Cotton Products: First 30 Years

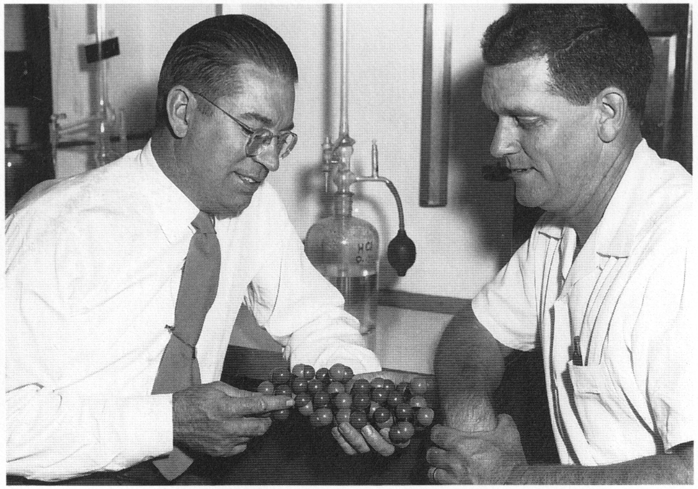
In 1947, when a married woman in the United States was still characterized in magazine articles as "the American housewife," the Department of Agriculture surveyed women on their preferences in fabric materials. The women said they preferred cotton for 11 of 16 ready-made apparel and household items, in some cases by an overwhelming margin.

The 11 items for which they definitely like cotton best were house dresses, anklets, aprons, bedspreads, dish towels, pajamas, curtains, part-wool blankets, nightgowns, raincoats, and tablecloths. In a twelfth category—summer street dresses—cotton tied with other materials. The five items in which cotton lost out to other materials were winter street dresses, hosiery, slips, and short-sleeved blouses. Women who made their own clothes voted for cotton by even larger margins.

The survey results might suggest that cotton in the late 1940's was still king, but the fact is that it was already losing out to synthetics. One of the first severe blows to cotton supremacy came, not in clothing, but in automobile and truck tire manufacturing. A rayon was developed that was strong enough and cheap enough to replace cotton in tire cords. The tire industry's switch to rayon cost growers an annual market for 1 million bales of cotton. Then came men's drip-dry shirts made from synthetics that required little or no ironing. They quickly caught on with travelers and with people who detested ironing. Nylon, sorely missed by women for hosiery during the war years, quickly invaded cotton's markets for all sorts of garments and for curtains and other household items.

Statistics help tell the story. In 1938, and again in 1939, when the four labs were under construction, cotton production was a little less than 12 million bales. In modern times, with twice as many consumers as in the 1930's, production is only slightly higher—about 15 million bales in 1987 and 1988.

Mary E. Carter, former SRRC director, displays washable flame-retardant cotton fabric developed in her laboratory.



In New Orleans in 1955, researchers J. David Reid (left) and Bill Weaver study molecular model of cotton finishing agent.

Cotton in 1947, when so many women voted in its favor, had many inherent virtues, and it still has them today. Cotton fabrics feel good next to the skin; they are soft and comfortable. They absorb perspiration. They launder well; stains come out. And a process developed in the 1930's reduced shrinkage to no more than 1 percent. Cotton fabrics are also durable and abrasion resistant, as military servicemen, wearing cotton fatigues under the most adverse conditions, can testify. Unlike other fibers, cotton is actually stronger when wet, and it is superior to many competitors in acceptance of colorfast dyes. And for countless industrial uses, cotton has been prized for its long flex life; it can withstand repeated bending.

But cotton products after World War II also had some serious shortcomings. SRRC scientists and the industry spent months identifying cotton's deficiencies in the competitive market and then set about to try to correct them with science.

Cotton wrinkled. Cotton is a cellulose fiber; its long molecular chains have no natural bonds, or crosslinks, between them. Cotton fabrics until 1958 possessed only weak chemical bonds that were broken by laundering. Applying heat under pressure (ironing) "mended" the bonds and restored the fabric's finish. That's where synthetic fibers had an advantage over cotton; they were usually designed with cross links built in. And these cross links meant that little or no ironing was necessary. The loss of market to growers and ginners was devastating.

