

# CONVENTIONAL AND HIGH-SPEED ROLLER GINNING OF UPLAND COTTON IN COMMERCIAL GINS

C. B. Armijo, M. N. Gillum

**ABSTRACT.** A conventional rotary-knife roller gin stand in a commercial ginning plant was converted to operate at high speed during the 2005 ginning season. Ginning rate on the high-speed stand was more than three times higher than a conventional roller gin stand. The ginning roller on the high-speed stand operated at normal temperature. A field test was conducted at the commercial ginning plant to compare roller ginning and saw ginning using one cultivar of upland cotton. The field test included the high-speed roller gin stand along with 11 conventional roller gin stands, and two saw gin stands. Fiber properties from the field test showed that HVI color grade, staple length, length uniformity, and fiber value were improved when using roller gin stands. Results from the 2006 California crop showed similar improvements in staple length and length uniformity when comparing roller-ginned upland cotton and saw-ginned upland cotton. Textile mills that value the significance of improved fiber properties were willing to pay a premium for roller-ginned upland cotton. Between 2005 and 2009, there were 48 roller gin stands converted to high speed, and 25 new high-speed roller gins sold. Life of the ginning roller on high-speed roller gin stands during 2006 was slightly less than conventional roller gin stands, but roller life improved in 2007-08 with use of variable frequency drives that may optimize ginning roller wear. Evaluation of high-speed roller ginning in commercial ginning plants will continue.

**Keywords.** Roller ginning, Upland cotton, Fiber quality, Cottonseed quality.

Roller ginning has historically been used to gin only Pima, an extra-long-staple cotton. Pima has inherent fiber advantages over upland cotton such as length, strength, and fineness. Conventional roller ginning on a production per-unit-width basis is about one-fifth the rate and therefore more expensive than saw ginning, but because the value of Pima cotton is considerably higher than upland cotton (USDA, 2007), the higher cost of roller ginning Pima cotton is justified.

Roller ginning compared to saw ginning produces better quality fiber. Hughs and Leonard (1986) and Hughs and Lalor (1990) showed that using conventional roller ginning to gin different cultivars of cotton improved the fiber length, length uniformity, and nep count when compared to saw ginning. Armijo and Gillum (2007) showed that both conventional and high-speed roller ginning of one cultivar of upland cotton, when compared to saw ginning, produced upland fiber that was more than one staple length longer (fiber staple length is an industry-wide-used measurement reported in units of 1/32 in.), and had higher length uniformity, less short fiber, fewer neps, and higher turnout (lint yield). However,

upland cotton has a stronger fiber-to-seed attachment than Pima cotton and is more difficult to gin, adding to the already higher cost of roller ginning.

Armijo and Gillum (2007) showed that when roller ginning upland cotton at high speed, the ginning rate was nearly equal to a conventional saw gin stand for a given length of ginning surface (i.e. 1 m). They also showed that the horsepower requirement of the high-speed roller gin stand was equal to that of a conventional saw gin stand. The high-speed roller-ginned upland cotton had the same fiber quality advantages as conventional roller ginning in that it did not damage the fiber. In the study by Armijo and Gillum (2007), bale value was not significantly different between conventional roller ginning, high-speed roller ginning, and saw ginning, but this was because the pricing system (based on the Commodity Credit Corporation loan chart) does not reward for upland cotton staple lengths longer than 37, and short fiber content is not valued in the loan chart. However, export markets, which now use about 75% of U.S. upland cotton, value the significance of increased staple length and decreased short fiber and neps, and some textile mills typically pay a 13 to 26 ¢/kg (6 to 12 ¢/lb) premium for roller ginned upland cotton. In addition, roller ginning (conventional or high speed) may help some upland cultivars meet the international fiber quality standards of a staple length of 35 to 36, strength of 27 to 28 g/tex, micronaire of 3.8 to 4.6, length uniformity of 82%, color grade of 21 to 31, and leaf grade of 2 to 3 (Southeast Farm Press, 2007).

