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ENGINEERING AND GINNING

Beltwide Cotton Quality Before and After Lint Cleaning

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ABSTRACT

A two-year, commercial cotton gin sampling project was conducted during the 2005-06 and 2006-07 ginning seasons to assess the changes in upland cotton quality during the ginning process and throughout the ginning season across the entire cotton belt. This report summarizes the cotton quality information collected to establish a baseline for cotton quality before and after saw-type lint cleaning for future research efforts to address cotton short-fiber content and fiber entanglements (neps) that occur during processing. Fiber quality measurements of ginned lint sampled before and after saw-type lint cleaning followed expected trends in that lint cleaning improved color grades, reduced foreign matter content, reduced fiber length and length uniformity, and increased short-fiber content and neps. Fiber quality measurements before and after lint cleaning summarized by cotton growing region showed similar trends to those summarized across the cotton belt. Differences in fiber quality measurements among regions were presented but not compared as many could likely be attributed to cultivar and environmental differences among sampling sites. As part of a broader effort, this report should aid in developing innovative approaches to clean and maintain the quality of cotton fiber, while reducing short-fiber content and neps.

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There has been more concern recently about the short-fiber content (SFC) and amount of neps (fiber entanglements) in U.S. upland cotton. SFC and neps can negatively impact spinning and dyeing at the mill (Backe, 1986; Cheek et al., 1990; Clegg and Harland, 1923). Also, on the international market, color grade 41 and leaf grade 4 cotton is often considered discount cotton, but they are base grades for the U.S. loan chart (Laws, 2006). Foreign matter removal at the modern saw-ginning plant is accomplished with seed-cotton cleaning machines (inclined cleaners and stick machines) prior to ginning (Baker et al., 1994), and lint cleaners (air-type and saw-type lint cleaners) after ginning (Mangialardi et al., 1994). Previous lint cleaning research has concentrated on saw-type cleaners with grid bars (Mangialardi and Anthony, 2003). It is well documented that this type of lint cleaning, although excellent at removing foreign material, reduces fiber length, and increases SFC and neps. More recent research with saw-type lint cleaners has concentrated on reducing fiber wastage during lint cleaning, but there is debate as to whether this actually affects overall fiber quality in the bale. Based on discussions at a summit held at Cotton Incorporated to address lint cleaning issues, researchers from Cotton Incorporated, the USDA-ARS Ginning Laboratories, and Texas A&M University developed the "dream": to clean fiber and maintain fiber quality as well as or better than current technology, but with further reductions in neps and SFC.

To realize this dream, some basic knowledge of lint cleaning effects on fiber quality needed to be confirmed and established with some of the better fiber quality measurement techniques used today. To that goal, a two-year, commercial cotton gin sampling project was conducted during the 2005-06 and 2006-07 ginning seasons to assess the changes in upland cotton quality both during the ginning process and throughout the ginning season for all four cotton producing regions. This report summarizes the information collected to establish a baseline for

cotton quality before and after saw-type lint cleaning for future research efforts.

MATERIALS AND METHODS

During the 2005-06 and 2006-07 ginning seasons, three saw gins were targeted in each cotton growing region: Far-West, Southwest, Mid-South, and Southeast (Fig. 1). Sampling occurred early in the season after approximately 1,000 total bales had been ginned and again at 5,000 bales-per-gin-stand intervals throughout the season (Table 1). Five lint samples were taken before and after each saw-type lint cleaner each time a gin was sampled. Care was taken to collect all the lint samples from the same module, and the same gin stand/lint cleaner lines were sampled each time a gin was visited.

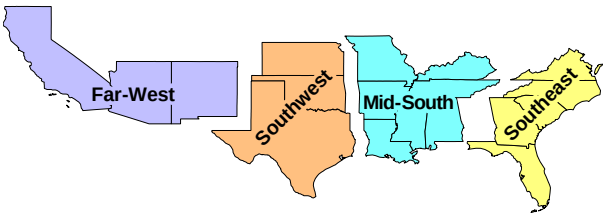

Figure 1. Four cotton growing regions where the gins were sampled.

Table 1. Region, saw-type lint cleaning stages used, and times sampled for cotton gins sampled during the 2005-06 and 2006-07 ginning seasons.

Gin ID	Region	Lint Cleaning Stages Used	Times Sampled (Visits) per Year	
			2005	2006
1	Southwest	1	3	0
3	Far-West	2	2	1
4	Far-West	1	3	3
5	Southwest	2	4	2
6	Far-West	2	3	2
10	Southwest	2	3	3
21	Mid-South	1	2	3
22	Mid-South	1	2	2
23	Mid-South	1	0	2
31	Southeast	1	4	5
32	Southeast	1	4	3
33	Southeast	1	2	2

All lint samples were processed and analyzed at Cotton Incorporated (Cary, NC). High Volume Instrument (HVI) (Uster Technologies, Inc., Charlotte, NC), Advance Fiber Information System (AFIS) (Uster Technologies, Inc., Charlotte, NC), and Micro Dust and Trash Analyzer III (MDTA3) (SDL Atlas, LLC, Rock Hill, SC) analyses were performed on each lint sample obtained from the commercial saw gins.

