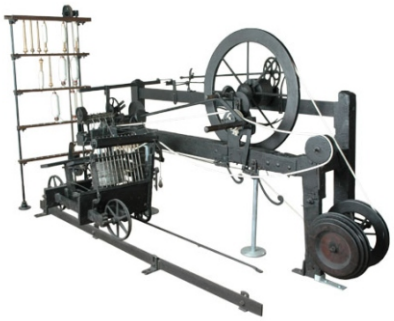
Later, spinning wheels were developed. These speeded up the process, but still required a lot of human energy - they were worked by means of a foot pedal.





The spinning jenny (left) was invented by James Hargreaves in about 1764. This device allowed a single worker to produce eight or more spools at once. This was later increased to 14.

In 1779 Samuel Crompton invented the spinning mule (right). This was basically a spinning jenny, but was powered by water. Like the spinning jenny it could produce several spools of thread at once. Later steam power was used to provide energy.



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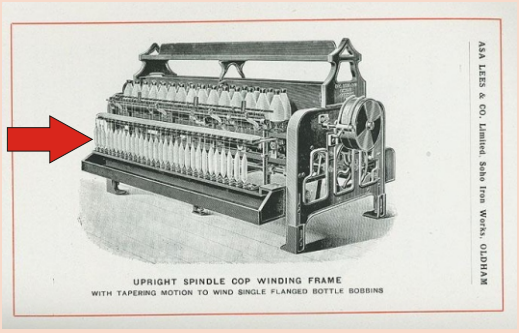
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In the nineteenth and early twentieth centuries, yarn was spun on huge spinning mules. The cotton was drawn from spindles between rollers of varying speeds which drew it out into an even finer thread. Finally they were twisted onto bobbins called 'cops'. A mule with 1,200 spindles could spin around 4,000 miles of yarn a day.

The illustration on the right is from a machinery manufacturer's catalogue published in 1931. The row of finished cops is marked with a red arrow.



Two Threads

Many different kinds of thread can be manufactured from simple one-ply mending cotton through to thicker and finer varieties. The skein of embroidery thread is made from mercerised cotton - cotton which has been treated to give it a lustrous appearance. The method of doing this was devised by John Mercer of Lancashire in the middle of the nineteenth century, but did not become popular until improvements were made to the process in 1890.



Cloth Samples

Cotton can be woven into an almost endless variety of fabrics. A few are given here to illustrate the range of possibilities.



Terry Towelling is a fabric with loops that can absorb large amounts of water. It is used to make towels and nappies.

Cotton Print - simple cloth, with colours applied after it has been woven.

Glazed Cotton - cotton print cloth which has been treated to give it a shine and to protect the colouring.

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Poplin is frequently made from cotton. It is available in various weights, making it suitable for shirts or rainwear, depending on the finish applied.

Seerloop is a gingham-type material in which a few coloured coarse warp yarns are spaced across the cloth. During weaving, these coarse yarns are fed forwards at a slightly faster rate so that they form loops on the surface of the cloth at regular intervals down the fabric length.

Rep is a cloth made of silk, wool or cotton. It is woven with fine cords or ribs across the width of the piece. In silk it is used for dresses. In wool and cotton it is used for various upholstery purposes.

Organdie is a lightweight fabric which has been given a stiff transparent finish, usually by treatment with strong sulphuric acid. It is used for dresses and stiffening.

Gauze is a thin, translucent fabric with a loose open weave. It is sometimes used to make bandages.

Gingham is a plain-weave, lightweight cloth of nearly square construction woven with dyed yarns to form a check. It is commonly made from cotton and is used for such things as dresses and tablecloths.

Sateen is a cotton fabric with a satin-like finish, often found in bed sheets.

Coarse Weave is woven cloth with an open structure and raised texture.

Stiffened Net has an open weave similar to lace and has been treated to stiffen it.

Flannelette is a cotton imitation of traditional wool flannel. It is used for nightwear and sheets.

Velvet - a fabric in which the cut ends form the surface. Velvet is made from silk, but cotton can also be used, though this often results in a slightly less luxurious fabric.

Tapestry was originally a wool fabric used in furnishing, particularly wall hangings, having a design in colours produced by inserting relatively short lengths of coloured weft into a uniformly dyed warp. Cotton is now sometimes used.