In the 2007 study by Amijo and Gillum, a Consolidated HGM roller gin stand was converted from conventional speed to high speed. This research was a cumulative effort that had built upon earlier work that determined the optimum design of the rotary knife (Gillum and Armijo, 2000; Armijo et al., 2004) and stationary knife (Armijo and Gillum, 2005). After work was completed on the Consolidated HGM roller

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The authors are **Carlos B. Armijo, ASABE Member**, Textile Technologist, and **Marvis N. Gillum, ASABE Member Engineer**, retired, USDA-Agricultural Research Service, Southern Plains Area, Southwestern Cotton Ginning Research Laboratory, Mesilla Park, New Mexico. **Corresponding author:** Carlos B. Armijo, USDA-Agricultural Research Service, Southern Plains Area, Southwestern Cotton Ginning Research Laboratory, P.O. Box 578, Mesilla Park, NM 88047; phone: 575-526-6381; fax: 575-525-1076; e-mail: cararmij@nmsu.edu.

gin stand, interest from the ginning industry led to a study that converted a Lummus roller gin stand to high speed. The motivation for research on high-speed roller ginning was to make it more feasible to gin upland cotton, but the benefit of running high speed also allowed Pima cotton to be ginned at a higher rate.

The main objective of this study was to describe the conversion process and performance of a conventional Lummus roller gin stand that was converted to high speed in a commercial ginning plant. Other objectives were to summarize a separate field test that compared roller ginning and saw ginning of upland cotton in a commercial ginning plant, and to discuss how high-speed roller ginning has been implemented in commercial ginning plants during the 2005-2008 ginning seasons.

## EQUIPMENT SETUP

### HIGH-SPEED ROLLER GINNING IN A COMMERCIAL GINNING PLANT

Figure 1 shows the principle of the rotary-knife roller gin stand. Fiber is separated from cottonseed by frictional forces between a moving (roller) and fixed (stationary knife) surface. There are three frictional forces that occur during roller ginning: 1) roller-to-stationary knife, 2) roller-to-fiber, and 3) stationary-knife-to-fiber. Because the roller-to-fiber force is greater than the stationary-knife-to-fiber force, fiber sticks to the surface of the roller and slips on the surface of the stationary knife. The greater the force between the stationary knife and roller, the greater the frictional pulling force between the fiber and roller. The rotary knife helps guide seed cotton to the ginning point, and removes cottonseed and any un-ginned seed cotton from the ginning point.

A 1.0-m (40-in.) wide conventional Lummus Rota-Matic rotary-knife roller gin stand and feeder (Lummus Corporation, Savannah, Ga.) were used in the study. The capacity (ginning rate) of the roller gin stand was approximately  $273 \text{ kg m}^{-1} \text{ h}^{-1}$  [ $1.25 \text{ bales m}^{-1} \text{ h}^{-1}$  based on a standard 218-kg (480-lb) bale] of cotton fiber. Lummus specifies a running frequency of 116 and 447 rpm for the ginning roller and rotary knife, respectively, and a roller-to-stationary knife force of 9.3 to 11.1 kN/m (53.0 to 63.6 lb/in.) [gage air pressure of 517 to 621 kPa (75 to 90 psig)] (Lummus Industries, Inc., 1989). As with the conversion of the Consolidated HGM roller gin stand by

Armijo and Gillum (2007), the Lummus roller gin stand was converted to high speed by increasing the frequency of the ginning roller and rotary knife to about three times the conventional frequency (the frequencies were increased by changing the sheaves on their respective drives). The new running frequency on the ginning roller and rotary knife was 393 and 1364 rpm, respectively. The roller-to-stationary-knife force was increased for this study to about 14.9 kN/m (85 lb/in.), 33% above the conventional force, by adjusting the pressure on the cylinders that push the ginning roller against the stationary knife to a gage air pressure of 827 kPa (120 psig). The stationary knife was made of hardened abrasion-resistant steel that would not deflect excessively with the increased roller-to-stationary knife force. It was later determined there is no benefit to increasing the roller-to-stationary knife force above what is recommended by the original equipment manufacturer.