Results for this report were analyzed to summarize and evaluate changes in fiber quality, especially trash content, SFC, and neps, before and after lint cleaning. The five samples taken from each location in the process stream at a gin on a particular visit were treated as subsamples and their fiber quality measurements were averaged before statistical analyses were performed. Analysis of variance procedures were conducted using the SAS GLIMMIX procedure (SAS for Windows v. 9.1, SAS Institute, Cary, NC) with fiber quality measurement as the response variable, level of lint cleaning (before and after one and/or two lint cleaners) as the main effect, and Gin ID × Year Sampled × Visit as the random covariate parameter. The LSMEANS statement was used to perform pairwise t-tests to compare treatment means. The analyses were separated into two categories: gins that used one lint cleaner and gins that used two lint cleaners. As seen in Table 1, the gins in the survey that utilized two stages of lint cleaning were from the Far-West and Southwest regions. Also, some gins in the Far-West region were, at sampling time, ginning Acala cultivars of cotton (Phytogen 72 and 710, and Deltapine Acala 90), which tend to have longer and stronger fibers. Thus, many differences in fiber properties between gins utilizing one and two stages of lint cleaning were likely related to differences between western and eastern cultivars as well as environmental factors in the field and gin. The analyses focused on summarizing the overall and by-region fiber quality measurements and identifying general trends for use as a benchmark or baseline for future lint cleaning research targeting the SFC and neps issue.

RESULTS AND DISCUSSION

In general, lint cleaning improved color grade with the number of samples having color grade 31 or better increasing from approximately 50% to more than 70% or 80% (Table 2). The number of samples with color grade 41 or better did not increase by as large a margin, but the majority of samples (greater than 80%) had that color grade before lint cleaning, leaving less room for improvement. But still, the number of samples with color grade 41 or better improved from about an average of 86% before lint cleaning to 94% and 99% for one and two lint cleaners, respectively. For both one and two lint cleaners, fiber reflectance and yellowness increased due to lint cleaning.

Table 2. HVI color measurements before and after lint cleaning (LC) for gins utilizing one or two stages of saw-type lint cleaning.

Measurement[z]	One lint cleaning stage		Two lint cleaning stages		
	Before LC	After LC	Before LC	After 1st LC	After 2nd LC
31 or better Color Grade, %	46.5	71.4	50.0	80.6	75.3
41or better Color Grade, %	87.6	93.5	84.0	94.9	98.9
	Mean (Minimum - Maximum)				
Reflectance, Rd	76.0 b (68.9 - 82.3)	77.7 a (71.2 - 83.4)	76.9 c (72.0 - 83.1)	79.4 b (75.3 - 83.2)	80.3 a (76.7 - 84.1)
Yellowness, +b	8.3 b (6.7 - 9.7)	8.5 a (6.8 - 10.0)	8.8 c (7.1 - 10.9)	9.0 b (7.2 - 11.6)	9.2 a (7.3 - 11.5)

[z] Means in a row under the one or two lint cleaning stage category followed by the same letter are not significantly different (α = 0.05) as determined by pairwise t-tests.

Fiber foreign matter content was reduced by lint cleaning, but varied greatly before and after lint cleaning (Table 3). AFIS total foreign matter count averaged 521 g^{-1} and 631 g^{-1} after the first lint cleaner for gins using one and two lint cleaners, respectively, and 436 g^{-1} after the second lint cleaner. AFIS trash size indicated that the average size of the foreign matter was larger after lint cleaning. A comparison of the ratio of AFIS dust count to AFIS trash count before lint cleaning (approximately 5:1) to the ratio after one lint cleaner (approximately 4.5:1) to the ratio after two lint cleaners (4.1:1) showed that lint cleaning tended to remove larger numbers of small dust particles than large trash and, thus, slightly increased the average foreign matter size. HVI foreign matter area averaged about 0.4% after the first lint cleaner and 0.28% after the second lint cleaner, but was not significantly different. MDTA3 trash content was 2.35% and 2.58% by weight after the first lint cleaner for gins using one and two lint cleaners, respectively. The first lint cleaner reduced both HVI foreign matter area and MDTA3 trash content by about 50%, whereas the second lint cleaner did not significantly reduce HVI foreign matter area and MDTA3 trash content. HVI foreign matter area of samples collected after the first lint cleaner were similar to the 2005 and 2006 crop averages of 0.38% and 0.41% (Cotton Inc., 2006, 2007).

Table 3. AFIS, HVI, and MDTA3 foreign matter (FM) measurements before and after lint cleaning (LC) for gins utilizing one or two stages of saw-type lint cleaning.

Measurement[z]	One lint cleaning stage		Two lint cleaning stages		
	Before LC	After LC	Before LC	After 1st LC	After 2nd LC
	Mean (Minimum - Maximum)				
Total FM Count[y], g^{-1}	794 a (439 - 1629)	521 b (232 - 1093)	1131 a (288 - 2001)	631 b (252 - 996)	436 c (163 - 817)
Trash Size[y], µm	328 b (289 - 381)	344 a (304 - 402)	332 c (291 - 390)	348 b (298 - 411)	357 a (296 - 408)
Dust Count[y], g^{-1}	655 a (368 - 1367)	428 b (183 - 854)	938 a (246 - 1670)	514 b (203 - 796)	351 c (133 - 650)
Trash Count[y], g^{-1}	129 a (71 - 276)	93 b (34 - 251)	193 a (41 - 331)	117 b (48 - 201)	85 c (30 - 167)
Visible FM[y], %	2.83 a (1.63 - 5.30)	2.01 b (0.87 - 4.57)	4.11 a (1.00 - 7.11)	2.33 b (1.38 - 3.74)	1.69 c (0.83 - 3.06)
FM Area[x], %	0.80 a (0.16 - 1.86)	0.43 b (0.11 - 1.25)	0.80 a (0.13 - 1.51)	0.38 b (0.09 - 0.88)	0.28 b (0.06 - 0.69)
Trash Content[w], %	4.61 a (2.76 - 8.26)	2.35 b (0.93 - 4.50)	6.26 a (1.46 - 12.43)	2.58 b (1.05 - 4.01)	1.58 b (0.75 - 2.44)
Fiber Fragments[w], %	0.25 a (0.15 - 1.87)	0.24 a (0.14 - 0.45)	0.31 a (0.07 - 0.49)	0.30 a (0.07 - 0.54)	0.25 a (0.07 - 0.38)
Dust[w], %	0.15 a (0.09 - 0.23)	0.11 b (0.04 - 0.18)	0.18 a (0.07 - 0.28)	0.11 b (0.06 - 0.22)	0.09 b (0.05 - 0.13)

[z] Means in a row under the one or two lint cleaning stage category followed by the same letter are not significantly different (α = 0.05) as determined by pairwise t-tests.

