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Influence of Seed Cotton Extractor Cleaners and Cleaning Rate on Gin Turnout and Fiber Quality

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Abstract. *Southern High Plains cotton has improved over the last ten years with regard to yield and HVI fiber quality. Harvesting and ginning practices are needed which preserve fiber quality and maximize return to the producer. The objective of this work is to investigate the influence of harvest method, number of seed cotton extractor cleaners (e.g. stick machines), and seed cotton cleaning rate on foreign matter content, lint turnout, bale value, and fiber and yarn quality. Picker harvested cotton contained less foreign matter than stripper harvested cotton which affected differences by harvest method for total foreign matter removed by the stick machines, total foreign matter removed during the ginning process, and lint turnout. The use of two stick machines removed more foreign material from seed cotton than using only one and more foreign material was removed by the stick machines at slower seed cotton cleaning rates. Total stick machine seed cotton loss was higher for seed cotton cleaning systems utilizing two stick machines but was unaffected by harvest method or seed cotton cleaning rate. Seed cotton cleaning system efficiency was greater for stripper harvested*

cotton and when two stick machines were used but seed cotton cleaning rate had no effect. Fiber quality was influenced most by harvest method where picker harvested cotton exhibited improved HVI and AFIS fiber quality parameters compared to stripper harvested cotton. The use of two stick machines improved fiber reflectance and yellowness properties and reduced lint foreign matter content. Seed cotton cleaning rate had a minimal effect on fiber quality. Total bale values were higher for picker harvested cotton but were not influenced by the number of stick machines used or seed cotton cleaning rate. Bale values for picker cotton decreased between one and two stages of lint cleaning while stripper harvested bale values increased. Yarn imperfections were reduced for ring spun yarn produced from picker harvested cotton processed through one stick machine at the high cleaning rate. The findings of this work support the current recommendations of using one stick machine in seed cotton cleaning systems processing picker harvested cotton and two stick machines in systems processing stripper harvested cotton.

Keywords. Cotton, harvesting, ginning, fiber quality, spinning

Introduction

Cotton grown in the Southern High Plains region is traditionally harvested with brush-roll stripper harvesters. These machines were developed to be a cost effective method for harvesting relatively low yielding cotton (1.2 – 3.7 bales/ha) grown on short plants with closed or "storm-proof" boll conformations. The spindle picker is not well suited to harvest cotton under these conditions. In contrast to spindle pickers, stripper harvesters indiscriminately harvest seed cotton from the plants. As a consequence of the indiscriminate harvesting action, foreign matter content of stripped cotton is often much higher than that of picked cotton. Subsequently, lint turnout values are typically in the range of 25%, 30%, and 35% for stripped - non-field cleaned, stripped - field cleaned, and picked cottons, respectively.

Cotton produced in the Southern High Plains has exhibited substantial improvements in terms of yield and fiber quality over the last ten years. These benefits stem primarily from cultivar changes and improved irrigation practices. In an effort to better preserve fiber quality, some producers in the region have begun to look to spindle pickers to harvest the High Plains crop. Recent work by Faulkner et al. (2011 a, b, and c) indicates that picker harvesters can in some cases, offer advantages with regard to harvesting productivity, gin turnout, and fiber and yarn quality when compared to brush-roll stripper harvesters.

Ginning practices in the High Plains region were developed to handle high trash levels contained in stripper harvested cotton. The recommended machinery sequence for processing stripper harvested cotton includes: green boll/rock trap, air-line cleaner, feed control, tower drier, inclined cleaner, stick machine, tower drier, inclined cleaner, stick machine, extractor-feeder, gin stand, and two saw-type lint cleaners (Baker et al., 1977). Anthony et al. (1986) recommended a similar sequence for processing machine picked cotton but included only the first stick machine listed (i.e. no stick machine just prior to the extractor feeder). Differences in the recommended machinery sequences for ginning picked and stripped cotton reflect the difference in the amount of required seed cotton cleaning to affect efficient ginning and acceptable lint trash grades.

Research on seed cotton cleaning equipment over the years indicates that extractors (e.g. stick machines and burr machines) and cylinder cleaners (e.g. horizontal and inclined cleaners) have little influence on fiber length characteristics while positively influencing color and leaf grades (Anthony, 1982; Anthony et al., 1986; Baker et al., 1977; Baker and Lalor, 1990, Holt et al., 2002). Cleaning efficiency of seed cotton cleaning equipment is influenced by many factors including initial seed cotton foreign matter content, processing rate, moisture content, machine configuration/setting, and distribution of cotton across the machine (Baker et al., 1982; Baker et al., 1994). Although ginners strive for maximum production and thus tend to push the processing rate limits of their cleaning equipment, compromises must be made to balance seed cotton cleaning rate with cleaning efficiency and seed cotton loss (higher processing rates tend to reduce cleaning efficiency and increase seed cotton loss). Moreover, mechanical actions on cotton fibers in the harvesting and ginning process have been shown to increase the amount of neps and short fibers in the bale (Anthony et al., 1986). Short fiber and nep content influence spinning performance and mill waste but neither is reported by the USDA – Agricultural Marketing Service (AMS) which uses the High Volume Instrument (HVI) classification system for Commodity Credit Corporation (CCC) loan value determination. Recent questions have arisen

from the industry concerning appropriate methods for ginning picker harvested cotton from high-quality cultivars that preserve fiber quality and bale value. Thus, the objective of this work was to investigate the influence of harvest method, number of seed cotton extractor cleaners, and seed cotton processing rate on foreign matter content, lint turnout, and fiber and yarn quality for cotton produced in the Southern High Plains.

Materials and Methods

A completely randomized experimental design was used to evaluate the main effects of harvest method (spindle picker or brush-roll stripper with field cleaner), number of stick machines used in the seed cotton cleaning machine sequence (one or two), and seed cotton cleaning rate (low, medium, high). The experiment was conducted six times from 2009 to 2010 and the location and various production conditions for each test are listed in table 1. Three replications of each treatment combination were used for a total of 36 runs per test (216 total).

Table 1. Location and production conditions for six tests conducted during 2009 and 2010.

Test	Location	Year	Irrigation	Soil Type*	Cultivar**	Lint Yield (kg/ha)
A	Lubbock, TX	2009	Pivot - Limited	Acuff loam	DPL 143 B2F	280
B	Lubbock, TX	2009	Pivot - Limited	Acuff loam / Amarillo fine sandy loam	FM 9180 B2F	662
C	Ralls, TX	2009	Sub-surface drip	Pullman silty clay loam	FM 9180 B2F	1234
D	Plains, TX	2009	Pivot	Amarillo loamy fine sand	FM 9180 B2F	1346
E	Lubbock, TX	2010	Furrow	Acuff loam / Estacado clay loam	FM 9180 B2F	897
F	Ralls, TX	2010	Sub-surface drip	Pullman silty clay loam	FM 9180 B2F	1458

*USDA (2009).

**DPL 143 B2F (Deltapine, Monsanto, St. Louis, MO), FM 9180 B2F (FiberMax, Bayer Crop Science, Research Triangle Park, NC).

