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Discover
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Update on Cotton Production Research

Index

100% of 100 Facts About Cotton

1. Cotton plays an important role in our lives. We are rarely very far away from something made of or containing cotton. In clothing, linens, furniture, mattresses, vehicles, dollar bills and much more, cotton is always around us.
2. Cotton is the most abundantly produced natural fiber in the world. Over 82 million tons of textile fibers were consumed in 2013, of which cotton accounted for 30%, chemical fibers, 68.6% and all other natural fibers less than 2%. In 2013, cotton represented 96% of all natural fibers consumed at the mill use level.
3. Cotton can absorb water up to 27 times its own weight and can be weaved into any desired density. This quality also enables cotton fabric to be dyed easily, offering designers the flexibility of making a wide variety of products.
4. It estimated that the following quantities of cotton are required to make the following 100% cotton items: one pair of jeans, 0.68 kg; one dress shirt, 0.28 kg; one T-shirt, 0.23 kg; one diaper, 0.07 kg; and one bath towel, 0.28 kg.
5. The Consultative Group on International Agriculture Research (CGIAR) has a chain of international research centers working on food crops. Despite the fact that cotton provides food, animal feed and fiber, it is only categorized as a fiber crop. There are no other international research institutes or centers dedicated to cotton along the lines of the CGIAR centers.
6. The cotton plant is a perennial tree that has been domesticated to grow as an annual crop. Cotton is planted towards the end of spring, nourished during the summer and harvested in the fall. Natural acclimatization processes have impacted cotton throughout its history, but exactly when the specifically targeted domestication process actually got started is not known.
7. Cotton is currently planted in only a few tropical locations because many countries in Central America have had to abandon cotton production due to heavy infestation by insects, particularly the boll weevil *Anthonomus grandis*.
8. A few countries that are divided by the equator, such as Colombia and Kenya, have overlapping cotton-growing seasons: cotton is being planted in one region while it is being harvested in another.
9. Cotton belongs to the family Malvaceae and genus *Gossypium*. Some researchers claim that 51 species belonging to the genus *Gossypium* have been identified so far, while others affirm that there are 52 and that there are many more sub species. Of the known species, only four species are cultivated on a commercial scale and are referred to as the cultivated species.
10. Two of the cultivated species, *G. arboreum* and *G. herbaceum* are diploid, i.e. they have A and D genomes 2n = 26. They are mainly grown in Bangladesh, India, Myanmar and Pakistan on less than 1% of the world cotton area. Small quantities may also be produced in China, Iran and Thailand for indigenous uses. Sometimes they are also referred as Asiatic cottons.
11. The other two cultivated species are allotetraploid with AADD genomes, 2n = 56. *G. hirsutum* and *G. barbadense*, are grown respectively on about 96-97% and 2-3% of the world cotton area. The tetraploid cottons grown around the world are Upland, Egyptian, Sea Island, Tanguis and Pima. Only the Upland species is *G. hirsutum*. Egyptian, Sea Island, Tanguis and Pima cottons belong to the *G. barbadense* species.
12. The cotton plant is indeterminate in nature and can be grown all year round provided that suitable weather conditions exist for the plant to grow.
13. The cotton season may extend from less than 180 days to over 300 days. The Central Asian cotton producing countries, as a region, have one of the shortest growing seasons in the world. Low soil temperature does not allow early planting while low temperature cut out is eminent. Biotechnological research is currently under way to shrink the cotton-growing season to around 120 days.
14. The number of bolls formed on the plant is far below the number of fruiting points on the plant. Fruiting forms are shed as tiny flower buds, young flower buds, unfertilized flowers and bolls usually less than 10 days old. Short

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duration, heat tolerance, early maturity, and dwarf plants have helped to increase the productive bolls to fruiting points ratio.

15. The causes of fruit shedding are complex and impossible to be eliminated forever. There are physical causes, such as insect damage, physiological causes, such as genotypic interaction with growing conditions and chemical causes, such as hormone imbalance. No matter how suitable and perfect the growing conditions may be for fruit formation and growth, it is just not possible to retain each and every flower bud and convert it into a yielding boll.
16. Under optimum conditions cotton seeds planted in soil take less than a week to germinate. The optimum depth to plant cotton seed is 3-4 centimeters. Acid delinting of seed is on the increase in the world.
17. The cotton seed emerges from the soil with two cotyledonary leaves, which have a seed coat to protect them as they traverse the 3-4 centimeter distance. The cotyledonary leaves may be located directly opposite to one another or parallel to each other.
18. The cotyledonary leaves reach their maximum size soon after emerging from the soil. They cease to grow in size as the true leaves start to emerge. The cotyledonary leaves drop at about 40 days and within about 3-4 days of each other.
19. Cotyledonary leaves and true leaves vary in shape and size. The true leaves are 5-6 pointed and palmatedly lobed, while the cotyledonary leaves have the same width from base to the end and round corners.
20. The cotyledonary leaves, some times also called seed leaves or first green leaves, are always two in number and located either on opposite sides of the stem or parallel to each other. Cotyledonary leaves reach their maximum size in about 10 days.
21. The cotyledonary leaves form the first node on the main stem of the plant, which is considered to be 'node zero.' Node numbers are counted above the cotyledonary node. True or normal leaves grow in a spiral arrangement around the stem.
22. The number of true leaves corresponds to the number of branches (including empty nodes) plus fruiting points. The leaf axil on the plant gives rise to a branch, a sub-branch or a fruiting form.
23. Many flower buds are shed even before they become visible. The loss of buds, squares, flowers and bolls early in the season stimulates vegetative growth, thereby creating an imbalance between vegetative and reproductive growth that may result in lower yields.
24. Excessive vegetative growth may enhance the rate of bud formation but not necessarily yield. Lack of productive bolls on the plant certainly increases internodal length resulting in a tall and bushy plant.
25. Bud shedding followed by square shedding is a major impediment for obtaining more productive bolls. Flowers and bolls are rarely shed.
26. It is also reported that antioxidant polyphenols, polyenes and carotenoids are higher in drought tolerant varieties, an interesting clue toward the development of drought-tolerant varieties.
27. The cotton plant has a tap root system. The root could be 30 cm long in two weeks and one meter at the squaring stage.
28. The cotton plant has two types of branches, monopodial and sympodial, but some varieties of cotton may not have any monopodial branches.
29. Monopodial braches can only be the first branches to appear on the plant. Once a sympodial branch is formed, no more monopodial branches appear.
30. A white open flower takes 50-55 days to develop to the stage where white and harvestable lint is showing. Higher heat accelerates boll maturation but does not result in genetic improvement.
31. In nature, cotton lint exists in only three colors: white, various shades of brown, and green. A very light blue shade has been reported in Uzbekistan, but it has never been grown commercially. Color develops only after the boll opens and exposes the lint to interaction with sunlight.
32. The diverse shades of light to dark brown, are due to phenolics and tannin vacuoles in the lumen of the fiber cells.
33. Green color in the lint is due to the presence of caffeic and cinnamic acids in the wax content of the outer layer of the fibers.
34. The brown and green colors fade, but the green color has a greater tendency to fade after repeated washing.
35. Picking of *G. arboreum* cotton is easier because of the poor capacity of burrs to hold locks for many days after the boll is open. In *G. herbaceum* the locks are more firmly embedded in the boll.
36. *G. barbadense* and *G. hirsutum* are in between the two diploid species. *G. hirsutum* has varieties that are easier to pick by hand than others.
37. The two most frequently used mechanical picking systems are stripping and spindle. Strippers have rollers or mechanical brushes that remove entire bolls from the plant and carry along with them a lot of plant material i.e. leaves, burs and branches. Spindle pickers pull the cotton fiber from the open bolls using revolving barbed spindles that entwine the fibers and release them softly to be carried to the basket.
38. Almost 1/3 of the cotton produced in the world is mechanically picked. About 2/3 is picked by hand, but

increasing labor costs are forcing more countries to consider machine picking.

