Science Societies

Improved cotton fiber sets these upland germplasm lines apart

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Dr. Jane Dever, project leader and cotton breeder at the Texas A&M AgriLife Research Center. Photo by Mark Arnold.

- Texas produces the most cotton of any U.S. state, and breeders are constantly seeking improvements to germplasm.
- Two Texas A&M programs recently released new and improved upland germplasm with superior fiber quality in the Journal of Plant Registrations.
- These public releases set the tone for private innovation, spurring improved fiber quality in lines growers will use in years to come.

In 2019, Texas growers produced about 6.5 million bales of cotton, cornering 40% of the cotton production in the United States, according to the USDA. Growers sell and export that cotton around the world where manufacturers turn it into yarn, textiles, and household goods.

Though yield is a major concern, growers aren't paid flat rates per bale—prices are determined based on the fiber quality. It's fiber quality that two programs at Texas A&M are working to improve, one germplasm release at a time.

At the Texas A&M AgriLife Research Station in Lubbock, cotton breeder Carol Kelly is first author on a release from Jane Dever's lab published in the *Journal of Plant Registrations* (JPR), "Registration of CA 4009 and CA 4010 Cotton Germplasm Lines," with cotton germplasm suited to production in the Texas High Plains (**https://doi.org/10.1002/plr2.20126**). Down in College Station, C. Wayne Smith's team partnered with Cotton Incorporated to release germplasm perfect for a somewhat

wetter climate and longer growing season, “TAM KJ-Q14 ESU and TAM 12J-39 ESU Upland Cotton Germplasm with Improved Fiber Bundle Strength,” also published in JPR (**https://doi.org/10.1002/plr2.20119**).

I had a chance to talk with some of the authors of these releases about the intricacies of breeding upland cotton for fiber quality while maintaining excellent yield. Plus, we discussed how the flexibility of public breeding programs like the one at Texas A&M can help industry breeders get quality varieties to growers.

That Golden Line

Harvesting cotton test plots using a stipper. Photo by Carol Kelly.

If you wanted to take cotton from a field in Texas all the way through to a finished textile, here’s what you’d do. First, you’d plant your cotton seed early in the season—sometime in mid-May up in Lubbock, TX, where the growing season is shorter. If you’re in College Station, you could plant a little earlier. Then you’d irrigate (or not—a fair amount of production is dryland) and wait. The cotton grows, forming woody stems and creeping upward. By July, you have peak bloom. These blooms eventually form bolls, which hold the lint, and by October or November, the cotton is mature enough to harvest.

Then, growers come through with a cotton harvester, which is typically a “stripper” harvester in North Texas and a “picker”-type harvester most everywhere else in the U.S. These machines pull the cotton bolls and some incidental leafy matter from the plant and then sort lighter, fluffier lint and seed cotton into their baskets while most of the heavier plant material drops off.

Next, producers gin the cotton, mechanically sorting the remaining leafy material and seeds and separating them from the cotton fibers. After it's ginned, producers set aside a small sample from the final 480-lb cotton bale and send it to the USDA cotton classing office for testing. The USDA grades these samples, and the whole bale is marketed accordingly.

There's a whole slew of attributes that make up the cotton fiber's grade, but the big ones are length and strength. These are the qualities that the Texas A&M breeders want to improve.

Length refers to the mean length of the longest 50% of cotton fibers. When spinning cotton yarn for textiles, length is a big determining factor for how smooth the cloth will feel. For example, cotton with short fibers is often destined for coarser cloth like denim while really fine, long fibers are used in super soft textiles like high-thread-count bedsheets.

Strength is measured in the force required to break a bundle of cotton fiber. At the USDA lab, a specialized machine grabs a bundle of fibers from the lint sample, combs them until they're parallel, clamps either end, and stretches the bundle until it breaks. That measure gives manufacturers a good sense of how strong yarn produced from the fiber will be.

Collecting cotton lint in the field. Photo by Carol Kelly.

For newer technologies like Murata Vortex Spinning, which is 20 times faster than old-school ring spinning, manufacturers have had difficulty using 100% cotton fibers, relying instead on polyester or polyester/cotton blends. But stronger cotton might mean that this faster, cheaper method could become the preferred option for manufacturing 100% cotton yarn. The strength of cotton fibers is directly related to the tenacity of yarn created in MVS systems, **according to Cotton Incorporated**.