Cotton for tests A and B was harvested near Lubbock, TX in 2009. Portions of a center pivot irrigated field were planted with Deltapine 143 Bollgard II® Roundup Ready Flex® (DP 143 B2F; Monsanto, St. Louis, MO) and FiberMax 9180 Bollgard II® Roundup Ready Flex® (FM 9180 B2F, Bayer Crop Science, Research Triangle Park, NC). DP 143 B2F was used for test A while FM 9180 B2F was used for test B to provide seed cotton with a potential range in fiber maturity. DP 143 B2F is a late maturing cultivar while FM 9180 B2F is early maturing. The irrigation volume was limited for this field due to declining well capacity as is evident by the low yield relative to the other tests. Cotton for tests A and B was planted on May 25, 2009 and harvested November 30, 2009 using a John Deere 9996 (Moline, IL) six-row picker and a John Deere 7445 six-row stripper with field cleaner.

Cotton for tests C and F was harvested from the same field near Ralls, TX in 2009 and 2010, respectively. FM 9180 B2F was the cultivar used in both tests and the cotton was irrigated by a sub-surface drip system. For test C, the field was planted on May 15, 2009 and harvested November 16, 2009. In 2010, the field was planted on May 20 and harvested November 2 with the picker and November 18 with the stripper for test F. A John Deere 9996 six-row picker and

John Deere 7460 eight-row stripper with field cleaner were used to harvest cotton for both test C and F.

Cotton for test D was produced on a center pivot irrigated field near Plains, TX. The field was planted to FM 9180 B2F on May 18, 2009 and harvested November 19, 2009. Irrigation capacity was considerably higher for the field used for test D compared to the field used for tests A and B. Thus, the lint yield was substantially improved for test D compared to tests A and B. A John Deere 9996 six-row picker and John Deere 7460 six-row stripper with field cleaner were used to harvest cotton for test D.

Cotton for test E was produced on a furrow-irrigated cotton field near Lubbock, TX. The field was planted to FM 9180 B2F on May 6, 2010 and harvested November 4, 2010. The cotton was harvested using a John Deere 9996 six-row picker and a John Deere 7445 six-row stripper with field cleaner.

Ginning and Fiber Testing

The cotton harvested for each test was ginned the USDA ARS Cotton Production and Processing Research Unit (CPPRU, Lubbock, TX). During each gin run, a seed cotton lot of approximately 113 kg was processed through the following initial seed cotton cleaning machinery: green boll/rock trap, feed control, tower drier, inclined cleaner, and stick machine (R320, Consolidated Gin Machinery Co., Lubbock, TX). After passing though the initial seed cotton cleaning machinery, the seed cotton was dumped in a bin located at the distributor auger overflow and weighed. The lot was then picked up and taken through the following final seed cotton cleaning machinery: feed control, tower drier, inclined cleaner, and R320 stick machine. The stick machine in the final seed cotton cleaning sequence was bypassed for half of the seed cotton lots. The cotton was taken though the same seed cotton cleaning equipment during the initial and final seed cotton cleaning passes to reduce any bias that may have been introduced if different machines were used. All seed cotton cleaning machinery was 1.83-m wide.

The flow rate of the seed cotton through the cleaning equipment was controlled by the feed control. The same three feed control settings were used for all tests to establish the low, medium, and high material flow rates without regard to initial foreign matter content (table 2). Thus, the feed rates for tests with higher turnout were higher in terms of lint mass per unit time than tests with cotton containing higher amounts of foreign matter (i.e. cotton with lower turnout). The feed control setting was adjusted so that the processing time through the final seed cotton cleaning machine sequence approximated that of the initial sequence. After seed cotton cleaning, each lot was processed through an extractor/feeder, 93-saw gin stand, and two-stages of saw type lint cleaning.

Table 2. Seed cotton cleaning rates used for tests conducted during 2009 and 2010.

	Seed Cotton Feed Rates by Test, kg/min (bales/hr-m)*						
Rate	A	B	C	D	E	F	Mean
Low	133 (5.2)	128 (6.0)	174 (8.4)	173 (7.8)	147 (7.5)	168 (7.9)	154 (7.1)
Med	190 (7.1)	153 (7.1)	207 (10.1)	210 (9.6)	182 (9.3)	209 (9.8)	192 (8.8)
High	203 (7.8)	190 (8.8)	238 (11.6)	225 (10.2)	211 (10.8)	252 (11.7)	220 (10.1)

*Bales/hr-m refers to the number of 218 kg lint bales processed per hour per m of machine width.

During each gin run, one seed cotton sample was collected at the suction telescope and extractor/feeder apron for gravimetric moisture content analysis and fractionation analysis (Shepherd, 1972). An additional seed cotton fractionation sample was collected from the overflow bin after the initial seed cotton cleaning machine sequence. The material removed from the seed cotton by the stick machine was weighed and sampled (one sample) for seed cotton loss after each pass. The waste material from both lint cleaners was collected, weighed, and sampled (one sample per machine) for foreign matter content analysis using the Shirley Analyzer method (ASTM, 2007). USDA ARS personnel at the CPPRU conducted all moisture content, fractionation, and Shirley Analyzer analyses. Lint samples were collected after the first and second lint cleaners (one sample per machine) for HVI and Advanced Fiber Information system (AFIS) fiber analysis at the Texas Tech University - Fiber and Biopolymer Research Institute (Lubbock, TX).

Lint turnout was calculated using the incoming seed cotton weight and lint weight after one and two lint cleaners. Total trash content (kg/bale) in the seed cotton ginned during each run was calculated as the incoming seed cotton weight less the seed weight and lint weight after two lint cleaners. Bale value after each lint cleaner was calculated using the lint weight and loan value determined from the 2010 Commodity Credit Corporation Loan Chart. The 2010 loan chart was used for all tests to preclude bale value differences resulting from changes in the premium/discount schedule between years. Bale value after two lint cleaners was based on a standard bale weight of 218 kg (480 lb). Lint weight after the first lint cleaner was higher than after the second lint cleaner by the weight of material removed by the second lint cleaner.

Spinning and Yarn Testing

Ring spun yarn was produced from fiber from tests B, C, D, E, and F at the Texas Tech University Fiber and Biopolymer Research Institute. Due to financial limitations, only a subset of the fiber ginned from each test was used in the spinning tests. Picker harvested fiber processed through one extractor cleaner at the high cleaning rate and stripper harvested fiber processed through two extractor cleaners at the high cleaning rate were used to produce 19.68-tex yarn. Yarn from each test was subjected to evenness testing using a Uster Tester 3 (UT3, Uster Technologies, Knoxville, TN) and tensile testing using a Uster Tensorapid 3 (Tensorapid 3, Uster Technologies, Knoxville, TN). Waste removed from the raw fiber during opening and carding was collected and weighed.

Ginning performance, bale value, and fiber quality data were analyzed for main effects and two-factor interactions by test using the general linear model (Proc GLM) in SAS (SAS v. 9.2, SAS Institute, Cary, NC) with a 0.05 level of significance. Main effects and two-factor interactions were evaluated over all tests using the mixed model (Proc Mixed) in SAS. For the mixed model analysis, test was considered a random effect. Seed cotton moisture content measured at the suction and extractor feeder apron were used as covariates in both the GLM and mixed model analyses. Separation of least square means was conducted in SAS using Tukey's test (α = 0.05). Yarn evenness and tensile properties were analyzed by "system" characterized by the harvest method, number of seed cotton extractor cleaners, and cleaning rate combination. Yarn data were analyzed by test using the general linear model (Proc GLM) and over all tests using the mixed model (Proc Mixed) in SAS (SAS v. 9.2, SAS Institute, Cary, NC) at a 0.05 level of significance.

