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Application of Powered Roll Gin Stand Technology to Gin Stands with Large Diameter Saws.

Weldon Laird, Agricultural Engineer

Greg Holt, Agricultural Engineer

Mike Buser, Agricultural Engineer

USDA-ARS, Rt 3 Box 215, Lubbock, TX.

James Askew, Agricultural Engineer

Servico, Courtland, AL.

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Abstract. _Field trials were used to prepare powered roll gin stand technology for transfer from the laboratory to modern commercial gin stands with large diameter saws. Test units were built to scale up the configuration developed on the 12-inch saw gin stand in the laboratory to fit modern gin stands with 16-inch and 18-inch diameter saws. The objective was to design and build powered roll fronts for the larger gin stands, test them in commercial operation, develop solutions to any problems and build smooth running equipment that saved all of the lint and preserved fiber quality. This included developing retrofit kits for existing gin stands that were economical to install and operated efficiently. The work resulted in powered paddle roll conversions for the 16-inch and 18-inch saw gin stands with significant operating performance and fiber quality advantages compared to unmodified gin stands. Determining the shape, size, and position of the gin stand parts was an empirical trial and error procedure requiring expensive and time consuming manufacture of machine parts. There is a wide range of these factors to be explored for the new powered paddle roll technology. The gin stand has several operating speed and load settings that were examined using analytical response surface experimental designs to look for optimized configurations. Work is going on in both the mechanical design and operating control areas concurrently. The current design of the experimental gin stand is being transferred into retrofit kits for the existing equipment in commercial gins and a technology transfer program to provide it to the industry is underway._

Keywords. Gin stand, saw gin, cotton quality,

Introduction

Laboratory ginning tests utilizing a new type of saw gin stand with a powered roll driving the seed roll and a rotating seed finger controlling cleaning and discharge of the seeds showed that it was capable of producing over two percentage points higher turnout from seed cotton compared to a modern high capacity gin stand, (Laird, Holt, and Lalor, 2001). A patent (Laird, 2000) was obtained through the USDA-ARS patent division covering the powered paddle roll gin stand technology. Laboratory research results with a 12-inch diameter saw gin stand showed that approximately 7 percent more lint (35 pounds per bale) was ginned from the seed cotton by the new technology. The experimental gin stand preserved fiber quality and staple length while running at higher ginning rates and using less power per bale ginned. A series of design modifications using the 12-inch diameter saw gin stand in the laboratory showed that the shape and position of the roll box, paddle roll, and seed finger roll were critical factors in obtaining high performance and optimum fiber quality and turnout, (Laird, Holt and Wedegaertner, 2000). Relative operating speeds of the saw, paddle roll and seed finger roll were also important. Optimum combinations of operating variables based on eleven response variables related to fiber quality, turnout, and processing rate were determined through the use of response surface testing and Taguchi's method, (Holt, Laird and Wedegaertner, 2002).

The USDA-ARS ginning laboratory at Lubbock, Texas, originally developed the new saw gin stand to regin cottonseed and remove residual long fiber on cotton seed. This was done to prevent entanglements that produced large clumps of cottonseed and wrapped up on the mixing machinery when a wet gelatinized starch paste was applied to make free flowing **EASI***flo*™ coated whole cottonseed. This project was a cooperative research agreement between Cotton Incorporated and the ginning laboratory. Fiber quality tests (Laird et al. 1999) showed that lint from reginning cottonseed had properties similar to that of Texas cotton measured in a survey by the Texas Tech University International Textile Center. Reginning typically yielded lint amounting to 2 to 3 percent of the seed weight, which equates to about 15 to 25 pounds per bale. Average U.S. cottonseed production of 6.8 million tons per year indicates about 544,000 to 816,000 bales of staple length lint is left on the cottonseed each year. This is a substantial amount of lint lost by producers and represents a significant monetary value.

Objective

The work reported in this study was done to prepare the technology developed in the laboratory for transfer to modern commercial gin stands with larger diameter saws. The main objectives were to design and build powered roll fronts for the larger gin stands, test these in commercial operation, identify any problems and develop solutions. The goals were to develop smooth running equipment that fully cleaned the seeds of staple length lint giving high turnout, and preserved fiber quality at a high level as had been done in the laboratory gin stand with 12-inch diameter saws. The objective included developing retrofit kits that were economical to install and operated efficiently, to fit existing gin stands.