A conventional ginning roller was used. It measured 0.38 m (15 in.) in diameter and consisted of a steel pipe and vulcanized rubber core wrapped with standard cotton packing. The original 11-kW (15-hp) 1750-rpm drive motor for the ginning roller and feeder was replaced with a 37-kW (50-hp) 1770-rpm motor. A 560-W (0.75-hp) variable-speed 180-volt dc motor drove the feed rollers on the feeder. The frequency of the doffing brush in the feeder was increased by about 33% by changing sheaves on the feeder drive. A conventional, 70-mm (2.75-in.) in diameter, 6-blade spiral-wrapped steel rotary knife, with knife angle (degrees of rotation per length) of 150 degrees was used. The rotary-to-stationary knife clearance was set to a standard 0.25 mm (0.010 in.) (Lummus Industries, Inc., 1989). A 2.2-kW (3-hp) 1760-rpm auxiliary motor drove the rotary knife. The roller gin stand used computer control (recommended for high-speed roller ginning) to monitor and adjust the feed (ginning) rate for a given setpoint. Past research has shown that computer control eliminated choke-ups at the rotary knife, and allowed elevated ginning rates without compromising fiber properties (Gillum and Armijo, 1995a).

Figure 2 shows modifications made to the feeder to increase the throughput of seed cotton. A top seed-cotton guide plate was added above the main cleaning saw to prevent seed cotton from developing a “roll” above the saw. In a conventional feeder, seed cotton slings off of the second spiked cylinder, hits the feeder containment above the cleaning saw, and drops onto the main saw. At high throughput rates, some of the seed cotton did not attach to the main saw and instead bounced back up into the path of seed cotton exiting the second spiked cylinder. This action caused the “roll” of seed cotton to develop above the main saw and eventually choke-up the feeder. The top seed-cotton guide plate placed the seed cotton directly onto the main cleaning saw, and therefore eliminated the “roll” that caused the choke-ups.

Another feeder modification involved shortening the saw scroll that surrounds part of the main saw cylinder (fig. 2). At high throughput rates, some seed cotton mistakenly passed between the saw scroll and the main saw, and then re-circulated around the main saw. To correct this, the saw-scroll edge was rotated 15-degrees clockwise which shortened the scroll a linear distance of about 59 mm (2.3 in.). In addition, at high seed-cotton throughput rates, seed cotton

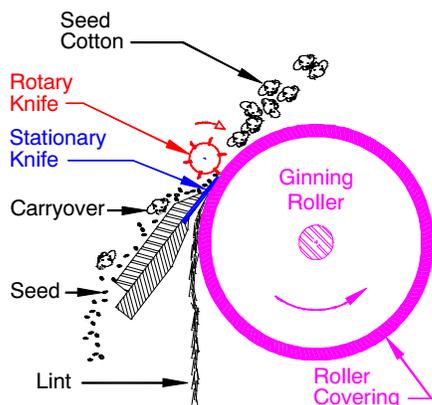


Figure 1. Principle of the rotary-knife roller gin stand.

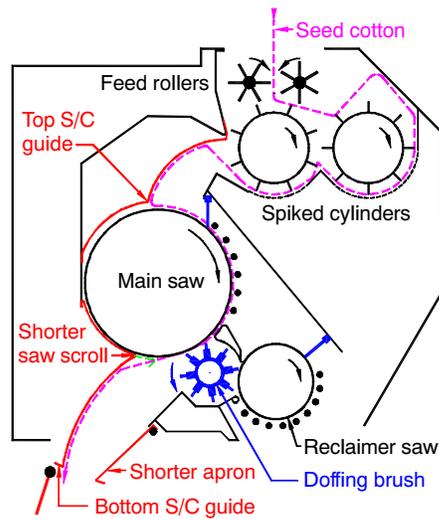


Figure 2. Lummus high-speed seed-cotton feeder (S/C = seed cotton).

tended to ricochet off of the straight metal piece that made up the bottom seed-cotton guide. Therefore, the straight piece of bottom seed-cotton guide was lengthened and made curvilinear to allow seed cotton to ride along its surface. The bottom seed cotton guide was attached to the saw scroll. The original straight seed-cotton guide was 399 mm (15.7 in.) long; the new curvilinear guide had a 406-mm (16-in.) arc length or 502-mm (19.75-in.) arc radius. The last feeder modification involved increasing the frequency of the doffing brush in the feeder by 33% (1354 to 1800 rpm) to improve doffing and accommodate the high throughput rates of seed cotton.