Results and Discussion

Ginning Analysis

Seed cotton fractionation results on samples collected from the inlet suction telescope at the gin indicate that picker harvested cotton had less foreign material in terms of total trash for all six tests (table 3). The mixed model analysis indicated differences for all foreign matter constituents by harvest method only. Since the data presented in table 3 are from fractionation analyses conducted on seed cotton samples taken before entering the gin plant, no difference by the number of stick machines or seed cotton cleaning rate was expected. The significant harvest method by stick machine interaction for fine trash and harvest method by seed cotton cleaning rate for burr and total trash content are a consequence of natural variation in the seed cotton foreign matter content.

Table 3. Fractionation results by test and harvest method (pick = picker, strip = stripper w/field cleaner) from seed cotton samples collected at the suction telescope before ginning.

	Test A		Test B		Test C		Test D		Test E		Test F		Mean*	
Foreign Matter Component	Pick	Strip	Pick	Strip	Pick	Strip	Pick	Strip	Pick	Strip	Pick	Strip	Pick	Strip
Burrs (B)	1.3	16.7	1.1	11.6	2.2	11.8	3.1	11.0	1.7	5.3	2.3	11.0	2.0	11.2
Sticks (S)	0.4	5.9	0.3	5.7	1.0	4.2	0.9	5.1	0.4	2.0	0.3	2.8	0.5	4.3
Fine Trash (F)	4.4	8.2	3.4	5.5	3.0	4.4	3.6	6.0	4.4	5.2	4.5	11.9	3.9	6.9
Total Trash (T)	6.1	30.8	4.7	22.8	6.2	20.3	7.6	22.1	6.6	12.5	7.1	25.8	6.4	22.4
Main Effects and Interactions**														
Harvest Method	B, T		B, S, F, T		B, S, F, T		B, S, F, T		B, S, T		B, S, F, T		B, S, F, T	
# Stick Machines	-		-		-		-		-		-		-	
SC Cleaning Rate	-		-		-		-		-		-		-	
HM x SM	-		-		-		F		-		-		-	
HM x Rate	-		-		B, T		-		-		-		-	
SM x Rate	-		-		-		-		-		-		-	

*Means in this column are reported from the mixed model analysis across all tests.

**Main effects and interactions were significant for the foreign matter fractions listed.

Total foreign matter removed by the stick machines used during seed cotton cleaning is shown in table 4. As expected, more foreign material was removed by the stick machines from stripped cotton than picked cotton in all tests. Over all six tests, an average of 76 kg/bale was removed from stripped cotton compared to 16.9 kg/bale from picked cotton. Seed cotton cleaning machinery sequences using only one stick machine removed less foreign material than those using two. Across all tests, seed cotton cleaning machinery sequences using two stick machines removed 13.5 kg/bale more foreign material compared to sequences using only one. Seed cotton cleaning rate significantly influenced the amount of foreign matter removed by the stick machines for tests A, B, and F, where the trend of increasing foreign matter removal with decreasing cleaning rate was observed. Significant harvest method by number of stick machines interactions were observed for all but test E. This interaction is linked to the initial seed cotton foreign matter content as the difference between the total foreign matter removed by one and two stick machines was greater for stripped cotton compared to picked (figure 1). Additionally, the difference in foreign matter removed by one and two stick machines was greater for stripped cotton in test A compared to the other tests. This is likely due to the difference in maturity between cultivars among tests as DPL 143 B2F requires a longer growing season to reach maturity compared to FM 9180 B2F. The harvest method by seed cotton cleaning rate interaction was significant for tests A, B, and F.

Table 4. Least square means for total foreign material (kg/bale) removed by the stick machines during seed cotton cleaning.

Test	A	B	C	D	E	F	Mean*
Harvest Method							
Picked	15.0	6.7	10.5	18.7	13.8	14.5	16.9
Stripped	116.1	73.7	77.9	88.8	36.7	84.5	76.0
p > *F*	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Stick Machines							
One	52.6	33.1	36.7	47.3	23.0	42.8	39.7
Two	78.5	47.3	51.7	60.1	27.4	56.3	53.2
p > *F*	<.0001	<.0001	0.0002	<.0001	0.0045	<.0001	<.0001
SC Cleaning Rate**							
High	59.9[a]	37.3[a]	40.0	52.9	24.0	48.4[a]	43.5
Med	68.5[b]	40.8[ab]	48.6	52.4	25.1	47.7[a]	47.3
Low	68.3[b]	42.5[b]	44.0	55.9	26.6	52.5[b]	48.5
p > *F*	0.0280	0.0044	ns	ns	ns	0.0004	ns

*Means in this column are reported from the mixed model analysis across all tests.

