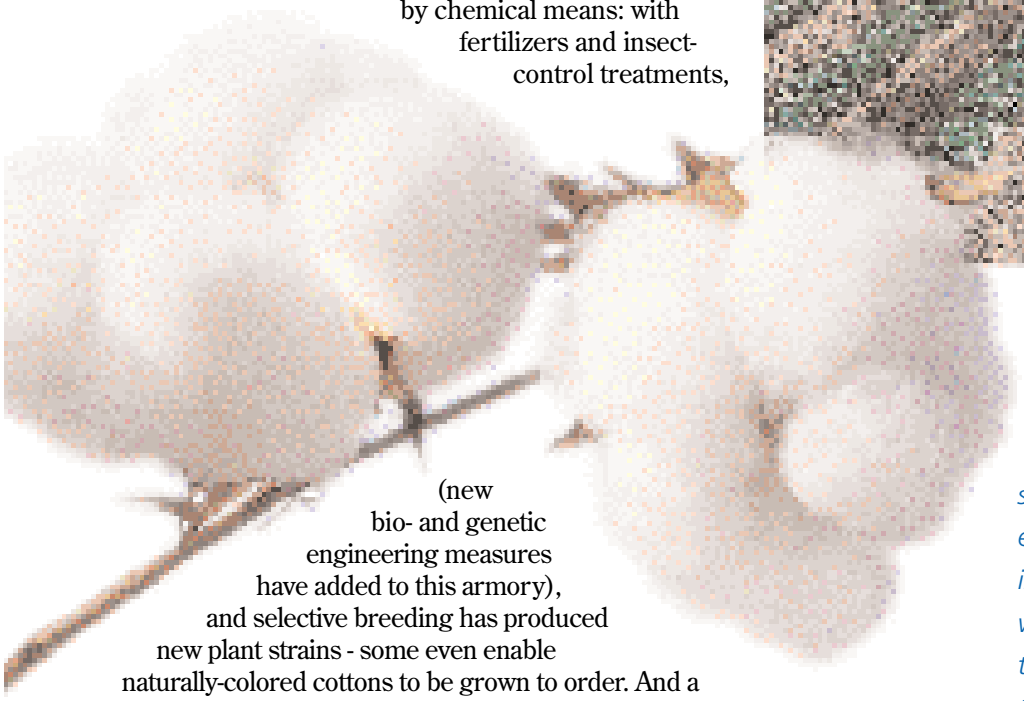
Cotton - mother of invention

Natural fiber, supernatural qualities: abundant thanks to boron

Two and a half centuries ago, cotton production was responsible for a level of invention and ingenuity that changed the world - and, in return, its own cultivation has been transformed by many of the new technologies, including boron supplementation, that have evolved as a result.

The Industrial Revolution of 18th century England was sparked by the need to build efficient cotton processing machinery, and the inventor of the cotton gin (which brought automation to the laborious extraction of fiber from the cotton boll seeds) was later responsible for the invention of the new machine tool technology which would make industrial mass production possible.

That industrial revolution in turn ushered in chemical, biochemical and biological revolutions, and since those early mechanical breakthroughs, cotton producers have been helped to increase their yields by chemical means: with fertilizers and insect-control treatments, (new bio- and genetic engineering measures have added to this armory), and selective breeding has produced new plant strains - some even enable naturally-colored cottons to be grown to order. And a major advance, some 70 years ago, was the recognition of the plant's critical need for an essential micronutrient - boron - without which the crop cannot prosper.

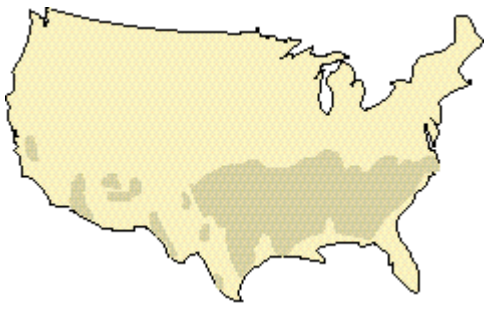


"Boron is a vital part of early season treatment of cotton. This element is critical to fruit initiation and boll retention, as well as being involved in the transport of nutrients throughout the cotton plant."

Claude Bonner, most recently cotton specialist, University of Arkansas

Cotton is the most-used vegetable fiber for making textiles and is grown in some 70 countries. It is big

Solubor® *fertilizer borate can be sprayed onto the cotton;* Fertibor® *or* Granubor® *can be applied to the soil either alone or with other fertilzers.* *Photos courtesy of the National Cotton Council of America*



The realm of 'King Cotton':
In the U.S., the Cotton Belt stretches from southern California across to the Carolinas of the east coast. Other major growing areas are found in China, India, South America, central/ southern Africa and Asia.

business: world production stands at nearly 20 million tonnes a year, the largest producers being the U.S. and the People's Republic of China, each producing just over four million tonnes of lint in 1997.