Figure 3 shows a cooling system that was added to the roller gin stand to keep roller temperature below the recommended maximum of 107°C (225°F) (USDA, 1994). In previous research, Armijo and Gillum (2007) used a cooling system that consisted of two water spray nozzles mounted inside an air duct. The water spray system was more than adequate in keeping roller temperature at an acceptable level, but due to small amounts of water dropping out of the duct onto the floor and creating a nuisance, a cooling system that used only ambient air was designed for the Lummus roller gin stand. The cooling system consisted of an industrial radial-blade belt-driven blower connected to a shop-built plenum to direct the air to the gin stand roller. The 3.7-kW (5-hp) blower (Grainger Industrial Supply, Lake Forest, Ill.) had a 0.31-m (12.25-in.) wheel diameter, ran at 3750 rpm, and produced 0.55 m<sup>3</sup>/s @ 2.2-kPa (1165 cfm @ 9-in. water column) static air pressure. The blower sat on top of a metal stand that measured 660-mm (26-in.) long by 464-mm (18.25-in.) wide by 254-mm (10-in.) tall. The plenum was connected to the fan via a 0.36-m (14-in.) long by 0.16-m (6.125-in.) wide by 0.18-m (7-in.) deep entrance duct welded onto it. The plenum measured 0.41-m (16.0-in.) long by 0.99-m (39.0-in.) wide (about the width of the ginning roller) by 0.17-m (7.0-in.) deep. The final 0.14 m (5.55 in.) of the plenum reduced in depth to a 61.0-mm (2.4-in.) deep nozzle that blew air onto the ginning roller. A rectangular-shaped “plug” that measured 0.19-m (7.5-in.) long by 0.99-m (39-in.) wide by 49.8-mm (1.96-in.) wide was installed into the exit point of the nozzle creating a 4.8-mm (0.188-in.) gap at the upper portion of the nozzle

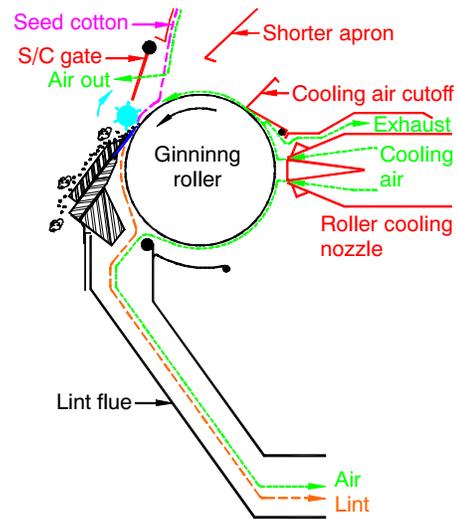


Figure 3. Lummus high-speed roller gin stand.

and a 6.4-mm (0.25-in.) gap at the bottom of the nozzle where air exits the nozzle and blows onto the ginning roller. The nozzle was placed about 25.4 mm (1 in.) away from the surface of the ginning roller. The exit velocity of the air in the nozzle was about 43 m/s (8500 ft/min). A cooling-air cutoff plate was installed near the top of the ginning roller to direct air exiting from the top gap of the nozzle away from the ginning point. The lip of the cooling-air cutoff plate actually rode on top of the ginning roller. Air exiting from the bottom gap of the nozzle went into the lint flue. In the study by Armijo and Gillum (2007), the lint flue exiting the Consolidated high-speed roller gin stand was enlarged to accommodate the higher ginning rate. The lint flue on the Lummus high-speed roller gin stand was not enlarged in this study. Figure 4 is a photograph of the rear of the high-speed roller gin stand showing the plenum and blower on the cooling system, the lint flue exiting the stand, and the 37-kW (50-hp) main drive motor.