Procedure

The work to transfer the powered roll technology to gin stands with large diameter saws was done in the field because the laboratory gin did not have the necessary equipment. The first test unit built was a scale up of the configuration developed on the 12-inch saw gin stand in the laboratory to fit a modern gin stand with 16-inch diameter saws. The shape and mechanical construction of the ginning ribs and roll box in the 16-inch saw gin stand were different from the older model 12-inch saw gin used to develop the pilot model in the laboratory. The site for field trials with this unit was Servico Gin in Courtland, AL. A series of ginning trials were used to check performance of the field unit. The shape and position of the roll box and position of the seed finger roll were determined to be vitally important because the first configuration which was attempted resulted in wad development and poor ginning performance. This unit was rebuilt twice to modify the shape and position of the lower front of the roll box, and the seed finger roll position, and operated for the full season, ginning about 12,500 bales. Experiments were conducted evaluating operating parameters and the gin stand was modified until it evolved into an effective and efficient design. Some of the performance results from this test program were reported in the 2003 Beltwide Cotton Production Research conferences (Laird and Holt. 2003).

Another test unit sized for a gin stand with 18-inch diameter saws was built and then installed at the end of the season in a commercial gin plant with three Murray 142-18 gin stands. The field site for this test was Midnight Gin at Midnight, MS. The roll box and rib configuration in the 18-inch saw gin stand was more similar to that of the 12-inch gin stand but the dimensions were 50 percent larger. Extreme wet weather caused severe problems harvesting and ginning the 2002 crop in Mississippi where this test gin was located, but late in the season dry weather allowed saving several modules of cotton that was used to conduct a series of tests in December 2002 and January 2003. After only a few hours of operation this unit was modified based on the experience from testing with the 16-inch version.

Results

Test operation of the 16-inch saw version of the powered roll gin stand revealed problems because the layout was scaled up approximately 33 percent to fit the 16-inch saw size, leaving the parts in the same relative angular position around the gin saw. Friction between the sides of the saws and lint caused lint to be dragged through the gap between the saw and rib, creating wads that lodged along the lower part of the rib rather than moving on around to the gin point. These wads forced the saws to bend sideways rubbing the rib and hitting the seed fingers, damaging the saw and seed finger. The wads would build up then gradually move until caught by the paddle roll which pulled them on through the ginning point. This caused a considerable jar to the saw and ribs. A root cause of the problem was that the shape of the ribs in the 16-inch saw gin stand is much different along the lower half compared to the 12-inch saw gin. The ribs in the 16-inch saw gin bend at a 3-inch radius near the midpoint above the saw mandrel and then drop straight down. The shape of the rib created a relative motion between the side surface of the saw that dragged lint through the gap between the saw and rib before the gin point.

Interaction between the seed finger roll and lower end of the gin ribs occurring in the original laboratory machine 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. This was partly a result of keeping the same angular placement with respect to the saw. The gin front was modified twice to solve the problem. In the first modification the lower edge of the front roll box and the seed finger was moved up about 4-3/8 inches to position it about even with the bottom of the rib bend. This change improved operation but testing indicated that more repositioning was needed. The lower part of the outer front was then moved up about 3 more inches and rotated to get a more horizontal flow of the cotton in the seed roll as it transferred from the front onto the saw. The seed finger roll was moved up another 1-1/2 inches but observation indicated it should be closer to the bottom edge of the front sheet for better contact with the seed roll as it transfers from the front sheet onto the saw.

After the gin front had been modified into what was considered a workable configuration, a series of ginning tests were carried out to evaluate turnout, ginning capacity and fiber quality. The new gin stand has the capability for adjusting ginning rate, saw speed, paddle roll speed, and seed finger speed independently and laboratory tests had indicated that all of these adjustments can affect the results obtained. Fiber quality results for two paddle roll/seed finger roll speed combinations were reported at the 2003 Beltwide Cotton Research Conference, (Laird and Holt, 2003). A multivariate response surface experiment was designed to explore a range of all the operating variables to look for optimized combinations. The testing was designed to use simultaneous side-by-side operation of the experimental and standard gin stands on the same cotton stream to allow evaluation of the various experimental gin setups with the standard gin stand for a control. The experimental design was set up as a multivariate central composite response surface type test to allow use of statistical modeling to find optimum gin stand setups based on the ginning test results.

