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EVALUATION OF LINT CLEANER LOUVERS AT A COMMERCIAL GIN

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Abstract

This study evaluated the Continental Eagle version of the ARS-developed louvers for saw-type lint cleaners in a commercial gin plant to determine the subsequent impact on fiber quality at the gin and mill levels. The study was conducted without regard as to whether the cotton was sufficiently clean after the gin stand to warrant a reduced number of grid bars. Sixteen bales of cotton, eight from each of two varieties, were processed through a Continental Eagle Model 24D lint cleaner equipped with eight automated louvers to allow from one to eight grid bars to be used; however, the two treatments used in this experiment were two and eight grid bars. Samples from each replication were analyzed for moisture, market classification, fiber length distribution, neps, trash, dust, foreign matter, and other factors. The fiber was spun at the Cotton Quality Research Station, Clemson, SC. The test cotton contained about 10% foreign matter before gin processing and was Low Middling color after gin processing. Mote weight at the gin averaged 6.0 and 11.5 pounds per bale for the two and eight grid bar treatments, respectively, for a savings of 5.5 pounds per bale or over $3.00. Spinning performance did not differ except for the impact of different trash levels in the bale. Thus the number of grid bars used at the gin should be selected based on the trash level in the ginned lint in order to assure optimum mill performance. In general, the number of grid bars significantly impacted only the trash-related variables at both the gin and mill.

Introduction

Prescription processing of cotton to match cleaning and drying needs to meet quality and marketing needs has increased remarkably since 1997. The ARS-developed computerized process control technology commercialized by Zellweger Uster under the trade name *IntelliGin* regulates drying and selects machine combinations to optimize farmer profits, and is currently used in 70 gins. A natural extension of this technology is control of the internal operation of gin machines such as lint cleaners. Anthony (1999a) patented a method to allow automated selection of the number of grid bars in saw-type lint cleaners. Lint cleaners remove good fiber and fibrous waste from lint in addition to foreign matter. In other words, good fiber is removed even if there is no foreign matter in the cotton. Each successive grid bar removes an increasing percentage of fiber and a declining percentage of foreign matter (Anthony 1999a). Thus when the appropriate amount of foreign matter has been removed to achieve the desired grade, subsequent grid bars should be bypassed. Processing cleaner cotton with fewer lint cleaner grid bars than used for trashier cotton can produce cotton bales with equal trash levels but less fiber damage (Anthony 2000). This procedure also produces heavier bales with equal foreign matter. The louver technology is licensed to Continental Eagle Gin Co., Prattville, AL, for commercialization.

Research has consistently shown advantages in reduced fiber waste when the number of functional grid bars were reduced (Anthony, 1999a; 1999b; and 2000). The spinning performance was also evaluated by McAlister, et al. (2002) and was maintained or improved by the use of a reduced number of grid bars. They also reported that some varieties were more difficult to clean than others and required more lint cleaner grid bars. Over 200,000 bales have been successfully processed by the commercial textile industry but documented results are not available publicly.

The purpose of this study was to evaluate the Continental Eagle version of the ARS-developed louvers for saw-type lint cleaners in a commercial gin plant to determine the subsequent impact on fiber quality at the gin and mill levels.

Materials and Methods

The Continental Eagle version of the ARS patented lint cleaner louvers was installed in a model 24-D lint cleaner in Prattville, AL (Figure 1). Note that the Continental louvers differed from the ARS louvers in that the louver and grid bar are mounted on the same base plate so that only one adjustment is required. Continental Eagle exchanged that lint cleaner during the season with a similar one at Milstead Farm Group in Shorter, AL. After the season was over, a study was conducted involving two modules of cotton that had been retained by the gin. Two varieties of cotton had been harvested and stored in separate modules in November 2001 by Tanner Farms of Greenville, AL, for the study.

