

**COTTON** (Fr., Sp. *coton*, from Ar. *quṭn*, *quṭn*, cotton, from *qaṭana*, to inhabit). An important vegetable fibre, distinguished from all other fibres by the peculiar twist it possesses, which makes it exceedingly valuable for spinning. It is cultivated in those parts of the globe between the two thirty-fifth parallels of latitude (a region which contains the largest portion of the land surface of the globe), although its most profitable cultivation is between the twentieth and thirty-fifth parallels north of the equator. Within this belt lie the cotton districts of the United States, northern Mexico, Egypt, northern Africa, and Asia, except the extreme southern parts of India and the Malay Peninsula. South of the equator cotton is grown in Brazil, nearly all of which country is said to be favorably adapted to its cultivation; in Argentina; in Australia, though not to any great extent; in Africa, where efforts to extend its production are being made; and in the islands of the Pacific. Cotton is grown under wider range of climatic conditions, over a greater area, and by a greater variety and number of people, and is useful for a larger number of purposes, than any other fibre. Its cheapness and the extent of its production preclude the demand ever exceeding the supply except locally and temporarily. Although cotton is grown mainly for the fibre surrounding its seeds, its by-products, the seeds as a source of oil and cake, and also the fibre of the stalks, are of great importance. The cottonseed products of the United States in 1912 were valued at \$132,230,000. See COTTONSEED AND ITS PRODUCTS, and Colored Plate of FIBRE PLANTS in article HEMP.

**Botanical and Commercial Classifications.** The cotton of commerce is the product of a few species of *Gossypium*, a genus of the family Malvaceae, to which also belong the hollyhock, mallow, hibiscus, etc., as may be readily seen

by a comparison of their flowers. (For illustration, see Plate with article HEMP.) There are numerous species of *Gossypium*, only three or four of which are economically important. They are small trees, shrubs, or herbaceous plants, and in their duration are perennials, biennials, or annuals. The leaves of the cultivated species are three to seven, or even nine, lobed, and are more or less sprinkled with small black or pellucid dots. The flowers vary in color, are white or light yellow, with purple spots at base, and are usually borne singly in the axils of the leaves except in the "cluster" type, where a number occur together. At their bases the flowers are surrounded by three or more green heart-shaped bracts, which constitute the "squares." The fruit, known as the boll, is a three to five celled capsule, containing the numerous seeds, more or less covered with lint, which is white or tawny. All of the species are of tropical origin, yet their most successful cultivation is in temperate climates where there is a period of six months free from frosts and where there is an abundant and well-distributed rainfall throughout the growing season.

The botanical origin of plants that have long been in cultivation is always a source of perplexity, and the exact species to which the different varieties of cotton belong has been the subject of much controversy. By almost common consent it is now agreed that most of the cotton of commerce is the product of three or four species and their hybrids. These species are *Gossypium arboreum* and *Gossypium peruvianum*, arborescent species grown only in the tropics, *Gossypium barbadense*, the source of the celebrated Sea Island and Egyptian cottons, and *Gossypium herbaceum*, the species from which most of the crop of India is grown. The American upland cotton is believed to have originated from *Gossypium hirsutum*. There is perhaps no other plant that responds so quickly to changes in environment and improved cultivation, and to this are doubtless due the many varieties and species.

The Sea Island and Egyptian cottons, *Gossypium barbadense*, with their beautiful, long, and silky staple, are among the most valuable of the races or species of cotton. The flower is of a rich cream color, and its seeds are black, small, and easily separable from the lint. This species attains the highest perfection along the coast region of South Carolina, Georgia, and Florida, with well-known varieties grown under irrigation in Egypt from American seed. The fibre of Sea Island cotton averages about  $1\frac{3}{4}$  inches in length, with  $1\frac{1}{2}$  to  $2\frac{1}{2}$  as the extremes. It is adapted to the finest thread and lace work, and other products for which the short staple is not suited. The Egyptian varieties are usually a little shorter in staple and are of a tawny color. These are often used for the natural-colored balbriggan underwear, hosiery, etc., where a smooth finish and silky lustre are desired. The cultivation of Sea Island cotton is highly developed, and the United States crop of 1912 was 73,777 bales of 382 pounds each. The value of the Sea Island cotton crop is about  $5\frac{1}{2}$  million dollars annually. The Department of Agriculture has in recent years imported a quantity of seed of the Egyptian cotton and by a series of experiments demonstrated the feasibility of its production. The quantity of Egyptian cotton imported in 1913

was approximately 100 million pounds, valued at about \$20,000,000. Most of this comes direct from Egypt, but a small part from England.