**Least square means within a column followed by the same letter are not different by Tukey's test (α = 0.05)

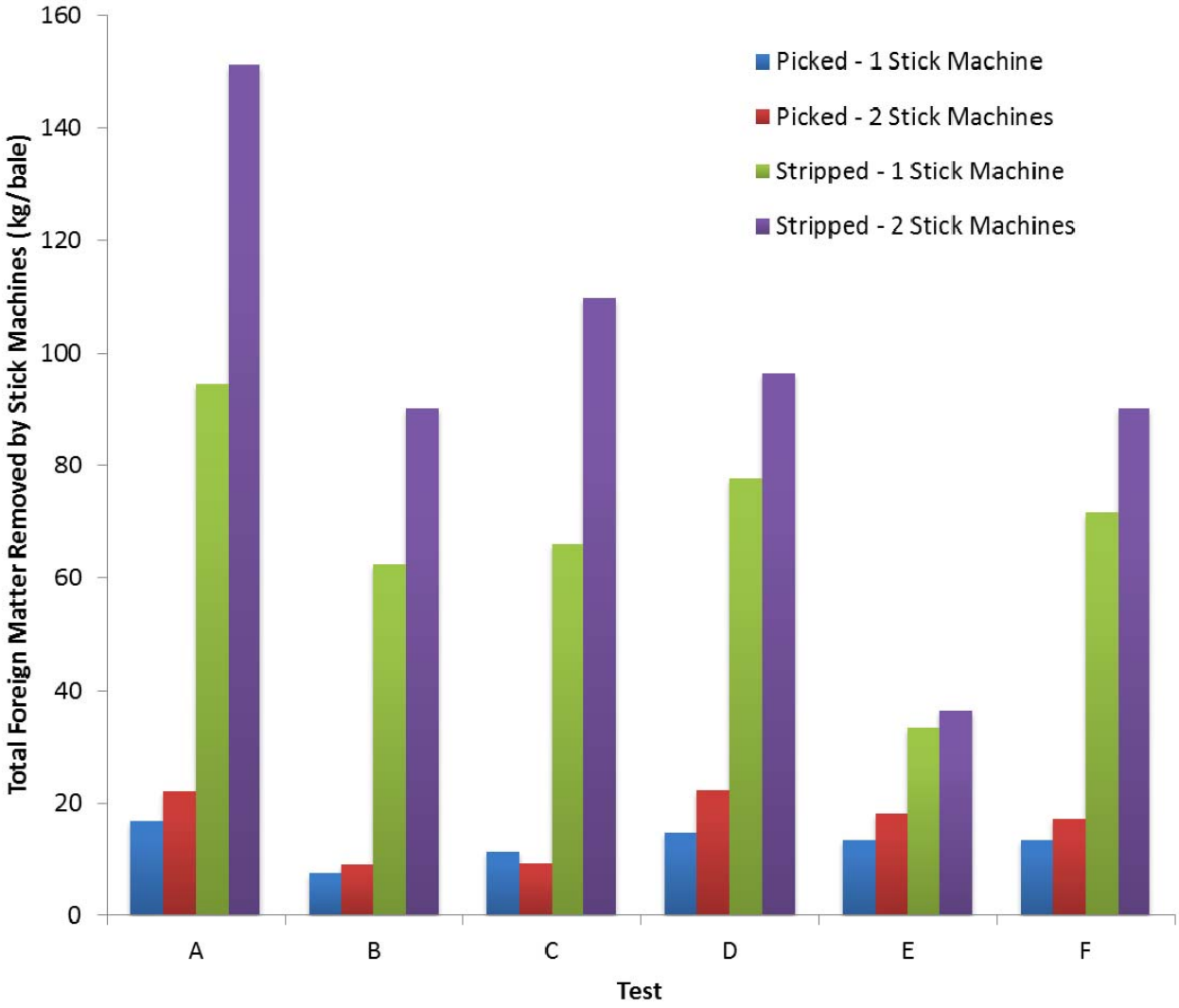

Figure 1. Total foreign matter removed by the stick machines for the medium seed cotton cleaning rate.

According to the mixed model analysis, stick machine seed cotton loss was different by the number of stick machines only (table 5) where the seed cotton cleaning sequence using two stick machines lost approximately 0.2 kg/bale more than the sequence using only one. The by-test analysis for test D indicated that the stick machines had higher seed cotton loss for picked cotton compared to stripped. Anecdotal evidence from ginners indicates that higher processing rates tend to lead to increased levels of seed cotton loss; however, we did not observe this finding. Potential reasons for additional seed cotton loss at higher processing rates under commercial conditions include: poor moisture control during seed cotton cleaning (e.g. excessive drying), improper saw to grid bar clearances, broken/worn grid bars, incorrect saw speeds due to worn drive components, worn/damaged channel saws, and worn/damaged doffer brushes.

Table 5. Least square means for stick machine seed cotton loss (kg/bale) by test.

Test	A	B	C	D	E	F	Mean*
Harvest Method							
Picked	1.2	0.3	0.2	0.2	0.3	0.4	0.5
Stripped	2.1	0.2	0.2	0.1	0.4	0.3	0.4
p > *F*	ns	ns	ns	<0.0001	ns	ns	ns
Stick Machines							
One	1.2	0.2	0.2	0.1	0.3	0.3	0.4
Two	2.1	0.4	0.2	0.2	0.4	0.5	0.6
p > *F*	0.0052	<0.0001	ns	0.0022	<0.0001	<0.0001	<0.0001
SC Cleaning Rate							
High	1.7	0.3	0.2	0.1	0.3	0.4	0.5
Med	1.7	0.3	0.3	0.1	0.3	0.4	0.5
Low	1.5	0.3	0.2	0.1	0.4	0.4	0.5
p > *F*	ns	ns	ns	ns	ns	ns	ns

*Means in this column are reported from the mixed model analysis across all tests.

The least square means for total trash removed by the extractor feeder just prior to the gin stand (table 6) indicate differences by harvest method and number of stick machines across all tests and for the mixed model. Over all tests, about 12.9 kg/bale more trash was removed from stripped cotton by the extractor feeder compared to picked cotton. The extractor feeder removed an additional 9.1 kg/bale of foreign material from cotton processed through only one stick machine indicating that the extractor feeder is able to compensate for some of the reduced cleaning performance of upstream equipment. Further analysis of the stick machine and extractor feeder trash data indicate that the level of compensation varies by harvest method. The extractor feeder removed 85 and 58% of the foreign matter from picked and stripped cottons, respectively, that was not removed when the second stick machine was bypassed. Total foreign material removed by the extractor feeder decreased significantly with decreasing seed cotton cleaning rate for test D. This indicates that for slower seed cotton processing rates, the seed cotton cleaning machinery upstream of the extractor feeder is able to remove more foreign material thus requiring less to be removed by the extractor feeder. The harvest method by number of stick machines interaction was significant for all tests and the mixed model mean. Similar to the stick machine foreign matter removal analysis, this interaction indicates that the difference in extractor feeder trash between seed cotton cleaning sequences using one and two stick machines is greater for stripped cotton due to the increased initial foreign matter content. The stick machine by cleaning rate interaction was significant for test D only.

Table 6. Least square means for foreign matter (kg/bale) removed by the extractor feeder by test.

Test	A	B	C	D	E	F	Mean*
Harvest Method							
Picked	5.8	3.6	3.6	5.1	3.1	1.8	7.1
Stripped	48.5	23.4	21.6	18.5	8.0	19.7	20.0
p > *F*	<.0001	<.0001	<.0001	<.0001	0.0003	<.0001	<.0001
Stick Machines							
One	34.4	17.4	17.1	16.4	7.7	14.1	18.1
Two	19.9	9.5	8.2	7.2	3.5	7.4	9.0
p > *F*	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
SC Cleaning Rate**							
High	27.8	14.1	13.3	13.1[a]	5.4	11.9	14.0
Med	28.4	13.5	12.5	11.3[b]	6.1	11.1	14.1
Low	25.2	12.8	12.0	10.9[b]	5.2	9.2	12.6
p > *F*	ns	ns	ns	0.0002	ns	ns	ns

*Means in this column are reported from the mixed model analysis across all tests.

**Least square means within a column followed by the same letter are not different by Tukey's HSD test (α = 0.05).

Total foreign matter removed during the ginning process (table 7) includes all of the material removed by the seed cotton cleaning, ginning, and lint cleaning systems combined. Less total foreign material was removed from picker harvested cotton. Harvest method significantly influenced total foreign matter content for the mixed model analysis which showed that 86 kg/bale (1 bale = 218 kg [480 lb]) total foreign matter was removed from picker harvested cotton whereas 203 kg/bale was removed from cotton harvested by a stripper equipped with a field cleaner. Total foreign matter removal was not different between seed cotton cleaning sequences using one or two stick machines for all but test E. The overall means for one and two stick machines from the mixed model were not different. This finding indicates that additional cleaning is taking place in machinery later in the ginning process to compensate for cleaning not performed by the second stick machine for seed cotton cleaning machine sequences using only one stick machine. Total foreign matter removed during ginning was different by seed cotton cleaning rate for only Test A where the medium rate increased total foreign matter removal compared to the low and high rates. Significant harvest method by cleaning rate and number of stick machines by cleaning rate interactions were observed for tests A and F, respectively.