Figure 3 also shows modifications that were made to pieces between the gin stand and feeder to re-direct air coming down from the feeder, and re-direct air that slipped past the cooling-air cutoff plate. The seed-cotton gate at the front of the gin stand was changed from a solid piece of plastic (original equipment) to a metal comb-like device.

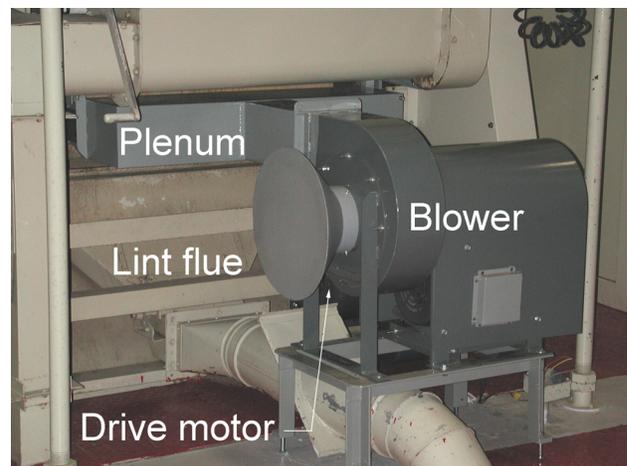


Figure 4. Rear of Lummus high-speed roller gin stand.

The fingers on the gate were made out of 6.4-mm (0.25-in.) steel rod on 15.9-mm (0.625-in.) center spacing. The fingers on the gate were spaced close enough to each other to prevent locks of seed cotton from escaping through the fingers, but wide enough to allow excess air from the feeder to exit the gin stand. Also, the feeder apron was shortened from 367 to 229 mm (14.44 to 9 in.) to allow back-lighting from the rear of the stand and to allow excess air that slipped past the cooling-air cutoff plate to exit through the fingers of the gate. Shortening the feeder apron did not affect the path of seed cotton, because at high throughput rates, seed cotton did not drop onto the feeder apron as it does when running at a conventional processing rate. Instead, seed cotton rode along the bottom seed-cotton guide at high-speed processing rates.

#### **INDUSTRY-WIDE USE OF HIGH-SPEED ROLLER GINNING**

In 2005 and 2006, commercial roller ginning plants in Arizona, California, and New Mexico converted numerous conventional roller gin stands and feeders to high speed. Some of the roller ginning plants in California and New Mexico made only partial conversions to their equipment. These partial conversions consisted of only increasing the throughput of seed cotton in the feeder, or only slightly increasing the speed of the ginning roller and rotary knife (but not by enough to require a cooling system). The partial-conversion roller gin stands and feeders did not achieve the same ginning rate as the full-conversion high-speed stands and were estimated to gin at about  $436 \text{ kg m}^{-1} \text{ h}^{-1}$  (2 bales  $\text{m}^{-1} \text{ h}^{-1}$ ) compared to about  $981 \text{ kg m}^{-1} \text{ h}^{-1}$  (4.5 bales  $\text{m}^{-1} \text{ h}^{-1}$ ) on a fully-converted stand. During the 2006 ginning season, two full-conversion high-speed roller gin stands operated in Arizona and 12 operated in California. During the same year (2006), 21 partial-conversion stands operated in California and four in New Mexico. In 2007, one gin manufacturer began offering a new high-speed roller gin stand. In 2007, 13 new high-speed roller gin stands operated in California, one operated in Arkansas, and one operated in Brazil. Also in 2007, six roller gin stands were fully converted to high speed in California, and two in New Mexico. In 2008, 10 new high-speed roller gin stands operated at one California ginning plant, and in 2009, one full-conversion high-speed roller gin stand was installed at the USDA-ARS Cotton Ginning Research Laboratory in Stoneville, Mississippi.