The response surface for the experimental gin stand used five paddle roll speeds and five seed finger speeds in a central composite rotatable design. These treatments were randomly selected using unbalanced combinations within two blocks and repeated three times. Each block of five treatments required one module of cotton. The treatment containing the central combination of paddle roll and seed finger speeds was included three times in each block or module. Six modules of cotton were necessary to conduct the test and fiber properties varied between these modules. Five lint samples were taken simultaneously behind each gin stand before lint cleaning on each treatment. The experimental gin saw speed was 615 rpm in the first replication and 721 rpm in the second and third reps. The conventional gin stand was operated with the standard recommended conditions throughout the test. Each gin stand was operated at 11 to 12 bales per hour ginning rate during the test.

The data comparing HVI fiber length properties for the two gin stands across the various combinations of operating settings for the experimental gin stand is summarized in table 1. The data in table 1 was normalized to remove the effect of variation between modules by dividing the mean values for the test treatments by the mean values for each module obtained from the standard gin stand operated and sampled in parallel with the experimental gin stand during the test. Values for fiber upper half mean (UHM) and uniformity greater than one in the table and for short fiber less than one indicate that the result for that treatment on the experimental gin stand was better than for the standard gin stand. The test results indicated potential for better fiber quality using the new gin stand technology, and response surface modeling of the data was used to estimate the optimum setup of the operating variables. The multivariate response surface procedure groups the data into subsets having a similar effect on response, and then estimates the optimum levels of the operating variables for each subset of response measurements. It is possible to use weighting or other data adjustment procedures to force desired variables into the optimization set, but that is beyond the scope of the current work. Two optimum setups were identified based on subsets of HVI and AFIS fiber quality measurements, and tests were conducted to evaluate both of these setups compared to the standard gin stand. Since that time, the gin has been modified further and research planned to repeat the optimization procedure.

Mean values, standard deviation, and minimum and maximum values for HVI upper half mean, length uniformity and short fiber content for the modules obtained from the samples ginned on the standard Continental Double Eagle 141 gin stand are given in table 2. The parallel mean values for all of the treatment combinations on the experimental gin stand are given in table 3. Some general conclusions from the data are that the experimental gin stand tends to have a more consistent standard deviation within a treatment and have less range of minimum and maximum values obtained compared to the conventional gin stand. Higher saw speed gave better fiber quality results. This is consistent with data from the laboratory experiments with the 12-inch saw machine. However, more research needs to be done to determine how high of a saw speed can be maintained within the physical capabilities of the machinery and still maintain favorable fiber quality and lint turnout.

Additional ginning trials comparing the powered roll gin stand to the standard gin stand showed that it gave significantly better lint turnout. We have not had the opportunity to include turnout, ginning cost, and dollar value in the optimization of the gin stand operation at this point. There are apparently several other factors that interact with operation of the gin stand such as variety differences, harvest method, moisture and trash content that need to be explored and economical tradeoffs developed.

Evaluation of the 18-inch saw gin stand conversion benefited from the experience with the 16-inch saw model. We did not have much time for testing this gin stand because of the limited time left at the end of the ginning season when we were able to install it and do the tests. We only needed a short set of evaluation runs before deciding to stop and rebuild it to reposition the gin front and the seed finger roll. Late in the season there was only a limited amount of cotton, so we were unable to conduct the multivariate testing needed for optimization of the operating parameters. We ran replicated side-by-side performance tests using five modules comparing the experimental gin stand at two paddle roll speeds to the standard Murray 142-18 gin stands. The paddle roll speeds were similar to those from the optimization done with the 16-inch saw gin. Fiber quality effects for this gin stand essentially showed no difference between paddle roll speeds or the experimental and standard gin stands, Table 4. Analysis of variance showed none of the important HVI or AFIS fiber length properties were different between gin stands or treatments, however, the experimental gin stand operated at 8 to 10 bales per hour on the wet cotton while the standard gin stand operated at 5 to 8 bales per hour. The late season wet and water damaged cotton was not suitable for making a viable comparison of turnout for the gin stands. A significant finding was that the new gin stand with the automatic control system in operation was able to handle wet cotton with soft rotten seeds that bogged down the conventional gin stands almost immediately.

