FIELD EVALUATION OF GINNING SYSTEM UPGRADES

Ross D. Rutherford
Lummus Corporation
Lubbock, TX
Jonathan D. McBride
Silver Creek Gin
Holly Bluff, MS
Benjamin C. McCray
Lummus Corporation
Lubbock, TX
Daniel E. Gonzalez
Lummus Corporation
Buenos Aires, Argentina
Herman D. Wardlaw, Jr.
Lummus Corporation
Memphis, TN

Abstract

The evolution of the end-user market for U.S. cotton from domestic to export textile mills has resulted in the need for gins to re-examine their machinery configurations in order to provide the most flexibility in producing a quality product that meets both the needs of its upstream customer (the farmer) and its downstream customer (the textile mill). A commercial ginning facility in Mississippi, initially constructed in 2001, featuring a machinery processing configuration based on marketplace conditions at that time, installed miscellaneous machinery upgrades to the seed cotton pre-cleaning and lint cleaning systems. Seed cotton and lint cotton samples were taken throughout the pre-cleaning and lint cleaning systems, respectively, to evaluate the various levels of cleaning obtained. Additionally, the finished bales were evaluated with regard to premiums or discounts in the market as a function of bale grade, staple length, and uniformity.

Introduction

Silver Creek Gin in Holly Bluff, Mississippi, constructed an all-new ginning complex in 2001. Actually two complete gin plants under one roof, the facilities are mirror images of each other. Each plant is laid out to be a 4-stand outfit, but each is currently a 2/170 outfit with two stages of single 144" wide pre-cleaning, Super-Jet® and single Sentinel™ saw-type lint cleaning, Moisture Conditioning (MC™) battery condenser, and Premier™ Dor-Les® press with bale handling.

At the time of Silver Creek's construction, the U.S. cotton ginning industry was seeing many gins marketing their cotton to U.S. mills in a "mill-direct" scheme, in which mills would not discount a grade of 41-4. This was done so as to encourage the gins not to over-machine or over-process the cotton. Thus, Silver Creek equipped their plants with what would be considered a minimum amount of pre-cleaning and lint cleaning, as compared to plant layouts of previous years. A photo of the original Silver Creek facility is shown in Figure 1.

Figure 1. Silver Creek Gin during the initial ginning season in 2001.

Over the next decade, end-user cotton markets drastically changed, and much of the U.S. cotton crop that had been going to domestic mills was now being shipped overseas. Many of these foreign mills placed a higher demand on cleaner cotton without excessive fiber damage, so over the years, Silver Creek added to its pre-cleaning and lint cleaning systems. In 2007, the North Plant added a Sentinel™ saw-type lint cleaner in the 1B position, and in 2011, two Model 700 II™ precleaner feeders were installed in the space above the Model 700 II™ extractor feeders (necessitating the raising of the conveyor distributor).

In 2013, the most substantial machinery additions were made, with both plants replacing the Little Giant™ 2-saw stick machines in the first-stage pre-cleaning with Series 2000™ 3-saw stick machines, the South Plant installing Model 700 II™ precleaner feeders, and both plants installing Model 108 controlled-batt, saw-type lint cleaners in the 1B positions. Comparisons of the first-stage pre-cleaning and the second-stage pre-cleaning/lint cleaning are shown in Figures 2 and 3, respectively. The current Silver Creek facility can be seen in Figure 4.