39. A normal healthy person can pick 25-30 kilograms of seedcotton in one day.

40. The first mechanical picker was developed in 1850, but machine pickers were not commercialized for almost another century, when International Harvester in the USA produced a dozen of them for their initial marketing attempt.

41. Machine picking was introduced in the USA in 1942 and all cotton in the USA has been picked by machine for many decades. Australia also uses 100% machine picking.

42. Most cotton picking in Argentina, Brazil, Colombia, Greece, Spain and Turkey is also mechanized.

43. Among the major cotton-producing countries, all cotton in China, India and Pakistan is picked by hand.

44. The amount of trash in seedcotton may vary from zero (in hand-picked cotton) to as much as more than 20% in machine-picked cotton. The probability of bringing in trash along with the seedcotton is significantly influenced by the weediness of the field, the hairiness of the leaves, the bushiness of a given variety, poor defoliation, poor maintenance of picking machines and the method of machine picking.

45. The product harvested from the cotton field is known as seedcotton, which is separated at a ginning mill into lint and cotton seed. The lint fraction accounts for 38-40% of the weight of seedcotton while the seeds make up about 2/3 of the seedcotton by weight. Seedcotton also caries unwanted trash that is inadvertently collected along with seedcotton.

46. In 1793, Eli Whitney invented the saw gin in order to improve efficiency. He received a patent for his technique in March 1794. Saw ginning made it possible to remove seeds from cotton fibers quickly and at lower cost than by manual removal of the lint. In the beginning, it was estimated that a single ginning machine could do the work of 50 laborers picking the seeds out by hand.

47. Later, much faster saw ginning machines were developed employing a greater number of saws and running at higher speed. The efficiency of roller gins has also improved greatly.

48. Lint is commercially sold in bales. Bale weights differ among countries due to variation in the pressing units. Under the conditions existing in cotton-producing countries today, it is totally unrealistic to expect uniform bale weight.

49. According to the study undertaken by the ICAC in 2008, Egypt produces the heaviest bales, weighing as much as 440 kg of lint. Cotton is repacked and baled in smaller sizes for export purposes.

50. Bale density also varies by country. In some countries, presses and pressures may vary from one gin to the next. Bale density is directly related to the amount of airspace inside the bale and the diffusion of air into and out of the bale. Lower density and greater amounts of air in the bale increases the risk of fire.

51. The recommended bale covering material is cotton. However, in some countries cotton continues to be packed in jute, plastic and polypropylene.

52. Bales are marked differently in various countries. The cotton industry is working toward a uniform bale identification system.

53. Dry fiber or lint is about 95% highly crystalline cellulose. The remaining 5% is typically composed of: protein (1.3%), pectic substances (1.2%), ash/minerals (1.2%), wax (0.6%), total sugars (0.3%) and other constituents (0.4%).

54. Over 50 million tons of cotton seed are produced annually, of which less than 1% is used to plant cotton. The rest goes to livestock feed as raw seed or is crushed to extract the oil.

55. In the USA, over two million tons of seed, almost half of the seed produced every year in the country, goes to crushing for oil. Linters account for about 11% on the gin run seed, of which around 8% is removed. The first cut amounts to about 18 kg/ton of seed and the second cut is about 55 kg per ton of seed. It is estimated that if all cotton seed produced in the world were processed to remove linters, over 3 million tons of linters, worth over US$700 million, would be produced on annual basis.

56. Cotton seed oil is trans-free because it does not contain linolenic acid and does not require hydrogenation. Its higher saturation and greater content of gamma- and delta-tocopherols make it more stable. Cotton seed oil does not impart its own flavor to food. (The Cotton Gin and Oil Mill Press, March 1, 2009)

57. According to the National Cotton seed Products Association of the United States, about 56% of the cotton seed oil consumed in the USA is used in salad dressings and cooking oil. About 36% goes into baking and frying fats, and a small percentage goes into margarine and other uses.

58. In its natural state, cotton seed oil has a light golden color and the level of refining certainly has an impact on the color. Technologies are being developed to add natural colors to cotton seed oil.

59. Non–species, non–cotton-plant genes may be successfully inserted into cotton with specific objectives and used for years without any deleterious effects on the cotton genome.

60. As of 2013/14, Argentina, Australia, Brazil, Burkina Faso, China, Colombia, India, Mexico, Myanmar,

Paraguay, Pakistan, South Africa, Sudan and USA have all commercialized biotech cotton. Australia, Mexico and the USA were the first countries to commercialize biotech cotton in 1996/97.