Table 7. Least square means for total foreign matter removed during ginning (kg/bale).

Test	A	B	C	D	E	F	Mean*
Harvest Method							
Picked	114	74	68	81	66	60	86
Stripped	353	199	178	217	99	234	203
p > F	<0.0001	<0.0001	<0.0001	<0.0001	ns	<0.0001	<0.0001
Stick Machines							
One	236	135	121	149	93	151	147
Two	232	138	125	149	73	143	142
p > F	ns	ns	ns	ns	0.0274	ns	ns
SC Cleaning Rate**							
High	215[a]	135	129	150	85	146	143
Med	257[b]	140	123	151	80	143	147
Low	229[a]	135	118	146	82	153	144
p > F	0.0009	ns	ns	ns	ns	ns	ns

*Means in this column are reported from the mixed model analysis across all tests.

**Least square means within a column followed by the same letter are not different by Tukey's HSD test ($\alpha = 0.05$)

The overall cleaning efficiency of the seed cotton cleaning system is shown in table 8. Differences by harvest method were observed for test C and the mixed model mean where the seed cotton cleaning system efficiency was higher for stripped cotton (68%) compared to picked cotton (58.2%). The number of stick machines significantly influenced the seed cotton cleaning system efficiency for tests B and F and the mixed model mean. Seed cotton cleaning system efficiencies were higher for machine sequences using two stick machines (66.1%) compared to those using only one (60%). Seed cotton cleaning rate had no significant influence on the seed cotton cleaning system efficiency. One reason for this finding is that the system efficiency values reported in table 8 include the cleaning performed by the extractor feeder. Seed cotton cleaning system efficiency was calculated by [(Suction Telescope Total Trash Content – Feeder Apron Total Trash Content) / Suction Telescope Total Trash Content]. The extractor feeder is used to regulate the flow of material into the gin stand and was operated at a constant material flow rate during all 216 gin runs conducted during this project. Thus the extractor feeder was able to remove more trash from cotton with higher trash content (at the inlet to the extractor feeder) resulting from higher processing rates effectively equalizing the trash content of the seed cotton measured at the feeder apron. No significant interactions were observed for the seed cotton cleaning system efficiency data.

Table 8. Least square means of cleaning efficiency (%) for the seed cotton cleaning system by test.

Test	A	B	C	D	E	F	Mean
Harvest Method							
Picked	35.3	47.3	53.1	69.3	66.0	69.9	58.2
Stripped	61.2	60.8	67.6	73.5	75.0	78.4	68.0
p > F	ns	ns	0.0209	ns	ns	ns	<0.0001
Stick Machines							
One	44.7	48.3	55.9	69.7	68.6	72.0	60.0
Two	51.8	59.8	64.8	73.1	72.5	76.4	66.1
p > F	ns	0.0230	ns	ns	ns	0.0295	<.0001
SC Cleaning Rate							
High	51.5	56.7	57.2	72.0	68.8	74.5	62.9
Med	47.6	54.9	58.3	70.8	70.0	74.1	62.6
Low	45.7	50.6	65.5	71.3	72.8	74.0	63.7
p > F	ns	ns	ns	ns	ns	ns	ns

*Means in this column are reported from the mixed model analysis across all tests.

Lint turnout measured after one lint cleaner was different by harvest method for all tests and the mixed model (table 9). Picker harvested cotton had an overall turnout of 34.1% compared to 28.1% for the stripped cotton. Turnout was significantly higher for seed cotton cleaning sequences utilizing two stick machines according to the mixed model but the difference of 0.3% is more likely a consequence of the difference in precision between the scales used to weigh the seed cotton and lint than a real difference in turnout by the number of stick machines used. Seed cotton cleaning rate was significant for test A only where the turnout for the high and medium cleaning rates were different (high = 26.9%, medium = 25.8%). The number of stick machines by cleaning rate interaction was significant for tests B and F only.

Table 9. Least square means of lint turnout (%) after 1 lint cleaner.

Test	A	B	C	D	E	F	Mean*
Harvest Method							
Picked	30.1	34.2	35.5	33.6	35.5	35.7	34.1
Stripped	22.4	28.2	30.1	27.2	33.4	27.6	28.2
p > *F*	0.0001	<0.0001	<0.0001	<0.0001	0.0244	<0.0001	<0.0001
Stick Machines							
One	26.3	31.2	32.7	30.2	33.9	31.4	31.0
Two	26.2	31.2	32.9	30.6	35.0	31.9	31.3
p > *F*	ns	ns	ns	ns	0.0121	ns	0.0246
SC Cleaning Rate**							
High	26.9[a]	31.4	32.7	30.2	34.4	31.7	31.2
Med	25.8[b]	31.1	32.8	30.6	34.6	31.8	31.1
Low	26.2[ab]	31.1	33.0	30.5	34.5	31.4	31.1
p > *F*	0.0364	ns	ns	ns	ns	ns	ns

*Means in this column are reported from the mixed model analysis across all tests.

**Least square means within a column followed by the same letter are not different by Tukey's HSD test (α = 0.05).

The difference in lint turnout between one and two lint cleaners was significant by harvest method for test B and F only (table 10). Over all tests, turnout for picker harvested cotton was reduced by 0.56% by the second lint cleaner and by 0.57% for stripped cotton but the difference by harvest method was not significant. No significant differences were observed in the lint turnout difference data by number of stick machines for any of the individual tests but the mixed model indicated that the turnout difference was greater for the sequence using only one stick machine. No differences in the turnout difference between lint cleaners was observed for seed cotton cleaning rate. A significant stick machine by cleaning rate interaction was observed for test F.

Table 10. Least square means of lint turnout differences between one and two lint cleaners [Diff. % = LC1 Turnout % – LC2 Turnout %].

Test	A	B	C	D	E	F	Mean
Harvest Method							
Picked	0.83	0.48	0.46	0.37	0.64	0.57	0.56
Stripped	0.75	0.58	0.50	0.35	0.61	0.62	0.57
p > *F*	ns	0.0038	ns	ns	ns	0.0430	ns
Stick Machines							
One	0.84	0.54	0.49	0.35	0.63	0.60	0.58
Two	0.74	0.52	0.47	0.37	0.62	0.59	0.55
p > *F*	ns	ns	ns	ns	ns	ns	0.0178
SC Cleaning Rate							
High	0.83	0.55	0.47	0.36	0.61	0.60	0.57
Med	0.77	0.54	0.47	0.38	0.64	0.58	0.56
Low	0.78	0.51	0.49	0.35	0.62	0.61	0.56
p > *F*	ns	ns	ns	ns	ns	ns	ns

*Means in this column are reported from the mixed model analysis across all tests.

Visible foreign matter content (measured by the Shirley Analyzer method) in the waste from lint cleaners one and two is shown in tables 11 and 12, respectively. Visible foreign matter in the waste from the first lint cleaner was higher for stripper harvested cotton and for cotton processed through only one stick machine. No differences by seed cotton cleaning rate were observed for the visible foreign matter content in the first lint cleaner waste. Significant harvest method by stick machine and stick machine x cleaning rate interactions were observed for test D.