[y] AFIS measurement

[x] HVI measurement

[w] MDTA3 measurement

Table 4 summarizes the AFIS and HVI length measurements for the samples collected before and after lint cleaning. Length measurements after lint cleaning for the gins using only one stage of lint cleaning were similar to the beltwide averages for the 2005 and 2006 crops: HVI upper-half mean length was 27.7 mm (1.09 in) and 27.9 mm (1.10 in), respectively (Cotton Inc., 2006, 2007). In general, fiber length measurements (HVI upper-half mean length, AFIS length by weight, and AFIS length, Upper 5%, and Upper 2.5% by number) were reduced by the first lint cleaner [approximately 0.38-mm (0.02-in) reduction], whereas the only significant reduction due to the second lint cleaner [approximately 0.2-mm (0.01-in.) reduction] was in HVI upper-half mean length. The distribution of fiber length was skewed to be shorter and less uniform, as shown by AFIS and HVI SFC based on weight increasing and AFIS length coefficient of variation increasing and HVI uniformity index decreasing after lint cleaning. Uniformity index for the gins sampled (81.1% and 81.7% after one lint cleaner and 81.3% after two lint cleaners) was slightly higher than the beltwide averages for 2005 and 2006 (80.7% and 81.2%, respectively) (Cotton Inc., 2006, 2007).

Table 4. AFIS and HVI length measurements before and after lint cleaning (LC) for gins utilizing one or two stages of saw-type lint cleaning.

Measurement[z]	One lint cleaning stage		Two lint cleaning stages		
	Before LC	After LC	Before LC	After 1st LC	After 2nd LC
	Mean (Minimum - Maximum)				
Upper-Half Mean Length[x], mm	28.3 a (26.2 - 30.2)	27.9 b (26.0 - 29.5)	29.6 a (26.5 - 32.7)	29.2 b (26.1 - 32.8)	29.0 c (26.1 - 32.4)
, in	1.12 a (1.03 - 1.19)	1.10 b (1.02 - 1.16)	1.16 a (1.04 - 1.29)	1.15 b (1.03 - 1.29)	1.14 c (1.03 - 1.27)
Length by wt.[y], mm	24.9 a (22.6 - 27.3)	24.5 b (22.1 - 27.1)	25.6 a (22.6 - 29.3)	25.3 b (22.1 - 28.7)	25.1 b (22.8 - 28.4)
, in	0.98 a (0.89 - 1.07)	0.96 b (0.87 - 1.06)	1.01 a (0.89 - 1.15)	0.99 b (0.87 - 1.13)	0.99 b (0.90 - 1.12)
Length by num.[y], mm	18.4 a (15.5 - 22.4)	17.8 b (15.0 - 22.2)	18.8 a (15.6 - 23.0)	18.4 b (15.3 - 22.4)	18.1 b (14.8 - 22.3)
, in	0.73 a (0.61 - 0.88)	0.70 b (0.59 - 0.87)	0.74 a (0.61 - 0.91)	0.72 b (0.60 - 0.88)	0.71 b (0.58 - 0.88)
Upper-Quartile Length by wt.[y], mm	30.3 a (28.0 - 32.6)	30.1 b (28.0 - 32.4)	31.5 a (28.0 - 35.3)	31.2 b (27.8 - 34.5)	31.1 b (28.2 - 34.5)
,in	1.19 a (1.10 - 1.28)	1.18 b (1.10 - 1.27)	1.24 a (1.10 - 1.39)	1.23 b (1.09 - 1.36)	1.22 b (1.11 - 1.36)
Upper 5% Length by num.[y], mm	34.1 a (31.7 - 36.5)	33.7 b (31.6 - 36.4)	35.3 a (31.4 - 39.7)	35.0 b (31.1 - 38.9)	34.8 b (31.8 - 38.9)
, in	1.34 a (1.25 - 1.44)	1.33 b (1.24 - 1.43)	1.39 a (1.24 - 1.56)	1.38 b (1.23 - 1.53)	1.37 b (1.25 - 1.53)
Upper 2.5% Length by num.[y], mm	36.5 a (34.2 - 39.0)	36.2 b (34.1 - 38.9)	37.8 a (33.9 - 42.3)	37.6 b (33.5 - 41.7)	37.4 b (34.2 - 41.7)
, in	1.44 a (1.35 - 1.54)	1.42 b (1.34 - 1.53)	1.49 a (1.33 - 1.66)	1.48 b (1.32 - 1.64)	1.47 b (1.35 - 1.64)
Short Fiber Content by wt.[y], %	9.8 b (4.8 - 15.7)	10.8 a (5.0 - 16.5)	10.2 b (4.9 - 16.0)	10.7 a (4.8 - 16.2)	10.9 a (4.7 - 17.5)
Short Fiber Content by num.[y], %	33.0 b (19.4 - 44.0)	35.4 a (20.4 - 46.0)	33.8 b (19.3 - 47.2)	35.1 a (18.6 - 47.6)	35.6 a (18.6 - 49.6)
Short Fiber Content[x], %	8.4 b (4.4 - 12.3)	9.3 a (5.5 - 15.1)	7.7 b (3.5 - 10.7)	8.4 a (3.9 - 11.3)	8.6 a (4.1 - 12.0)
Length by wt. CV[y], %	35.8 b (30.2 - 41.2)	36.7 a (30.3 - 41.8)	36.5 b (30.6 - 43.3)	37.1 a (30.5 - 43.6)	37.3 a (30.2 - 44.7)
Length by num. CV[y], %	59.2 b (46.4 - 67.5)	61.4 a (47.4 - 69.4)	60.6 b (46.5 - 74.0)	61.7 a (45.5 - 74.4)	62.2 a (45.6 - 75.8)
Uniformity Index[x], %	81.9 a (78.8 - 83.9)	81.1 b (78.7 - 83.6)	82.3 a (80.8 - 84.3)	81.7 b (79.4 - 84.1)	81.3 c (79.5 - 83.7)

[z] Means in a row under the one or two lint cleaning stage category followed by the same letter are not significantly different ($\alpha = 0.05$) as determined by pairwise t-tests.