61. The first transgenic cotton varieties to have two independently acting insect resistant biotech genes were introduced in Australia and the USA in 2003.
62. Biotech cotton was planted on 23 million hectares or 68% of the world cotton area in 2012/13. In the same year, 72% of the cotton produced and 73% of the cotton traded internationally originated from biotech varieties, either insect-resistant or insect-resistant plus herbicide-tolerant.
63. Arthropods and a number of weeds have developed resistance to insect-resistant and herbicide-resistant biotech cotton respectively.
64. According to Cropnosis Ltd., plant protection chemicals worth US$56.3 billion were sold in the world in 2013. Herbicides accounted for 45%, insecticides 20%, fungicides 20% and seed care and specialized chemicals such as growth regulators/desiccants/defoliants, etc., accounted for 7%.
65. Cotton consumed 5.7% by value of all the plant protection chemicals sold in 2013.
66. Cotton used 16.5%, by value, of all insecticide sales in 2013.
67. Only 1% of the fungicide sales by value were used on cotton in 2013.
68. The share of pesticides (by value) used on cotton has declined from 11% in 1986 to the current level of 5.7%. This decline is expected to continue due to higher levels of awareness of the toxic effects of the chemicals used in agricultural production.
69. Sale by value of insecticides used on cotton declined significantly in the beginning of this century, from almost 19% in 2000 to 14.8% in 2010. In two of the five major cotton-producing countries, a specific pest brought about an increase in the share of insecticides used on cotton in the last two years to 18.7% in 2011 and 16.5% in 2013. No further increases in this share are expected.
70. The cotton boll weevil, also called Mexican boll weevil, *Anthonomus grandis,* is only a pest in the Americas. The boll weevil is also the most destructive pest in the Americas and no biotech cotton resistant to the boll weevil has yet been developed.
71. The Central American countries quit cotton production because of the inability to protect their crop from the boll weevil. Despite the fact that yields were still higher than the world average in some countries, insecticide use intensity increased to the point that it became uneconomical to continue producing cotton.
72. According to Weed Science Society of America, herbicide resistance is defined as “the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type.” Resistance to herbicides may occur naturally or may be induced by techniques such as genetic engineering or selection of variants produced by tissue culture or mutagenesis.
73. Tolerance or resistance to herbicides in cotton is so far only a transgenic feature of herbicide-tolerant biotech cotton.
74. Much has been published on many commonly occurring pests on cotton. The mealybug is a comparatively new pest on cotton. Lately, mealybugs have become a highly significant pest in India and Pakistan. Mealybug *Solenosis* trials in Australia have shown that mealybug damage is most common on the base of the leaf (where petiole and leaf blade meet) but it can affect the entire leaf, buds and bolls.
75. Mealybug eggs hatch in one hour: the nymphs take another 5-10 days to become adults and a further 5-7 days to start laying eggs.
76. The mealybug winters in the form of large and small nymphs under the soil within the root zone. Thus, cotton fields with a history of mealybug infestation are more likely to be affected by mealybug.
77. Cotton fiber length varies greatly among species and varieties. Among cultivated species, *G. barbadense* has the longest and finest fibers. The two diploids species *G. arboreum* and *G. herbaceum* have short and rough (high micronaire) fibers. The fourth cultivated species, *G. hirsutum,* has a wider range of fiber length (in excess of 25.4 mm or one inch), but is shorter than *G. barbadense*.
78. The cotton fiber, a tuberous outgrowth from the seed coat, is a single cell and the largest cell in the plant kingdom. The fibers grow in length after fertilization of an ovule and reach their maximum length in 16-25 days, depending on varieties and growing conditions.
79. Formation of the secondary wall begins before the fibers have grown to their full length.
80. The cotton fiber does not divide into cells under field conditions but the cells surrounding the hair (fiber and fuzz) forming cells on the ovule divide and multiply as a fertilized ovule grows into a seed.
81. All hairs formed on the epidermal layer of the ovule do not develop as fibers. Fuzzy fibers fail to grow and even remain stuck to the seed coat during ginning. Fuzzy hairs, called linters, may or may not be removed after ginning.
82. The cotton fiber takes about 50 days to develop and mature inside the green boll, which then cracks open to reveal the white harvestable lint. These are called “open bolls”.

83. The cotton boll is first formed as a flower bud called a square. The square becomes a bud and ultimately a white flower on the day of anthesis. After pollination, the ovules, which are arranged linearly in the ovary of the flower, develop into seeds.

84. Among the cultivated types, *G. arboreum* has fewest number of locks, mostly 3 and occasionally 4. *G. herbaceum* usually has four locks, which is also true for *G. barbadense. G. hirsutum* commonly has four locks and many varieties may have even five locks. The same plant may have four and five lock bolls. Three lock bolls are extremely rare in *G. hirsutum*.

85. All fiber quality parameters that determine a 'grade' and instrument readings are largely impacted by environmental and agronomic conditions. In most cases the genetic expression is either suppressed or aggravated by extreme conditions.

86. Cotton is usually planted on about 34-35 million hectares in the world, with a maximum and minimum range of 30-36 million hectares. Since 1951/52 the world cotton area has exceeded 36 million ha on only three occasions: 1951/52, 1995/96 and 2011/12. The increase over the 36 million hectare mark did not represent even half a percent of the total area. Since 1951/52, cotton was planted on less than 30 million hectares only once, in 1986/87.

87. The greatest volume of cotton ever produced in the world was 28.04 million tons in 2011/12. Only 6.7 million tons of cotton was produced in 1950/51.

88. Cotton production increased by over 54% during 1950s, 12% during 1960s, 20% during 1970s, 25% during 1980s, only 1% during 1990s and by 14% during 2000s.

89. All increases in production have come from increases in yields. There are periods of slow growth in yields and the highest yield ever achieved was 793 kg/ha of cotton in 2007/08 and 2012/13 compared to 234 kg/ha in 1951/52.

90. In the last 60 years or more, the average world cotton yield has increased by 4% per hectare every year or 9 kilograms of lint per hectare per annum.

91. Fiber quality improvements have also occurred on a continuous basis, but far short of the productivity gains. The over threefold increase in productivity has not been matched in any of the parameters of fiber quality. Fiber quality improvement is complex and direct selection may not result in a significant enhancement. Negative correlations among parameters and productivity further complicate the achievement of an enhanced progress rate.

92. Currently, the highest cotton yields in the world occur in Australia, 2,138 kg lint/ha in 2012/13. Cotton yields in Australia have usually been more than double the world average, but the gap has increased in recent years.

93. China was the top cotton producing, importing and consuming country in the world in 2012/13.

94. World mill consumption of cotton peaked in 2006/07, reaching 26.6 million tons.

95. In 2012/13, mill consumption in China stood at 8.3 million tons or 36% of total world consumption. India was the second largest consumer of cotton (4.9 million tons) followed by Pakistan with 2.4 million tons. China, India and Pakistan together shared 58% of world production and almost 2/3 of world consumption in 2012/13.

96. Ever since cotton statistics became available, the USA has been the largest exporter of cotton in the world. Almost 80% of cotton produced in the USA in 2012/13 was exported. Conversely, mill consumption of cotton halved in the USA in the seven years from 2000/01 to 2006/07 and expected to half again by 2016/17.

97. The cost of cotton production is continuously increasing. According to ICAC statistics, the average net cost of production increased to US$1.50 per kg of lint in 2012/13. Net cost assumes that farmers own the land, so does not include land rent, and that they sell the cotton seed after ginning.

98. The cost of the fertilizers applied to produce a kilogram of lint doubled since 2000/01.

99. Emphasis on weed control is rising and the cost of weed control almost tripled from 2000/01 to 2012/13.

100. During the same period, only 13-17 US cents were spent on insecticides to produce a kg of lint, compared to 21 cents in 1994/95, which means that the share of insecticide costs has drastically declined.

Research Associate Program - 2014

The International Cotton Advisory Committee has conducted the Research Associate Program for decades. The core of the Program alternates between in economics and marketing and production research. Member governments of the ICAC nominate researchers for the Program, while researchers from non-member countries can participate on a fee-paying basis. Candidates are chosen by the ICAC Standing Committee based on the recommendations of the Secretariat. The 2014 Research Associate Program, conducted from May 4-11, 2014, was attended by 13 researchers from eleven countries. The complete list is attached at the end.