Test results for the experimental powered roll conversions of both gin stand sizes showed that the shape and position of the gin front, seed finger roll and ginning ribs are critical in obtaining satisfactory performance. The field modifications enabled ginning performance that was significantly better compared to the unmodified gin stand, but observation convinced us that further modification was needed. This is essentially a trial and error process as there is no analytical method for determining ideal configuration of these shape and size factors. We were only able to do a limited amount of change in the field, so the gin fronts were returned to the shop after the season and redesigned and new parts have been manufactured. At this point the physical design for these gin stands is probably near optimum within the constraints posed by the existing gin frame and rib designs.

The configuration of the saw and rib from the laboratory gin stand and the two larger gin stands are shown to scale in figure 1. The lower end of the ribs traditionally drops away to allow seeds to drop out of the gin by gravity. With the seed finger roll added in the experimental gin stand to handle discharge of the seeds this part of the rib very likely needs to be redesigned. The included angle between the point where the saw periphery passes the tip of the seed finger roll to where it crosses the rib at the gin point is 83.5 degrees in the laboratory 12-inch saw gin stand, 81.5 degrees in the current revision of the 16-inch saw gin and 86.4 degrees in the current 18-inch saw gin. The gin rib shape seems to be the main reason for the difference in angle. The length of saw exposure was 8.7 inches in the 12-inch saw gin, 11.4 inches in the 16-inch saw gin, and 13.6 inches in the 18-inch saw gin. This is only about 23 or 24 percent of the saw circumference.

We shaped the front and lower section of the roll box to use more of the saw in the initial design for these units in hopes of getting more saw teeth on the larger saw exposed to the cotton in the roll box. We believed this would increase efficiency, but tests showed that more saw exposure caused problems with wads forming against the ribs if the lower front sheet was too far from the paddle roll. Repositioning the lower part of the front roll box and seed finger roll in a series of steps showed that the shape and position of these elements is very important to ginning performance. This was an empirical trial and error procedure but resulted in a design for the current revision of these two gin fronts that operates very efficiently and is considered ready for commercial adoption. We plan to further explore the effects of shape and position using a set of fronts with four position/shape factors in a replicated series of ginning tests on a 12-inch saw unit that has been built in the laboratory gin.

Conclusion

The field trials and development work resulted in designs for powered paddle roll conversions for the 16-inch and 18-inch saw gin stands that have significant operating performance advantages and also preserve fiber quality at a high level. Deciding the shape, size, and position of the physical elements of the gin stand is an empirical trial and error procedure requiring expensive and time consuming manufacture of machine parts, and there is a wide range of these factors to be explored for the new powered paddle roll technology. The gin stand has several speed and load settings that can be examined using analytical response surface experimental designs to find optimized configurations. Work in both the mechanical design and operating control areas concurrently has resulted in a Powered Roll gin stand conversion kit for both the 16-inch and 18-inch saw models that is ready for commercialization. It is possible to link the dollar value of fiber quality, turnout, and gin costs in the analytical model to optimize for maximum economic return to the industry and plans are being formulated to expand the research into this area. The current design of the experimental gin stand is being used to create retrofit kits for the existing equipment in commercial gins and a technology transfer program is underway to provide it to the industry.

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Disclaimer

Commercial brand names are included in this paper to give precise information and do not indicate recommendation or endorsement by USDA-ARS over other similar products.

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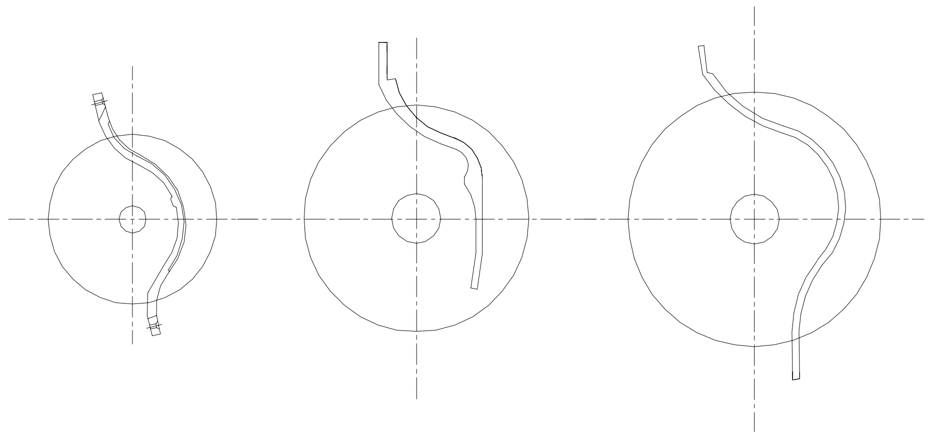

Figure 1. The saw and rib combinations for the twelve, sixteen and eighteen-inch saw types of gin stands that were tested in the powered roll gin stand research program.

