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# APPLICATION OF POWERED PADDLE ROLL TECHNOLOGY IN A 16-INCH SAW GIN STAND

**Weldon Laird and Greg Holt**
**USDA-ARS-CPPRU**
**Lubbock, TX**

## Abstract

Powered paddle roll gin stand technology was developed in the Lubbock ginning laboratory on a 12-inch saw gin stand. The research effort was expanded to apply this technology on modern gin stands with the larger diameter saws that make up a large percentage of the commercial gin stands in the U.S. This study gives the results from application on a 16-inch saw gin stand. Several shape and size factors were found to be very important in creating a gin stand design that gave the high efficiency ginning performance previously found in the 12-inch saw platform. Research trials to optimize the relationships of the various parts of the gin stand in the 16-inch saw size resulted in improved preservation of fiber properties and 27 to 37 pounds per bale higher lint yield compared to the conventional 16-inch saw gin stand. The powered roll gin stand was capable of ginning more than 55 percent faster than the conventional gin on wet late season cotton.

## Introduction

The USDA-ARS ginning laboratory at Lubbock, Texas, developed a new powered paddle roll saw gin stand that produced over two percent points higher turnout from seed cotton compared to a modern high capacity gin stand, (Laird, Holt, and Lalor, 2001). A patent was obtained through the USDA-ARS patent division for the powered paddle roll gin stand technology development (U. S. Patent number 6,061,875). Laboratory research results showed yields of approximately 7 percent more lint (35 pounds per bale) from the seed cotton through use of the new technology. Research also showed that the experimental gin stand tended to preserve better fiber quality and staple length while providing higher production rates and less power used for ginning. About seven iterations of design modification and testing with the 12-inch diameter saw gin stand in the gin lab had shown that several shape and position factors for the roll box, paddle roll and seed finger roll were critical in obtaining high performance and optimum fiber quality and yield, (Laird, Holt and Wedegaertner, 2000). Relative operating speeds of the saw, paddle roll and seed finger roll were also important. Additional work showed that there were optimum combinations of operating variables based on eleven response variables related to turnout, processing rate and fiber quality, (Holt, Laird and Wedegaertner, 2002). The technology was applied in this study to adapt the development to gin stands with larger size saws, starting with a simple scale up of the 12-inch configuration to fit a 16-inch saw size gin stand. There were a number of shape and mechanical construction factors that were different for the ginning ribs and roll box in the Continental Double Eagle 141 saw gin stand used for the 16-inch platform compared to the 12-inch saw gin previously developed on an older model Continental 90 saw gin stand.

## Objective

The objective of the research effort described in this paper was to develop design information for applying the powered paddle roll technology to a modern gin stand with 16-inch saws, and to demonstrate the new gin stand technology in full scale field studies. An essential part of this project was to try to determine an optimum design and operating configuration of the new technology in the 16-inch saw diameter gin stand. An additional purpose for the demonstration was to evaluate the performance of the powered paddle roll design in comparison to an unmodified gin stand in the commercial ginning environment.

## Acknowledgment

Thanks to Cotton Incorporated for financial support and encouragement for this research effort. Also many thanks to the management and personnel of Servico Gin at Courtland, AL for providing a test site and additional financial support and carrying most of the work load for the project. Thanks to several of the gin machinery and equipment shops in Lubbock, Texas who helped design and build the non-standard parts on an expedited basis to make this project a success.

## Material and Methods

The cooperating field site selected for the research was Servico Gin in Courtland, AL. This is a high volume gin operating three Continental Double Eagle 141 saw gin stands. The initial step was to build a new gin front section to incorporate the powered paddle roll technology into one of the gin stands with 16-inch saws. Early in the season we made a trip to install the new parts on one of three gin stands in the host gin plant. The gin stand selected for the experimental installation was the third one of the three gin stands under the conveyor distributor. After installation we began a program of test and modification of the experimental gin stand to reach optimum performance. Three design modifications were made as the 16-inch saw powered roll gin stand was developed in the field study. With a satisfactory configuration of the experimental gin stand in operation the next step was to explore a range of operating settings for the experimental gin stand and conduct parallel tests with the unmodified gin stands to determine effects on fiber quality, lint turnout and ginning capacity. Another part of the research was to adapt an automatic control and data system from the laboratory to the computerized control system in the commercial gin. This was not fully accomplished until very late in the gin season. The automatic control system provides the opportunity for sensing and control of gin operation to optimize the process based on incoming cotton properties for a range of targeted end uses or mill requirements. This will be a subject requiring extensive additional research but the system enabling the research has been developed.