The objectives of the Program are to familiarize participants with the work of the ICAC and recent developments in the cotton sector, while also strengthening contacts among researchers in the member countries. The Program included presentations from the ICAC staff, as well as representatives of the USDA, World Bank, Cotton Council International and experts on organic cotton and environmental issues. All research associates made presentations on current developments in the cotton sector in their own countries, highlights of which are reported in the present article. The group also travelled to Virginia to visit the Virginia Tech Tidewater Agricultural Research and Extension Center and to meet with two cotton growers. Researchers were able to talk to growers about their farming operations and witness cotton planting operations in the field.

This report on the Research Associate Program 2014 has been complied from the country reports, individual contributions and perusal of various reports/sources by the Secretariat. Wherever necessary, facts and figures have been amended to present the latest available information.

Argentina

Argentina planted cotton on 410,650 hectares in 2012/13. This figure was 34% lower than the previous season's planted area. Of the above-mentioned area, 88% or 361,770 hectares were ultimately harvested. The abandonment of almost 50,000 hectares was caused by unfavorable weather conditions, particularly water stress and high temperatures. About 91% of the area was grown under rainfed conditions and only 9% had assured irrigation. As for distribution by province, Chaco, with about 36% of the planted area, continues to be the main producer, followed by Santiago del Estero with 31% and Santa Fe with 27%. These three provinces collectively account for 94% of the total area planted to cotton in Argentina.

Cotton area and production have been increasing in Argentina since 2000 and the 34% decline in area in 2012/13 was unusual. Abandonment of cotton area varies from year to year, but another decline in area is expected in the forthcoming 2013/14 season. Cotton consumption has also been increasing in Argentina at a rate almost equal to that of production. Recent declines in the cotton area will put further stress on cotton volumes in the country and leave less cotton available for export.

Currently there are seven non-biotech and three biotech varieties being grown commercially in Argentina. Almost 98% of the cotton area was planted to biotech varieties in 2012/13, but a single variety (NuOpal), which is a biotech variety with stacked insect resistance and Roundup-ready genes, was planted on about 85% of the total cotton area. This would normally be considered undesirable because the same variety is predominantly planted all over the area despite the different production conditions in the various provinces.

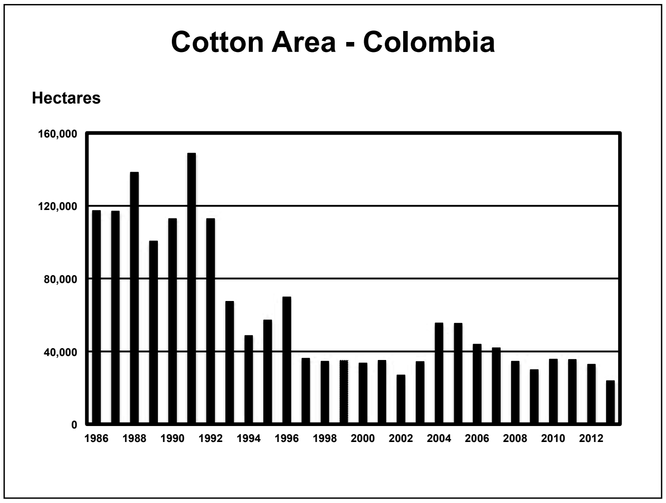
In Argentina, a no-tillage cropping system in narrow rows is predominantly practiced. The most commonly used row spacing ranges from 38 to 52 centimeters between rows with a plant density of 200,000 to 250,000 plants per hectare (20 to 25 plants/m^2). The main purpose of the narrow row spacing is to mitigate losses due to wind erosion.

As happened in the previous year, a high population density boll weevil attack took place towards the end of the season. Farmers have to be very careful to keep this pest under control because it has not given up on cotton and 3-5 sprays are usually required just to keep it under control. The blue disease appeared with a new race that broke down the existing varietal resistance, so the control of the aphid, *Aphis gossypii* Glover, which serves as a vector for spreading the virus, is strongly recommended.

In Argentina, farmers with holdings of 10-100 hectares are categorized as small-scale farmers, 100 to 600 ha as medium-scale growers and only farmers with more than 600 ha are considered large growers. Some farmers plant cotton on a much smaller scale, i.e., only a few hectares, but almost the entire cotton area is machine-picked. Stripper harvesting has extended to cover 70-75% of the harvested area. Year-to-year variation in fiber quality is common due to the significant impact of weather conditions. Argentina has 91 ginning factories with a combined ginning capacity of 1.8 thousand tons of seedcotton.

Colombia

In Colombia, the cotton crop follows a six-month cycle and is produced in alternating regions. The planting and harvesting times are exactly opposite in the two regions, resulting in the country having two cotton harvests. The coastal region contributes 70% of national output, while the inland region accounts for the remaining 30%. Cotton is a crop predominantly cultivated by small- and medium-sized producers with an average plantation size of 11 ha/farmer. Additionally, 75% of cotton lands are rented and about 97% of the area was planted to biotech varieties in 2013. Growing cotton on rented land on a short-term basis (often on a yearly



basis) is detrimental to planning or long-term investment in the improvement of soil fertility and texture.

Cotton yields in Colombia are normally higher than the world average. The main weaknesses in the production system are:

- Adverse weather conditions that limit the possibilities for boosting crop yields;
- Problems related to the adaptability of imported transgenic varieties. The breeding material has a sensitive/delicate background that severely limits its tolerance to any kind of stress. It would be beneficial to use Colombian varieties developed in Colombia for local Colombian conditions, thereby making them more tolerant to the conditions existing in this tropical region.
- Colombia is one of the countries with the highest production costs in the world. The cost of inputs, such as planting seed, fertilizer, pesticides and fuel, are extremely high. It is highly competitive to rent land to produce cotton.

One of the main strengths of the cotton sector in Colombia is the excellent quality of fiber produced. Some 75% of output is classed as having good staple, with high strength and uniformity that make it ideal for the production of ring-spun yarn used to make premium quality fabrics. All Colombian cotton is sold with quality testing and a farm-to-mill traceability system, i.e. barcodes and HVI testing.

Colombia's cotton sector has to deal with the same problems as the agricultural sector in general. Its competitiveness and sustainability over the medium- to long-term will depend on implementing an agricultural policy that clearly targets the resolution of infrastructure problems, the improvement of the soil, research and technical development. Mechanization of farming operations, control of input costs, as well as financing and marketing policies will have a tremendous impact on cotton production in the country. The cost of production has to be brought down to cap the declining trend in cotton planting. Above all, cotton has to be converted into a profitable undertaking for farmers.

Egypt

One of the most recent issues in Egyptian cotton production has been high temperatures during plant growth. Such high temperatures have a significant impact on productivity and a great deal of work is currently under way in this area at the Cotton Research Institute, the most important cotton research institution in the country. Its objective is to minimize the results of climate change and concomitant impacts on productivity. Cotton area in Egypt has significantly contracted in the last two decades and the two main factors responsible are:

- Farmers shy away from planting cotton for a number of reasons: they are unable to extract a reasonable profit because of the high cost of items involved in cotton production, particularly fertilizers, insecticides, different service operations and picking. The government's reaction is to institute policy changes by securing a guaranteed price to satisfy farmers and encourage them to increase the area planted to cotton.
- The spinning and weaving machinery is not suitable for the quality of Egyptian cotton. The result is that the high quality of the local cotton is not optimally exploited. The country's industry must improve its spinning machinery in order to spin cotton better than upland qualities.