[y] AFIS measurement, CV

[x] HVI measurement

Nep counts after the first lint cleaner averaged 232 g^{-1} of lint for gins using one stage of lint cleaning and 363 g^{-1} of lint for gins using two stages and varied from approximately 150 to over 500 g^{-1} (Table 5). As would be expected, nep counts rose with lint cleaning by 35 to 45 g^{-1} on average for the first lint cleaner and an additional 65 g^{-1} for the second lint cleaner. Nep size decreased slightly by about 10 µm, due to lint cleaning. Seed coat nep count, an indirect measure of the number of seed coat fragments in the ginned lint, did not change, whereas seed coat nep size decreased slightly, possibly indicating larger seed coat neps were not always removed, but fractured into smaller seed coat neps.

AFIS and HVI maturity and strength measurements are shown in Table 6. Fineness averaged approximately 171 mTex and 165 mTex for gins using one or two lint cleaners, respectively, and was relatively unchanged due to lint cleaning. Average immature fiber content was 8.6% and 10.4%, maturity ratio was 0.86 and 0.83, and micronaire was 4.37 and 3.71 for gins using one or two lint cleaners, respectively, indicating that fiber tended to be slightly less mature after lint cleaning. These data suggest that lint cleaners might remove more mature fibers or might create more immature fibers through breakage of immature fibers. Average micronaire for gins utilizing only one lint cleaner was within the range of the crop averages for 2005 and 2006 (4.26 and 4.40) (Cotton Inc., 2006, 2007), but not so for gins using two lint cleaners. Strength decreased slightly after the first lint cleaner to 278.4 kN m kg^{-1} (28.4 g tex^{-1}) and 283.3 kN m kg^{-1} (28.9 g tex^{-1}), while elongation remained unchanged after lint cleaning at 5.4% and 6.4% for one and two lint cleaner systems, respectively. Average strength for the sampled cotton was slightly lower than the 2005 and 2006 crop averages (286.3 kN m kg^{-1} [29.2 g tex^{-1}]) (Cotton Inc., 2006, 2007).

Table 5. AFIS nep measurements before and after lint cleaning (LC) for gins utilizing one or two stages of saw-type lint cleaning.

Measurement[z]	One lint cleaning stage		Two lint cleaning stages		
	Before LC	After LC	Before LC	After 1st LC	After 2nd LC
	Mean (Minimum - Maximum)				
Neps Count, g^{-1}	196 b (129 - 379)	232 a (143 - 500)	315 a (186 - 497)	363 b (179 - 547)	428 c (244 - 728)
Nep Size, µm	723 a (699 - 762)	710 b (686 - 728)	744 a (709 - 790)	734 b (712 - 776)	728 b (706 - 770)
Seed Coat Nep Count, g^{-1}	15 a (8 - 37)	16 a (10 - 31)	28 a (12 - 46)	29 a (16 - 48)	28 a (15 - 49)
Seed Coat Nep Size, µm	1217 a (1050 - 1367)	1185 b (1052 - 1320)	1200 a (1050 - 1328)	1195 ab (1081 - 1328)	1175 b (1021 - 1306)

[z] Means in a row under the one or two lint cleaning stage category followed by the same letter are not significantly different (α = 0.05) as determined by pairwise t-tests.

Table 6. AFIS and HVI maturity and strength measurements before and after lint cleaning (LC) for gins utilizing one or two stages of saw-type lint cleaning.

Measurement[z]	One lint cleaning stage		Two lint cleaning stages		
	Before LC	After LC	Before LC	After 1st LC	After 2nd LC
	Mean (Minimum - Maximum)				
Fineness[y], mTex	172 a (158 - 186)	171 b (153 - 184)	166 a (150 - 182)	165 a (150 - 182)	166 a (150 - 181)
Immature Fiber Content[y], %	8.0 b (4.5 - 12.2)	8.6 a (5.1 - 12.9)	10.1 b (6.1 - 13.6)	10.4 a (6.2 - 15.5)	10.3 ab (6.6 - 14.0)
Maturity Ratio[y]	0.88 a (0.79 - 0.96)	0.86 b (0.78 - 0.96)	0.84 a (0.77 - 0.95)	0.83 b (0.75 - 0.95)	0.83 b (0.76 - 0.94)
Micronaire[x]	4.47 a (3.60 - 5.14)	4.37 b (3.42 - 4.94)	3.78 a (2.94 - 4.66)	3.71 b (2.82 - 4.62)	3.71 ab (2.80 - 4.60)
Strength[x], kN m kg^{-1}	283.3 a (257.8 – 312.7)	278.4 b (243.1 – 308.8)	285.3 a (257.8 – 332.3)	283.3 b (253.9 – 334.3)	283.3 ab (254.9 – 337.3)
, g tex^{-1}	28.9 a (26.3 - 31.9)	28.4 b (24.8 - 31.5)	29.1 a (26.3 - 33.9)	28.9 b (25.9 - 34.1)	28.9 ab (26.0 - 34.4)
Elongation[x], %	5.4 a (4.1 - 8.0)	5.4 a (4.1 - 8.0)	6.6 a (4.8 - 9.3)	6.4 a (4.5 - 9.1)	6.3 a (4.7 - 9.0)

[z] Means in a row under the one or two lint cleaning stage category followed by the same letter are not significantly different (α = 0.05) as determined by pairwise t-tests.