**Modifications**

Initial construction used the same relative position of the parts in the gin stand as they were 12-inch saw gin developed in the laboratory. The layout was scaled up approximately 33 percent to fit the 16-inch saw size with the parts in the same angular position in relation to the gin saw. Testing showed that changes in the position and shape for the outer front parts of the gin stand were necessary to get high performance comparable to the original 12-inch stand in the laboratory. A problem was that the gin ribs in the Continental 141 saw gin stand have a much different shape for the lower half compared to the 12 inch saw gin. The Continental ribs bend at about a 3-inch radius above the saw mandrel and then drop straight down. Friction pulled lint between the side of saw and rib up against the vertical part of the rib and built up wads there that would finally move up enough to be caught by the paddle roll and pulled on through the ginning point. This caused impact and rumble that could damage the gin as the wads went around the roll. The wads also put pressure on the saws causing them to lean sideways and hit some of the seed fingers which operate between the saws. The seed fingers were made from aluminum which was non-sparking and softer than the saw to minimize damage in case of wads. Some of the tip ends of the seed fingers got trimmed off but it was also not good for the saw teeth. It became evident that there is interaction between the seed finger roll and lower end of the gin ribs in the original machine in the laboratory, that was lost when the seed finger roll and lower edge of the front roll box was placed below the bend in the ribs in the 16-inch saw machine by keeping the same angular placement with respect to the saw. This was solved in two steps. First the lower edge of the front roll box was moved up about 4 3/8 inches to get above the bottom of the rib bend. This improved operation but more was needed. The second change was accomplished by rotating the lower part of the front sheet to get a more upward flow of the cotton in the seed roll as it came off the front onto the saw. The seed finger roll was then moved up closer to the bottom edge of the front sheet.

**Final Design**

The changes resulted in the lower front of the roll box being reshaped and repositioned to have about the same distance with respect to the lower part of the seed roll and saw as the 12-inch gin rather than being in the same relative angular position. The seed finger roll was moved up along with the lower front so that it touched the cotton seed roll in the gap between the tip of the lower gin front and the saws. This demonstrated that position of the seed finger roll in relation to the lower part of the gin ribs is very important.

**Design Conclusions**

The changes required to get the gin stand operating efficiently showed that the important factors are size and position of the operating elements, with respect to the active part of the saw and ribs. Saw size and angular position around the saw were relatively unrelated to efficient performance since the final configuration of the 16-inch saw machine had about the same length of saw periphery in contact with the seed roll as the 12-inch saw machine. Seed finger roll size was increased by a factor of about 33 percent, to 7 inches diameter compared to 5.5 inches for the 12-inch saw machine, and one finger was added to give a six finger roll. The optimum operating speed for the larger seed finger roll was found to be around 30 rpm compared to 7 to 13 rpm for the smaller roll in the 12-inch gin stand. The general conclusion was that size, shape, and position of the ribs, seed finger roll and roll box as well as relative speeds needs more study.

## Results

Preliminary operating tests with the final version of the 16-inch saw machine indicated that it was a powered paddle roll gin stand that ginned efficiently with advantages in turnout, ginning capacity and fiber properties. The gin stand was operated for the season in tandem with two unmodified gin stands in the gin plant. The experimental gin stand handled about 12,000 to 13,000 bales. A late season testing program was conducted to determine the effects on fiber quality, turnout, and ginning capacity for the powered roll gin stand compared to the unmodified Continental 141 saw gin stands operating in parallel with the test stand. The gin saws at that point had ginned about 7,000 bales on each stand. Replicated ginning tests exploring paddle roll and seed finger speeds at two gin saw speeds were done to develop data for Greg Holt to use in multi variate analysis of turnout, ginning rate, and HVI and AFIS fiber quality measurements to find optimized combinations for the gin stand operating parameters. Two optimum setups were identified based on slightly different subsets of the fiber and operating measurements, and a replicated test was conducted to evaluate these setups. The sample data and the final results from these tests will be reported later when it becomes available.