Table 1. HVI Upper Half Mean, Uniformity and Short Fiber content for several operating speed combinations of the experimental 16-inch saw gin stand, expressed as the ratio to the module mean for a conventional gin stand running in parallel with the powered roll gin stand, for a range of seed finger and paddle roll speeds, and two saw speeds in the experimental gin stand.

Saw rpm.	Paddle Roll rpm.	Seed Finger rpm.	Module no. and cotton variety	No. of reps.	UHM, ratio.	Uniformity, ratio.	Short fiber, ratio
615	165	20	11273 DPL-451	5	0.996	0.998	0.986
	175	10	11270 DPL-451	5	0.990	0.994	1.019
		30	11270 DPL-451	5	1.001	1.001	0.999
	200	6	11273 DPL-451	5	0.983	0.994	1.037
		20	11270 DPL-451	15	1.003	0.993	1.012
		20	11273 DPL-451	15	1.000	0.993	0.985
		35	11273 DPL-451	5	0.994	0.989	1.024
	225	10	11270 DPL-451	5	0.992	0.996	1.026
		30	11270 DPL-451	5	1.003	0.996	0.963
	235	20	11273 DPL-451	5	0.994	0.995	0.946
721	165	20	11572 DPL-451	3	1.008	1.005	0.944
	175	10	11562 DPL-451	3	1.011	1.013	0.913
		30	11562 DPL-451	3	0.996	0.998	1.003
	200	6	11572 DPL-451	3	0.999	1.003	0.991
		20	11562 DPL-451	9	1.009	1.006	0.998
		20	11572 DPL-451	9	1.006	1.009	1.033
		35	11572 DPL-451	3	0.996	1.003	1.055
	225	10	11562 DPL-451	3	1.017	1.022	0.954
		30	11562 DPL-451	3	1.005	1.019	0.936
	235	20	11572 DPL-451	3	0.993	1.002	1.018
721	165	20	13832 DPL-436	5	1.001	1.005	0.914
	175	10	13833 DPL-436	5	0.998	1.004	0.984
		30	13833 DPL-436	5	1.018	1.009	0.888
	200	6	13832 DPL-436	5	1.010	0.997	0.956
		20	13833 DPL-436	15	1.004	0.998	0.940
		20	13833 DPL-436	15	1.004	1.002	0.973
		35	13832 DPL-436	5	1.023	1.010	0.833
	225	10	13833 DPL-436	4	0.993	1.007	1.020
		30	13833 DPL-436	5	1.009	1.001	0.979
	235	20	13832 DPL-436	5	1.002	0.995	0.990

Table 2. Module mean for HVI fiber properties of samples ginned in the Standard Continental Double Eagle 141 gin stand operating simultaneously with the experimental gin, for six modules used in testing the experimental 16-inch saw gin stand.

Module	Variable	N	Mean	Std Dev	Min	Max
11270	UHM	35	1.0566	0.0170	1.0200	1.1100
	UI	35	82.366	0.6646	81.000	83.900
	SFC	35	11.189	0.7756	9.8000	12.800
11273	UHM	35	1.0523	0.0144	1.0100	1.0800
	UI	35	82.417	0.6793	80.800	83.200
	SFC	35	11.780	1.0530	9.9000	14.300
11562	UHM	7	1.0814	0.0261	1.0300	1.1100
	UI	7	80.571	1.1427	79.400	82.500
	SFC	7	12.957	1.5065	11.000	15.400
11572	UHM	7	1.0743	0.0223	1.0500	1.1200
	UI	7	80.257	1.0486	78.700	81.700
	SFC	7	13.457	0.9502	12.000	15.100
13832	UHM	35	1.0914	0.0197	1.0400	1.1300
	UI	35	82.311	0.6225	80.900	83.500
	SFC	35	11.134	0.7577	9.7000	13.100
13833	UHM	35	1.0980	0.0151	1.0500	1.1300
	UI	35	81.940	0.6647	80.200	83.400
	SFC	35	10.829	0.7168	9.1000	12.200

Table 3. Mean HVI fiber length measurements for samples from the experimental 16-inch saw powered roll gin stand for a series of combinations of saw speed, seed finger speed, and paddle roll speed, spread out over six modules of cotton.