## **EXPERIMENTAL PROCEDURES**

### **HIGH-SPEED ROLLER GINNING IN A COMMERCIAL GINNING PLANT**

A study was conducted during the 2005 ginning season in the Gila River Valley of Southeastern Arizona to determine the operating characteristics of a roller gin stand converted to high speed, and to compare roller versus saw ginning of upland cotton in a separate field test. As mentioned earlier, the motivation for conducting research on high-speed roller ginning centered on roller ginning upland cotton. A conventional roller gin stand was converted to high speed at the Glenbar Gin Company Inc. (Pima, Ariz.). The converted roller gin stand was 1 of 12 stands at the Glenbar Gin.

The Glenbar Gin is a combination gin that utilizes either roller or saw gin stands, but uses the same overhead (seed-cotton cleaning and drying) and press. The gin equipment at the Glenbar Gin was manufactured by the

Lummus Corporation. The overhead included three 6-cylinder inclined cleaners and two tower dryers. The roller gin had 12 roller gin stands; one of these stands was converted to high speed for the study. (Another roller gin stand was converted to high speed in 2006 after the study was completed.) Lint cleaning in the roller gin included two 6-cylinder inclined cleaners with cylinders running at a frequency of 1000 rpm. The saw gin had two 158-saw gin stands, each followed by one saw-type lint cleaner.

Cotton used for the field test included 164 bales of FiberMax 989RR upland cotton. The cotton was grown in one field by the same producer, and harvested with the same picker, i.e. the same growing and harvesting conditions apply to all 164 bales. Seventy-seven bales were roller ginned and 87 bales were saw ginned (two treatments). Roller ginning included one high-speed stand and 11 conventional stands. Saw ginning included two saw gin stands. Analysis of variance was performed with the General Linear Model (GLM) procedure of PC-SAS (SAS Institute, Inc., 2003) with a 5% level of significance. Fiber properties of the 164 bales were determined by the High Volume Instrument (HVI) at the USDA-AMS Phoenix Classing Office.

#### **INDUSTRY-WIDE USE OF HIGH-SPEED ROLLER GINNING**

In addition to results from the field test in Arizona, HVI fiber properties from the California cotton crop of 2006 are presented. The California results include fiber properties of roller-ginned upland cotton.

## **RESULTS**

### **HIGH-SPEED ROLLER GINNING IN A COMMERCIAL GINNING PLANT**

Prior to running the field test, about one module of upland cotton (12 bales) was ginned to check the initial start-up of the high-speed roller gin stand. The high-speed roller gin stand averaged  $1046 \text{ kg m}^{-1} \text{ h}^{-1}$  (4.8 bales  $\text{m}^{-1} \text{ h}^{-1}$ ) ginning rate. This compares to a ginning rate on a conventional roller gin stand of about  $109 \text{ kg m}^{-1} \text{ h}^{-1}$  (0.50 bales  $\text{m}^{-1} \text{ h}^{-1}$ ) when ginning upland cotton. During start-up, the high-speed roller stand performed well. Roller temperature averaged about  $93^\circ\text{C}$  ( $200^\circ\text{F}$ ), and there were no choke-ups. The only modification made at start-up involved changing a sprocket on the feed-rollers drive on the feeder to increase the throughput of seed cotton.

Treatment means and observed significance levels of the HVI fiber properties from the field test are shown in table 1. (Recall that the roller ginning treatment included one high-speed stand and 11 conventional stands.) Leaf grade, micronaire, and strength were not different between the roller and saw ginning treatment and averaged 2.66, 3.56, and  $29.5 \text{ g/tex}$ , respectively. Color grade was different between ginning treatments, averaging 104.7 and 104.3 (old code) on the roller and saw gin, respectively. These color grades equate to a new code color grade of 11 and 21 for the roller and saw gin, respectively. Reflectance and yellowness were different between ginning treatments. Reflectance averaged 81.3 and 82.4 on the roller and saw gin, respectively, and yellowness averaged 8.78 and 8.04 on the roller and saw gin, respectively.