**Fiber Length Effects**

Initial fiber data obtained from this field test show that the experimental gin stand can be operated in a manner to better preserve the fiber length properties. Operating relationships in the powered roll gin stand between paddle roll, seed finger, and saw speed can be tuned to optimize fiber properties yet maintain high turnout and ginning rate. Results of multivariate studies on the 12-inch model in the ginning laboratory reported by Holt, et.al. showed that the optimum combination of operating variables in the gin stand varies with subsets of performance, AFIS and HVI measurements. The most optimum combination depends on which variables are given the most emphasis or greater weighting. The results were dominated by fiber length measurements but turnout and ginning rate are also important to the ginner and producer. This opens up the possibility of customized gin stand operation tailored to give maximum production while maintaining fiber quality for specific mill requirements. An example of the potential is illustrated in figures 1 and 2 which are fiber array data for simultaneous samples taken from each gin stand operating side by side on the same cotton. This data is from two modules ginned during the earlier test operation. Figure 1 is a length by weight array of the fiber distribution for lint samples from the experimental and conventional gin stands operating side-by-side on the first module. The experimental gin stand gave a higher proportion of fiber in the 1-inch and slightly longer fractions, and less fiber in some of the shorter length fractions. Figure 2 is a length by number array for samples from the second module and shows that the relative number of fibers in the middle upper length fractions increased and the number in shorter fractions decreased. AFIS and HVI data for these two test runs are given in table 1. Length measurements tended to be slightly better for the experimental gin stand but were inconsistent between AFIS and HVI on the second module. These test runs were from early in the gin stand test program before we had done much optimization of the operating parameters. Two extensive tests of combinations of ginning operating parameters were conducted and multivariate analysis on data from the first test indicated two optimum configurations that were evaluated in the second test. Evaluation of the samples from these tests is underway and the results will be reported later.

**Ginning Capacity**

The laboratory conversion of an old 90 saw gin stand to a powered paddle roll gin stand resulted in a large increase in ginning capacity. The original gin stand was capable of ginning about 2 bales per hour when pushed and after conversion to the powered roll technology can gin over 12 bales per hour easily. We conducted timed runs using paddle roll motor load (amps) as the automatic controller set point for the gin stand feeder to determine the ginning capacity of the experimental 141 saw gin stand. The test was set up to time three consecutive bales with the gin stand feeder control sensing the paddle roll load at a series of increasing set points. This ginning capacity test was conducted late in the season after the automatic control system from the gin lab had been adapted and put into operation for the experimental gin stand at Servico. For most of the season the gin stand was operated under manual control based on a conventional controller following the gin saw motor load. With manual control the ginning rate was 10 to 13 bales per hour, which was the upper limit for the lint cleaner behind the gin stand. The lint cleaner was bypassed for the ginning capacity test. Figure 3 gives the ginning capacity from the timed runs in terms of standard 500 lb bales ginned per hour versus the controller set points at steps from 18 to 29.5 amps. The ginning rate with paddle roll load set at 29.5 amps averaged 17 bales per hour on late season, wet, machine picked cotton. Ginning rate was not linear as the paddle roll amp set point increased but was a better fit to a quadratic function of the amps set point. This agrees with the non-linear relationship of motor power to current draw as a motor approaches full load. The gin stand was ginning with a loose roll but we decided not to go higher because of visible flexing and vibration of the gin rib rail. We used an old style 3 inch by 3 inch angle iron rib rail to build the experimental gin stand, and stiffened it with a piece of 2 7/16-inch shaft welded on for reinforcement. The gin stand can easily gin higher rates but will need a substantial rib rail such as used in the newer Double Eagle and Golden Eagle gin stands to support the cantilever mounted ribs against the steady pressure of the high ginning rate.

**Power Use**

The current draw measured for the powered roll gin saw motor was 69 amps at 11 bales per hour and 77 amps at 17 bales per hour, Table 2. The nameplate on the 125 hp gin saw motor showed 139 amps full load, so the gin saw motor was only lightly loaded at the maximum ginning rate used in the ginning capacity test runs. The saw motors for the two conventional gin stands were indicating about 83 amps at their maximum practical ginning rate of about 11 bales per hour on this wet cotton. The paddle roll motor used 18 amps at 11 bales per hour and 29.5 amps at 17 bales per hour. At similar ginning rates of 11 bales per hour the experimental and conventional gin stands used 5.7 kW per bale (including the power for the paddle roll motor). At 17 bales per hour the experimental gin stand used 4.7 kW per bale which is 1 kW or 17.5 percent less power and was ginning 55 percent faster. The gin stand energy cost savings to a ginner is seven cents per bale at an average electrical charge of $0.07/kWh, but a more significant cost benefit results from operating 55 percent faster. The total variable cost per bale reported in a 2001 ginning cost survey published by Tommy Valco et.al. for a gin in the Southeast region processing more than 40 thousand bales per year was $11.27 per bale, less bagging and ties. A gin stand running at 11 bales per hour would have $123.97 hourly costs. By converting to powered roll gin stand technology running 55 percent faster (17 bales/hour) the per bale cost would be diluted $3.98 per bale assuming that the hourly labor and other costs would not change:

$$\$11.27 - (\$123.97/17) = \$3.98$$

This results in the ginner gaining $4.05 per bale when the seven cent per bale gin stand saw power cost saving is included.

**Automatic Control with Limits**

The automatic control system program has adjustable high limits for saw and paddle roll amp load. Hitting one of the limits stops the feeder until the load drops back within range. We conducted additional timed ginning capacity runs with a module of wet machine stripped cotton and the paddle roll high limit in effect. We set the high limit at steps from 32 to 35 amps and tested at gin stand feeder set points of 30 to 32 paddle roll amps. Figure 4 is a repeat of the previous figure with the added runs with the high limit in effect (triangle symbols) and shows that the high limit worked as intended and kept the gin from overloading. The automatic controller overrode the higher set points because of hitting the high limit and ginning rate stayed within the 15 to 17 bales per hour range although the set point was in the range that would go much higher. The high limit is programmed to work by completely stopping the feed rolls on top of the gin stand feeder and looping for one second intervals until the motor load drops back below the high limit. When the load drops back below the limit control is returned to the modulating control to maintain feeder speed to keep the paddle roll motor load at the set point. The automatic gin stand feeder control also contains a programmable high limit for gin saw motor load which was not tested because saw load never reached motor capacity.

**Lint Turnout**

Replicated tests were conducted to determine lint turnout of the experimental powered roll gin stand compared to the conventional gin stand (stand no. 2) using four modules, broken approximately into halves and weighed, with one half ginned on each gin stand. The first module (No. 12497) was ginned on Nov. 2, 2002 with fairly fresh gin saws and early season cotton, the remaining three modules were ginned on Dec. 11, 2002 after each gin stand had handled about 7,000 bales since changing to new gin saws. The lint turnout results for the standard Continental Double Eagle-141 gin stand and the modified 141saw gin stand with powered paddle roll technology are given in Table 3. The experimental gin stand averaged 2.2 percent points higher turnout than the conventional gin stand for these four modules. The additional turnout ranged from 27.4 to 36.7 pounds of lint per bale using the seed cotton required for a 500 lb bale on the conventional gin stand as the basis. The calculated result for alternatively using the experimental or conventional gin stand on the test modules is given in Table 4. The producer would have benefitted by one bale of lint per module (396 to 664 lbs) through using the new technology gin stand.

## Summary and Conclusions

The research was successful in applying the powered paddle roll technology to a modern gin stand with 16-inch saws and demonstrated that it can maintain fiber quality at a high level compared to the conventional gin stand. The gin stand with powered roll technology was capable of ginning at 17 bales or more per hour on wet late season cotton. The conventional gin stand roll got too tight and stopped on this cotton at about 12 bales per hour. The gin would need to increase lint cleaning capacity to handle the increased output from the powered roll gin stand. Overall ginning cost was lowered through reduced power usage for the gin stand and higher ginning capacity. The powered roll technology gin stand increased average lint turnout more than 2 percent points or over 30 pounds per bale compared to the conventional gin stand. In four test modules the difference in turnout would give the producer one additional bale of lint per module.

The gin stand energy cost savings to a ginner is seven cents per bale at an average electrical charge of $0.07/kWh, but a more significant cost benefit is the fact that the gin operated 55 percent faster. The total variable cost per bale reported in a 2001 ginning cost survey published by Tommy Valco et.al. for a gin such as this in the Southeast region and processing more than 40 thousand bales per year was $11.27 per bale, less bagging and ties. A ginner operating at this average cost per bale and running a gin stand at 11 bales per hour would have $123.97 hourly costs for that gin stand. By converting to powered roll gin stand technology to run 55 percent faster (17 bales/hour) they would experience $3.98 per bale ginning cost reduction by dilution assuming that the hourly labor and other costs would not change:

$$\$11.27 - (\$123.97/17) = \$3.98$$

This results in the ginner gaining $4.05 per bale when the seven cent per bale gin stand saw power cost saving is included. If the gin experienced a proportional increase in annual volume because of the higher ginning rate it would also dilute the variable and fixed costs that are not seasonal. Depending on the individual plant configuration there could also be other costs to be recovered for upgrading the overhead, lint cleaners and press to handle the increase in processing rate.