To help cotton growers and the industry hold on to at least part of the shirt market, researchers developed chemical treatments and processes that gave cotton and cotton-blend fabrics the wrinkle resistance of fabrics made wholly from synthetic fibers. The first wash-and-wear cotton shirts appeared on the market in

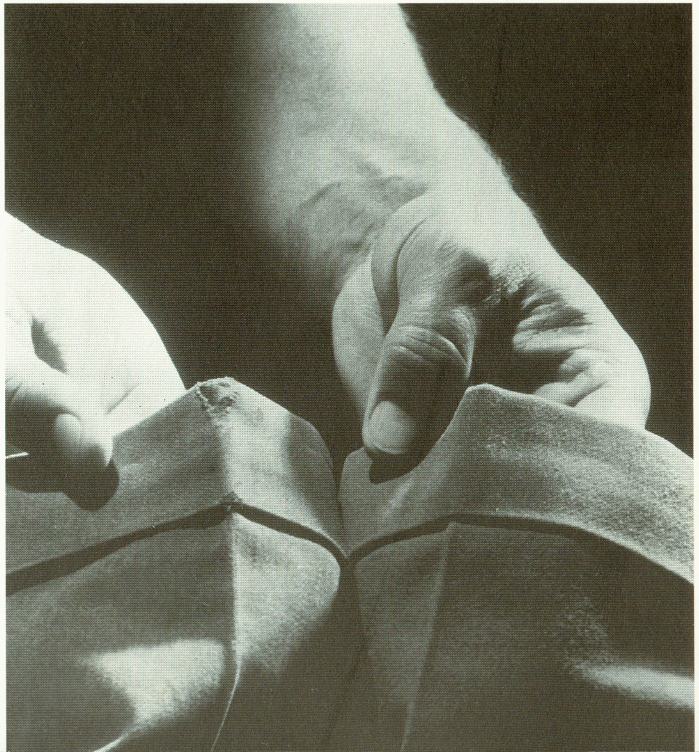
SRRC research chemist F. A. Blouin removes irradiated cotton from a chemical solution. She will test treated cotton for improved properties, including softness and stretchability.

Cotton Facts

Cotton is the most-used vegetable textile fiber in the world. It is grown on six continents. All parts of the cotton plant are useful. The fiber, or lint, is used to make cotton textiles. Cottonseed produces edible oil and cottonseed meal to feed animals and, in some places, to make flour for human consumption. Linters, the short fuzz on the seeds, are used to make explosives and other industrial products. The leaves and stalks provide fertilizer or are left on the soil to protect it from erosion.

Cotton is cellulose, which is also the structural material found in trees. Cotton cellulose is made of long chains of about 3,000 units of simple sugar, or glucose. These chains associate with each other in a definite pattern and reflect X-rays. This property defines cotton cellulose as a crystalline material.

A pound of cotton contains 90 million fibers. The entire cotton fiber is a single tubelike cell, and its length may be from 1,000 to 3,000 times its diameter. No other vegetable fiber has the spiral form of cotton fiber, and its tensile strength approximates that of steel. Its natural colors are brown, green, cream, and white.



At the Southern lab, durably pressed trouser cuffs of experimental cotton fabric (right) withstood 22 accelerated laundry cycles without damage. Cuffs of conventionally treated fabric showed severe abrasion after only 11 cycles.

1958, with SRRC scientists contributing to their development. These were soon followed by improved clothing made from a new blend of 35 percent cotton and 65 percent synthetic. Finally, in 1965, technology developed at the New Orleans lab made it possible for consumers to purchase all-cotton shirts, pants, and dresses that looked newly pressed after repeated washings. The age of durable press cotton textiles had arrived, providing an annual market for an estimated 2.5 million bales of cotton that would not otherwise be sold.

The research didn't stop there, of course. SRRC scientists kept working to improve their product. During the mid-1960's, they developed a process that doubled the resistance to abrasion of durable-press fabrics. They also invented a chemical finishing process that imparts to durable-press cottons the capacity to dry smoothly when hung on the line while damp. To travelers, the improvement meant no more shirts drip-dripping all night long onto the motel bathroom floor. Other improvements included a host of new finishing and crosslinking agents to make fabrics last longer and resist wrinkling, soiling, and damage by bleaches.

Cotton lacked stretchability. Stretch cottons were developed first in response to wartime military demand for self-clinging, elastic bandages. This was followed in postwar years by increased consumer demand for stretch cotton in diapers, socks, and underwear. In a few years, chemists at SRRC had invented three different ways to put more stretch in cotton.