[y] AFIS measurement

[x] HVI measurement

Gins in each region of the U.S. cotton belt deal with interacting variables unique to that region that affect the impact of lint cleaning on cotton quality. These variables mainly include environmental and cultivar differences. Thus, select fiber quality measurements that mainly target the SFC and nep issues for each region follow in Tables 7 through 10. Similar trends with lint cleaning as those found in the across-the-belt data summaries (Tables 2–6) can be seen in the regional data tables (Tables 7–10). These data are not intended to be used for comparisons among regions, but to document baseline fiber quality at the time of sampling.

Table 7. Select fiber quality measurements before and after lint cleaning (LC) for gins in the Southeastern region that utilized one stage of saw-type lint cleaning.

	One Stage Lint Cleaning	
Measurement[z]	Before LC	After LC
	Mean (Minimum - Maximum)	
Micronaire[x]	4.63 a (4.16 - 5.04)	4.54 b (4.04 - 4.94)
Maturity Ratio[y]	0.89 a (0.82 - 0.96)	0.87 b (0.80 - 0.94)
Upper-Half Mean Length[x], mm	28.2 a (27.0 - 29.8)	27.6 b (26.5 - 28.5)
, in	1.11 a (1.06 - 1.17)	1.09 b (1.04 - 1.12)
Length by wt.[y], mm	24.9 a (23.7 - 27.1)	24.3 b 23.1 - 25.7)
, in	0.98 a (0.93 - 1.07)	0.96 b (0.91 - 1.01)
Length by num.[y], mm	18.3 a (16.4 - 21.1)	17.5 b (16.0 - 19.3)
, in.	0.72 a (0.64 - 0.83)	0.69 b (0.63 - 0.76)
Upper-Quartile Length by wt.[y], mm	30.3 a (29.2 - 32.5)	29.9 b (28.8 - 31.4)
, in	1.19 a (1.15 - 1.28)	1.18 b (1.13 - 1.24)
Upper 5% Length by num.[y], mm	34.0 a (33.0 - 36.2)	33.5 b (32.3 - 35.2)
, in	1.34 a (1.3 - 1.42)	1.32 b (1.27 - 1.38)
Upper 2.5% Length by num.[y], mm	36.4 a (35.5 - 38.6)	35.9 b (34.6 - 37.3)
, in	1.43 a (1.4 - 1.52)	1.41 b (1.36 - 1.47)
Uniformity Index[x]	82.0 a (80.6 - 83.6)	81.0 b (79.4 - 82.4)
Length by wt. CV[y], %	35.8 b (31.7 - 39.7)	37.0 a (33.2 - 40.3)
Length by num. CV[y], %	60.0 b (53.3 - 66.9)	62.5 a (53.6 - 68.1)
Short Fiber Content[x], %	8.3 b (5.8 - 10.7)	9.5 a (6.9 - 12.1)
Short Fiber Content by wt.[y], %	9.9 b (6.5 - 13.3)	11.2 a (7.5 - 14.2)
Short Fiber Content by num.[y], %	33.7 b (25.9 - 41.2)	36.6 a (27.2 - 42.9)
Nep Count[y], g^{-1}	176 b (135 - 223)	212 a (143 - 288)
Nep Size[y], µm	722 a (699 - 762)	711 b (686 - 728)
Total FM Count[y], g^{-1}	778 a (478 - 1204)	505 b (239 - 796)
Trash Size[y], µm	324 b (289 - 381)	342 a (308 - 386)
Trash Content[w], %	4.37 a (2.76 - 5.79)	2.24 b (1.30 - 3.88)

[z] Means in a row followed by the same letter are not significantly different ($\alpha = 0.05$) as determined by pairwise t-tests.

[y] AFIS measurement

[x] HVI measurement

[w] MDTA3 measurement

Table 8. Select fiber quality measurements before and after lint cleaning (LC) for gins in the Mid-South region that utilized one stage of saw-type lint cleaning.

Measurement[z]	One Stage Lint Cleaning	
	Before LC	After LC
	Mean (Minimum - Maximum)	
Micronaire[x]	4.59 a (3.88 - 5.14)	4.46 b (3.80 - 4.92)
Maturity Ratio[y]	0.90 a (0.86 - 0.96)	0.89 b (0.82 - 0.96)
Upper-Half Mean Length[x], mm	28.1 a (26.2 - 29.6)	27.8 b (26.0 - 29.2)
, in	1.11 a (1.03 - 1.17)	1.09 b (1.02 - 1.15)
Length by wt.[y], mm	24.9 a (22.9 - 27.3)	24.8 b (22.8 - 27.1)
, in	0.98 a (0.90 - 1.07)	0.975 b (0.90 - 1.06)
Length by num.[y], mm	19.0 a (16.3 - 22.4)	18.7 b (15.8 - 22.2)
, in	0.75 a (0.64 - 0.88)	0.74 b (0.62 - 0.87)
Upper-Quartile Length by wt.[y], mm	30.0 a (28.0 - 31.9)	29.8 b (28.0 - 31.9)
, in	1.18 a (1.10 - 1.25)	1.175 b (1.10 - 1.25)
Upper 5% Length by num.[y], mm	33.8 a (31.7 - 35.8)	33.6 a (31.6 - 35.8)
, in	1.33 a (1.25 - 1.41)	1.32 a (1.25 - 1.41)
Upper 2.5% Length by num.[y], mm	36.3 a (34.2 - 38.6)	36.1 a (34.1 - 38.3)
, in	1.43 a (1.35 - 1.52)	1.42 a (1.34 - 1.51)
Uniformity Index[x]	82.2 a (78.8 - 83.9)	81.5 b (78.7 - 83.6)
Length by wt. CV[y], %	34.7 a (30.2 - 38.9)	34.9 a (30.3 - 39.8)
Length by num. CV[y], %	56.2 b (46.4 - 64.3)	57.1 a (47.5 - 66)
Short Fiber Content[x], %	8.1 b (4.4 - 10.9)	8.8 a (5.5 - 12.0)
Short Fiber Content by wt.[y], %	8.7 b (4.8 - 13.1)	9.1 a (5.0 - 14.0)
Short Fiber Content by num.[y], %	30.0 b (19.4 - 39.8)	31.0 a (20.4 - 41.6)
Nep Count[y], g^{-1}	172 b (129 - 216)	192 a (147 - 251)
Nep Size[y], µm	725 a (710 - 758)	702 b (687 - 713)
Total FM Count[y], g^{-1}	935 a (612 - 1629)	638 b (232 - 1093)
Trash Size[y], µm	346 b (323 - 381)	362 a (336 - 402)
Trash Content[w], %	5.4 a (3.53 - 8.13)	2.97 b (1.70 - 4.5)