The study was conducted as a randomized complete block with varieties (modules) as the block. The grid bar arrangement chosen was to use either two active grid bars or eight active grid bars and change the treatment throughout the ginning test. Two bales from each variety of cotton were processed with two grid bars and two were then processed with eight grid bars. Since the objective of the experiment was to compare the mills ability to process cotton after two and eight grid bars, the actual trash levels and color levels of the cotton were not considered in determining the number of grid bars to be used. The following gin sequence was used; drier, cylinder cleaner, stick machine, cylinder cleaner, extractor-feeder gin stand, and one 24-D lint cleaner equipped with either two or eight active grid bars. Samples were taken at the module feeder for wagon fractionation and wagon moisture. Samples were taken at the feeder apron for fractionation. Samples were also taken after the lint cleaner for lint moisture, High Volume Instrument (HVI), Advanced Fiber Information System (AFIS), and Shirley Analyzer evaluations. When only two grid bars were activated, the first two of eight were active.

Results

Photographs of the seed cotton in the module are shown in Figures 2 and 3 and indicate a higher than normal trash level. Replication test data collected during ginning is shown in Table 1. Means for the samples collected during and after ginning are shown in Tables 2a, b, c, and d. Initial foreign matter was about 10% which was higher than desired for the test because high initial foreign matter content usually requires one or more full lint cleaners to achieve the desired market grade; however, no other cotton was available for the study. Shirley Analyser visible trash was about 3.3% and ranged from 2.9% for Variety 2 and 8 grid bars to 3.9% for Variety 1 with 2 grid bars. Leaf grade averaged 3.9 and was 4.0 and 3.8, respectively, for two and eight grid bars. Color grade was Low Middling and Rd and +b averaged 71.5 and 7.6, respectively. Lint moistures ranged from 5.7 to 6.2%. Bale weight, adjusted for sample removal, ranged from 424 to 549 pounds. Lint cleaner waste (motes) was collected immediately before the mote press but after having been cleaned with one 6-cylinder cleaner. These weights were divided by 0.67 to estimate the weight prior to the mote cleaner (Anthony, 1999b). Mote weights ranged from 5.8 to 12.5 pounds per bale, corrected to a 500-pound bale weight. Analyses of variance for the classing data (HVI), AFIS data, and lab data are shown in Table 3. Varieties significantly affected a number of factors including upper quartile length, length at the 5% level, length at the 1.5% level, fineness, immature fiber content, maturity ratio, dust per gram, trash per gram, visible foreign matter, Shirley Analyzer total waste, Shirley Analyzer visible waste, leaf, HVI percent area, and motes. Grid bars significantly affected AFIS dust per gram, trash per gram, visible foreign matter; Shirley Analyzer total; and HVI leaf grade, HVI percent area, and motes. Examination of the means in Tables 2a, 2b and 2c indicates that the small differences were sufficient to cause statistically significance but are not of practical importance except for Shirley Analyser waste.

The mode color for the five subsamples taken after lint cleaning for each of the bales indicated that 12 of the bales graded color 51, leaf grade 4. Four of the bales graded color 41, leaf grade 4; of those four bales, three were processed with eight grid bars and one was processed with two grid bars. In general, the five subsamples seemed to fluctuate between 41 and 51 colors with a few 52 and 42 scattered in suggesting that the cotton was near the intersection of those grades on the reflectance and yellowness chart. With this in mind, the reflectance and yellowness with two and eight grid bars for each variety was considered. The reflectance changed from 71.2 for two grid bars to 71.8 for eight grid bars; however, the yellowness remained constant at 7.6. The cotton was basically color 51, leaf grade 4 for the entire test across varieties and grid bars. Mote weight was 6.0 and 11.5 pounds, respectively, for two and eight grid bars for a savings of 5.5 pounds per bale at the same color leaf grade. Raw motes were significant for grid bars (Table 3b) but not for varieties or the grid bar*variety interaction.

Mill Evaluation

The spinning performance of the 16 bales of cotton was evaluated at the Cotton Quality Research Station, Clemson, SC. Means for the data collected during mill evaluation are at Table 4 and the significant variables are separated with lowercase letters. The analyses of variance for the mill data are at Table 5. For the within variety analysis, eight grid bars affected the trash left in the lint in the raw stock (bale) and the amount of trash removed at the cleaning line, with the two grid bars yielding more trash. Opening/cleaning waste ranged from 2.79% to 3.80% and was significant but card waste was not significant. There was no difference in spinning performance either between varieties or within varieties. However, Classimat Minor yarn defects were affected by variety with Variety 2 yielding more defects than Variety 1. This is to be expected as small trash left in yarn is classed as a minor defect by the Classimat because it disrupts the drafting process and can potentially create areas of thick and thin places. Thus, reducing the number of grid bars active in a lint cleaner should be done with consideration to trash. However since the louvers are employed to maintain the desired leaf grade, the artificial difference created in this study by simply using two and eight grid bars regardless of trash level before lint cleaning, would not occur commercially because foreign matter levels would be constant. In summary, spinning performance is not adversely impacted by reduced number of grid bars.