The Cotton Research Institute is also prioritizing the introduction of new varieties with improved yield and better quality, aside from obtaining varieties tolerant to high temperatures, drought and salinity. Egypt strictly monitors the area planted to each variety because this has a direct bearing on the quality of the cotton to be exported.

Fiber Quality of Cotton Varieties Planted in Egypt - 2013/14
(Measured on HVI)

Varieties	UHM Length (mm)	Fiber Strength (g/tex)	Micronaire	Color	Brightness (Rd%)
Giza 70	35.7	46.7	3.9	Creamy	66.4
Giza 80	28.7	34.1	4.6	Creamy	61.7
Giza 86	32.0	43.1	4.3	White	74.2
Giza 88	32.5	38.2	4.2	Creamy	65.7
Giza 90	28.5	34.2	4.3	Creamy	65.0
Giza 92	32.9	46.0	3.6	White	77.0

Greece

In Greece, a soil temperature of least 14°C is very important for cotton seeds to achieve good germination. Such conditions become available by the start of the planting season in late April and continue through the month of May. Cotton planted beyond those dates may produce suboptimal yields or a fiber of lower quality. Fertilizing is based on soil data analysis of the farms or throughout a given pocket of soils within a region. In the event that such an analysis is unavailable, compound fertilizers having an NPK ratio of 2:1:1 are applied. A small portion of the fertilizer is added to the soil immediately after sowing; the rest is applied in June so that it is available later in summer when the needs of the plant have tremendously increased. Over 90% of the cotton area has assured irrigation; most of the remainder, about 8%, is grown under rainfed conditions. Sprinkler and drip irrigation are the most commonly used irrigation techniques, but small-scale surface irrigation by furrow is still practiced. In southern Greece, irrigation normally starts in June and continues, as needed, up to mid-August.

Cotton needs protection from several insect pests, such as *Thrips tabaci*, *Aphis gossypii* and *Tetranychus* spp. Bollworms also make their appearance and, in recent years, the most dangerous threat has come from *Helicoverpa armigera*. Fungicide seed treatment is always applied. Chemicals are used to control weeds. Herbicides may be applied at the pre-sowing, pre-emergence and post-emergence stages. Herbicide application varies from year to year and location to location, depending on the extent of mechanical weeding. Greece produces organic cotton on small-scale holdings, which add up to 1,000 hectares. Picking starts in September and winds up by early November. All cotton is machine-picked.

Cotton yields in Greece are almost 25% higher than the world average. Farmers sell their seedcotton to ginners who take full charge and own both the lint and seed resulting from the ginning process. In 2006, a new Common Agricultural Policy (CAP), combining direct (single decoupled aid) and a special area payment (attached support, coupled aid) was introduced. The amount of the direct payment scheme is in principle, equal to the average of the grants received by each farmer in the 2000-2002 period. A single payment is around 600 euros per hectare, regardless of the type of production in which the grower is currently involved. The special area payment accrues to farmers who cultivate and produce cotton. Its amount depends on the total cultivated area and reached 805 euros/ha in 2011/12.

India

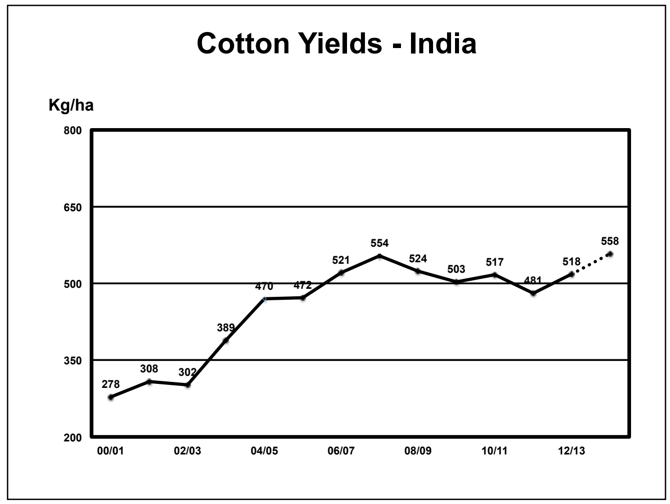
Cotton Development

India planted cotton on 11.4 million hectares in 2013/14, more than half of that area being located in the states of Maharashtra and Gujarat. Cotton area in the northern region has been declining. In the mid-1990s diploid cotton species were planted on 37% of the cotton area. The diploid species area declined to 24% in 2000, immediately before the commercialization of biotech cotton in 2002/03. Subsequently, diploid species dwindled even further and came to occupy less than 10% in 2012/13. Lately, the area under *G. barbadense* has also declined. Cotton yields in India jumped after the commercialization of biotech cotton, but have stagnated since 2008/09. In the six years from 2002 to 2008, the cost of bollworm control insecticides used on cotton in India declined by over 50%.

Biotech Cotton Events and Their Aproval - India

Biotech Event	Developer	Year of Approval
MON 531	Mahyco / Monsanto	2002
MON 15985	Mahyco / Monsanto	2006
Event – 1 JK	Agri-Genetics	2006
GFM Event	Nath Seeds	2006
Cry 1 Ac Event	CICR & UAS	2008
Cry 1 Ac Event 9124	Metahelix Life Sciences	2009

CICR = Central Institute for Cotton Research, UAS = University of Agricultural Sciences



Some of the issues of concern for cotton production in India are:

- The high number of hybrids/varieties recommended for commercial production – 1,340 have been approved and each one requires different packages of production practices. It is recommended that no more than 30 seed companies should choose their two best biotech hybrids for each of the 13 agro-ecological subzones and sell only these in the specific subzones.
- New emerging pests and diseases – The pest complex in India is changing. Mealybugs, mirids, thrips, *Spodoptera*, gall midges, *Perigea capensis*, CLCuV, grey mildew and tobacco leaf streak virus are on the increase.
- Leaf reddening and wilt disease are becoming a challenge in rainfed areas.
- Hybrids have a low harvest index - They tend to be vegetative in growth and require more fertilizer and

insecticides compared to straight varieties. Hybrids also deplete soil faster. It is recommended that hybrids be replaced with varieties wherever possible.

- Jassid Resistance to Gaucho - All seeds are treated and the crop is also sprayed with Imidacloprid (50 to 5450-fold R in 75% of the populations tested).
- Refuge compliance is not strictly followed.
- About 90% of the area under biotech cotton is at a high risk of developing resistance to the bollworm.