World demand for cotton has increased dramatically over the last few years - but alongside this, in many major cotton-producing countries there have been significant production problems caused mainly by insect appetites. The shortfall has been taken up largely by increases in American production, aided by new insect control measures, better yields per hectare, and newcomers to cotton-growing encouraged by the government to exploit this ready market.

To the north of Florida, the 14 states of the southern U.S. make up the Cotton Belt. Here, for the last two centuries cotton has been cultivated on a vast scale; and as the industrial revolution came up with invention after invention to aid planting, harvesting and processing, production of U.S. cotton increased from a tiny 680 tonnes in 1790 to around 350,000 tonnes 50 years later on. Modern developments in agriculture, harvesting and processing have taken the U.S. yield to more than 9,000,000 tonnes of seed cotton with more than four million hectares under cultivation.

But at the root of this is a combination of climatic and geologic factors without which the plant just will not grow and prosper on an economic scale, for cotton is a very particular plant when it comes to the weather. It likes the sun and can't stand frosts; summer temperatures need to better the mid-70s, with plenty of rain (or irrigation) in the germination and growing seasons.

Cotton's history as an economic force, of course, goes back much further than its cultivation in the U.S. Prehistoric remnants of cotton yarn and fabric have been found in Pakistan, New Mexico and Arizona and there is also evidence that the dyeing of cotton fabric was practiced even then.

When Christopher Columbus landed in the New World, he found the West Indian natives wearing cotton clothes, and it is known that it was also indigenous to south western parts of what is now the U.S., Mexico and Peru - even then it was an important trade commodity. However, it is believed that the

Natural fiber, 'supernatural' qualities - made abundant by boron
A cotton lint fiber is an epidermal hair of the cotton seed's coat: it is a single cell, up to 6cm long ('long staple') but only 50 microns wide.

When the boll opens, the cell wall dries out and collapses in on itself to become a flat twisted ribbon of virtually pure cellulose. It has a tensile strength equivalent to mild steel - and is 25 percent stronger when wet.

A typical cotton yarn has 500 individual cotton lint fibers in its cross section, is absorbent and rub-resistant. No other fiber withstands heat as well; and it is adaptable equally to thin and thick weaves - each is key to its unique 'wearability'.

Cotton yarn is woven (above) and becomes the world's most-used natural cloth. *Photos courtesy of the National Cotton Council of America*

beginnings of cotton agriculture that began the Cotton Belt were plantings in Florida by the Spanish in the mid-1500s. These were not very successful, probably because of badly-drained land and torrential autumn rains, but further north and west the conditions were much better. Cotton cultivation was to start, in earnest, two centuries later.

Ironically where the U.S. climate is right for cotton, in those southern soils the element boron is generally in short supply. Lack of this essential plant micronutrient is felt keenly by cotton, but unusually for a plant that is so boron dependent, it is rare for a cotton crop to show any visible symptoms. Plantations can look perfectly healthy, but the yield of fiber (lint) is severely depressed: and with every season that goes by, the boron available from the soil depletes as it is used up by the crop.

Planters can detect boron deficiency by an analysis of plant or soil boron content and avoid the risk of low yield with a replenishment regime - for example, by regular applications of fertilizer borates *Fertibor*® or *Granubor*® to the soil, or alternatively *Solubor*® or *Solubor*® DF - both highly effective in liquid formulation - directly to the plant themselves. *Fertibor* (powder) or *Granubor* (granules) can be applied alone, or mixed by the planter or fertilizer makers with other nutrients; *Solubor* can conveniently be combined with pesticide sprays. The best amount to apply depends upon local conditions (and Borax is always happy to give advice) but typically about one to three kg boron equivalent per hectare is sufficient. With a few kilos of Borax product, seed cotton yields can increase 25 percent or more - perhaps yielding an extra 500 kg a hectare.

For cotton, boron availability is now acknowledged to be the crop's principal limiting nutrient factor - no amount of any other fertilizer is able to produce so significant an increase in productivity. The plants, growing and fruiting vigorously are also better able, and naturally, to resist the attentions of voracious boll weevils and pink boll worms.

New strains of cotton plant - for example the genetically-engineered 'Bt' strain (so named from the inclusion of *Bacillus thuringensis* genes, which makes the plant distinctively unattractive to weevils) are, with other eradication programs, helping to combat insect-depleted yields. As the insect menace is pushed back, low yields due to boron deficiency are coming into more prominence. Growers who are new to the crop but not, perhaps, this horticultural technology can take a tip from the 'old hands': that, by supplementing each hectare with a few kilos of borate, their seed cotton yields can increase massively.