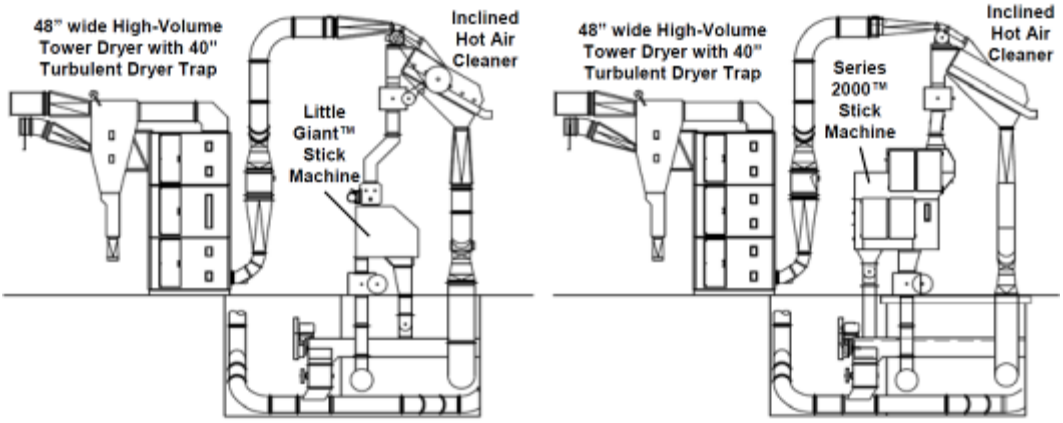

Figure 2. Comparison of original and current first-stage pre-cleaning systems.

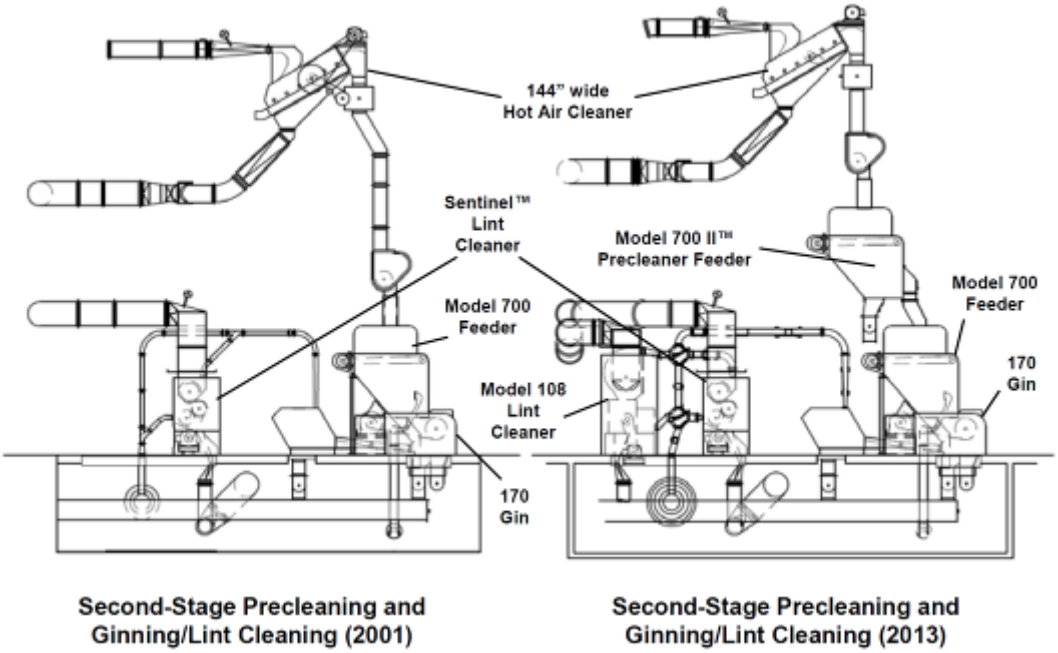

Figure 3. Comparison of original and current second-stage pre-cleaning and lint cleaning systems.

Figure 4. Silver Creek Gin during the 2013 ginning season.

With the completion of the machinery upgrades in 2013, both Silver Creek plants were, once again, identically configured with improved extractor cleaning (the Series 2000™ 3-saw stick machines in the first stage and the Model 700 II™ precleaner feeders in the second stage). The Model 108 lint cleaners in the 1B positions provided additional cleaning and combing of the ginned lint.

To evaluate the performance of the upgraded plants, it was decided to collect samples throughout the ginning systems in order to quantify the various trash types and amounts within the seed cotton and lint cotton. Trash

samples from the new extractor cleaners were analyzed, and residual lint on the ginned seed was quantified. Lastly, the final bale grades were analyzed to determine whether premiums or discounts were applied to the finished bales.