Disclaimer

Mention of a trade name, propriety product or specific equipment does not constitute a guarantee or warranty by the United States Department of Agriculture and does not imply approval of a product to the exclusion of others that may be suitable.

References

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McAlister, III, D.D., W.S. Anthony and E. Edwards. 2002. Quality impact of louvers on a 24-D lint cleaner. Proc. Beltwide Cotton Conf. CD-ROM. National Cotton Council, Memphis, TN.

Table 1. Replication data collected at the gin.

Gin I.D.	Variety	Lint Moisture, %	Module moisture, %	Bale weight, lb.	Motes after 6 cyl. cln, lb.	Grid bars
1	1	5.94	10.53	499	3.5	2*
2	1	6.13	10.42	545	3.5	2*
3	1	5.94	10.18	499	6.5	8
4	1	5.93	10.78	497	6.5	8
5	1	6.11	10.46	484	3.5	2*
6	1	5.78	10.51	526	3.5	2*
7	1	5.86	10.82	471	6.5	8
8	1	5.84	10.34	418	6.5	8
9	2	5.77	13.08	485	3.5	2*
10	2	5.77	12.62	459	3.5	2*
11	2	6.25	12.03	509	6.5	8
12	2	6.20	12.53	456	6.5	8
13	2	5.77	12.52	483	4.0	2*
14	2	5.73	11.90	526	4.0	2*
15	2	5.79	11.96	488	7.5	8
16	2	5.70	12.96	534	7.5	8

*first and second.

Table 2a. Means for the gin variables.

Grid bars	Variety	Wagon Fractionation	Moisture		Motes per bale, lb.	Shirley Analyzer waste, %	
			Module	Lint		Total	Visible
2	1	10.9	10.5	6.0	5.63	5.76	3.86
2	2	10.1	12.5	5.8	6.33	5.14	3.50
8	1	10.3	10.5	5.9	11.42	4.78	3.05
8	2	9.3	12.4	6.0	11.63	4.62	2.89

Table 2b. Means for the HVI variables.

Grid bars	Variety	Leaf	Mike	Strength, g/tex	Rd	Plusb	HVI color grade index	% Area	Length	Uniformity
2	1	4.00	4.0	29.10	71.1	7.7	87.5	0.555	1.08	82.1
2	2	3.95	4.1	28.75	71.3	7.6	86.5	0.500	1.08	82.1
8	1	3.85	4.0	28.99	72.0	7.6	90.4	0.450	1.08	82.4
8	2	3.80	4.0	28.82	71.6	7.6	88.2	0.440	1.08	82.2

Table 2c. Means for AFIS variables.

Grid bars	Variety	Length	Upper quartile	Short fiber content, %, weight	Short fiber content, %, number	Length, 5% level	Length, 2.5% level	Fineness
2	1	0.92	1.12	9.45	25.95	1.26	1.34	176.13
2	2	0.91	1.10	9.46	25.78	1.24	1.32	175.00
8	1	0.92	1.11	9.76	26.62	1.26	1.33	176.45
8	2	0.92	1.11	9.47	25.87	1.25	1.33	174.75

Table 2c. Means for AFIS variables – continued.

Grid bars	Variety	Immature fiber content	Maturity ratio	Nep/gm	SCN/gm	Dust/gm	Trash/gm	Visible foreign matter
2	1	4.22	0.86	268.70	15.92	629.62	150.03	2.93
2	2	4.39	0.85	280.50	15.45	565.85	121.85	2.47
8	1	4.26	0.86	273.95	15.85	555.75	124.25	2.40
8	2	4.39	0.85	274.20	14.55	490.10	105.90	2.07

Table 3a. Analyses of variance for gin and HVI data.