---------------------------- **Module 11270** ----------------------------

saw rpm	SF rpm	PR rpm	Variable	N	Mean	Std Dev	Min	Max
615	10	175	UHM	5	1.0460	0.0167	1.0300	1.0700
			UI	5	81.840	0.3782	81.400	82.400
			SFC	5	11.400	0.4848	10.600	11.800
		225	UHM	5	1.0480	0.0130	1.0300	1.0600
			UI	5	82.000	0.4528	81.300	82.400
			SFC	5	11.480	0.5119	11.000	12.300
	20	200	UHM	15	1.0600	0.0193	1.0300	1.1000
			UI	15	81.820	0.7930	80.100	83.300
			SFC	15	11.320	0.9390	9.6000	13.300
	30	175	UHM	5	1.0580	0.0164	1.0400	1.0800
			UI	5	82.480	1.1454	81.400	84.200
			SFC	5	11.180	0.9230	9.9000	11.900

saw rpm	SF rpm	PR rpm	Variable	N	Mean	Std Dev	Min	Max
		225	UHM	5	1.0600	0.0187	1.0400	1.0800
			UI	5	82.020	0.7727	81.300	83.000
			SFC	5	10.780	0.9935	9.3000	11.800

------------------------------ Module 11273 ------------------------------

saw rpm	SF rpm	PR rpm	Variable	N	Mean	Std Dev	Min	Max
615	6	200	UHM	5	1.0340	0.0114	1.0200	1.0500
			UI	5	81.900	0.6285	81.300	82.800
			SFC	5	12.220	0.8075	11.200	13.200
	20	165	UHM	5	1.0480	0.0084	1.0400	1.0600
			UI	5	82.260	0.4099	81.900	82.800
			SFC	5	11.620	0.4919	11.000	12.100
		200	UHM	15	1.0520	0.0121	1.0300	1.0700
			UI	15	81.853	0.7200	80.700	83.500
			SFC	15	11.600	0.9863	9.5000	13.100
		235	UHM	5	1.0460	0.0089	1.0400	1.0600
			UI	5	82.020	0.5630	81.500	82.900
			SFC	5	11.140	1.0040	9.9000	12.000
	35	200	UHM	5	1.0460	0.0114	1.0300	1.0600
			UI	5	81.500	1.0296	79.800	82.500
			SFC	5	12.060	0.7570	10.900	12.900

------------------------------ Module 11562 ------------------------------

saw rpm	SF rpm	PR rpm	Variable	N	Mean	Std Dev	Min	Max
721	10	175	UHM	3	1.0933	0.0153	1.0800	1.1100
			UI	3	81.600	1.6371	79.800	83.000
			SFC	3	11.833	1.1590	10.600	12.900
		225	UHM	3	1.1000	0.0200	1.0800	1.1200
			UI	3	82.367	0.4041	81.900	82.600
			SFC	3	12.367	1.0017	11.600	13.500
	20	200	UHM	9	1.0911	0.0176	1.0600	1.1200
			UI	9	81.022	0.9203	79.500	82.800
			SFC	9	12.933	1.1769	10.900	14.900
	30	175	UHM	3	1.0767	0.0153	1.0600	1.0900
			UI	3	80.400	0.7937	79.800	81.300
			SFC	3	13.000	1.2166	12.200	14.400
		225	UHM	3	1.0867	0.0115	1.0800	1.1000
			UI	3	82.100	0.6557	81.400	82.700
			SFC	3	12.133	0.0577	12.100	12.200