Currently this technology has been licensed to PRT Inc. and will be commercially available to ginners in the 2003 season on a limited basis. The first commercial version for the CDE 141 gin stand is being manufactured and the cost is projected be near $30,000.00 per unit. Additional research is needed to determine PR design criteria for gin stands other than the Continental 16-inch saw models. A similar study is being conducted at the Midnight gin in Midnight, MS, using Murray stands with 18-inch saws. The prototypes for 12-inch saw gin stands are being constructed and tested in the Lubbock, TX, ARS Ginning Laboratory.

## References

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Table 1. AFIS fiber test results from the ARS Cotton Quality Research Lab at Clemson, SC and HVI data from Cotton Incorporated for simultaneous samples from two test runs (modules) with the conventional (CDE-141) and experimental (PR) gin stands operating side by side. The numbers in parentheses following the PR gin stand give the paddle roll and seed finger rpm used while ginning on that module.

| Gin stand | Lw in. | UQL(w) In. | SFC(w) %<0.5in | Ln in. | Mat. ratio | Nep cnt/g | Trash cnt/g | VFM % |
|---|---|---|---|---|---|---|---|---|
| Module # 1 | | | | | | | | |
| CDE-141 | 0.93 | 1.13 | 10.1 | 0.75 | 0.94 | 185 | 95 | 2.12 |
| PR (223 30) | 0.94 | 1.14 | 10.1 | 0.76 | 0.91 | 226 | 75 | 1.72 |
| Module #2 | | | | | | | | |
| CDE-141 | 0.90 | 1.09 | 11.4 | 0.72 | 0.92 | 158 | 71 | 1.45 |
| PR (204 30) | 0.95 | 1.13 | 9.1 | 0.78 | 0.91 | 199 | 110 | 2.49 |

**High Volume Instrument Data**

| | MIC | UHM | UI | STR | ELO | Rd | +b | CGRD | AREA % | SFC % |
|---|---|---|---|---|---|---|---|---|---|---|
| Module # 1 | | | | | | | | | | |
| CDE-141 | 3.7 | 1.09 | 82.6 | 28.2 | 5.0 | 70.0 | 8.3 | 41-4 | 1.3 | 9.5 |
| PR (223 30) | 4.0 | 1.10 | 81.7 | 27.0 | 4.8 | 69.7 | 8.4 | 41-4 | 1.1 | 9.1 |
| Module # 2 | | | | | | | | | | |
| CDE-141 | 4.3 | 1.08 | 80.8 | 25.3 | 4.6 | 68.7 | 9.4 | 42-2 | 1.0 | 11.4 |
| PR (204 30) | 4.4 | 1.06 | 80.7 | 24.9 | 5.3 | 67.6 | 9.4 | 42-2 | 1.1 | 12.4 |

Table 2. Average ginning rate, gin saw motor load and total amps load (saw + paddle roll) for a modified 141 saw gin stand with powered roll technology (PR) and two conventional Continental Double Eagle 141 gin stands (CDE-141). The CDE stands were operated at their maximum practical rate for the cotton condition and the PR gin stand was operated at ginning rate settings of 18 to 29.5 amps based on the gin stand feeder control regulating feed rate to maintain the paddle roll motor amps at the setting. The data for the PR gin stand are averages of three timed runs at each feed rate setting.