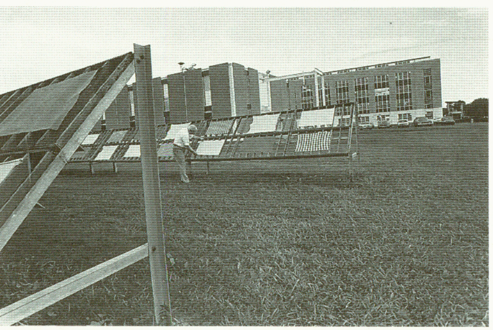
The earliest method, slack mercerization, uses a relatively concentrated solution of sodium hydroxide (household lye) to impart stretch properties to cotton yarn. The process had its origins in observations made by John Mercer 100 years earlier. The lye solution causes the fibers to twist and crimp, giving cotton its stretch.

In a variation of this method, which was quickly adopted by industry, oversized, loosely knitted socks are made from untreated yarn. The whole sock is then chemically treated, causing it to draw up to about half its original size. When manufactured in sizes 11 to 14, the socks have about 4 inches of stretch.

A second method makes use of resin-forming chemicals similar to those used in producing wash-and-wear fabrics. Cotton yarn is twisted in one direction, treated with a resin, and then twisted in the opposite direction. The back-twisted yarn tries to return to the highly twisted state in which it was treated. In so doing, it pulls itself into tiny resilient helical coils with as much as 200 percent stretch.

A third method treats cotton yarn with a chemical that gives it thermoplastic qualities (the ability to become pliable when heated). The yarn can then be permanently crimped while being heated. This process is similar to that used in making stretch yarns from thermoplastic synthetic fibers. Development of stretch cottons for a variety of uses has helped cotton stay competitive with other fibers and has resulted in millions of dollars of increased farm sales.

Fabrics for outdoor and industrial use are tested on racks outside New Orleans laboratory. Researchers found that weatherability of such fabrics is improved by combining cotton with high-tenacity artificial fibers, like glass.



Cotton lacked resistance to heat, rotting, weather. Not one, but many different chemical treatments were devised in New Orleans during the fifties and early sixties to decrease cotton's vulnerability to attack from weathering, mildew, and rot. The discoveries were used to improve cotton tents, tarpaulins, and boat covers. SRRC scientists also used partial acetylation to make cotton resistant to heat, a development responsible for the sale of millions of ironing board covers.

Cotton was flammable. So many injuries and deaths used to be caused by fabrics catching fire that Congress in 1953 passed a Flammable Fabrics Act, setting mandatory standards for all wearing apparel. The law was strengthened in 1967, and a tougher flammability standard subsequently added children's nightgowns, pajamas, and robes to the list of garments required to be fire retardant.

Initial work at SRRC to develop flame-retardant finishes for cotton was directed at bedsheets, since fires from smoking in bed caused many deaths each year. In 1953, a chemist in the Southern laboratory discovered a compound he called THPC for short. (Tetrakis[hydroxymethyl]phosphonium chloride is its full name.) The researcher found that cotton fabrics treated with THPC did not flare up when held in a flame; instead, they formed a tough black char that retained its fiber structure and strength. The char was thus able to provide flame protection and some insulation. Unlike many other chemicals tested for flame retardancy, the THPC treatment survived laundering and drycleaning. It was used first in military combat clothing, firemen's uniforms, and hospital linens and uniforms. In a short time, flame-resistant finishes, which underwent many improvements, were applied to children's nightwear and many products. Still used today in an improved form, THPC has proved safe, effective, and nontoxic.

Cotton's colors were limited. Before 1957, cotton textile manufacturers used dyeing processes with poor wet fastness and a limited range of attractive shades. SRRC chemists experimented with ways to color cotton by modifying the fibers so they would react chemically with specially synthesized dyes. These experiments led to commercial development of several fiber-reactive dyestuff groups, sold under various tradenames. The process provided textile mills with the means to dye cotton in bright new shades with excellent color fastness and helped improve cotton's competitive market position.

Cotton batting lost its shape. On the market since 1965, a chemically treated cotton batting called Cotton Flote has been much improved over the old-style batting, which became shapeless and lumpy after prolonged use. Developed by SRRC in the early 1960's, Cotton Flote is so resilient and holds its shape so well that it has made cotton batting competitive with all types of cushioning and upholstery materials, including polyurethanes and foam rubber. The material can be treated for fire retardancy.

Cotton lace looked cheap and flat. Before the New Orleans lab developed an improved product in the mid-1960's, cotton lace looked flat and inexpensive. It lacked the handmade, nubby look of fine lace. The new treatment, similar to one developed for stretch cottons, consists of soaking woven lace in a solution of lye, or caustic soda. This causes the fibers to swell and crimp, giving the lace the three-dimensional look of the handmade product. The best news is that greatest improvement in appearance occurs in the least expensive laces.