The upland cotton of the United States is mostly derived from *Gossypium hirsutum*. In this country the varieties of this species have white flowers, which turn red the second day after opening. The fibre of this series is shorter, but the plant can be cultivated over a much greater extent of territory than the others. The seed of the upland varieties is usually of a greenish color and has a closely adherent gray fuzz in addition to the longer lint, making the process of ginning more difficult. There are doubtless many hybrids between these series, as may be seen in the character of some upland cottons. In 1896 descriptions were published in the United States Department of Agriculture, Office of Experiment Stations, *Bulletin 33*, of more than 130 varieties of cotton in cultivation in the United States at that time, together with about an equal number of so-called varieties which were only old ones renamed. Most of these varieties were upland cottons, and they varied widely in their production and character of lint. *Gossypium arboreum* is a small tree rather common about the temples of India and China, and also grows wild in Abyssinia and Senegal, but it is said never to be cultivated as a regular crop. The trees are rather short-lived, and they yield a fine, silky fibre an inch or more in length. This is called Nurma or Deo cotton and is little used except by the priestly class. It is probable that its value has been overrated. It will not mature in the United States. The origin of the cottons supposed to be derived from *Gossypium peruvianum* is somewhat in doubt. They are South American, as their name would indicate, and their smooth black seeds adhere in a reniform mass, hence the name "kidney cotton," which is usually applied to them. Their fibre is strong, rather coarse and woolly,  $1\frac{1}{2}$  inches or less in length, and from its great resemblance to wool is frequently used in combination with that staple. About  $4\frac{1}{2}$  million pounds, valued at nearly \$1,000,000, are annually imported into the United States, and it is claimed that most of it is used by woolen manufacturers to mix in making underwear, hosiery, etc., much of the material being sold as all-woolen goods.

In *commercial usage*, to fibres under 0.98 inch, or 25 millimeters, in length there has been given the name "short staple"; "medium" means from 0.98 to 1.17 inches (25 to 30 millimeters), and "long," 1.18 to 1.57 inches (30 to 40 millimeters); "extra," including those which are 1.58 inches (40 millimeters) or more. The extra and the long in the United States seem to come from Sea Island cotton or some of its hybrids; the short and medium from *Gossypium hirsutum*.

The commercial classification of cotton in New York is as follows: The "full grades" are fair, middling fair, good middling, middling, low middling, good ordinary, and ordinary. Half grades are designated by the prefix "strict," quarter grades by prefixes "barely," meaning the point above half grade and the next full grade above, and "fully," meaning the mean point between the half grade and the next full grade below. Liverpool high grades are lower, and low grades higher, than New York. Acting under authorization from Congress, the United States Department of Agriculture established

nine grades of cotton based on middling cotton. They are: middling fair, strict middling, good middling, strict good middling, middling, strict low middling, low middling, strict good ordinary, and good ordinary. Standard sets of these grades have been prepared, and they have been officially adopted by the leading cotton exchanges of this country.

**Cultivation.** The plant requires for its best development a peculiar soil and climate. While the method of cultivation is about the same in the various countries where it is grown, that in the United States is the most perfect. Although the plant is not really an annual, and in the tropics it can be grown as a perennial, yet it is treated as an annual in its cultivation in most countries. The land is prepared in winter or early spring, the time of beginning varying with the locality. After thorough plowing, and after all frost has gone, the ground is bedded into rows from 3 to 4 feet wide, according to situation and the quality of the soil; the seed is sown along the centre of these beds, either in a straight furrow made with a small plow or opener, or in holes 12 to 18 inches apart. Flat culture is also used. Where artificial fertilizers or cottonseed meal is drilled in, this method of preparation is indispensable. The usual date to begin preparing land is from January 15 in southern Texas to March 5 in South Carolina. Sowing usually commences March 10 to April 15 and continues to May 15; but late spring frosts may delay it longer. The young shoots, which appear in from 10 to 15 days, are weeded and thinned when they have attained a height of 2 to 6 inches, say, when the third or first true leaf appears. The average date of bloom is June 5. As a general rule, cotton is a dry-weather plant, heavy rainfall interfering with both the culture and the stand, although an extremely dry spring interferes with the growth. For plowing it is best to have just enough rain to make the soil moist and spongy. When young, the crop flourishes best with warm steamy weather, with an occasional shower until blooming. An excess of rain produces weeds and wood; severe drought stunts the plant, matures it too early, and causes a small light-stapled crop. Early frost causes the plant to turn brown; cold nights cause many of the plants to die. Lands in hilly or upland districts require more moisture than those lying in the plains and river bottoms. Overflowing often causes injury on bottom and flat prairie lands, but replanting or recuperation often redeems the most hopeless cases. Where, however, overflowing causes "sanding," the land is rendered utterly useless for cotton culture that year. The experiment stations in the Southern States have aided in introducing improved methods of cultivating, fertilizing, and handling the crop. Rotation of crops and green manuring have been shown to be of great advantage. From the date of bloom, warm, dry weather is needful, until picking time, which usually commences from July 10 in southern Texas up to September 10 in Tennessee, and continues until frost puts a stop to further growth. During the harvest all available hands are called into full employment. The cotton is gathered into baskets or bags hung from the shoulders of the pickers, and as the crop is secured it is either sent directly to the gin or dried, and then the fibre separated from the seeds. Recent investigations have

shown the quality of the fibre is improved by storing cotton for a time before ginning. For long-staple or Sea Island cotton in South Carolina the usual date to begin preparing land is February 1; planting begins April 1 and ends May 1; picking is from August 25 to December 10.