	Means squares for								
Source of variation	Leaf	Mike x 10^{-2}	Strength	Rd	Plusb	Trash, % area	Length x 10^{-4}	Uniform	HVI color grade index
Variety	0.01ns	0.09ns	0.270ns	0.04ns	0.022ns	0.004ns	0.903ns	0.023ns	10.24ns
Grid bars	0.90*	0.04ns	0.002ns	1.44ns	0.005ns	0.027**	0.423ns	0.123ns	21.16ns
Variety* gridbars	0.01ns	1.96ns	0.032ns	0.25ns	0.005ns	0.002ns	0.723ns	0.023ns	1.69ns
Error	0.018	0.692	0.283	0.38	0.025	0.002	0.389	0.176	5.06
Mean	3.900	4.008	28.915	71.475	7.593	0.486	1.081	82.188	88.125
CV	0.135	0.083	0.532	0.618	0.158	0.049	0.006	0.419	2.250
MSE	3.472	2.075	1.841	0.864	2.081	10.058	0.577	0.510	2.553
R-Square	0.312	0.201	0.082	0.274	0.097	0.538	0.305	0.074	0.353

*Indicates significance at the 5% probability level.
**Indicates significance at the 1% probability level.

Table 3b. Analyses of variance for Shirley, wagon fractionation and moisture.

	Mean squares for					
Source of variation	Shirley Analyzer		Wagon	Moisture		Motes
	Total	Visible	Fractionation	Wagon	Lint	Raw
Variety	0.612**	0.280**	3.40ns	15.12**	0.019ns	1.56ns
Grid bars	2.250**	2.028**	1.90ns	0.012ns	0.016ns	108.51**
Variety* gridbars	0.218ns	0.037ns	0.026ns	0.044ns	0.104ns	0.17ns
Error	0.07	0.031	0.893	0.140	0.027	0.29
Mean	5.076	3.326	10.144	11.478	5.907	8.64
CV	0.255	0.176	0.945	0.374	0.165	0.54
MSE	5.033	5.284	9.316	3.258	2.786	6.22
R-Square	0.797	0.864	0.332	0.901	0.300	0.97

*Indicates significance at the 5% probability level.
**Indicates significance at the 1% probability level.

Table 3c. Analyses of variance for AFIS data.

Source of Variation	Length, w x 10^{-5}	Upper quartile length, w x 10^{-5}	Short fiber content, w%	Short fiber content, n%	Length, n x 10^{-5}	Length, 2.5% level x 10^{-4}	Fineness	Immature fiber content x 10^{-2}
	Mean squares for							
Variety	5.38 ns	20.07**	0.079ns	0.86ns	1.003ns	4.84**	8.028**	8.70**
Grid bars	0.01 ns	0.003ns	0.095ns	0.57ns	1.003ns	0.09ns	0. 004ns	0.12ns
Variety* grid bars	4.01 ns	6.67*	0.089ns	0.33ns	2.67ns	1.00ns	0.321ns	0.12ns
Error	2.05	0.95	0.121	0.60	5.19	3.58	0.41	0.66
Mean	0.918	1.110	9.533	26.052	0.752	1.329	175.583	4.311
CV	0.005	0.003	0.348	0.774	0.007	0.006	0.640	0.081
MSE	0.493	0.277	3.653	2.969	0.958	0.451	0.364	1.886
R-Square	0.276	0.701	0.153	0.196	0.070	0.580	0.630	0.530

*Indicates significance at the 5% probability level.
**Indicates significance at the 1% probability level.

Table 3c. Analyses of variance for AFIS data – continued.

Source of variation	Maturity ratio x 10^{-5}	Nep/gm	SCN/gm	Dust/gm	Trash/gm	Visible foreign matter
	Mean squares for					
Variety	21.025**	145.20ns	3.12ns	16748.67**	2165.35**	0.613**
Grid bars	0.025ns	1.10ns	0.93ns	22385.15**	1741.67**	0.881**
Variety*grid bars	2.025ns	133.40ns	0.69ns	3.55ns	96.69ns	0.017ns
Error	0.51	113.84	3.07	1130.45	81.64	0.044
Mean	0.854	274.338	15.442	560.33	125.508	2.467
CV	0.002	10.669	1.753	33.62	9.035	0.210
MSE	0.264	3.889	11.351	6.00	7.199	8.516
R-Square	0.791	0.170	0.114	0.74	0.803	0.740

*Indicates significance at the 5% probability level.
**Indicates significance at the 1% probability level.