Table 11. Least square means of visible foreign matter (kg/bale) in the waste material from lint cleaner #1.

Test	A	B	C	D	E	F	Mean*
Harvest Method							
Picked	12.6	5.3	4.9	4.0	3.9	3.5	7.2
Stripped	29.2	13.4	9.3	8.0	4.3	8.1	10.5
p > *F*	0.0110	<0.0001	<0.0001	<0.0001	ns	<0.0001	<0.0001
Stick Machines							
One	22.6	9.9	7.7	6.6	4.3	6.1	9.7
Two	19.2	8.7	6.5	5.3	3.9	5.5	8.0
p > *F*	0.0104	0.0133	0.0314	0.0013	0.0033	ns	<0.0001
SC Cleaning Rate							
High	21.4	9.5	6.9	6.5	4.3	6.3	9.1
Med	22.1	9.6	7.3	5.8	4.0	5.4	9.1
Low	19.1	8.9	7.1	5.6	4.0	5.7	8.4
p > *F*	ns	ns	ns	ns	ns	ns	ns

*Means in this column are reported from the mixed model analysis across all tests.

Visible foreign matter content in the lint cleaner waste was substantially lower for the #2 lint cleaner compared to the #1 lint cleaner. For the #2 lint cleaner waste, visible foreign matter content was higher for stripper harvested cotton for tests B, C, D, and F and the mixed model mean. The number of stick machines influenced the visible foreign matter in the #2 lint cleaner waste for test C (one stick machine = 1.4 kg/bale, two stick machines = 1.2 kg/bale) and the mixed model mean. The amount of visible foreign matter in the #2 lint cleaner waste decreased significantly from the high cleaning rate (1.8 kg/bale) to the low rate (1.5 kg/bale) for test B. The harvest method by number of stick machines and harvest method x seed cotton cleaning rate interactions were significant for tests F and B, respectively.

Table 12. Least square means of visible foreign matter (kg/bale) in the waste material from lint cleaner #2.

Test	A	B	C	D	E	F	Mean*
Harvest Method							
Picked	3.0	1.0	1.0	0.8	0.7	0.6	1.5
Stripped	5.2	2.2	1.6	1.2	0.8	1.2	1.8
p > F	ns	<0.0001	<0.0001	0.0009	ns	<0.0001	0.0037
Stick Machines							
One	4.4	1.7	1.4	1.0	0.7	1.0	1.7
Two	3.8	1.6	1.2	1.0	0.7	0.8	1.5
p > F	ns	ns	0.0137	ns	ns	0.0	0.0033
SC Cleaning Rate**							
High	4.3	1.8[a]	1.3	1.0	0.8	0.9	1.7
Med	4.0	1.7[ab]	1.3	1.0	0.7	0.8	1.6
Low	4.0	1.5[b]	1.3	1.0	0.7	0.9	1.6
p > F	ns	0.0085	ns	ns	ns	ns	ns

*Means in this column are reported from the mixed model analysis across all tests.

**Least square means within a column followed by the same letter are not different by Tukey's HSD test ($\alpha = 0.05$).

The clean lint content (measured by the Shirley Analyzer method) in the waste from the #1 and #2 lint cleaners is shown in tables 13 and 14, respectively. The clean lint content in the waste from the first lint cleaner was higher for stripper harvested cotton for tests E and F and the mixed model mean. The number of stick machines and seed cotton cleaning rate had no influence on the clean lint content in the first lint cleaner waste. Differences were observed in the clean lint content in the #2 lint cleaner waste by harvest method and seed cotton cleaning rate for test C and F. The mixed model indicated a slight but significant increase in clean lint content in the #2 lint cleaner waste for stripper harvested cotton. Interactions were not significant for the amount of clean lint removed by the first lint cleaner but the harvest method by cleaning rate interaction was significant for tests E and F for the number two lint cleaner.

Table 13. Least square means of clean lint content (kg/bale) in the waste material from lint cleaner #1.

Test	A	B	C	D	E	F	Mean*
Harvest Method							
Picked	5.7	4.0	4.2	3.8	3.5	3.3	4.0
Stripped	3.9	4.0	4.2	4.2	4.2	4.7	4.3
p > F	ns	ns	ns	ns	0.0029	0.0019	0.0008
Stick Machines							
One	4.9	4.0	4.3	4.0	3.9	4.1	4.2
Two	4.8	3.9	4.1	4.0	3.8	3.8	4.1
p > F	ns	ns	ns	ns	ns	ns	ns
SC Cleaning Rate							
High	4.9	4.0	4.1	4.3	3.7	4.0	4.2
Med	4.7	3.9	4.2	3.9	4.0	3.8	4.1
Low	4.8	4.1	4.2	3.9	3.9	4.0	4.1
p > F	ns	ns	ns	ns	ns	ns	ns

*Means in this column are reported from the mixed model analysis across all tests.

Table 14. Least square means of clean lint content (kg/bale) in the waste material from lint cleaner #2.

Test	A	B	C	D	E	F	Mean*
Harvest Method							
Picked	2.9	1.9	1.8	1.5	1.7	1.5	1.9
Stripped	2.4	2.1	1.9	1.6	1.7	2.0	2.0
p > F	ns	ns	0.0478	ns	ns	0.0005	0.0008
Stick Machines							
One	2.8	2.0	1.9	1.5	1.8	1.8	1.9
Two	2.6	2.0	1.9	1.6	1.6	1.8	1.9
p > F	ns	ns	ns	ns	0.0	ns	ns
SC Cleaning Rate**							
High	2.6	2.0	1.9^{ab}	1.5	1.6	1.8^{ab}	1.9
Med	2.6	2.0	1.8^{a}	1.6	1.7	1.7^{a}	1.9
Low	2.8	2.0	2.0^{b}	1.5	1.7	1.8^{b}	2.0
p > F	ns	ns	0.0299	ns	ns	0.0362	ns

*Means in this column are reported from the mixed model analysis across all tests.

**Least square means within a column followed by the same letter are not different by Tukey's HSD test ($\alpha = 0.05$).

Fiber Quality and Bale Value Analysis

Least square means from the mixed model analysis on HVI fiber properties measured from lint samples collected after one and two lint cleaners are shown in tables 15 and 16, respectively. Micronaire differences by harvest method were observed for all tests (data not presented) and for the overall analysis (mixed model analysis) for samples taken from both lint cleaners. Picker harvested cotton exhibited a higher micronaire than stripper harvested cotton in each case. This is due to the difference in maturity by harvest method affected through the selective harvesting action of the picker. Stripper harvesters indiscriminately collect seed cotton and foreign material from the plants whereas picker harvesters only remove seed cotton from mature, well opened bolls. This same phenomenon is observed in the immature fiber content (IFC) and maturity ratio (MR) data presented in tables 17 and 18. For samples collected after one and two lint cleaners, harvest method is the primary driver of IFC and MR differences.

HVI length and length uniformity index (uniformity) were greater for picker harvested cotton after one lint cleaner and for the high cleaning rate after two lint cleaners. Strength was slightly higher for stripper harvested cotton after both lint cleaners. The higher bundle strength observed for stripper harvested cotton is likely caused by an increase in the number of fibers included in the strength test samples relative to the picker harvested samples. HVI strength indicates the force required to break a bundle of fibers of a given weight. The number of fibers

contained in the bundle is greater for less mature and finer fibers (i.e. fibers with lower linear density).