The occurrence of the cotton-boll weevil over much of the cotton area has caused some modification in the growing of the crop. Clean cultivation, earlier planting, wider spacing, and the use of early maturing varieties are recommended for infested regions.

**Insect Enemies of the Cotton Plant.** See COTTON INSECTS.

**Cotton Diseases.** There are a number of well-characterized diseases of the cotton plant, some of which are due to disturbances in the nutrition of the plant, others are caused by fungus attacks, while still others are attributed to the presence of minute worms, called "nematodes," in the roots. Attention to the requirements of the plants will correct the first class of diseases. For the fungus troubles but little in the way of prevention is known. Among the most important diseases due to physiological causes are those known as the "mosaic disease," or "yellow leaf blight," and the shedding of bolls. In the first, small areas of the leaves become yellow, giving to the leaf a peculiar checkered appearance. Later these areas turn brown and dry up, leaving the leaf in a more or less ragged condition. At this stage the disease is usually referred to as the "black rust." Heavy applications of kainite or similar fertilizer are said to correct this evil. The shedding of the bolls, or their drying up while still attached to the plant, is often a serious trouble. Extreme dry or wet weather causes this disease by interfering with the proper supply of moisture and nutriment furnished the plant through its roots. Among the diseases due to parasitic fungi a few of the most serious and widely distributed may be mentioned. Damping off, sore shin, or seedling rot is caused by *Pythium debaryanum* and a number of other fungi. They attack the young plants at or near the surface of the ground, producing ulcer-like spots, and later rot the plant off. The sunken, ulcer-like spots can be readily seen on the affected stems. Another common disease is anthracnose (q.v.), due to *Glomerella*, or *Colletotrichum gossypii*. It is a widely distributed fungus that attacks the bolls, stems, and leaves, and is probably the most destructive of cotton diseases. Upon the bolls small reddish spots appear which later become black. The centre then becomes gray or pink, and the spots enlarge in a concentric manner with well-marked zones of color. The boll is killed outright or has its development checked so that the lint is worthless. Upon the stems the fungus is somewhat similar in its behavior, although the spots are not quite so definitely marked. Upon the leaves the disease is not very well characterized. Cotton anthracnose is carried with the seed, and it may be prevented by the use of good seed and rotation of crops. A root rot is very destructive in some places. Its behavior is so marked as to need no description. It is due to a rather widely distributed fungus that has been called *Ozonium auricomum*. It attacks a number of plants in addition to cotton. Rotation of crops is about the only method of relief known. A leaf blight (*Sphaerella gossypina*) and a mil-

dew (*Ramularia areola*) are common diseases in the cotton field, but they seldom occasion much injury.

Another of the serious fungus diseases to which the cotton plant is subject is the wilt disease. It makes its appearance usually in May, when the plants are 6 or 8 inches high. The plants are dwarfed, have an unhealthy appearance, the leaves turn yellow between the veins, and their margins dry up. Sometimes plants wilt and die at once, while at other times the progress of the disease is slower and the plant may partly recover. A plant attacked by this disease will show a brownish stained color in the wood when cut across. The cause of the trouble is a fungus, *Fusarium vasinfectum*, and the same or a closely related form occurs on the okra and watermelon. Some varieties and individual plants seem less liable to this disease, which attacks the plants through the soil, and it is thought the means for overcoming this trouble lies in resistant plants. This disease, as well as some others, is very much complicated by the presence in the roots of the cotton of nematodes (*Heterodera radicola*), minute worms that enter the roots of cotton and a number of other plants, causing a large number of galls to be formed. The plant is injured by the nourishment being taken from other parts of the plant to make the galls. This weakens the plant so that it is more liable to fungus attack. When nematodes occur in abundance in the field, no entirely efficient means of eradication is known as yet.