| Gin stand | Paddle roll amp setting | Measured Saw load amps | Average ginning rate, bales/hr | Total amps saw + PR | Power use rate kWh | Gin Power use kW/bale | $/bale at $0.07 per kWh |
|---|---|---|---|---|---|---|---|
| PR | 18 | 69 | 11.6 | 87.7 | 66.4 | 5.7 | 0.40 |
| PR | 19 | 71 | 11.8 | 90.0 | 68.1 | 5.8 | 0.41 |
| PR | 21 | 70 | 12.2 | 91.7 | 69.4 | 5.7 | 0.40 |
| PR | 23 | 71 | 12.7 | 94.0 | 71.1 | 5.6 | 0.39 |
| PR | 25 | 72 | 13.4 | 97.3 | 73.7 | 5.5 | 0.39 |
| PR | 27 | 73 | 15.1 | 100.7 | 76.2 | 5.1 | 0.36 |
| PR | 28 | 74 | 15.7 | 103.3 | 78.2 | 5.0 | 0.35 |
| PR | 29 | 77 | 16.1 | 106.0 | 80.2 | 5.0 | 0.35 |
| PR | 29.5 | 77 | 17.0 | 106.5 | 80.6 | 4.7 | 0.33 |
| CDE-141 | na | 83 | 11.0 | 83.0 | 62.8 | 5.7 | 0.40 |

Table 3. Turnout results for a standard Continental Double Eagle-141 gin stand and the modified 141saw gin stand with powered paddle roll technology. The test was conducted using four modules, broken into weighed halves with one half ginned on each gin stand. Module 12497 was ginned on Nov. 2, 2002 with fairly fresh gin saws and early season cotton, the remaining three modules were ginned on Dec. 11, 2002 after each gin stand had handled about 7,000 bales since new saws were installed on the saw cylinder.

| Module number | Gin stand | Raw cotton lbs. | Lint yield lbs. | Lint turnout % | Raw cotton /500 lb bale lbs. | Lint gain by Exp. gin lb/bale |
|---|---|---|---|---|---|---|
| 12497 | CDE | 15020 | 5009 | 33.35 | 1499 | |
| | PR | 12100 | 4332 | 35.80 | 1397 | 36.7 |
| 14331 | CDE | 10800 | 3679 | 34.06 | 1468 | |
| | PR | 11500 | 4132 | 35.93 | 1392 | 27.4 |
| 14348 | CDE | 9020 | 3317 | 36.78 | 1360 | |
| | PR | 9980 | 3878 | 38.86 | 1287 | 28.3 |
| 14352 | CDE | 11000 | 4003 | 36.39 | 1374 | |
| | PR | 9800 | 3800 | 38.78 | 1289 | 32.8 |

Table 4. Turnout and lint produced from the four test modules if all of it was ginned on either the standard Continental Double Eagle-141 gin stand or the experimental powered paddle roll 141saw gin stand, and the additional lint that would have resulted for ginning all of the module in the experimental powered roll gin stand.

| | | Turnout | | Calculated lint weight, for: | | Lint gain/module by PR gin lbs |
|---|---|---|---|---|---|---|
| Module number | Module weight lbs. | For Exp. % | For CDE % | PR gin lbs | Conv. gin lbs. | |
| 12497 | 27,120 | 35.80 | 33.35 | 9709 | 9045 | 664 |
| 14331 | 22,300 | 35.93 | 34.06 | 8012 | 7596 | 416 |
| 14348 | 19,000 | 38.86 | 36.78 | 7383 | 6987 | 396 |
| 14352 | 20,800 | 38.78 | 36.39 | 8065 | 7569 | 496 |