Reflectance and yellowness were improved after both lint cleaners for picker harvested cotton and cotton processed through two stick machines. Improvement in fiber color parameters is not unique to this study as Seed cotton cleaning rate had no influence on reflectance or yellowness after either lint cleaner. Leaf grade was reduced for cotton processed through two stick machines for samples collected after one lint cleaner but no difference in leaf grade was observed between the number of stick machines after two lint cleaners. Leaf grade was not influenced by harvest method or seed cotton cleaning rate after either lint cleaner.

The harvest method by number of stick machines interaction was significant for yellowness measured after one lint cleaner. The harvest method by number of stick machines interaction was significant for length and length uniformity after two lint cleaners. The harvest method by seed cotton cleaning rate interaction was significant for yellowness after two lint cleaners.

Table 15. Mixed model least square means of HVI fiber analysis results from lint samples collected after one lint cleaner.

	Micronaire	Length (mm)	Uniformity (%)	Strength (g/Tex)	Reflectance	Yellowness	Leaf Grade
Harvest Method							
Picked	3.60	29.42	81.2	29.30	81.10	7.48	2.15
Stripped	3.43	29.31	80.9	29.50	80.47	7.80	2.36
p > F	<0.0001	0.0126	0.0001	0.0095	0.0002	<0.0001	ns
Stick Machines							
One	3.52	29.35	81.1	29.37	80.51	7.67	2.40
Two	3.51	29.38	81.1	29.44	81.06	7.60	2.11
p > F	ns	ns	ns	ns	<0.0001	0.0078	0.0024
SC Cleaning Rate							
High	3.52	29.38	81.1	29.45	80.72	7.64	2.21
Med	3.52	29.39	81.1	29.45	80.78	7.63	2.28
Low	3.51	29.33	81.0	29.31	80.85	7.64	2.27
p > F	ns	ns	ns	ns	ns	ns	ns

Table 16. Mixed model least square means of HVI fiber analysis results from lint samples collected after two lint cleaners.

	Micronaire	Length (mm)	Uniformity (%)	Strength (g/Tex)	Reflectance	Yellowness	Leaf Grade
Harvest Method							
Picked	3.60	29.09	80.7	29.08	82.05	7.61	1.63
Stripped	3.43	29.06	80.6	29.33	81.61	7.94	1.78
p > *F*	<0.0001	ns	ns	0.0049	0.0029	<0.0001	ns
Stick Machines							
One	3.52	29.04	80.6	29.18	81.72	7.81	1.77
Two	3.51	29.12	80.6	29.22	81.95	7.73	1.65
p > *F*	ns	ns	ns	ns	0.0392	0.0029	ns
SC Cleaning Rate*							
High	3.51	29.14[a]	80.7[a]	29.29	81.79	7.77	1.73
Med	3.52	29.06[ab]	80.6[ab]	29.18	81.81	7.76	1.76
Low	3.52	29.02[b]	80.5[b]	29.14	81.90	7.78	1.63
p > *F*	ns	0.0385	0.0050	ns	ns	ns	ns

*Least square means within a column followed by the same letter are not different by Tukey's HSD test (α = 0.05).

Differences in AFIS nep content after one and two lint cleaners was primarily influenced by harvest method and favored picker harvesting (tables 17 and 18). A considerable increase in overall nep content was observed between tests A (985 average neps/g) and B (522 average neps/g) and is likely a consequence of the difference in maturity and immature fiber content between cultivars. Mean length by number [L(n)] was longer for picker harvested cotton after both lint cleaners. L(n) was not influenced by the number of stick machines after either lint cleaner but was longer for the medium and high cleaning rates after two lint cleaners. Short fiber content by number [SFC(n)] was lower for picker harvested cotton but was unaffected by the number of stick machines or seed cotton cleaning rate after both lint cleaners. Total trash content (Total) and visible foreign material (VFM, measured by AFIS) in the lint samples collected after both lint cleaners indicated increased levels of foreign matter for cotton processed though one stick machine compared to two stick machines. After one lint cleaner, picking significantly reduced VFM. None of the two factor interactions were significant according to the mixed model analysis for the AFIS parameters measured after either lint cleaner.

Table 17. Mixed model least square means of selected AFIS fiber analysis results from lint samples collected after one lint cleaner.

	Nep Content (cnt/g)	L(n) (mm)	SFC(n) (%)	Total (cnt/g)	VFM (%)	IFC (%)	MR
Harvest Method							
Picked	475	19.10	29.7	851	2.05	9.02	0.831
Stripped	543	18.83	30.9	934	2.35	9.69	0.824
p > *F*	<0.0001	<0.0001	<0.0001	ns	0.0268	<0.0001	<0.0001
Stick Machines							
One	511	18.92	30.5	987	2.36	9.41	0.826
Two	507	19.02	30.1	799	2.04	9.31	0.829
p > *F*	ns	ns	ns	0.0002	0.0015	ns	0.0236
SC Cleaning Rate							
High	515	19.04	30.1	901	2.20	9.36	0.827
Med	508	18.96	30.3	914	2.26	9.31	0.828
Low	504	18.90	30.5	863	2.13	9.40	0.826
p > *F*	ns	ns	ns	ns	ns	ns	ns

Table 18. Mixed model least square means of selected AFIS fiber analysis results from lint samples collected after two lint cleaners.

	Nep Content (cnt/g)	L(n) (mm)	SFC(n) (%)	Total (cnt/g)	VFM (%)	IFC (%)	MR
Harvest Method							
Picked	633	18.80	30.6	503	1.38	9.63	0.823
Stripped	683	18.56	31.6	527	1.45	10.02	0.817
p > *F*	0.0075	0.0162	0.0052	ns	ns	0.0042	0.0014
Stick Machines							
One	667	18.63	31.3	572	1.53	9.89	0.819
Two	649	18.72	30.9	458	1.30	9.75	0.821
p > *F*	ns	ns	ns	0.0008	0.0011	ns	ns
SC Cleaning Rate*							
High	654	18.74[a]	30.9	505	1.42	9.73	0.821
Med	650	18.77[a]	30.8	501	1.41	9.77	0.821
Low	669	18.52[b]	31.6	539	1.41	9.97	0.818
p > *F*	ns	0.0120	ns	ns	ns	ns	ns

*Least square means within a column followed by the same letter are not different by Tukey's HSD test (α = 0.05).

Bale weight was higher for stripper harvested cotton after one lint cleaner compared to picker harvested cotton. Since 218 kg was assumed as the bale weight after the second lint cleaner, higher bale weights after one lint cleaner indicate that the second lint cleaner removed more total weight from the bale for stripper harvested cotton. Loan values for picker harvested cotton were higher than stripper harvested cotton after both lint cleaners and resulted in higher total bale values for picked cotton. However, bale value for picked cotton decreased from the first lint cleaner to the second indicating that the second lint cleaner provided no economic benefit for the cotton used in this project. Stripper harvested bale values increased between one and two lint cleaners indicating an economic benefit for utilizing the additional stage of lint cleaning. No difference in bale weights, loan values, or bale values were observed by the number of stick machines or seed cotton cleaning rate after one or two lint cleaners. No significant interactions were observed for the bale weight, loan value, or bale value parameters presented in table 19.

