Ginning Right Along

by D'Lyn Ford

The rumble and throb of agricultural progress vibrates through the U.S. Department of Agriculture's Southwestern Cotton Ginning Research Laboratory, a three-story warehouse of a lab at the edge of the NMSU campus.

Brainpower from engineers, scientists and technicians here, one of only three Agricultural Research Service ginning labs in the nation, has helped the cotton industry accelerate from the era of hand-picked cotton to the age of the high-speed "gin," short for "engine."

Hard hats on, ear plugs in, wooden gin sticks at the ready, the research team cleans cotton the same way a commercial gin does. They vacuum seed cotton from a trailer or module, sending it soaring overhead at 70 miles per hour, lofted on air through a gauntlet of machines that separate the valuable fiber and seeds from unwanted leaves, sticks, hulls and other trash.

"Ginning is quite a violent operation in some ways," says Ed Hughs, the lab's supervisory engineer. "You're drying cotton at temperatures of up to 350 degrees, spearing it with spikes and whipping it over metal bars. The cotton has an interesting life there for about 90 seconds or so."

From 1,500 pounds of harvested cotton comes 800 pounds of seed, 500 pounds of fiber or lint and 200 pounds of trash.

To illustrate what happens during

ginning, visiting schoolchildren are given handfuls of lumpy cotton and asked to pick out the dark seeds inside. It's slow going by hand—so tedious that by 100 B.C., inventors had created a hand-cranked machine, the churka, to pull off the fiber.

Engineering technician Tye Lightfoot tells the kids that it would take someone using a single churka more than three months to produce enough fiber for one 500-pound bale. The fastest modern saw gin plants crank out that much in just 60 seconds.

That's long enough for the cotton to pass through driers, over spiked cylinders and into revolving saws before reaching the gin stand, where fiber and seed are separated. Final cleaning with a saw cylinder dislodges all but 1 to 2 percent of remaining trash from the lint.

Ginning's goal is to get the cotton as clean as possible for textile mills while treating the valuable fiber as gently as possible to protect its quality. Innovations from the ginning lab have made a difference on both fronts.

From field to fabric

The lab opened 54 years ago to serve the West, home to irrigated desert valleys where some of the country's finest cotton grows.

On Dec. 17, 1949, more than 300 people attended dedication ceremonies in Mesilla Park. Secretary of Agriculture Clinton P. Anderson, a New Mexican, was instrumental in opening the first ginning lab outside the "rainbelt" of the South.

"For today, cotton's main problem is to find markets that will afford the grower and the industry good volume and income in the production and marketing of the crop," Anderson told onlookers.

Locating the lab on a 5-acre site donated by New Mexico College of Agriculture and Mechanic Arts proved prescient.

The lab's eastern windows frame a bucolic view of NMSU, home of one of the nation's most influential cotton breeding programs, less than a mile away.

"You couldn't ask for a better partnership," Hughs says.

The ginning lab is the central link in a chain that stretches from test plot to textile mill. Prospective new releases from NMSU are ginned and sent for textile evaluations to the Cotton Quality Research Unit, a USDA Agricultural Research Service lab at Clemson University. Researchers at the experimental textile plant there spin the fiber and collect data on its utility, strengths and shortcomings.

In one case, the gin's findings halted NMSU breeding work early in development of a hybrid Pima/upland cotton that couldn't meet textile mill standards.