Fiber length and length uniformity were different between ginning treatments. Fiber length averaged 27.8 and 27.1 mm

**Table 1. Treatment means and statistical analysis of USDA-AMS Classing Office HVI results and loan value on bale samples of upland cotton from the Glenbar Gin Co.**

Measurement	Treatment		Observed Significance Level <sup>[a]</sup>
	Roller Ginning	Saw Ginning	
Color grade, Index <sup>[b]</sup>	104.7	104.3	0.0113
Leaf grade, Index	2.65	2.66	NS
Micronaire, Reading	3.56	3.56	NS
Length, (mm) (in)	27.8 (1.094)	27.1 (1.066)	<0.0001
Staple length (32nd in.) <sup>[c]</sup>	35.3	34.2	<0.0001
Strength (g/tex)	29.5	29.5	NS
Length uniformity (%)	80.2	79.7	<0.0001
Reflectance, Rd	81.3	82.4	<0.0001
Yellowness, +b	8.78	8.04	<0.0001
Loan Value, (\$/kg) (¢/lb) <sup>[d]</sup>	1.26 (57.0)	1.21 (54.8)	<0.0001

[a] NS = not statistically significant at (P > 0.05).

[b] Upland old code index, 100 = 31, 104 = 21,105 = 11.

[c] Staple length in 32's of an inch is an industry-wide unit of measure.

[d] 2005 Commodity Credit Corporation loan chart.

(1.094 and 1.066 in.), or 35.3 and 34.2 staple length, on the roller and saw gin, respectively. One of the benefits of roller ginning is improved fiber length, which may be important in meeting world quality standards of a 35 staple length. Length uniformity averaged 80.2 and 79.7 on the roller and saw gin, respectively. This difference was somewhat less than expected as Armijo and Gillum (2007) found that roller ginning had about 2% better length uniformity than saw ginning. Loan value of the fiber was significantly different between roller and saw ginning. Loan value averaged 1.26 \$/kg (57.0 ¢/lb) on roller ginning and 1.21 \$/kg (54.8 ¢/lb) on saw ginning. Loan value was based on the Commodity Credit Corporation loan value for the 2005 crop.

#### INDUSTRY-WIDE USE OF HIGH-SPEED ROLLER GINNING

Table 2 shows the fiber quality of cotton classed at the USDA-AMS Cotton Classing Office (Visalia, Calif.) during the 2006 ginning season. The results include roller-ginned upland cotton (91,307 bales), saw-ginned upland cotton (600,239 bales), and roller-ginned Pima cotton (720,215 bales). The roller ginning results include conventional and high-speed roller ginning combined. The bales of roller-ginned upland cotton were made up of the Acala cultivars, but it is prudent to roller gin the better-quality upland cultivars to retain their quality characteristics. Comparing roller-ginned upland cotton to saw-ginned upland cotton, there was no difference in color grade or leaf grade, averaging 31 and 3, respectively. Roller-ginned upland cotton was about 2 mm (0.07 in.), or two staple lengths (39.6 vs. 37.3) longer than saw-ginned upland cotton. Length uniformity of roller-ginned upland cotton was 1.7 percentage points higher than saw-ginned upland cotton. These HVI results on length and length uniformity are similar to those found by Armijo and Gillum (2007). In 2006, commercially roller-ginned upland cotton received a premium from textile mills of 13 to 26 ¢/kg (6 to 12 ¢/lb).

One item that cannot be tested in the laboratory is life of the ginning roller on high-speed stands. In a 4-year field study that investigated roller life at a commercial roller ginning plant, Gillum and Armijo (1995b) found that roller life on conventional roller gin stands had a high coefficient of

**Table 2. HVI fiber quality results from the USDA-AMS Cotton Classing Office in Visalia, California for the 2006 ginning season.**

Measurement	Ginning Type and Cultivar		
	Roller Ginned Upland 91,307 bales	Saw Ginned Upland 600,239 bales	Roller Ginned Pima <sup>[a]</sup> 720,215 bales
Color grade, Index <sup>[b]</sup>	31	31	2
Leaf grade, Index	3	3	2
Micronaire, Reading	4.51	4.21	3.99
Length (mm) (in.)	31.4 (1.237)	29.6 (1.167)	35.3 (1.390)
Staple length (32nd in.) <sup>[c]</sup>	39.6	37.3	44.5
Strength (g/tex)	34.2	33.8	40.1
Length uniformity (%)	84.1	82.4	85.1
Reflectance, Rd	77.2	78.9	70.6
Yellowness, +b	8.75	8.13	11.39

[a] Includes 67,013 bales from Arizona, New Mexico, and Texas.