Remote Sensing

India is extensively working on its cotton area at the national level and on production forecasting using remote sensing data supplied by the Indian Remote Sensing (IRS) satellite before the beginning of the harvest. In this connection, India is using the IRS AWiFS data with a resolution of 56 meters that is available on a five-day repetitive cycle. Since the crop is grown during the monsoon season, high repetition ensures the availability of cloud-free data during the crop growth period. Multi-date data are used to segregate the cotton crop from other vegetation and crops that look like cotton. The area forecast is made at the district level, then aggregated at state and, subsequently, national levels. A grid segment of 5x5 kilometers is used for area estimation. The cotton area is estimated in each grid and a statistical method of sampling aggregation is used to arrive at district, state and national estimates.

If it is not possible to get adequate optical satellite data then SAR data obtained from the RISAT satellite is used. The former is a microwave data band that can penetrate cloud cover, although accuracy may not be as good as that of optical satellite data.

A forecast is made in November of each year. In case of any disaster, such as flooding, drought or epidemics, efforts are made to revise the forecast, as in the case of the mealybug infestation that occurred in 2010/11 on the cotton crop in the northern states.

Experts use verified ground information of sample locations using GPS coordinates to generate training sites for acreage estimation. The method has evolved over the last two decades and has now become established as a reliable methodology in India. The weather research forecast (WRF) model is used to obtain 3-day forecasts of weather data at a five-kilometer resolution. This weather data is used to detect pest incidence outbreaks and to develop yield models.

Kenya

In the last 20 years, there has been a significant shift in the national, regional and international policy environment in relation to the Kenyan textile sector. Some of the policies had a positive impact on the country's cotton sector, others adversely affected Kenyan cotton, and yet others did had no impact on cotton in the country.

In the cotton sector, the government does not currently provide subsidies to cotton cultivation or price support for producers, ginning or marketing. However, the Government has continued to provide targeted support to smallholder farmers by providing them with planting seeds (fuzzy seeds not certified) as a food security measure, as well as free advisory and extension services. Like most other cotton producing countries, the government of Kenya also provides funding for agricultural and technological research on cotton. Multi-disciplinary research on cotton is undertaken at government research stations and a technology package is developed, publicized and passed on to cotton growers through public sector employees.

The key challenges to the cotton sector in Kenya are:

- Poor productivity – Cotton yields in Kenya are the lowest in the world. Low yields offer no incentive for farmers to invest in inputs or in the adoption of technology.
- High input costs – The open market price of fertilizers and insecticides are high compared to the yields achieved.
- High labor and energy costs – Most operations in cotton farming involve extensive use of labor, making the cost of labor and energy prohibitive for farmers.
- Farmers lack resources – Obtaining credit is not only difficult but also expensive since interest rates are high.
- Cotton is a low investment and poor output crop in Kenya.
- Technology is outdated.
- Price volatility – Cotton prices are highly variable and unpredictable.
- The influx of second-hand products and cheap fabrics (often untaxed) displaces Kenyan industry.

The solution lies in increasing productivity throughout value chain. At the farm level, provision of high yielding certified seed is a priority and, at the processing level, cotton classification is very important. Recently, Kenya has developed an infrastructure that could reliably support 100% testing and classing of cotton through an instrument-based classing system with technical support from its development partners. The program commenced in 2012. Through the ICAC, Kenya has secured funding from the Common Fund for Commodities for the project entitled *Development of National Cotton Testing and Classing Systems*. The goal is to improve the income position of smallholder cotton producers by introducing a structure that will be conducive to a transparent and effective price formation system both within the country as well as in relation to export trade. This structure would involve 100% bale testing within an institutionally transparent framework. The system is envisaged to become self-financing through fees and levies as production volumes increase.

Pakistan

Pakistan is the fourth largest producer and importer of cotton in the world. Pakistan stands second in yarn production and third in cloth production and other value-added exports. Pakistan's economy depends heavily on cotton, which contributes to 60% of the country's foreign exchange earnings, i.e. about 60% during 2013/14. Cotton contributes up to 7% of overall added value in agriculture and 1.5% of GDP. In addition to providing raw material for various industries, cotton ensures the livelihood of several millions of workers in cities and towns, and is a source of employment for more than 1.5 million farming families. Pakistan is the single largest country in the Organization of Islamic Cooperation (OIC) and accounts for 32% of the collective cotton area, 30% of production and 41% of consumption.

The cotton crop in Pakistan has had to deal with the following major issues during the current decade:

- Cotton leaf curl virus (CLCuV) has remained a constant threat to cotton productivity over the last two decades. Research studies have shown that complete immunity to the leaf curl disease is not possible in the Upland germplasm. In earlier efforts, when the disease was widespread in the country in the early 1990's, researchers quickly searched for tolerant material in their germplasm. A much wider tolerance level was discovered and researchers aggressively pressed the appropriate authorities to discard susceptible varieties and replaced them with CLCuV resistant varieties. This change represented a drastic shift in the varietal adoption policy and process, but was quickly rewarded. The severity of the disease continued to increase, but resistant cultivars provided a respite for researchers to explore other means of controlling the disease.
- Consistent stringent measures were taken to control the vector, but bringing the whitefly level down below the threshold level for transmittance of the disease proved impossible. The was conclusion was reached that the only way to escape heavy yield losses due to the disease was to develop material with high resistance to the CLCuV.
- Researchers observed that *G. arboreum* grown as a commercial crop was in many cases immune to the disease and certainly carried resistant genes. Lower fiber quality and inter-genomic differences prevented expedited results, but efforts continued in Upland cotton and the disease subsided to a great extent. Then the virus mutated and a new strain of the virus appeared that was able to overcome even tolerant varieties.
- Efforts were made by many teams of breeders to achieve the expression of resistance characters from wild species and 'Desi' cotton, especially *G. arboretum,* into Upland cottons through inter-specific hybridization. Currently, the genetic material is at Backcross stage (BC5), but appears very promising. However, significant progress has been prevented by the variation in incidence levels over the years.
- As a result of climate change, the cotton crop in Pakistan has had to face severe weather abnormalities since 2010/11 in the form of heavy rains and floods that have brought about substantial decreases in cotton yields. Heavy rains, especially in the cotton belt, resulted in substantial damage to the cotton crop. The year 2010/11 brought the deadliest flooding in the country, resulting in a shortfall in cotton production from a target of 2.5 million tons (14 million bales) to around 1.9 million tons (11 million bales), a production loss of as much as 30%. The country was in no way prepared to cope with such a large-scale disaster. A similar situation developed during the cotton season of 2011/12 when torrential rains brought about heavy flooding during August-September and damaged over 70% of the standing cotton crop in the Sindh province. Persistent heavy rains lasting for days severely affected cotton production in the Punjab as well.
- Most of the cotton area in Pakistan is planted to biotech varieties. The introduction of transgenic cotton and the ensuing simultaneous replacement of conventional varieties has created a very different plant protection scenario and a change in cropping patterns. One of the major changes in the cropping pattern was the planting of cotton some 40 to 50 days earlier than in the normal season.
- The successful early sowing of biotech cotton did indeed minimize bollworm infestation and reduce the incidence of CLCuV, but also created many other undesirable problems for cotton growers. Early sowing coupled with biotech cotton has facilitated a manifold increase in the population of sucking pests, which in turn increased the number of insecticide applications against these pests. Indiscriminate use of insecticides, specifically Imidacloprid and Acetamiprid, is conspiring to develop resistance to insecticides by sucking insect pests.
- The need for chemicals and insecticides to control bollworms has been significantly reduced by the introduction of biotech cotton. In some cases, insecticide applications have been dispensed with totally, while the need to control sucking insects close to the end of the effective fruit formation period was already at a minimum. Normally, once the plant enters the peak boll formation stage, no insecticides are used against sucking pests. This dramatic change in insecticide application protocols has brought minor pests to the fore, leading them to emerge as major pests. Two major emerging problems are the red cotton bug (*Dysdercus koenigii*) and the dusky cotton bug (*Oxycarenus laetus*: Kirby) which are causing significant losses, both qualitatively and quantitatively.
- The mealybug is another pest that has been limiting yields in Pakistan for the last over ten years. It is a sucking pest that attacks growing parts, main stem and branches. The growing parts become bunchy and affected plants remain underdeveloped and produce fewer flowers and fewer bolls of a smaller size. The severely affected