Table 19. Mixed model least square means for bale weight and value after one and two lint cleaners.

	After 1 Lint Cleaner			After 2 Lint Cleaners	
Harvest Method	Bale Weight* (kg)	Loan Value ($/kg)	Bale Value ($)	Loan Value ($/kg)	Bale Value ($)
Picked	220.9	1.191	262.90	1.201	261.72
Stripped	222.3	1.139	252.92	1.167	254.18
p > *F*	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Stick Machines					
One	221.7	1.164	257.72	1.185	258.16
Two	221.5	1.166	258.10	1.183	257.75
p > *F*	ns	ns	ns	ns	ns
SC Cleaning Rate					
High	221.7	1.162	257.31	1.186	258.42
Med	221.5	1.166	258.05	1.181	257.40
Low	221.6	1.167	258.37	1.184	258.04
p > *F*	ns	ns	ns	ns	ns

*A bale weight after two lint cleaners of 218 kg (480 lb) was used for the bale value calculations.

Spinning and Yarn Quality Analysis

The subset of lint samples from tests B, C, D, E, and F that were spun into yarn are characterized by two systems: 1) picker harvested cotton processed through one stick machine at the high seed cotton cleaning rate and 2) stripper harvested cotton processed through two stick machines at the high seed cotton cleaning rate. Total waste removed from the lint during opening (prior to carding and spinning) was not different between systems and averaged 2.28%. Total waste removed during carding was also not different between systems and averaged 3.64%. Tensorapid 3 tensile properties measured on skein and yarn samples are shown in table 20. No differences by system were observed for any of the skein or yarn tensile properties measured and reflects minimal differences observed in HVI fiber length, length uniformity, and strength measured after two lint cleaners (table 16). Yarn mass coefficient of variation (mass CV), thin places, and thick places were not different by system. Yarn neps (neps > 200%) and total imperfections were higher for yarn produced from the stripped-2SM-high fiber. Yarn hairiness and standard deviation of hairiness were not different by system.

Table 20. Skein and yarn tensile properties for ring spun yarn produced from tests B, C, D, E, and F.

	Skein Break Force	Skein Break Factor	Yarn Properties			
			Force to Break	Break Elongation	Tenacity	Work to Break
System*	(N)	(cN/Tex)	(g_f)	(%)	(cN/Tex)	(g_f – cm)
Picked-1SM-High	357	1825	275	5.57	13.8	420
Stripped-2SM-High	348	1782	275	5.58	13.8	420
p > F	ns	ns	ns	ns	ns	ns

*Picked-1SM-High = picker harvested cotton processed through one stick machine at the high seed cotton cleaning rate and Stripped-2SM-High = stripper harvested cotton processed through two stick machines at the high seed cotton cleaning rate.

Table 21. Yarn evenness properties for ring spun yarn produced from tests B, C, D, E, and F.

	Mass CV	Thin Places	Thick Places	Neps >200%	Total Imperf.	Hairiness	Hairiness Std. Dev.
System*	%	cnt/km	cnt/km	cnt/km	cnt/km		
Picked-1SM-High	16.5	28.0	273	285	585	5.67	1.248
Stripped-2SM-High	16.8	33.3	309	341	683	5.76	1.272
p > F	ns	ns	ns	0.0237	0.0447	ns	ns

*Picked-1SM-High = picker harvested cotton processed through one stick machine at the high seed cotton cleaning rate and Stripped-2SM-High = stripper harvested cotton processed through two stick machines at the high seed cotton cleaning rate.

Conclusions

An experiment designed to evaluate the influence of harvest method (picker or stripper with field cleaner), number of stick machines used in the seed cotton cleaning system (one or two), and the processing rate of seed cotton through the seed cotton cleaning system on foreign matter content, lint turnout, bale value, fiber quality, and yarn quality was conducted six times over the two year period 2009 to 2010. As expected, picker harvested cotton had less foreign matter in seed cotton samples collected after harvest (prior to ginning) than cotton harvested by a stripper equipped with a field cleaner. The stick machines used in the seed cotton cleaning system removed less foreign matter (kg/bale) from picked cotton than from stripped cotton. Seed cotton cleaning sequences utilizing two stick machines removed more foreign material from both picker and stripper harvested cottons than sequences using only one. However, the difference in total foreign matter removal between one and two stick machines was greater for stripped cotton

than for picked. Although differences in total stick machine trash were not statistically different among the three seed cotton cleaning rates tested, the trend of increasing trash removal with lower processing rates was observed for all tests. No differences in total stick machine seed cotton loss were observed by harvest method or seed cotton cleaning rate but seed cotton cleaning systems utilizing two stick machines lost more cotton than those only using one. However, the amount of seed cotton lost for either harvest method or number of stick machines used was considered to be within acceptable levels. Total seed cotton cleaning system efficiencies were higher for stripper harvested cotton and seed cotton cleaning systems using two stick machines but no difference was observed by seed cotton cleaning rate. Total foreign matter removed during ginning was higher for stripper harvested cotton (due to the difference in initial foreign matter content by harvest method) but no difference was observed by the number of stick machines or seed cotton cleaning rate. Consequently, lint turnout after one lint cleaner was higher for picked cotton (34%) compared to stripped (28%). Analysis of the extractor feeder trash indicated that the extractor feeder compensated for most of the difference in total foreign matter removed during ginning affected through using only one stick machine or higher seed cotton cleaning rates but the level of compensation varied by harvest method (i.e. initial foreign matter content). HVI and AFIS fiber quality parameters were primarily influenced by harvest method and favored picking. The use of two stick machines improved reflectance and yellowness parameters and reduced the amount of foreign matter contained in lint after one and two lint cleaners. Seed cotton cleaning rate had a minimal effect on fiber quality. Bale values were higher for picker harvested cotton but were not influenced by the number of stick machines used in the seed cotton cleaning system or seed cotton cleaning rate. Although lint value increased, total bale value for picked cotton decreased from one to two stages of lint cleaning due to the loss of bale weight. Total bale value for stripper harvested cotton increased between one and two stages of lint cleaning. Thus, ginners should be mindful of the cost of extra stages of lint cleaning on picker harvested cotton especially under conditions with low initial foreign matter content. Evenness testing on ring spun yarn produced from picker harvested cotton processed through one stick machine at the high cleaning rate contained fewer neps and total imperfections. No differences in opening and cleaning waste or skein/yarn tensile properties were observed by system treatment.

The cleaning efficiency, seed cotton loss, and fiber and yarn quality results for this project were observed for ginning tests conducted on well adjusted and maintained equipment processing cotton with moisture content in the range of 6 – 9%. These findings could be different given commercial ginning conditions utilizing worn or poorly adjusted equipment processing excessively dry cotton. Thus, the findings of this work support current recommendations for using two stick machines in seed cotton cleaning systems processing stripper harvested cotton and one stick machine for seed cotton cleaning systems processing picker harvested cotton.

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