**Production and Distribution.** The oldest-known cotton-producing country is India, where for 30 centuries the plant has been grown and its fibre manufactured. For 400 years before the Christian era cotton was well known in what was then the civilized world, the writings of the Greeks and Egyptians plainly indicating the knowledge of the value of this fibre. Columbus found it in the Western world, although not so extensively cultivated as in the East; but during the past 50 years its culture here has distanced in quantity and in quality the produce of the Old World. Down to 1800 the cotton consumers of Europe depended upon the Indies and the Levant for their raw material; but by 1860, so far had the inventive genius, the superior farming, and the greater energy of the planters of our Southern States pushed the production of the fibre, that they furnished the greater part of the cotton used by Great Britain and the continent of Europe. From 1858 to 1860 America furnished 79 per cent of the cotton imported into Great Britain. During our Civil War this dropped to 3½ per cent, rising to 58 per cent in 1871, and amounting to 80 per cent in 1900 and 62.8 per cent in 1912. During the Civil War, when the price of cotton was abnormally high, attempts were made to grow cotton in many countries. The industry flourished there for a while, but it has ceased to be profitable in Europe, Australia, etc. Russia in her Asiatic possessions has developed cotton growing greatly in recent years, so that the imports into the Empire have fallen off 50 per cent in the past decade. Great Britain, Germany, and France are making especial efforts to develop cotton growing in Africa, and in 1912 nearly 60,000 bales were produced in their colonies, mostly in Africa.

**Cotton Production of the World.** This is difficult to state except approximately, as a large

proportion and amount consumed is produced in uncivilized or in semicivilized countries, where no accurate record is kept; and in many countries and districts absolutely no data are available—as in China, where soil and climate are favorable and the clothing of the population is largely of cotton, yet the extent of its cultivation is a close secret; and in some parts of India, where the production can be estimated only by the amount in sight and the known or assumed requirements for dress. The amount produced in the vast unknown continent of Africa is even more of a mystery, although native cottons form there a large proportion of the dress.

The world's production of cotton has increased more rapidly in recent years than that of any other of the chief materials of clothing, wool, silk, or flax, and the growth in world consumption has been far greater than that of population. The total cotton production of the world in 1850 was approximately 3 million bales, in 1900, 12½ million, and in the cotton year 1911-12, 25 million, the production of 1912 being practically double that of 1900 and fully eight times that of 1850. As the world population increased but about 50 per cent from 1850 to 1912, while cotton production increased 700 per cent and that of wool about 200 per cent, it is apparent that the popularity of cotton as an article of clothing has greatly increased.

**Cotton in the United States.** The first authentic record of cotton cultivation in the United States was at Jamestown, Va., in 1607. The first exportation was in 1747, when eight bags were sent to England, the first shipment of any importance being 2000 pounds in 1770. In 1791, 189,316 pounds were exported; Whitney's invention of the saw gin in 1793 raised this amount to 17,789,803 pounds by 1800. The production reached 1,920,000,000 pounds in 1860; 3,178,000,000 in 1880; 5,133,000,000 in 1900; 6,840,000,000 in 1904; and 7,157,000,000 in 1912. Cheapening the processes of cultivation and cleaning, and increase of acreage, have so lowered the cost of the fibre that while the average price in Liverpool was ls. 6d. (say,

of a million in 1864, against 4½ millions in 1861. In 1867 there was a decline from the high prices consequent upon the Civil War to 7¾d. (14¾ cents), but in a few months it reached 1s. 1d. (26 cents). In 1890 it ranged from 5½d. to 6¾d. in Liverpool, and from 10¼ cents to 12¾ cents in New York. From 1891 to 1901 prices were low, falling to an annual average of 5.94 cents per pound in New York in 1898, advancing to 11.18 cents per pound in 1911 and an annual average of 15.11 cents per pound in 1910—the highest record since 1875. In 1912 the average price of middling cotton in New York was 11.52 cents and in 1914 about 12.4 cents.

The acreage and yield of cotton, including linters, for the season of 1912, as reported by the United States Bureau of the Census, were as follows:

STATE	Acres	Running Bales
Alabama.....	3,730,000	1,367,136
Arkansas.....	1,991,000	805,021
Florida.....	224,000	60,248
Georgia.....	5,335,000	1,888,963
Louisiana.....	929,000	392,720
Mississippi.....	2,889,000	1,049,604
North Carolina.....	1,545,000	935,080
Oklahoma.....	2,665,000	1,057,125
South Carolina.....	2,695,000	1,259,672
Tennessee.....	783,000	289,731
Texas.....	11,338,000	4,888,623
All others.....	159,000	96,850
Total.....	34,283,000	14,090,863

The accompanying Table No. 1, taken from *Bulletin No. 116, United States Census Bureau*, gives the cotton crop in the United States by States, according to censuses of 1870, 1880, 1890, 1900, and 1910 for the crops of the preceding year. The bale measurement of 1910 was 502.6 pounds; in 1890 it was 477 pounds; in 1880 it was 433 pounds; in 1870 it was 440 pounds. The early settlers north of the Ohio River planted cotton for domestic uses between 1749 and 1780. The census for 1860 gave for Illinois 1482 bales, or 659,490 pounds, of cotton.