plants show blackish symptoms similar to burning of leaves. According to the Department of Agriculture, Punjab, Pakistan, 28.2% fields visited throughout the season during 2007/08 required insecticide treatments against the mealy bug. Hotspots (above the threshold level and requiring spraying) for mealy bug are higher than for any other pest. The biology of the pest and recommended control measures have been extensively studied but it continues to threaten cotton production. At the peak growing season in end August/early September 2013, the hotspots were around 15% lower than in 2007/08, but still capable of causing significant losses.

Cotton Area, Production and Yield in Sudan

Year	Area in hectares	Production in tons	Yield in kg/ha
2010/2011	32,151	13,132	386
2011/2012	116,098	41,729	395
2012/2013	49,732	15,051	301
2013/2014	46,986	37,619	360
2014/2015*	90,300	87,692	363

*Projection

Sudan

Cotton is the main foreign exchange in the country. More than 300,000 families in Sudan depend on cotton for their livelihood and several thousand more are employed in cotton-related activities.

Cotton is grown in Sudan under various topographical and environmental conditions, utilizing various methods of irrigation and using different applications of chemical inputs. Cotton is grown in the Gezira, Rahad, New Halfa, Suki, Blue Nile and White Nile schemes, which are run by independent managements. Categorized by system of irrigation, it is grown by gravity and pumps in the Gezira, Rahad, New Halfa (Girba), White Nile, Blue Nile, and Suki Schemes, by flood in the Tokar Delta and by rainfall in the Nuba Mountains and in some areas of the Blue Nile (Agaddi). Chemical input applications vary from moderate in some places to nonexistent in others. Private companies are strongly encouraged to invest in cotton production. Led by the Sudan Cotton Company Limited, private sector companies have assumed responsibility for direct finance and management of cotton production operations. Other enterprises, such as the Arab Authority for Investment and Agricultural Development, a Brazilian company and a number of individual farmers have undertaken to finance and manage cotton production in different parts of the country. However, cotton production in Sudan is still under the influence of the Gezira Act adopted in 2005. The act gives farmers the right to choose their preferred crop or crops, and to allocate areas among competing products.

The focus of the cotton research under way is the development of varieties suitable for a wide variety of agro-climatic conditions and different balances of fiber characteristics for meeting export demands. The public sector has the responsibility of developing production technology packages, including the management of abiotic stresses.

The area under cotton in Sudan has fluctuated considerably over the years and yields have not increased in almost three decades. The low level of yields keeps the cost of production of lint relatively high. Low yields and high production costs are the main factors retarding cotton production in Sudan. Although early-maturing, insect-resistant varieties have been released for commercial production, farmers are reluctant to grow cotton. Lately, Sudan has commercialized biotech cotton through a cooperation scheme between a Chinese research center and the Sudan Ministry of Agriculture. The biotech cotton appears to be having beneficial impact on yields, as well as lowering the cost of production.

Though biotech cotton has proved successful and two Chinese varieties, Chinese 1 and Chinese 2, are favored by growers, the Government does not take it for granted that the provision of technology and its use will continue. Thus, the Government has begun to look for additional sources of collaboration to be able to exploit the full potential of biotechnology.

Tanzania

In Tanzania, cotton is grown in 15 of the country's 25 regions. The average yearly area planted to cotton is 400,000 hectares distributed among some 500,000 smallholder farmers in 45 districts. All cotton is rain-fed and the average yield is about 260 kg of lint/ha. If sustainable cotton production can be ensured, it will contribute significantly to poverty alleviation and the socio-economic development of the country. Depending on the annual crop size, 70-80% of production is exported and the remainder is channeled to the domestic textile industry.

In the 2013/14 season, Tanzania produced 82,400 tons of lint, a drop of 31% below the production of 119,661 tons in the 2012/13 season. The volume of cotton output depends heavily on:

- Weather patterns: there are years of low productivity when farmers struggle just to recover their investment;
- Prices paid to farmers during the preceding year: higher prices in one season encourage growers to plant a greater area to cotton in the following season;
- Arrangements used to supply inputs to growers

The government, in collaboration with the cotton industry, managed to revive the seed multiplication industry, which had collapsed after liberalization. A new variety, UKM08, with ginning outturn of over 40% is being introduced to replace the older UK 91, which has a ginning outturn of 36%. The private sector has also invested in seed processing, with the result that delinted seed is now available for planting.

The transformation of the cotton industry in Tanzania is long overdue. The industry, in collaboration with the government, is implementing a number of measures to boost productivity and production including the following:

- Enhancement of the usage of inputs through introduction of contract farming;
- Development and transfer of new cost-effective production technologies through Farmer Field Schools, cinema shows and radio programs;
- Releases of new seed varieties with better GOT and other quality parameters;
- Implementation of campaigns to revamp productivity and re-opening of new areas for increased cotton production, especially in the Eastern Cotton Growing Area;
- Introduction of conservation farming, for which 3,000 rippers have been procured and distributed to progressive cotton growers. These will serve as demonstration plots in order to create commercial demand, which will encourage agro-dealers to stock these implements;
- Introduction of contract farming to facilitate the distribution of certified seeds to growers and provide them with access to inputs on credit;
- Strengthen the extension services delivery system by creating an enabling environment for extension workers to better perform in a results-oriented approach;
- Empower growers to manage their affairs.