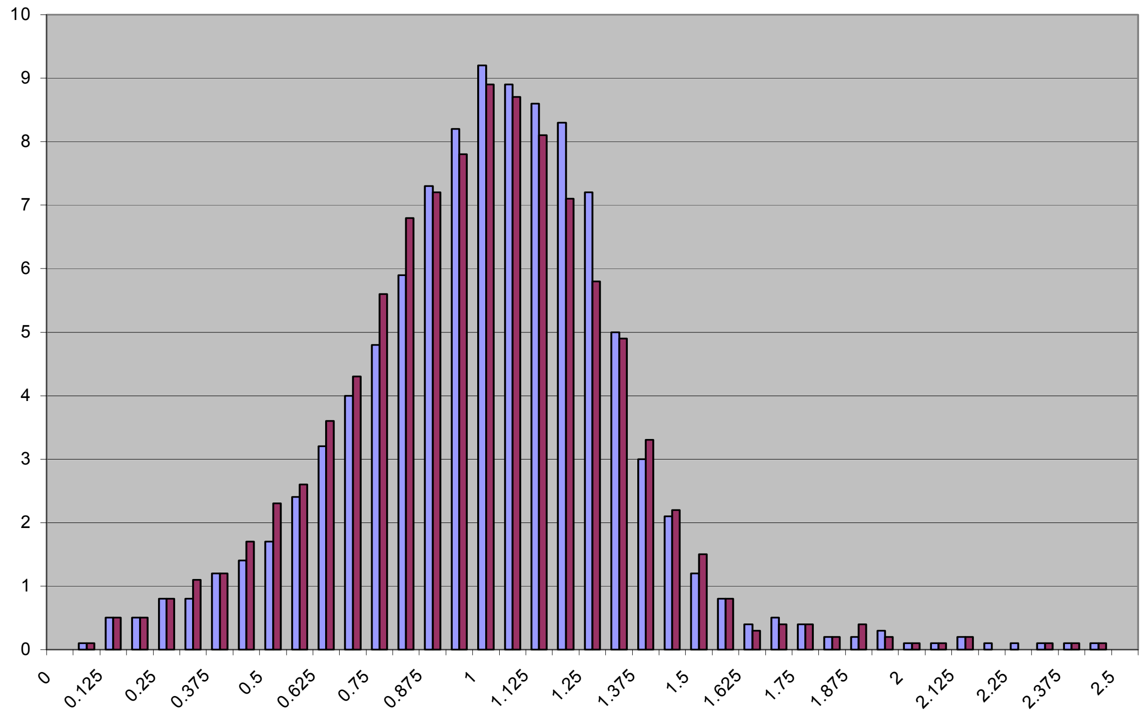


Figure 1. Fiber length array, AFIS length by weight, falling into 1/32-inch length categories for fiber samples taken concurrently from the conventional and experimental gin stands ginning side-by-side on the same module. Blue bars (left) represent lint from the experimental powered paddle roll gin stand and red bars (right) represent lint from the conventional gin stand.