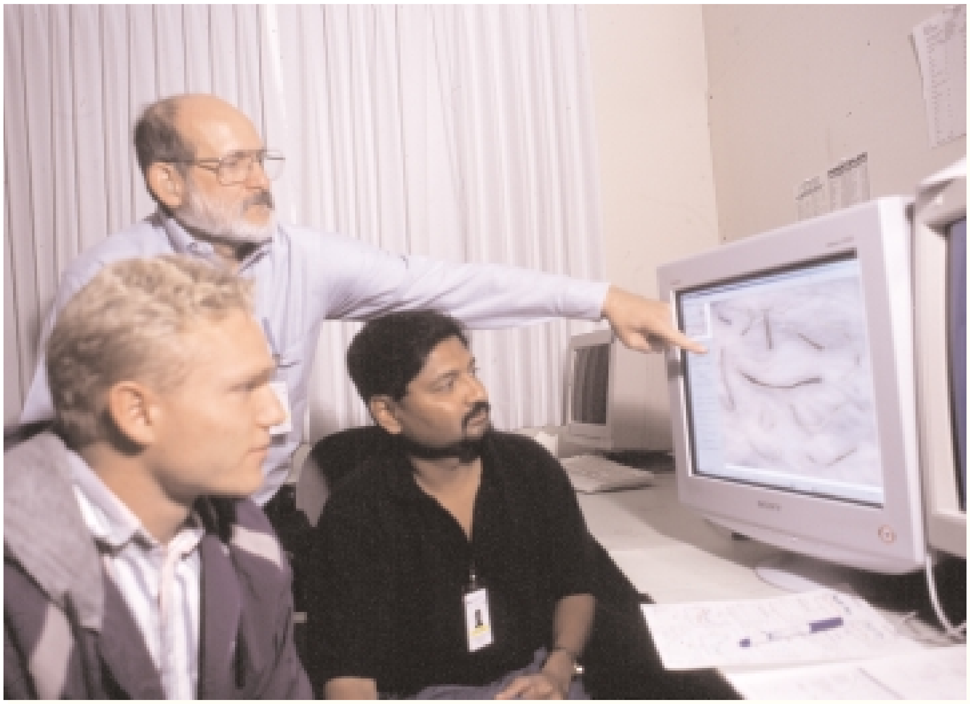
In a happier ending, researchers at the lab nurtured development of NMSU's Sea Island variety, enlisting the ginner's father and brother, both farmers, to plant seed from Barbados and select open bolls. Several hundred bales of the silky Sea Island fiber, prized for polished cottons and artificial silks, are now grown in the region.

But the heart of the lab's work is done in the two gins under the same roof: a complete saw gin and the country's only roller ginning research facility.

Up to speed: At left, Billy Armijo, senior engineering technician, adjusts controls for the saw gin stand at the lab. Above, innovations from the lab have helped pick up the pace at gins throughout the West, including B. E. Harvey Gin Co. in Las Cruces, which has a row of four saw gin stands.

The saw gin, descended from the invention patented by Eli Whitney in 1794, is used to clean upland cottons, which have shorter fibers or staple. "A saw gin plucks fiber off seed like plucking a chicken," Hughs explains. "It may take 30 times before all of the fiber is off the seeds."

But the gin's serrated saws break more fibers, lowering the quality and price of long-staple cotton. The gentler principle of the churka has survived in the roller gin, used for extra-long staple Pima cotton grown in the West. "The roller gin works



Fiber focused: From left, NMSU student Luke Clemens, research physicist Mike Lieberman and research engineer Murali Siddaiah demonstrate how they use sophisticated computing techniques to identify small trash particles in cotton.

Picker perfect: Researchers are designing cotton picker spindles that are gentler on fiber.

by pulling fiber underneath a knife edge, similar to shucking an ear of corn," Hughs says, pantomiming. Although easier on cotton, roller gins have been slower and more expensive to operate.

A major advance came in the 1960s, when the lab's first director, Victor Stedronsky, led a team of lab and industry engineers who designed a new rotary knife roller gin that raised roller gin output sixfold. Mesilla Park researchers also lowered costs by creating a stronger roller covering made of layers of bonded cotton and rubber that replaced rare walrus hide rollers.

To prolong the valuable roller's life, the team designed a cooling nozzle. Agricultural engineer Marvis Gillum installed the first computer-controlled feeders to detect cotton jams against the roller and slow the feed or shut down the gin to prevent damage.

"The auto controls really worked in saving the gin time and money," says Carlos Armijo, textile technologist. "Every time you have to change the roller, it costs the gin a couple of hours in lost productivity. It takes two people to install a new roller, which costs about $1,200."

Though the improvements save thousands annually for gins, researchers still feel the need for speed. "We're testing ways to make roller ginning four times faster," Armijo says.

In saw ginning, too, the lab has made long-lasting progress. Some of the initial saw ginning research here yielded a flow-through lint cleaner that survives today. "Saw-type lint cleaners have changed somewhat, but they still have the basic saw and brush doffing mechanism Stedronsky developed," Hughs says.

In the last few years, a new feeding mechanism from the lab was incorporated in the Sentinel lint cleaner released by Lummus Corporation. "It's a gentler way of cleaning that doesn't break as many fibers or tie as many knots in the cotton," Hughs explained. "It also has an environmental advantage of lower gin emissions because the fiber is moved along mechanically instead of with air."

Emissions research here has refined the cyclone, equipment that filters out dust and particles. Designs are now about 99 percent efficient, helping gins meet more stringent air quality regulations. Painstaking research also has shown that gins are not a source of harmful chemicals and do not significantly increase particulate matter in the air.