In short, increasing both fiber length and strength could make cotton more versatile for manufacturers, where increased speed during the spinning process means lower production costs.

"When we're making selections, it's really tough because you might have one line with great yield, but bad fiber, or another with fantastic fiber quality and a low yield," Carol Kelly says. "We're really looking for that 'golden line' that has it all—we want the good yield and high fiber quality."

So how do the Texas A&M breeders create that golden line?

Target Traits

Before you can start winnowing down lines to a release, you have to pick your parents. And that happens *years* before you'll ever see a release. Both of the germplasm releases in JPR went through several years of selection, then at least three years of multiple-location field trials. The parents are key—what you start with sets the

boundaries for what you can get down the line.

So how do you decide which traits to improve—the traits that industry will be looking for in germplasm in 8 to 10 years?

“You have a breeder’s sense of these things,” Smith says. “The Number 1 priority for private industry is keeping yield potential up, so as public breeders, we have the flexibility to improve other traits. Then the pipeline moves this germplasm from land grant universities to industry to growers.”

Don Jones, co-author on the Smith release and Director of Breeding, Genetics, and Biotechnology at Cotton Incorporated, attributes the emphasis on fiber quality directly to breeders like Smith and Kelly.

“The improvements you see in cotton released by private breeders in recent years came from a push by public breeders way back in 2003 through 2010,” Jones says. “We have a real sense of satisfaction, knowing that public breeders have driven the science forward that led to the release of cultivars growers are using in the field now.”

For TAM KJ-Q14 ESU and TAM 12J-39 ESU, Smith and the research team created hybrids of standout upland cotton lines, advancing them to the F3 population before selecting individual plants based on preferred field phenotypes. They also evaluated the seed cotton, ginned in the laboratory, and the fiber quality of that cotton using Texas Tech University’s laboratory at the Fiber and Biopolymer Research Institute.

Field maintenance (also known as weed control) in a field of young cotton. Photo by Andrea Maeda.

They planted the next generation in the field, selected progeny that performed well, and then conducted performance testing with these lines at multiple locations in Central and South Texas for three years.

After somewhere between 21 and 42 total performance trials, the lines were consistently producing high yields and high fiber quality compared with commercial checks grown under the same conditions.

Like the releases from College Station, Jane Dever's lab in Lubbock (where Kelly is a research scientist) parallels the breeding process. The team in Lubbock went through a similar series of crosses, selections, and field trials to ensure they had a great line to release.

"In certain areas around here, even irrigation is limited," Kelly says. In fact, it's sometimes not used at all. "Those environmental stresses effect the yield and the fiber quality, but we're looking for something that survives, provides adequate yield, and still maintains excellent fiber quality. Everyone's looking for that, but if you only give the plant five inches of rain, that's extra challenging."

The Lubbock lab's registrations are adapted for shorter growing seasons and less irrigation and have better fiber length and strength than the commercial upland varieties they compared them to under the same conditions. Plus, their yield is similar to the commercial checks.

But plant breeding always leaves one with a small, squirming degree of uncertainty. When do you know you have a finished product?

"Dr. Norman Borlaug said that if you wait for the perfect variety, you'll never release it," Smith laughs. "You know you're ready to release a variety when you think what you

have will benefit the breeding industry, if it's better than what's out there, or if it broadens the germplasm pool."

With the public release of these four new germplasm lines in JPR, the door is wide open for private and public programs alike to build on them. We'll keep our eyes peeled for new commercial varieties of exceptional upland cotton, expanding the foundational work completed at Texas A&M.

Dig Deeper

Read more about these new germplasm lines in the *Journal of Plant Registrations*:

- "Registration of CA 4009 and CA 4010 Cotton Germplasm Lines": **https://doi.org/10.1002/plr2.20126**
- "TAM KJ-Q14 ESU and TAM 12J-39 ESU Upland Cotton Germplasm with Improved Fiber Bundle Strength": **https://doi.org/10.1002/plr2.20119**

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