------------------------------ Module 11572 ------------------------------

saw rpm	SF rpm	PR rpm	Variable	N	Mean	Std Dev	Min	Max
721	6	200	UHM	3	1.0733	0.0115	1.0600	1.0800

saw rpm	SF rpm	PR rpm	Variable	N	Mean	Std Dev	Min	Max
			UI	3	80.467	0.3512	80.100	80.800
			SFC	3	13.333	0.4619	12.800	13.600
	20	165	UHM	3	1.0833	0.0306	1.0500	1.1100
			UI	3	80.867	0.9018	80.000	81.800
			SFC	3	12.700	0.9539	11.700	13.600
		200	UHM	9	1.0811	0.0176	1.0600	1.1100
			UI	9	81.000	0.5958	80.300	82.200
			SFC	9	13.900	0.8958	12.800	15.400
		235	UHM	3	1.0667	0.0058	1.0600	1.0700
			UI	3	80.400	0.6000	79.800	81.000
			SFC	3	13.700	0.4583	13.200	14.100
	35	200	UHM	3	1.0700	0.0265	1.0500	1.1000
			UI	3	80.500	0.6928	80.100	81.300
			SFC	3	14.200	0.9539	13.300	15.200

---------------------------- **Module 13832** ----------------------------

saw rpm	SF rpm	PR rpm	Variable	N	Mean	Std Dev	Min	Max
721	6	200	UHM	5	1.1020	0.0179	1.0900	1.1300
			UI	5	82.100	0.6892	81.100	82.800
			SFC	5	10.640	1.1696	9.0000	11.900
	20	165	UHM	5	1.0920	0.0148	1.0700	1.1100
			UI	5	82.720	0.9039	81.500	84.000
			SFC	5	10.180	1.2153	8.4000	11.700
		200	UHM	15	1.0953	0.0168	1.0600	1.1200
			UI	15	82.147	0.8175	80.800	83.600
			SFC	15	10.467	0.9998	9.3000	12.400
		235	UHM	5	1.0940	0.0195	1.0700	1.1200
			UI	5	81.880	0.6140	81.100	82.500
			SFC	5	11.020	1.2133	9.4000	12.200
	35	200	UHM	5	1.1160	0.0261	1.1000	1.1600
			UI	5	83.100	0.5568	82.600	83.800
			SFC	5	9.2800	0.7430	8.3000	10.300

---------------------------- **Module 13833** ----------------------------

saw rpm	SF rpm	PR rpm	Variable	N	Mean	Std Dev	Min	Max
721	10	175	UHM	5	1.0960	0.0152	1.0800	1.1200
			UI	5	82.280	0.8585	81.600	83.700
			SFC	5	10.660	0.5413	10.000	11.300
		225	UHM	4	1.0900	0.0141	1.0700	1.1000
			UI	4	82.525	0.7805	81.400	83.100
			SFC	4	11.050	0.6455	10.400	11.700
	20	200	UHM	15	1.1020	0.0178	1.0700	1.1300
			UI	15	82.113	0.5436	80.900	82.800

		SFC	15	10.540	1.0056	9.1000	13.300
30	175	UHM	5	1.1180	0.0084	1.1100	1.1300
		UI	5	82.680	0.6834	82.000	83.800
		SFC	5	9.6200	0.4868	9.1000	10.300
	225	UHM	5	1.1080	0.0130	1.0900	1.1200
		UI	5	82.060	0.3912	81.700	82.700
		SFC	5	10.600	0.5831	10.100	11.500

Table 4. Mean HVI fiber length data for the experimental and standard 18-inch saw gin stands operating side-by-side on the same five modules of wet late season cotton, using two paddle roll speeds in the experimental gin stand.

Paddle roll rpm	gin	Variable	N	Mean	Std Dev	Min	Max
185	Murray 142-18	UHM	25	1.0728	0.0221	1.0400	1.1300
		UI	25	83.012	0.9057	81.400	85.400
		SFC	25	10.280	1.0128	8.6000	12.200
	Experimental	UHM	24	1.0867	0.0137	1.0700	1.1200
		UI	24	83.129	0.6849	82.000	84.500
		SFC	24	9.8667	0.7411	8.3000	11.500
205	Murray 142-18	UHM	25	1.0828	0.0146	1.0600	1.1100
		UI	25	83.064	0.7228	81.600	84.400
		SFC	25	10.096	0.7673	8.7000	11.900
	Experimental	UHM	25	1.0780	0.0189	1.0200	1.1200
		UI	25	82.868	0.6694	80.900	84.400
		SFC	25	10.320	1.0190	8.4000	13.500