[z] Means in a row followed by the same letter are not significantly different (α = 0.05) as determined by pairwise t-tests.

[y] AFIS measurement, CV

[x] HVI measurement

[w] MDTA3 measurement

Table 9. Select fiber quality measurements before and after lint cleaning (LC) for gins in the Southwest region, some of which utilized one stage of saw-type lint cleaning and some two stages.

Measurement[z]	One lint cleaning stage		Two lint cleaning stages		
	Before LC	After LC	Before LC	After 1st LC	After 2nd LC
	Mean (Minimum - Maximum)				
Micronaire[x]	3.75 a (3.60 - 4.04)	3.61 a (3.42 - 3.86)	3.70 a (2.94 - 4.60)	3.59 b (2.82 - 4.46)	3.58 b (2.80 - 4.50)
Maturity Ratio[y]	0.82 a (0.79 - 0.84)	0.79 a (0.78 - 0.81)	0.83 a (0.77 - 0.90)	0.82 b (0.75 - 0.89)	0.82 b (0.76 - 0.89)
Upper-Half Mean Length[x], mm	28.0 a (27.0 - 28.6)	27.9 a (26.3 - 28.8)	28.6 a (26.5 - 31.0)	28.2 b (26.1 - 30.6)	28.1 b (26.1 - 30.2)
, in	1.10 a (1.06 - 1.13)	1.10 a (1.04 - 1.13)	1.13 a (1.04 - 1.22)	1.11 b (1.03 - 1.21)	1.10 b (1.03 - 1.19)
Length by wt.[y], mm	24.3 a 22.6 - 25.5)	23.9 a 22.1 - 25.0)	24.5 a (22.6 - 26.3)	24.1 b (22.1 - 25.3)	24.2 b (22.8 - 25.1)
, in	0.96 a 0.89 - 1.00)	0.94 a 0.87 - 0.98)	0.96 a 0.89 - 1.03)	0.95 b 0.87 - 1.00)	0.95 b 0.90 - 0.99)
Length by num.[y], mm	17.3 a (15.5 - 18.5)	16.6 a (15.0 - 17.5)	17.5 a (15.6 - 19.8)	17.1 b (15.3 - 19.3)	17.0 b (14.8 - 19.4)
, in	0.68 a (0.61 - 0.73)	0.65 a (0.59 - 0.69)	0.69 a (0.61 - 0.78)	0.67 b (0.60 - 0.76)	0.67 b (0.58 - 0.76)
Upper-Quartile Length by wt.[y], mm	30.4 a (28.8 - 31.5)	30.1 a (28.2 - 31.2)	30.4 a (28.0 - 32.9)	30.0 b (27.8 - 32.4)	30.1 b (28.2 - 32.2)
, in	1.20 a (1.13 - 1.24)	1.19 a (1.11 - 1.23)	1.20 a (1.10 - 1.30)	1.18 b (1.09 - 1.28)	1.18 b (1.11 - 1.27)
Upper 5% Length by num.[y], mm	34.1 a (32.2 - 35.4)	33.6 a (31.6 - 34.7)	34.0 a (31.4 - 36.7)	33.7 b (31.1 - 35.9)	33.8 b (31.8 - 35.9)
, in	1.34 a (1.27 - 1.39)	1.32 a (1.24 - 1.37)	1.34 a (1.24 - 1.44)	1.33 b (1.23 - 1.42)	1.33 b (1.25 - 1.41)
Upper 2.5% Length by num.[y], mm	36.5 a (34.5 - 37.7)	36.2 a (34.1 - 37.2)	36.5 a (33.9 - 39.3)	36.2 b (33.5 - 38.5)	36.3 ab (34.2 - 38.6)
, in	1.44 a (1.36 - 1.48)	1.42 a (1.34 - 1.47)	1.44 a (1.33 - 1.55)	1.425 b (1.32 - 1.52)	1.429 ab (1.35 - 1.52)
Uniformity Index[x]	80.5 a (79.3 - 81.4)	80.0 b (78.7 - 80.9)	81.7 a (80.8 - 84.1)	81.0 b (79.4 - 83.2)	80.8 b (79.5 - 82.7)
Length by wt. CV[y], %	38.5 b (36.4 - 41.2)	39.5 a (37.8 - 41.8)	37.9 b (32.6 - 43.3)	38.6 a (33.2 - 43.6)	38.6 a (33.3 - 44.7)
Length by num. CV[y], %	63.7 a (60.8 - 67.5)	66.5 a (65.1 - 69.4)	63.1 b (51.1 - 74)	64.2 a (52.1 - 74.4)	64.5 a (51.8 - 75.8)
Short Fiber Content[x], %	10.9 a (10.0 - 12.3)	12.0 a (10.3 - 15.1)	8.7 b (6.9 - 10.7)	9.5 a (7.6 - 11.3)	9.6 a (8.1 - 12.0)
Short Fiber Content by wt.[y], %	12.3 a (9.9 - 15.7)	13.2 a (11.4 - 16.5)	11.7 b (7.3 - 16)	12.4 a (8.1 - 16.2)	12.4 a (7.9 - 17.5)
Short Fiber Content by num.[y], %	38.2 a (34 - 44)	40.8 a (38.1 - 46)	37.2 b (25.6 - 47.2)	38.6 a (27.1 - 47.6)	38.7 a (26.6 - 49.6)
Nep Count[y], g^{-1}	329 b (248 - 379)	417 a (313 - 500)	342 c (186 - 497)	396 b (239 - 547)	474 a (265 - 728)
Nep Size[y], µm	715 a (711 - 718)	711 a (708 - 713)	739 a (718 - 761)	729 b (716 - 746)	726 b (714 - 743)
Total FM Count[y], g^{-1}	789 a (439 - 1273)	375 a (287 - 550)	1331 a (720 - 2001)	677 b (375 - 997)	489 c (289 - 817)
Trash Size[y], µm	324 a (319 - 331)	328 a (304 - 354)	341 b (310 - 390)	356 a (322 - 411)	362 a (326 - 408)
Trash Content[w], %	4.93 a (3.07 - 8.26)	1.38 a (0.93 - 2.11)	8.00 a (3.27 - 12.43)	2.81 b (1.85 - 4.01)	1.88 b (1.56 - 2.44)