Cost of Producing One Hectare of Cotton in Turkey (US$)

Operation/Item	Regions		
	SE Anatolia	Mediterranean	Aegean
1. PRE-SOWING			
Land rent for cotton	585.11	1,063.83	851.06
Ploughing	106.38	106.38	106.38
Planking	85.11	85.11	85.11
Other	63.83	63.83	63.88
Sub-total	**840.43**	**1,319.15**	**1,106.43**
2. SOWING			
Land preparation	106.38	319.15	319.15
Seed	93.09	85.11	111.70
Herbicides (Pre-sowing)	106.38	26.60	26.60
Fertilizer (Basal dose)	159.57	159.57	159.57
Drilling	53.19	53.19	53.19
Sub-total	**518.61**	**643.62**	**670.21**
3. GROWING			
Weeding	505.32	505.32	505.32
Herbicides (Post-sowing)		26.60	26.60
Fertilizer (Total)	15.96	345.74	345.74
Irrigation	345.74	212.77	212.77
Insecticides	319.15	372.34	372.34
Defoliation	212.77		
Other	79.79		
Sub-total	**1,478.73**	**1,462.77**	**1,462.77**
4. HARVESTING			
Picking cost	239.36	425.53	425.53
Sub-total	**239.36**	**425.53**	**425.53**
Seed Cotton Costs	**3,077.13**	**3,851.07**	**3,664.94**
5. GINNING			
Transportation to gin factory	79.79	26.60	26.60
Ginning (Including bagging)	740.22	744.85	1,116.61
Other	10.64	53.19	53.19
Sub-total	**830.65**	**824.64**	**1,196.40**
6. ECONOMIC COSTS			
All		265.96	319.15
Sub-total		**265.96**	**319.15**
7. TOTAL COST	**3,907.78**	**4,941.67**	**5,180.49**
8. VALUE OF SEED COTTON	**2,632.98**	**2,457.45**	**3,071.81**
9. NET VALUE OF LINT	**2,965.69**	**2,814.89**	**3,635.90**
10. NET VALUE OF SEED	**694.15**	**647.87**	**809.84**

During the 2013/14 farming season a total of 460,000 hectares were planted to cotton; Tanzania is forecast to produce 250,000 tons of seed cotton in the 2014/15 season.

Turkey

Thanks to its direct and indirect employment capability, cotton continues to be a basic source of income for many people in Turkey. However, the volatility of cotton prices experienced during recent seasons has had made a great impact on the cotton sector in Turkey. The area under cotton is decreasing as a result of the many problems it faces, including the fall in cotton prices compared to previous years, as well as the decreasing competitiveness of cotton in relation to wheat, corn and soybeans. Cotton competes against wheat and corn for land use as a function of year and prices. Given the high cost of cotton production in Turkey, wheat and corn are becoming more profitable for producers.

Among the most important components of Turkey's high cost of production are: land rents; high cost of labor for weeding and picking; and the cost of insecticides. Turkey has not commercialized biotech cotton yet and no plans are in the offing to grow biotech cotton, whether insect-resistant or herbicide-tolerant. The high cost of labor is the underlying factor responsible for the fast popularization of machine-picking. High production costs have a negative affect on the area planted to cotton, although cotton yields in Turkey are among the highest in the world.

In the meantime, Turkey continues to be a major cotton importing country in the world. Cotton price increases in recent years have also piqued the interest of farmers in many areas and encouraged them to return to cotton cultivation. This trend is also evident in the increase in cotton consumption figures. The most important issue facing Turkey's cotton industry today is the unfair competition created by government measures implemented in various cotton-producing countries. Other key issues facing the sector are:

- High input and production costs (labor, fuel, chemicals, fertilizers etc.);
- High cost of finance – high interest rates are creating barriers for farmers by blocking their access to funding with which to buy inputs, machinery, and cover other costs;
- Greater profit expectation from alternative crops, especially food crops, often making the market prices for cotton lower than the cost of production;
- Likelihood of entering another period of worldwide recession and financial crisis, with inevitable repercussions on the world cotton economy; and
- Contamination – The textile industry has become very sensitive to the contamination of cotton with plastic and polypropylene.

The cotton sector in Turkey continues to enjoy certain privileges not available to many cotton production systems in the world. Its strengths include:

- Soil and climatic conditions suitable for cotton production;
- Fully developed agricultural mechanization and technology;
- High yield potential;
- Good level of expertise among growers;
- Modern ginning, yarn and textile industries; and
- High textile export rates.

Zambia

More than 200,000 farmers produce cotton in Zambia. Land holdings are small and the average surface area planted to cotton is one hectare. Cotton stakeholders can be grouped in four categories:

(i) public sector,

(ii) non-governmental organizations (NGOs),

(iii) private companies, and

(iv) donor agencies.

The public sector stakeholders include the Ministry of Agriculture and Livestock, the Seed Control and Certification Institute and the Cotton Development Trust. The Cotton Development Trust is a research organization. The Cotton Association of Zambia, Cotton Ginners Association, Indaba Agricultural Policy Research Institute, Organic Producers and Processors' Association of Zambia, Community Markets for Conservation and the Chongwe Organic Producers and Processors Association are active in the NGO sector. The key players in the private sector are nine ginning companies, including: NWK Agri-services (former Dunavant), Cargill, Alliance Ginnery, Continental and the Chipata Cotton Company. The Cotton Association of Zambia has recently set up the Mumbwa Farmers Ginning and Pressing Company (MFGP) as a private company in which it is a shareholder along with two other companies.

Some recent changes in the cotton sector in Zambia are government support to farmers through the Farmer Input Support Program, cotton levies to fund cotton development, diversification of business operations by ginners, ginners pushing their own varieties and increased support to farmers by ginners.

Agents in the cotton value chain are not maintaining good and open relations and there is significant distrust of farmers in the small number of large ginneries that historically control the cotton value chain. However, both types of economic agents are mutually dependent in this chain. Inputs are supplied by ginning companies. Most field operations are performed manually and farmers sell their seedcotton to ginning companies. The cotton sector faces the following challenges:

- Fluctuations in productivity and production – Cotton yields vary drastically from year to year. Yields are not a true reflection of the local technology but of conditions that are beyond the control of the farmers. Cotton growers switch frequently from one crop to another because the profit margin of cotton production is very low. In the competition for land area, cotton often loses out to maize.
- Insect pest problem - Fortunately, cotton never became a monoculture in Zambia and no major outbreaks have occurred. Indiscriminate use of organochlorines and, more recently, organophosphates played a role in the introduction and subsequent establishment of the red bollworm, *Diparopsis castanea*, on cotton as a major pest throughout the country. Two species of spiny bollworm, *E. insulana* and *E. biplaga*, in addition to cotton leafworm, *Spodoptera littoralis*, and leaf roller, *Sylepta derogata* may often appear. Among sucking insects, aphids must be controlled.
- Extreme weather – Varieties are not available to produce good yields under extreme weather.
- Price volatility - As a result of government involvement in procuring maize at attractive prices, cotton is at disadvantage in terms of price.

During the past few years the Government of Zambia has increased interest in the cotton sector. Some actions are anticipated from the Government to support the sector. However, systematic and continuous policies and actions are required from the Government to restore confidence in cotton production. There is also a need to improve the difficult and sometimes even conflicting interests among various segments of the cotton sub-sector.

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