TABLE I

COTTON GROWN IN THE UNITED STATES IN THE YEARS 1869, 1879, 1889, 1899, AND 1909 IN BALES

STATE	1869	1879	1889	1899	1909
Alabama.....	429,482	699,654	915,210	1,095,329	1,065,377
Arkansas.....	247,968	608,256	691,494	711,739	718,117
Florida.....	39,789	54,997	57,928	56,875	62,936
Georgia.....	473,934	814,441	1,191,846	1,300,184	1,901,830
Louisiana.....	350,832	508,569	659,180	713,929	269,573
Mississippi.....	564,938	963,111	1,154,725	1,257,772	1,109,580
North Carolina.....	144,935	389,598	336,261	477,070	649,886
Oklahoma*	224,500	17,000	34,540	212,010	573,786
South Carolina.....	224,500	522,548	747,190	881,192	1,164,309
Tennessee.....	181,842	330,621	190,579	215,668	253,397
Texas.....	350,628	805,284	1,471,242	2,556,413	2,554,520
All others.....	3,148	41,280	22,326	29,605	62,898
Total.....	3,011,996	5,755,359	7,472,511	9,507,786	10,386,209

\* Includes Indian Territory.

36 cents) per pound in 1793, it was 5¾d. (say, 11½ cents) in 1851; averaging 7d. (14 cents) for the five years ending 1861. During the period of the Civil War in the United States the prices were very high owing to the small production, the quantity produced being less than half a million bales in 1863 and but about one-fourth

Among the States classed as "all others" are Missouri, Virginia, California, Kansas, Arizona, all of which are producing cotton in commercial amounts, and a number of other States where its cultivation as a crop has been abandoned. Stimulated by the high prices following the Civil War, the cultivation of cotton was con-

ducted to a limited extent in California, Illinois, Indiana, Nevada, Utah, and West Virginia. With the coming of low prices cotton culture gradually disappeared from those sections not peculiarly adapted to it, and censuses after 1870 credited none to Illinois, Indiana, Nevada, Utah, or West Virginia. Natural selection continues to eliminate the industry from sections less favored by climatic conditions. To illustrate: Kentucky is credited by the censuses of 1880 and 1890 with 1367 and 873 bales respectively, but the census of 1900 finds in this State only 84 commercial bales. The loss in those States lying along the northern border of the cotton belt is more than offset by the increase found in the territory west and southwest of the Mississippi River. According to the eleventh census 2,872,524 bales, or 38 per cent of the entire American crop of 1889, was grown in that region, while in the census of 1900, in the same territory, the production reached 4,250,940 bales, or 45 per cent of the whole crop. In 1912 the States of Arkansas, Louisiana, Oklahoma, and Texas, all west of the Mississippi River, produced 7,169,604 bales, or 52.3 per cent of the entire crop.

The exports of cotton from the United States averaged less than 2 billion pounds per annum in the decade ending with 1880, and between 2 and 3 billions per year up to 1895. During the next decade the exports averaged over 3 billion pounds per annum, and from 1907 to 1914 averaged over 4 billion pounds per annum, the quantity exported in the fiscal year 1911 being 5,535,125,000 pounds, the high record up to that date, and in 1913 was 4,562,926,000 pounds. The high record in value of exports was in 1911, being \$585,318,869, that of 1913 being \$547,357,195. The exports to the principal countries in 1913 were to Great Britain, \$224,783,457; Germany, \$144,175,157; France, \$64,137,024; Italy, \$30,169,663; and Japan, \$25,022,050. The imports of cotton for 1913 were valued at \$22,987,318, of which \$18,753,197 was imported direct from Egypt, and between one and two million dollars' worth of Egyptian cotton from England. For the same fiscal year the exports of cotton goods were valued at \$53,743,977, and the imports at \$66,065,857, of which \$35,776,301 was laces, embroideries, and other articles of this character.

The amount of cotton consumed by all the mills in the world for the year ending Aug. 31, 1913, was approximately 21,000,000 bales. At the same date there were 30,590,553 active spindles in the United States, 11,971,092 of which were in the cotton-producing States and 18,619,461 in all other States. The consumption of domestic cotton in the United States for the above period was 5,786,061 bales. About one-third of the cotton grown in the United States is consumed in domestic manufactures, and about two-thirds is exported, chiefly to Europe.

**Manufacture.** The process of transforming cotton from its raw condition into the thread or cloth that is such an essential of daily life is one which involves many different operations. It must first be cleaned to remove sand, dust, and other foreign substances. It then contains about two-thirds of its weight in seeds, which must be removed.

**Cotton Ginning.**—Before Eli Whitney's invention of the cotton gin, the removal of the seeds by hand was so difficult a task that very little cotton was raised. It would take one person

two years to turn out an average bale of cotton 3 to 15 of which are produced by one machine in one day. Before the Civil War the gins were run chiefly by mule power, which, when operated in connection with slave labor, was cheaper than steam. Whitney's cotton gin, known as the saw gin, may be briefly described as a series of circular saws with fine teeth, revolving with an arc of their circumference projecting through a guide into a receptacle for seed cotton. These saws tear the lint from the seed and carry it through the guide. It is removed from the saws by a brush and carried to a condenser. Great care must be exercised not to injure the cotton (1) by having the saws too close to the bars of the grate, so as to rub, (2) by having them revolve too fast, or (3) by having the teeth too sharp. The roller gin is growing in favor among cotton producers, especially for the long-staple or Sea Island cotton, and in the United States and Egypt all long-staple cotton is ginned in this way. It removes the seed with only one-fifth the rapidity of the saw gin, but it does not injure the fibre. In a primitive form it has been used in Egypt and India for many centuries. It consists of two rollers, revolving in opposite directions, between which the cotton is passed and the smooth, hard seeds thrown off. Both the saw gin and roller gin have been much modified and their effectiveness increased by successive improvements.