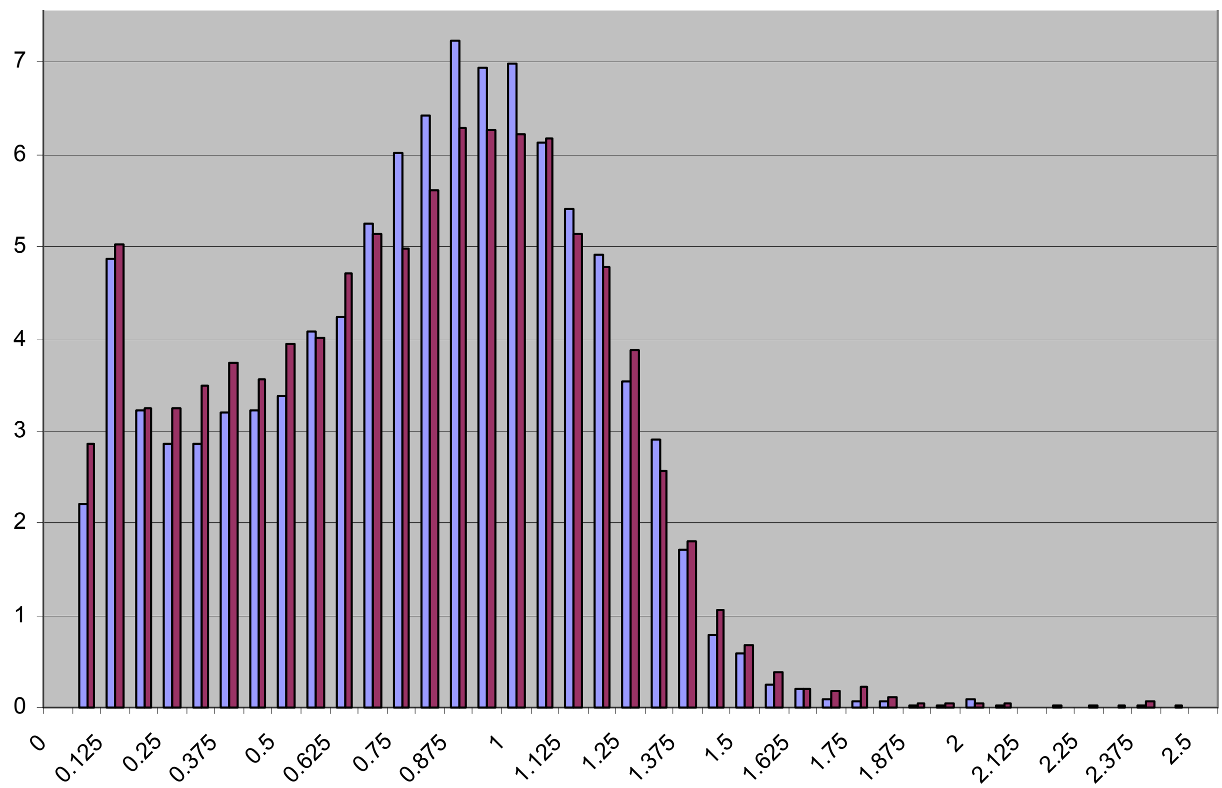


Figure 2. Fiber length array, AFIS length by number, falling into 1/32-inch length categories for fiber samples taken concurrently from the conventional and experimental gin stands ginning side-by-side on the same module. Blue bars (left) represent lint from the experimental powered paddle roll gin stand and red bars (right) represent lint from the conventional gin stand.

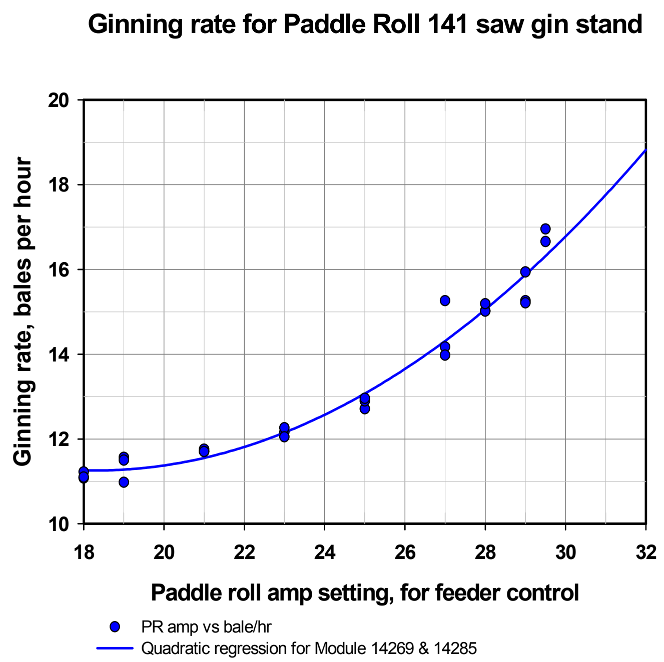


Figure 3. Ginning rate, bales per hour, for the experimental powered paddle roll 141 saw gin stand with the automatic feeder control following paddle roll motor amps load for set points from 18 to 29.5 amps. From one bale timed runs, replicated 3 times and corrected to 500 pound bale weight.

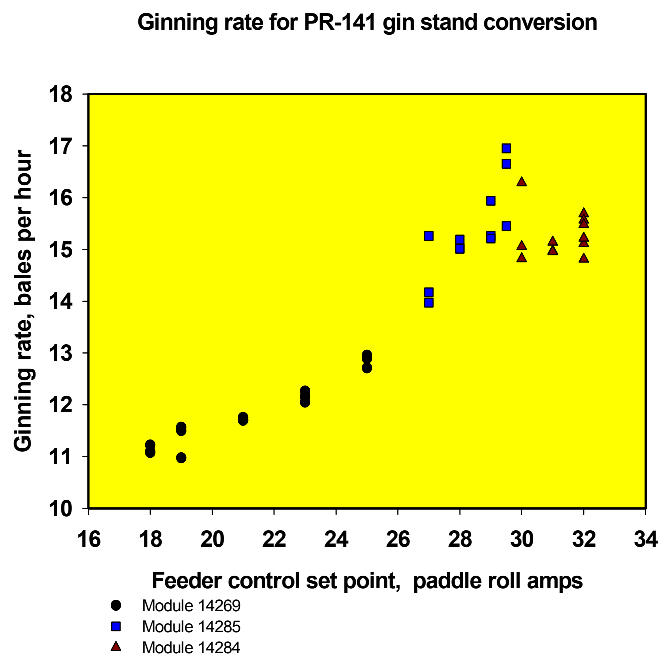


Figure 4. Ginning rate, bales per hour, for the experimental powered paddle roll 141 saw gin stand with the automatic feeder control following paddle roll motor amps load. Repeated from figure 3 with an additional set of runs (Module 14284) with a high limit of 32 to 35 amps for paddle motor amps in effect at set points of 30 amps and higher. From one bale timed runs, replicated 3 times and corrected to 500 pound bale weight.