[z] Means in a row under the one or two lint cleaning stage category followed by the same letter are not significantly different ($\alpha = 0.05$) as determined by pairwise t-tests.

[y] AFIS measurement, CV

[x] HVI measurement

[w] MDTA3 measurement

Table 10. Select fiber quality measurements before and after lint cleaning (LC) for gins in the Far-West region, some of which utilized one stage of lint cleaning and some two stages.

Measurement[z]	One lint cleaning stage		Two lint cleaning stages		
	Before LC	After LC		Before LC	After LC
	Mean (Minimum - Maximum)				
Micronaire[x]	4.12 a (3.72 - 4.52)	4.06 a (3.64 - 4.48)	3.90 a (3.26 - 4.66)	3.90 a (3.16 - 4.62)	3.94 a (3.16 - 4.60)
Maturity Ratio[y]	0.86 a (0.82 - 0.92)	0.85 b (0.81 - 0.91)	0.86 a (0.81 - 0.95)	0.86 a (0.80 - 0.95)	0.86 a (0.79 - 0.94)
Upper Half Mean Length[x], mm	29.2 a (28.4 - 30.2)	28.8 b (28 - 29.5)	31.0 a (29.7 - 32.7)	30.8 b (29.8 - 32.8)	30.3 c (29.2 - 32.4)
, in	1.15 a (1.12 - 1.19)	1.13 b (1.10 - 1.16)	1.22 a (1.17 - 1.29)	1.21 b (1.17 - 1.29)	1.19 c (1.15 - 1.27)
Length by wt.[y], mm	25.0 a (23.3 - 26.9)	25.0 a (22.9 - 26.5)	27.3 a (24.9 - 29.3)	27.0 ab (24.7 - 28.7)	26.8 a (24.6 - 28.4)
, in	0.98 a (0.92 - 1.06)	0.98 a (0.90 - 1.04)	1.07 a (0.98 - 1.15)	1.06 ab (0.97 - 1.13)	1.05 b (0.97 - 1.12)
Length by num.[y], mm	18.2 a (16.2 - 20.6)	17.9 a (15.7 - 19.6)	20.7 a (16.9 - 23)	20.3 ab (16.6 - 22.4)	20.1 b (16.2 - 22.3)
, in	0.72 a (0.64 - 0.81)	0.71 a (0.62 - 0.77)	0.81 a (0.66 - 0.91)	0.80 ab (0.65 - 0.88)	0.79 b (0.64 - 0.88)
Upper Quartile Length by wt.[y], mm	30.9 a (28.8 - 32.6)	31.0 a (29.2 - 32.4)	33.2 a (31.5 - 35.3)	33.0 ab (31.4 - 34.5)	32.7 b (31.4 - 34.5)
, in	1.22 a (1.13 - 1.28)	1.22 a (1.15 - 1.27)	1.31 a (1.24 - 1.39)	1.30 ab (1.24 - 1.36)	1.29 b (1.24 - 1.36)
Upper 5% Length by num.[y], mm	34.7 a (32.2 - 36.5)	34.8 a (32.8 - 36.4)	37.2 a (35.3 - 39.7)	37.0 b (35.3 - 38.9)	36.7 b (35.2 - 38.9)
, in	1.37 a (1.27 - 1.44)	1.37 a (1.29 - 1.43)	1.464 a (1.39 - 1.56)	1.455 b (1.39 - 1.53)	1.45 b (1.39 - 1.53)
Upper 2.5% Length by num.[y], mm	37.2 a (34.6 - 39)	37.3 a (35.3 - 38.9)	39.8 a (38.1 - 42.3)	39.7 ab (38 - 41.7)	39.3 b (37.8 - 41.7)
, in	1.47 a (1.36 - 1.54)	1.47 a (1.39 - 1.53)	1.57 a (1.50 - 1.66)	1.56 ab (1.50 - 1.64)	1.55 b (1.49 - 1.64)
Uniformity Index[x]	81.8 a (81.2 - 83)	81.2 a (80.1 - 82.6)	83.1 a (82.0 - 84.3)	82.7 b (81.2 - 84.1)	82.2 c (80.7 - 83.7)
Length by wt. CV[y], %	36.7 a 33.5 - 40.9)	37.7 a 35.2 - 41.6)	34.4 a 30.6 - 41)	34.9 a 30.5 - 41)	35.1 a 30.2 - 42)
Length by num. CV[y], %	60.4 b (55.5 - 66.3)	62.7 a (58.6 - 67.9)	56.8 b (46.5 - 69.4)	57.8 ab (45.5 - 70.6)	58.2 a (45.6 - 72.5)
Short Fiber Content[x], %	8.1 a (5.7 - 9.5)	8.3 a (6.2 - 10)	6.2 b (3.5 - 8.9)	6.7 ab (3.9 - 9.3)	7.0 b (4.1 - 9.3)
Short Fiber Content by wt.[y], %	10.4 b (7.4 - 14.7)	11.2 a (8.5 - 15.6)	7.9 b (4.9 - 13.6)	8.2 ab (4.8 - 13.9)	8.5 a (4.7 - 14.6)
Short Fiber Content by num.[y], %	34.2 b (27.9 - 41.9)	36.3 a (31 - 44)	28.7 b (19.3 - 42.3)	29.8 ab (18.6 - 43.4)	30.3 a (18.6 - 45.2)
Nep Count[y], g^{-1}	243 b (193 - 338)	280 a (236 - 384)	276 c (187 - 398)	313 b (179 - 492)	350 a (244 - 557)
Nep Size[y], µm	731 a (721 - 742)	722 b (715 - 728)	751 a (709 - 790)	742 ab (712 - 776)	733 b (706 - 770)
Total FM Count[y], g^{-1}	615 a (537 - 693)	434 b (354 - 486)	831 a (288 - 1676)	562 b (252 - 809)	345 b (163 - 612)
Trash Size[y], µm	309 b (297 - 338)	326 a (317 - 343)	319 b (291 - 341)	337 a (298 - 378)	347 a (296 - 378)
Trash Content[w], %	3.84 a (3.68 - 3.97)	2.03 b (1.71 - 2.24)	3.88 a (1.46 - 5.75)	2.32 b (1.05 - 3.39)	1.23 b (0.75 - 1.72)