In 1912 there were 28,358 ginneries in the United States, 25,279 of which were reported as active by the Census Bureau. The average outturn was 535 bales, a somewhat lower average than that of 1911, but a decided increase over the average for the preceding five years. The number of idle ginneries was 3079, or 203 more than in 1911. While the crop of 1912 was somewhat less than that of 1911, yet it would seem from the steady increase in the number of idle gins that the process of ginning is being gradually concentrated in the larger establishments.

In *Bulletin No. 58*, on Cotton Ginning, Twelfth United States Census, Daniel C. Roper divides cotton ginneries into three general classes: Those conducted exclusively for the public, those conducted exclusively for the plantation, and those conducted for both the public and plantation. The *Bulletin* states that "the rapidity with which the private or plantation ginneries have been supplanted by public and more modern equipments is noteworthy. Through inquiries of the census of 1880, covering the power and machinery of cotton-ginning establishments, it was ascertained that a large percentage of the crop of 1879 was handled by ginneries of a private character. The motive power of these ginning and baling plants consisted of horses or mules, and each had a daily capacity of from three to five bales. The general introduction of steam power brought economic methods that have crowded out primitive horse ginneries to such an extent that they are now curiosities."

**Baling.**—The cotton having been separated from the seed, the next step is to pack it in bales for shipment. Different methods of baling prevail among the cotton-producing countries. The American product, as put up in the old-fashioned tortoise-back bales, has the reputation of being the worst-baled cotton in the world. East Indian cotton is shipped in cubical

bales, weighing about 400 pounds, covered with thick Indian hemp and held together with strong iron bands. The Egyptian bale weighs about 700 pounds, is a little thicker and not so long as the American, and has 11, instead of 7 or 8, bands around it. Brazilian cotton comes in very light bales, weighing only 200 pounds, which are tied with trailing vines. In the cotton States of America the cotton which is not consumed by the Southern mills is shipped to the exporting city by rail, steamboat, or wagon. It is there graded by the exporter, who fastens a tag to each bale and also to a sample taken from it. It is from these labeled samples that the foreign manufacturer makes his purchases. The bales are then subjected to enormous pressure, usually by the transportation company, to reduce the size of the export bale, a standard bale weighing 500 pounds. During its progress from the farm to the factory a bale of cotton is given a series of brands, by the farmer and the ginnery, as well as the exporter, so that fraud can easily be traced. One of the objections to the American baling methods, however, is that the covering becomes so torn that the marks on it cannot be deciphered.

The manner in which American cotton is generally baled and pressed for transportation to the markets and mills is not only needlessly expensive and wasteful, but fails to protect the cotton from damage and theft. The bales are covered with jute cloth, made of thread so coarse and loosely woven that, while it adds unnecessarily to the weight of the bale, it does not protect the cotton. The bales are held together by steel bands, which still further increase the weight. The weight of the bagging and ties on a bale weighing 500 pounds is about 23 pounds. Besides the increased freight rates due to this bulky method of baling, the necessity of a second pressing, and the bad condition in which the cotton reaches the factory, a more grave defect is its excessive inflammability, resulting in high insurance charges. So great is this risk that on some passenger steamers cotton is not carried, on account of the danger of fire. An illustration of this danger was afforded by the terrible fire which occurred on the docks of the North German Lloyd Steamship Company at Hoboken, N. J., on June 30, 1900. The fire started in some unknown manner in a lot of cotton bales and spread with such rapidity that efforts to check it were unavailing. The loss of property caused by this cotton fire has been estimated variously at from \$4,000,000 to \$6,000,000, and the loss of life was about 200 persons.

Some years ago a cylindrical bale was devised that is made directly from the gin. This seemed to meet with favor for a time, but the census reports show a diminishing number of round bales, only 99,916 such bales being reported for the crop of 1913. The American Cotton Company makes a bale 4 feet long and 2 feet in diameter, weighing over 35 pounds per cubic foot. The cotton is pressed gradually, so as not to injure the fibre, and is in the form of a continuous lap or roll. Since the air is pressed out of the cotton, it has no tendency to expand, and the covering is only sufficient to keep the cotton clean. The heavy bagging and ties are entirely dispensed with. The cotton is compressed as fast as ginned and is shipped direct from the ginhouse to the warehouse or mill. The cylin-

drical bale of the Planters' Compress Company is 36 inches long, 18 inches in diameter, and weighs 250 pounds. This bale is held together by wires passing from end to end through a small opening in the centre. It is covered with cotton duck, and the weight of the cloth and wire is about three pounds per bale. Most satisfactory tests have been made with each of these types of bales, showing that they are both fire and water proof. The other objections to the old-fashioned methods of baling are also met by the cylindrical bales described. The reason for the failure of the round bale to be more widely adopted is not evident.