On the gin's top floor, scientists are using sophisticated technologies—soft computing, fuzzy logic and neural networks—to pinpoint the presence of small trash particles that are particularly troublesome for textile mills.

"If trash is caught in the yarn while you're spinning, it breaks the yarn," explains Mike Lieberman, research physicist. The impurities also show up as flaws in clothing.

The lab's system is more than 95 percent accurate in distinguishing pieces of bark, leaves, sticks and pepper trash, four common impurities found in local cotton. The next step is using that information for just-in-time customized ginning. Cleaner cotton might bypass a step entirely, while another batch could undergo specialized treatment to remove a particular type of trash.

"We can control the sequence of

gin machinery with cameras at various stages of the process," says Murali Siddaiah, research engineer.

Another futuristic idea at the lab involves using chemical sensors that tested for nerve gas and blister agents during Operation Desert Storm.

Agricultural engineer Paul Funk believes ion mobility spectrometers (IMS) could help sniff out expensive contaminants for the cotton industry: plastic bale twine and plastic shopping bags that blow into fields, become entangled with cotton during harvest and mix with the fiber when it's processed in the gin.

The plastic problem costs the cotton industry millions annually. Dye won't penetrate plastic fibers, leaving irregularities that lower cotton's value and clothing prices.

"The problem is that these plastic particles are the same diameter, density and length as cotton, so they can't be removed with traditional machinery," Funk says. "But with IMS we can smell the plastic in the cotton. The time to detect and remove the plastic is before the cotton leaves the gin."

Beyond the bale

Though ginning is its prime focus, the lab's research doesn't stop once cotton is baled. For science, researchers have tried their best to burn bales to find out whether cotton could be ignited by a spark at the gin and smolder during a long trip overseas, an insurer's nightmare.

Happily, tests showed that tightly compressed universal density bales were poor fuel. "In terms of flammability, a bale is like a large, solid piece of wood—very difficult to burn," Hughs says.

At densities above 14 pounds per cubic foot—about half that of a typical universal density bale—sparks were extinguished because of inadequate air exchange. As a result, the U.S. Department of Transportation reclassified baled cotton, changing the insurance rules for container shipping overseas.

"That reduced insurance rates by $2 per bale on 10 million bales, for a $20 million savings on insurance premiums," Hughs says.

In another series of experiments, researchers worked with live insects—pink bollworms, pests that eat into yields and quality. Their work found that ginning, baling and adequate fans take out the pest, which is found from Oklahoma to Arizona. Cotton traveling into uninfested areas, such as California's San Joaquin Valley, however, has had to be fumigated, creating a problem as chemicals like methyl bromide were banned.

Seeds of the future: Engineering technician Tye Lightfoot shows visiting students how to separate seeds from cotton during a tour of the gin.

"In the 1950s, they had what they called a 'pink bollworm fan' in gins. It was small, and the impact on trash killed any pinkies," Hughs says.

But no one knew whether the introduction of larger gin fans with fewer revolutions and less centrifugal force would provide the same protection. The lab tested a variety of fan sizes and speeds, monitoring insect emergence rates in the trash.

"We found that if the tip speed of the fan is at least 13,000 feet per minute, it kills pink bollworms," Hughs says. USDA responded by rewriting the Animal and Plant Health Inspection Service's field manual to fit modern gins.

Scientists even want to make productive use of ginning's leftover trash. Every day, Funk checks the progress of steaming vats of fermenting gin trash and dairy manure at the back of the building. The goal is to produce methane gas that could be used for heating. "Ideally, the value of the methane could pay for the cost of processing," he says.

Parked nearby is a red, single-row cotton picker, a newfangled idea when the lab opened and every boll of U.S. cotton was picked by hand. In fact, cotton pickers didn't harvest a majority of the crop until 1960.

"We're looking at making changes in the spindles on the picker, which was designed more than 50 years ago," says Kevin Baker, an agricultural engineer. "Our goal is to reduce the knots or neps in cotton before it ever reaches the gin."

Though cotton is king, engineers are applying their ginning knowhow to the similar problems of cleaning machine-harvested chile, a popular rotation crop for area cotton farmers.

At coffee breaks and on the gin floor, discussions revolve around scientific presentations and spindle grease. It's all part of what it takes to pace progress in the cotton industry.

In mid-discussion, the researchers pause at the sound of visiting schoolchildren, who have no such worries. Giggling and shrieking, they scramble up a hill of cotton that's ready for ginning, coating their jeans and T-shirts with another layer of cotton.