Materials and Methods

Module Type

Silver Creek Gin processes both conventional seed cotton modules and the new round modules produced with the John Deere spindle picker (referred to in this paper as "rounds"). Four "rounds" constitute the equivalent of a conventional module. At the time of the testing, the South Plant was processing conventional modules, while the North Plant was processing "rounds."

Test Protocol

For the multiple location sampling tests on 10/23/13 afternoon (South Plant) and 10/24/13 morning (North Plant), the sampling points are documented in Figure 5.

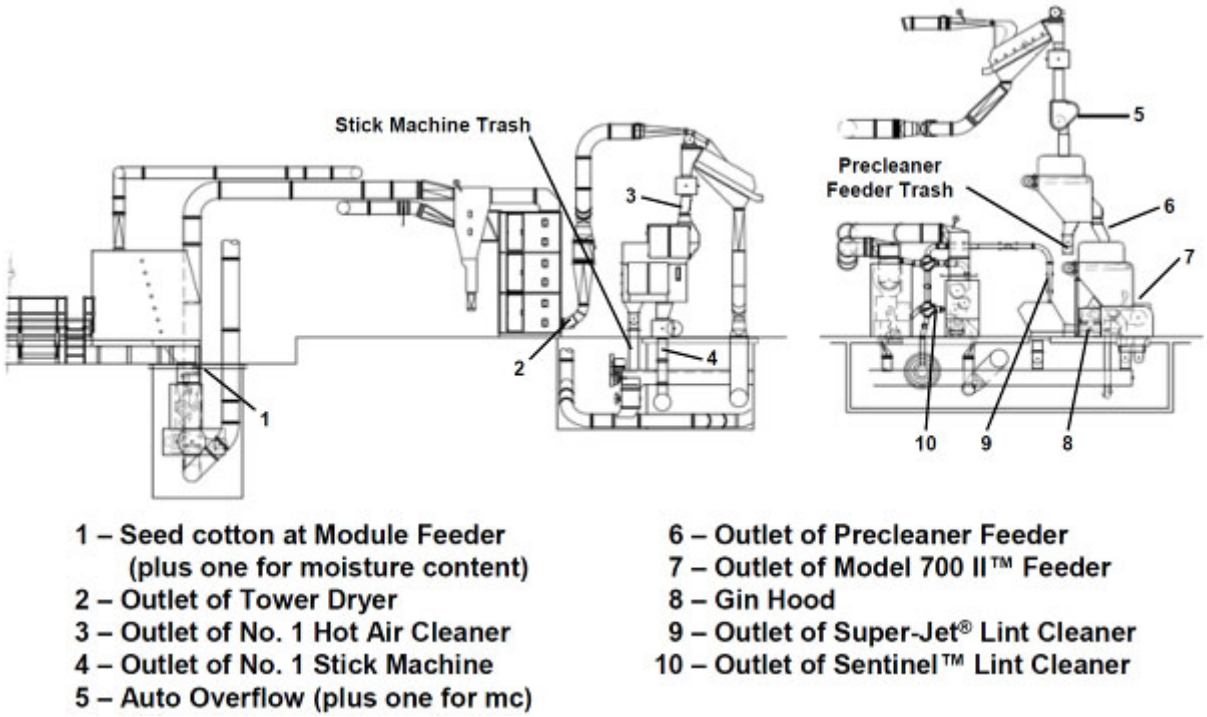

Figure 5. Sampling locations for Silver Creek Gin (both plants).

Three seed cotton or lint cotton samples were taken and individually bagged at each sampling point, and separate seed cotton samples were obtained and double bagged at Locations 1 and 5 to obtain moisture content readings. For the extractor trash analysis, trash samples were hand pulled from the respective trash chutes of the Series 2000™ stick machines and the Model 700 II™ precleaner feeders, and ginned seed from each of the gin stand seed fall areas was captured and bagged for residual lint analysis.