[z] Means in a row under the one or two lint cleaning stage category followed by the same letter are not significantly different ($\alpha = 0.05$) as determined by pairwise t-tests.

[y] AFIS measurement

[x] HVI measurement

[w] MDTA3 measurement

SUMMARY

A two-year, -commercial cotton gin sampling project was conducted during the 2005-06 and 2006-07 ginning seasons to assess the changes in upland cotton quality during the ginning process and throughout the ginning season across the entire cotton belt. This report summarizes the cotton quality information collected to establish a baseline for cotton quality before and after saw-type lint cleaning for future research efforts to address cotton SFC and neps.

Fiber quality measurements of ginned lint sampled before and after lint cleaning followed expected trends and varied from gin to gin and across cotton growing regions. Much of the variability was likely due to cultivar and environmental differences among sampling sites. Lint cleaning improved color grades with more than 70% of samples collected after lint cleaning having color grade 31 or better. Foreign matter content was reduced by lint cleaning to approximately 2.5% by weight or 0.4% by area after one lint cleaner and 1.5% by weight or 0.28% by area after two lint cleaners. Lint cleaning tended to reduce fiber length by approximately 0.38 mm (0.02 in) and reduce fiber length uniformity by approximately 0.7 percentage point. As is typical of machine processing of cotton, nep counts increased due to lint cleaning (35 to 45 neps g^{-1} increase for one lint cleaner). Fineness was relatively unchanged by lint cleaning, however, results showed that fiber tended to be less mature after lint cleaning. Strength measures also tended to be lower after lint cleaning.

Fiber quality measurements before and after lint cleaning summarized by cotton growing region showed similar trends to those summarized across the cotton belt, but relative differences in fiber quality measurements among regions highlights the impact of regional cultivars and environmental factors. The data reinforce the importance of considering regional differences of an already variable biological product when working to address future quality and processing issues.

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DISCLAIMER

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REFERENCES

Backe, E.E. 1986. Effect of short fiber content in cotton on plant performance and quality. Textile Res. J. 56:112–115.

Baker, R.V., W.S. Anthony, and R.M Sutton. 1994. Seed cleaning and extracting. p. 69–89. *In* Anthony and Mayfield (ed.) Cotton Ginners Handbook. USDA Agricultural Research Service Handbook No. 503. Government Printing Office, Washington, DC.

Cheek, L., L. Hsu, and D.P. Thibodeaux. 1990. Web-nep procedure for predicting potential dyeing problems in cotton. Textile Res. J. 60:108–112.

Clegg, G.G., and S.C. Harland. 1923. Neps in cotton fabrics and their resistance to dyeing and printing. J. . Textile Inst. 14:125–132.

Cotton Incorporated. 2006. Quality summary of 2005 U.S. upland cotton. [Online]. Available at http://www.cotton-inc.com/CropQualitySummary/2005FinalCropQualitySummary/ (verified 2 Aug. 2011).

Cotton Incorporated. 2007. Quality summary of 2006 U.S. upland cotton. [Online]. Available at http://www.cottoninc.com/CropQualitySummary/2006-Final-Crop-Quality-Summary/ (verified 2 Aug. 2011).

Laws, F. 2006. U.S. growers need to grow cotton outside the middle of the box. Western Farm Press [Online]. Available at http://westernfarmpress.com/news/121906-cotton-category/ (verified 5 Nov. 2010).

Mangialardi, G.J. and W.S. Anthony. 2003. Review and Summation of Lint Cleaners for Cotton Gins. The Cotton Foundation and National Cotton Ginners Association, Memphis, TN.

Mangialardi, G.J., R.V. Baker, D.W. VanDoorn, and B.M. Norman. 1994. Lint cleaning. p. 102–119. *In* Anthony and Mayfield (ed.) Cotton Ginners Handbook. USDA Agricultural Research Service Handbook No. 503. Government Printing Office, Washington, DC.