Table 4. Means for AFIS data collected during mill evaluation for two and eight grid bars. Significant variables in each row are separated by lowercase letters based on Waller/Duncan at the 5% level.

Variety 1			Variety 2		
RAW STOCK - Gin ID	**Two grid bars**	**Eight grid bars**	**RAW STOCK - GIN ID**	**Two grid bars**	**Eight grid bars**
AFIS (9000 Fibers)	**Means**	**Means**	AFIS (9000 Fibers)	**Means**	**Means**
UQL(w) (in)	1.11	1.11	UQL(w) (in)	1.11	1.11
SFC(w) (%)	11.13	12.40	SFC(w) (%)	10.78	10.93
Mat.Ratio	0.87	0.88	Mat.Ratio	0.87	0.86
Nep Cnt/g	240.50	247.75	Nep Cnt/g	245.75	253.25
VFM (%)	2.94a	2.30b	VFM (%)	2.89a	2.44ab
CARD SLIVER					
AFIS(9000 Fibers)	**Means**	**Means**	AFIS(9000 Fibers)	**Means**	**Means**
UQL(w) (in)	1.13	1.13	UQL(w) (in)	1.11	1.13
SFC(w) (%)	13.03	11.23	SFC(w) (%)	12.08	11.98
Mat.Ratio	0.87	0.87	Mat.Ratio	0.87	0.88
Nep Cnt/g	59.00	62.75	Nep Cnt/g	66.50	64.50
VFM (%)	0.18	0.17	VFM (%)	0.17	0.19
FINISH. DRAWING					
AFIS(9000 Fibers)	**Means**	**Means**	AFIS(9000 Fibers)	**Means**	**Means**
UQL(w) (in)	1.17	1.17	UQL(w) (in)	1.16	1.16
SFC(w) (%)	10.30	10.35	SFC(w) (%)	10.05	10.15
Mat.Ratio	0.94a	0.94a	Mat.Ratio	0.93b	0.93b
Nep Cnt/g	58.50a	55.75ab	Nep Cnt/g	50.25b	60.50ab
VFM (%)	0.18	0.19	VFM (%)	0.19	0.21
FMT-Micromat Data					
FMT - MICROMAT	**Means**	**Means**	**FMT - MICROMAT**	**Means**	**Means**
Micronaire	4.04ab	4.11a	Micronaire	4.01b	4.01b
Maturity	0.94	0.95	Maturity	0.93	0.93
Maturity (%)	83.03	83.57	Maturity (%)	82.32	82.45
Fineness	161	164	Fineness	161	161
MTM Data					
MTM Waste	**Means**	**Means**	**MTM Waste**	**Means**	**Means**
Visible %	2.8ab	2.43b	Visible %	3.1a	2.75ab
Invisible %	1.1	1.13	Invisible %	1.5	1.23

Table 4. Means data collected during mill evaluation – continued.