Based on seed cotton conditions on the afternoon of 10/23/13 (South Plant – conventional module) and the morning of 10/24/13 (North Plant – four "rounds"), the hourly throughput for each plant ranged from 36 to 38 bales per hour (bph) or 18-19 bph per gin stand. For these tests, a minimal amount of heat was applied in both stages of drying. It was a concern that such low heat levels might lead to inadequate cleaning in the pre-cleaning systems, but as will be shown in the Results section, this was not the case.

On the afternoon of 10/24/13, the North Plant was processing a much wetter and trashier module (set of four "rounds"), so the first-stage drying system temperature was elevated to assist in better conditioning the seed cotton for improved cleaning.

Data Analysis

Fractionation (seed cotton and trash), Shirley Analyzer (lint cotton), and moisture content tests were all performed at the USDA, ARS, Cotton Ginning Research Unit in Lubbock, Texas. Oven moisture content determinations were performed according to the ASTM-D2495 method. Residual lint contents on the ginned seed samples were performed at Mid-Continent Laboratories, Inc. in Memphis, Tennessee. Results were recorded, tabulated, and analyzed using Microsoft Excel.

Results and Discussion

Moisture Content

The incoming and final moisture contents for the seed cotton are shown in Table 1.

Table 1. Seed Cotton Moisture Content Results.

Location/Date	Incoming Moisture Content (%)	Final Moisture Content (%)
South Plant 10/23/13 (Afternoon)	11.69	9.98
North Plant 10/24/13 (Morning)	12.05	9.80
North Plant 10/24/13 (Afternoon)	15.06	10.83

While the optimal seed cotton moisture content for ginning is normally in the 6-7% range, the fact that both plants were maintaining excellent capacity indicates that much of the moisture shown in the final moisture contents of the samples was in the seed, rather than the lint.

Seed Cotton Trash Analysis

The fractionation analyses for the South and North Plants are seen in Tables 2 and 3, respectively.

Table 2. Fractionation results for South Plant (10/23/13 afternoon).

Sampling Location	Burrs (%)	Sticks & Stems (%)	Leaf Trash (%)	Motes (%)	Fine Trash (%)	Seed Cotton (%)	Total Trash (%)
1 - Seed Cotton at Module Feeder	1.3	0.2	1.7	0.6	0.4	94.5	4.2
2 - Outlet of Tower Dryer	1.0	0.3	0.7	1.0	0.3	94.9	3.4
3 - Outlet of No. 1 Hot Air Cleaner	0.5	0.3	0.5	0.7	0.3	96.1	2.3
4 - Outlet of No. 1 Stick Machine	0.6	0.3	0.2	0.9	0.3	96.0	2.2
5 - Auto Overflow	0.7	0.4	0.3	0.8	0.2	96.3	2.4
6 - After Precleaner Feeder	0.6	0.2	0.1	0.5	0.1	96.9	1.6
7 - Feeder Apron	0.1	0.2	0.1	0.6	0.1	97.6	1.1

Table 3. Fractionation results for Silver Creek North Plant (10/24/13 morning).

Sampling Location	Burrs (%)	Sticks & Stems (%)	Leaf Trash (%)	Motes (%)	Fine Trash (%)	Seed Cotton (%)	Total Trash (%)
1 - Seed Cotton at Module Feeder	1.7	0.4	0.7	0.6	0.4	94.7	3.7
2 - Outlet of Tower Dryer	0.6	0.4	0.4	1.0	0.5	96.0	2.8
3 - Outlet of No. 1 Hot Air Cleaner	1.1	0.4	0.1	0.9	0.2	95.2	2.8
4 - Outlet of No. 1 Stick Machine	1.0	0.5	0.2	1.2	0.4	95.6	3.2
5 - Auto Overflow	1.1	0.2	0.1	0.8	0.2	96.2	2.5
6 - After Precleaner Feeder	0.6	0.2	0.1	0.6	0.1	96.8	1.7
7 - Feeder Apron	0.3	0.2	0.1	0.6	0.1	97.3	1.3

Since there were not enough samples taken in this study to demonstrate any statistical significance, only general trends in the reduction of trash amounts throughout the pre-cleaning systems can be observed.