*Spinning.*—When the cotton bales are received at the factory, the cotton from the different bales is first mixed in order that the yarn produced may be of uniform quality. It is next submitted to a process of opening and picking that loosens the fibres which became closely packed together when the bale was pressed. Then follow the processes of *carding*, *drawing*, *slubbing*, *roving*, *spinning*, and *doubling*, by which the cotton fibre is reduced by successive stages from a web or sheet into cotton yarn. The process of carding is described under that title. Its object, besides cleaning the cotton of any foreign substances still adhering, is to reduce the lap into a thin fleece and then contract it into a ribbon or sliver. The sliver, after being doubled so that inequalities in the single slivers are counter-balanced, is put through a drawing machine, consisting of successive pairs of rollers, each of which revolves more rapidly than the preceding one, and which reduces the sliver to a finer and finer thread. By slubbing and roving, the process of attenuation is continued, the thread in each case taking the name of the machine through which it has just passed. The thread is also twisted, and when it leaves the roving machine it is strong enough to be wound on a bobbin. Spinning is the concluding process, and in this the thread is given the requisite firmness and twist. Doubling is the combining of two or more threads into a single cord. Every step in the manufacture of cotton yarn has for its object (1) the removal of finer and finer impurities, (2) the attenuation and strengthening of the thread, (3) correcting the mistakes of the preceding process. The whole process is described in more detail in the article SPINNING.

The thread may be subjected to the additional processes of *gassing* and *polishing*. The object of gassing is to singe off all the loose fibres and so produce a very smooth yarn. This is accomplished by passing the thread through a very fine jet of gas, as it is wound from one bobbin to another. The yarn is polished by applying a sizing made of starch, beeswax, or other materials. This not only gives the yarn a gloss, but increases its strength and weight. The process of weaving cotton into cloth does not differ materially from that of silk and wool and is treated in the article WEAVING.

The bulk of the world's cotton is shipped into foreign countries and often across the ocean twice—once to the factories to be transformed into yarn and cloth, and again, perhaps, back to the very region where it was first raised, in the form of cotton goods. The best example of this fact is offered by the United States, which raises nearly three-fourths of the world's cotton, yet in 1911 exported less cotton goods, measured by values, than the Republic of Swit-

zerland, which raises not a pound of cotton and has not even a seaport. Of course the United States is an enormous consumer of cotton, one-third of its large crop being consumed by its own mills, and this fact must be remembered in considering the extent of her export trade. Obviously the amount of cotton goods imported,

It is interesting to note that this enormous industry is concentrated about Lancashire, in a district whose area is about 50 per cent greater than that of the State of Rhode Island. In the United States the most marked development is the relative importance of Southern factories, situated in the very locality where cotton is produced. Since 1890 the number of spindles has greatly increased and now more than one-third of the whole number in the country are in the cotton-producing States. The number in the Southern States grew from 4,368,000 in 1900 to 11,583,000 in 1912, while those in the Northern States only increased from 15,104,000 to 18,996,000 in 1912. Other industrial conditions besides the nearness to the cotton crop produced this growth, chief of which has been the general industrial awakening experienced by the South. Capital, however, in this section, has shown greater progress than labor, so that the latter is still cheap; a working day is long, and there are comparatively few labor laws restricting the age, sex, and other conditions of labor.

TABLE II  
VALUE OF THE WORLD'S EXPORTS OF COTTON  
GOODS BY COUNTRIES

(From Bureau of Census Bulletins, 106, 110, 115, and 115)

COUNTRY	1909	1910	1911
Austria-Hungary	\$13,257,962	.....	\$18,153,373
Belgium	54,004,530	.....	62,367,303
France	64,619,295	\$63,768,744	67,789,127
Germany	95,524,870	103,466,692	114,108,624
Great Britain	558,269,108	515,222,235	595,584,160
Italy	25,646,333	.....	42,003,541
Netherlands	16,116,466	26,369,009	.....
Russia	10,689,328	13,155,995	.....
Switzerland	52,967,250	.....	52,206,307
United States	31,878,566	33,398,672	40,851,918
British India	37,428,252	40,216,450	48,478,362
Japan	29,260,177	38,446,485	34,049,000

and the amount produced and consumed at home, are also important factors.