Variety 1			Variety 2		
RING WASTE	**Two grid bars Means**	**Eight grid bars Means**	**RING WASTE**	**Two grid bars Means**	**Eight grid bars Means**
Opening & Cleaning	3.80a	2.79b	Opening & Cleaning	3.67a	2.87b
Total Card Waste (w/o front)	3.04	2.88	Total Card Waste (w/o front)	3.13	3.06
			SPINNING		
Front Roll Speed (RPM)	233	233	Front Roll Speed (RPM)	233	233
Spindle Speed (RPM)	16,000	16,000	Spindle Speed (RPM)	16,000	16,000
Yarn Twist (T.M.)	3.75	3.75	Yarn Twist (T.M.)	3.75	3.75
Spindle Hours Tested	480	480	Spindle Hours Tested	509	480
Actual Ends Down/ M Sp. Hrs.	20.5	32.75	Actual Ends Down/ M Sp. Hrs.	50	43
Calculated Ends Down/ M Sp. Hrs.	22b	29b	Calculated Ends Down/ M Sp. Hrs.	56a	42ab
Lapped Ends (%)	28.2a	8.1b	Lapped Ends (%)	7.3b	4.0b
Hard Ends (%)	0	0	Hard Ends (%)	0	0
Yarn Size Desired	30/1	30/1	Yarn Size Desired	30/1	30/1
Yarn Size Obtained (YCA)	30.4	30.1	Yarn Size Obtained (YCA)	30.5	30.3
			SINGLE STRAND DATA (Statimat)		
Strength (Grams/tex)	14.36	14.61	Strength (Grams/tex)	14.39	14.33
Elongation (%)	6.83	7.11	Elongation (%)	6.89	6.71
Strength C.V. (%)	10.27	9.03	Strength C.V. (%)	9.03	9.76
			EVENNESS DATA (ILE DS 65)		
Neps/1000 yds.	282.5	263.25	Neps/1000 yds.	262	259
Thick Places/1000 yds.	635.75	581.25	Thick Places/1000 yds.	583	574
Thin Places/1000 yds.	78.5	73.25	Thin Places/1000 yds.	78	74
Irregularity C.V. (%)	18.13	17.95	Irregularity C.V. (%)	18.0	18.0
Irregularity C.V. Card Sliver (%)	2.65	2.56	Irregularity C.V. Card Sliver (%)	2.63	2.62
Irregularity C.V. Finish. Draw. (%)	3.28	3.41	Irregularity C.V. Finish. Draw. (%)	3.29	3.44
			CLASSIMAT		
Major Faults	4.25	3.5	Major Faults	5	3.25
Minor Faults	676.5b	666.2b	Minor Faults	887.8a	849.2ab
Long Thick	7.75	6.25	Long Thick	7.75	5.5
Long Thin	216ab	220ab	Long Thin	429a	171b
YARN APPEARANCE	C+(100)	C+(100)	**YARN APPEARANCE**	C+(100)	C+(100)

Table 4. Means data collected during mill evaluation – continued.

SHIRLEY ANALYZER DATA					
VARIETY 1			VARIETY 2		
SHIRLEY ANALYZER WASTE	**Two grid bars MEAN**	**Eight grid bars MEAN**	**SHIRLEY ANALYZER WASTE**	**Two grid bars MEAN**	**Eight grid bars MEAN**
Visible (%)	4.5	3.3	Visible (%)	4.2	3.5
Invisible (%)	0.9b	0.9b	Invisible (%)	1.0ab	1.1a
OPENER MOTES			**OPENER MOTES**		
Visible (%)	8.9a	6.5bc	Visible (%)	7.9ab	5.8c
Invisible (%)	1.6	1.7	Invisible (%)	1.6	1.7
GBRA			**GBRA**		
Visible (%)	44.1a	36.8bc	Visible (%)	39.8b	33.5c
Invisible (%)	1.9	1.8	Invisible (%)	1.9	1.8
AXI-FLO			**AXI-FLO**		
Visible (%)	65.0a	55.3c	Visible (%)	60.7b	52.5c
Invisible (%)	1.9b	1.9b	Invisible (%)	2.1a	2.2a
RN			**RN**		
Visible (%)	70.4a	66.8bc	Visible (%)	68.9ab	64.9c
Invisible (%)	1.4	1.3	Invisible (%)	1.4	1.4
CARD WASTE			**CARD WASTE**		
Visible (%)	24.4	22.8	Visible (%)	23.8	23.7
Invisible (%)	3.9	3.9	Invisible (%)	3.9	3.6

Table 5. Analyses of variance for data collected during textile processing.