The fractionation results from the trashier module (four "rounds") that was processed in the North Plant with additional drying heat on the afternoon of 10/24/13 are presented in Table 4.

Table 4. Fractionation results for Silver Creek North Plant (10/24/13 afternoon).

Sampling Location	Burrs (%)	Sticks & Stems (%)	Leaf Trash (%)	Motes (%)	Fine Trash (%)	Seed Cotton (%)	Total Trash (%)
1 - Seed Cotton at Module Feeder	2.6	0.5	1.3	0.9	0.5	93.1	5.7
7 - Feeder Apron	0.3	0.6	0.1	0.7	0.2	96.5	2.0

Drying this cotton from the 15.06% moisture level to the 10.83% level at the feeder apron facilitated an impressive level of seed cotton cleaning, as is evidenced in the "before" and "after" photos shown in Figure 6.

Figure 6. Before (left) and after (right) seed cotton from the Silver Creek North Plant on 10/24/13 afternoon.

Lint Cotton Trash Analysis

The Shirley Analyzer results for the lint samples from the South and North Plants are shown in Tables 5 and 6, respectively.

Table 5. Shirley Analyzer results from Silver Creek South Plant (10/23/13 morning).

Sampling Location	Visible Foreign Matter (%)	Invisible Foreign Matter (%)	Clean Lint (%)
8 - Gin Hood	3.97	0.93	95.09
9 - After Super-Jet	3.86	0.81	95.33
10 - After No. 1 Sentinel L/C	3.38	0.58	96.04

Table 6. Shirley Analyzer results from Silver Creek North Plant (10/24/13 afternoon).

Sampling Location	Visible Foreign Matter (%)	Invisible Foreign Matter (%)	Clean Lint (%)
8 - Gin Hood	4.98	1.15	93.86
9 - After Super-Jet	4.02	1.24	94.74
10 - After No. 1 Sentinel L/C	3.41	0.74	95.85

Like the seed cotton samples, only general trends in the reduction of Visible and Invisible Foreign Matter in the lint as it progresses through the levels of lint cleaning can be seen, and there were not enough samples for any statistical significance.

Extractor Cleaner Trash Analysis

One of the more interesting areas of analysis came from the examination and quantification of trash from the new extractor cleaners (Series 2000™ stick machines in the first stage and Model 700 II™ precleaner feeders in the second stage. The results are presented in Table 7.

Table 7. Extractor Trash Analysis from Silver Creek Gin South Plant (10/23/13) and North Plant (10/24/13)

Location	Burs (%)	Sticks (%)	Good Seed Cotton (%)	Other Bad Fiber (%)	Motes (%)	Leaf (%)	Fine Trash (%)
South Plant Stick Machine Trash	32.3	9.0	3.9	1.7	8.5	27.6	10.0
South Plant Precleaner Feeder Trash	44.6	6.0	5.3	5.3	14.4	9.7	10.8
North Plant Stick Machine Trash	57.3	6.8	9.6	2.1	8.3	5.6	7.0
North Plant Precleaner Feeder Trash	45.0	6.8	5.8	10.6	12.7	7.0	7.6

Since the trash samples were hand pulled at a single time in each location, the results showed some areas of uncommon levels (e.g., the 27.6% leaf in the South Plant Stick Machine Trash as compared to 5.6% in the North Plant Stick Machine). While the tabulated results are telling, the side-by-side visual comparisons are more demonstrative. Photos of trash samples can be seen in Figure 7.

Figure 7. Extractor cleaner trash samples from South and North Plants at Silver Creek Gin.

Residual Lint Analysis

In any gin plant, effective seed cleaning is critical to good performance. Failure to adequately clean the seed leads to good lint going to the seed pile, rather than the bale. Photos of the ginned seed with the results of the residual lint analyses can be found in Figure 8.