Table II gives the value of the world's export trade in cotton, by countries, for 1909, 1910, and 1911. The table is compiled from *Bureau of Census Bulletins*. Of more value, however, as showing the actual extent of the cotton

In 1909, according to the census report, there were in the United States 1324 establishments engaged in the manufacture of cotton goods. The materials used cost \$371,009,000 and the manufactured products were valued at \$628,392,000. There were 387,771 persons engaged in these industries and the wages paid in 1909 were \$132,859,000 against \$66,025,000 in 1889, having thus doubled in 20 years.

During the closing years of the nineteenth

TABLE III  
NUMBER OF SPINDLES IN COTTON MILLS

SEASON OF	Great Britain	Continental Europe	Northern United States	Southern United States	Total United States	India
1889-90	43,750,000	25,460,000	12,800,000	1,605,000	14,405,000	3,274,000
1899-1900	45,500,000	33,000,000	14,400,000	4,700,000	19,100,000	4,945,000
1909-10	53,729,000	40,190,000	17,770,000	10,490,000	28,226,000	6,053,000
1912-13	55,576,000	43,400,000	18,700,000	11,700,000	30,500,000	6,400,000

industry, including both home and foreign consumption, and its geographical tendencies as well, are the Tables III and IV, showing the number of cotton mills and spindles, the amount consumed, and the value of the output. By studying these tables certain facts and tendencies in the cotton trade are apparent. Great Britain is and for many years has been at the head of the cotton-goods trade, both in the amount exported and in the actual amount produced.

century the manufacture of cotton was much advanced in China and Japan. In China cotton has been made into cloth since 1260, and for four centuries it usurped the place of silk. Steam power was introduced into Chinese cotton factories in 1865-67 and into Japan in 1889. Great difficulty has been experienced in both China and Japan in getting laborers. There is no factory legislation in either country limiting the hours of labor, and in China children

TABLE IV  
COTTON CONSUMPTION OF THE WORLD, IN 500-POUND BALES

YEAR	Great Britain	Continent of Europe	United States	India	All Others	Total World
1889-90	3,227,000	3,432,000	2,185,000	791,000	.....	9,635,000
1899-1900	3,334,000	4,576,000	3,856,000	980,000	789,000	13,535,000
1900-1	3,269,000	4,576,000	3,727,000	1,060,000	784,000	13,416,000
1901-2	3,253,000	4,836,000	4,037,000	1,384,000	905,000	14,415,000
1902-3	3,185,000	5,148,000	4,015,000	1,364,000	766,000	14,478,000
1903-4	3,017,000	5,148,000	3,908,000	1,368,000	869,000	14,310,000
1904-5	3,620,000	5,148,000	4,310,000	1,474,000	1,060,000	15,612,000
1905-6	3,774,000	5,252,000	4,726,000	1,586,000	1,097,000	16,435,000
1906-7	3,892,000	5,460,000	4,950,000	1,552,000	1,145,000	16,999,000
1907-8	3,690,000	5,720,000	4,227,000	1,561,000	1,083,000	16,281,000
1908-9	3,720,000	5,720,000	4,912,000	1,653,000	1,159,000	17,164,000
1909-10	3,175,000	5,460,000	4,533,000	1,517,000	1,304,000	15,989,000
1910-11	3,776,000	5,460,000	4,485,000	1,494,000	1,400,000	16,615,000
1911-12	4,160,000	5,720,000	5,211,000	1,600,000	1,788,000	18,479,000

begin to work at a very early age. The working day is 11 or more hours long, and the factories run seven days in the week. Labor is also very cheap, as estimated by the amount of money paid for a day's work, which averages from 10 to 15 cents; but the standard of intelligence and faithfulness among operatives is so low that, measured by the amount and quality of the product, the real cost of labor is high. In Japan it is particularly hard to keep steady employees. The girls are used to the freedom and out-of-door life of the country and will not stay long at their situations, so that mill operators are constantly hampered with green hands. In Japan the weaving of cotton and other fabrics is still largely a household industry. In 1896, according to the French Consul at Yokohama, 660,408 dwellings or establishments contained 949,123 looms, at which 1,043,866 persons were engaged in weaving. The yarn used in this household art is largely factory spun, thus increasing rather than diminishing the demand for cotton factories.

The preceding Table IV, compiled from various sources, shows the cotton consumption of the world for a number of years. In China most of the cotton cloth made is produced by hand labor, in part from yarns made by the Chinese mills, and in part from yarns imported from India and Japan. The cotton mills of China up to 1905 produced only yarn, but since that time have begun the manufacture of cloth.

Japan had 200,000 spindles in operation in 1889; 1,358,125 spindles in 1899; and 2,192,000 in 1912. Japan consumed 99,375 bales of cotton in 1890; 644,818 bales in 1898; and 1,190,000 bales in 1912. China had 570,000 spindles in operation in 1899 and 831,000 in 1912. It is estimated that on July 1, 1900, the world's working spindles numbered 105,000,000, and 140,996,000 in 1912.

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