[b] Index system is different for Upland and Pima cotton.

[c] Staple length in 32's of an inch is an industry wide unit of measure.

variation (31%) and ranged from 219 to 1297 h. Considering that a conventional roller gin stand processes seed cotton at about 273 kg m<sup>-1</sup> h<sup>-1</sup> (1.25 bales m<sup>-1</sup> h<sup>-1</sup>), this equates to a range in roller life during this study of 274 to 1621 bales per roller. Reasons for unusually short roller life included damage by scrap metal or spindle twist, or premature wear-out due to a high roller surface temperature. Gillum and Armijo (1995b) also found that cooling the roller by blowing ambient air onto it reduced roller temperature rise above ambient by 39% and increased roller life by 24%. A roller cooler is definitely needed on a high-speed roller gin stand due to higher levels of frictional heat generated between the ginning roller and the stationary knife. Because lint at the ginning point carries away some of the heat (the lint, rather than the roller, is sliding under the stationary knife), it is very important to start feeding the stand immediately upon startup to avoid burning up a roller (a slow-start process such as a variable frequency drive may help on startup). It is too early to determine roller life associated with high-speed roller ginning, but estimates by industry personnel who used high-speed roller ginning in 2006 reported roller lives of 800 to 1000 bales per roller. This compares to estimates of roller life of 1000 to 1200 bales per roller found with conventional roller ginning. In 2007, one roller ginning plant in California that used high-speed stands exclusively had an average roller life of 2000 bales per roller. In 2008 another ginning plant with new high-speed roller gins averaged 1500 bales per ginning roller for the season. Current research by industry includes optimizing ginning roller wear by varying the ginning roller/rotary knife speeds via VFD (variable frequency drive) based on capacity as well as ginning roller temperature. Future research is needed to find roller covering materials that extend roller life, and improve ginning efficiency.

#### CONCLUSIONS

Converting a conventional Lummus rotary-knife roller gin stand and feeder to high speed is summarized as follows:

- The path of seed cotton in the feeder was modified by adding a seed-cotton guide plate above the main saw, shortening the saw scroll below the main saw, and

increasing the frequency of the doffing brush by 33% to 1800 rpm.

- The motor on the main drive was increased from 11 to 37 kW (15 to 50 hp).
- The running frequency of the ginning roller was increased from 115 to 393 rpm.
- The running frequency of the rotary knife was increased from 447 to 1364 rpm.
- The force between the roller and stationary knife was increased from about 10 to 15 kN/m (58 to 85 lb/in.). Commercial ginning plants found that an increase was not needed to achieve high capacity. It only increases horsepower requirements and ginning roller wear.
- An air-fed plenum and cooling nozzle apparatus was added to the rear of the gin stand to cool the ginning roller. A 3.7-kW (5-hp) auxiliary blower supplied the air.
- An automatic computer control [that included a 2.2-kW (3-hp) auxiliary motor to drive the rotary knife] was added to monitor and adjust the feed rate of seed cotton to the gin stand.

A roller gin stand may be partially converted by modifying only one part of the stand such as partially speeding up the ginning roller and rotary knife, but ginning rate will only be increased by a proportionate amount.

In a previous laboratory study, it was found that roller ginning at either conventional or high speed did not damage or degrade cotton fiber. A 2005 field test in a commercial ginning plant verified the improvements in fiber quality obtained when roller ginning upland cotton; one high-speed roller gin stand was used in the test. Fiber properties from the 2006 California crop also verified the benefits of roller ginning upland cotton. Between 2005 and 2009, there were 48 roller gin stands converted to high speed, and 25 new high-speed roller gins sold.

New markets may open up due to the improved fiber quality of roller ginned upland cotton. Typically, commercially processed roller ginned upland cotton receives a premium of 13 to 26 ¢/kg (6 to 12 ¢/lb). A better evaluation of roller life will ensue as more high-speed roller gin stands are used.

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