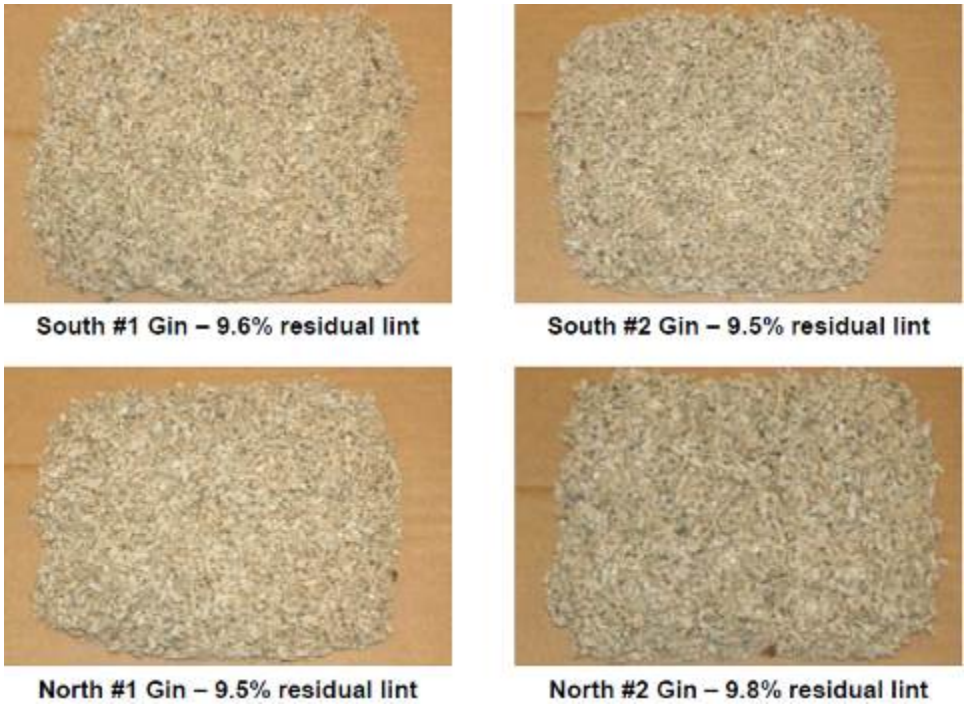

Figure 8. Ginned seed samples with residual lint contents from the South and North Plants at Silver Creek Gin.

Final Bale Grades, Quality, and Value

The ultimate measure of gin plant performance is the quality of the finished bale and the value it brings in the marketplace, based on its fiber properties, especially those which generate financial premiums. The final bale grades for the three modules tested are shown in Table 8.

Table 8. Final bale grades for the test modules at Silver Creek Gin.

Module	Total Bales	Grades	Staple	Average Uniformity	Average Leaf	Premium Paid
#24786 10/23/13 (afternoon)	19	31-3 (9), 41-3 (8), 41-4 (2)	37.00	82.40	3.11	19 of 19
#25827 10/24/13 (morning)	16	31-4 (4), 41-3 (1), 41-4 (11)	37.00	82.80	3.94	16 of 16
#26463 10/24/13 (afternoon)	16	41-3 (1), 41-4 (9), 41-5 (6)	37.06	83.13	4.31	9 of 16

Although there were initial concerns about the level of drying used during these tests, it is clear from the results that lint quality was preserved, since all staple was 37 or longer, uniformities were 82.40 or higher (with even the "trashy/wet" module #26463 achieving a uniformity of 83.13 and garnering premiums in 9 out of 16 bales). Cotton with uniformities this high will perform extremely well in a variety of spinning systems, and through the reduction in ginning costs (from not over-drying the cotton), both the gin and the producer profit.

Summary

Enhancements to the pre-cleaning and lint cleaning systems at Silver Creek Gin demonstrated improved performance and fiber quality preservation, even when processing cotton at moisture content levels considered higher than optimal. This resulted in excellent production throughput (lowering the cost of ginning) while producing outstanding quality lint in the bale (maximizing producer profits). This combination leads to long-term financial success for the gin as a business and in satisfied repeat customers (along with potential new ones) who value a gin that preserves the quality of their cotton and provides the best financial return.

Acknowledgements

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