Source of variation	Raw Stock: Upper quartile length, wt x 10^{-4}	Raw Stock: Short fiber content, weight	Raw Stock: Mat Ratio x 10^{-4}	Raw Stock: Neps/ gm	Raw Stock: Visible foreign matter	Card Sliver: Upper quartile length, wt x 10^{-3}	Card Sliver: Short fiber content, weight.	Card Sliver: Mat ratio x 10^{-4}	Card Sliver: Neps/ gm	Card Sliver: Visible foreign matter x 10^{-3}
Variety	0.250 ns	3.33 ns	2.25 ns	115.56 ns	0.008 ns	0.306 ns	0.040 ns	0.063 ns	85.56 ns	0.100 ns
Grid bars	0.01 ns	2.03 ns	0.01 ns	217.56 ns	1.188 *	0.506 ns	3.610 ns	1.563 *	3.06 ns	0.100 ns
Variety*gridbars	0.01 ns	1.27 ns	0.99 ns	0.063 ns	0.038 ns	0.156 ns	2.890 ns	0.063 ns	33.06 ns	1.225 ns
Error	0.792	2.16	1.38	850.94	0.145	0.148	1.286	0.271	165.06	1.129
Mean	1.109	11.31	0.869	246.81	2.64	1.123	12.08	0.871	63.19	0.174
MSE	0.009	1.47	0.012	29.17	0.38	0.012	1.13	0.005	12.85	0.034
CV	0.802	13.00	1.350	11.82	14.43	1.083	9.39	0.598	20.66	19.34
R-Square	0.026	0.20	0.165	0.03	0.41	0.353	0.30	0.342	0.06	0.095

*Indicates significance at the 5% probability level.
**Indicates significance at the 1% probability level.

Table 5. Analyses of variance for data collected during textile processing- continued.

Source of variation	Finish Drawing: Upper quartile length, wt x 10^{-4}	Finish Drawing: Short fiber content, %, by weight	Finish Drawing: Mat ratio x 10^{-4}	Finish Drawing: Neps/ gm	Finish Drawing: Visible foreign matter x 10^{-3}	FMT – Micromat: Mike	FMT – Micromat: Mat ratio x 10^{-3}	FMT – Micromat: Maturity, percent	FMT – Micromat: Fineness	MTM Waste: Visible	MTM Waste: Invisible
Variety	3.063 ns	0.203 ns	6.25 **	12.25 ns	0.756 ns	0.018*	1.056 ns	3.303 ns	7.563 ns	0.391*	0.250 ns
Grid bars	0.063 ns	0.023 ns	0.250 ns	56.25 ns	1.056 ns	0.006 ns	0.156 ns	0.452 ns	7.563 ns	0.456*	0.063 ns
Variety*gridbars	1.563 ns	0.003 ns	0.250 ns	169.00 *	0.156 ns	0.005 ns	0.006 ns	0.170 ns	10.563 ns	0.001 ns	0.090 ns
Error	1.063	1.041	0.583	24.458	0.577	0.003	0.252	1.437	13.229	0.056	0.120
Mean	1.163	10.213	0.931	56.25	0.189	4.043	0.938	82.84	161.81	2.76	1.238
MSE	0.010	1.020	0.008	4.95	0.024	0.057	0.156	1.20	3.64	0.24	0.346
CV	0.886	9.990	0.820	8.79	12.685	1.406	1.692	1.45	2.25	8.59	27.94
R-Square	0.269	0.018	0.491	0.45	0.221	0.426	0.287	0.19	0.14	0.56	0.22

*Indicates significance at the 5% probability level.
**Indicates significance at the 1% probability level.

Table 5. Analyses of variance for data collected during textile processing – continued.

Source of variation	Waste: Opening/ cleaning	Waste: Total Card Waste	Spinning: Actual ends down	Spinning: Calculated ends down	Spinning: Lapped ends	Spinning: Yarn size obtained	Single strand: Strength	Single strand: Elongation	Single strand: Strength C.V.
Variety	0.002 ns	0.076ns	1620.06 ns	2256.25*	637.56**	0.040 ns	0.061 ns	0.112 ns	0.265 ns
Grid bars	3.303**	0.051ns	27.56 ns	56.25 ns	554.60**	0.203 ns	0.039 ns	0.009 ns	0.260 ns
Variety *gridbars	0.045 ns	0.006ns	370.56 ns	420.25 ns	272.25*	0.003 ns	0.101 ns	0.221 ns	3.901 ns
Error	0.168	0.039	401.77	269.08	43.43	0.193	0.193	0.130	0.934
Mean	3.28	3.03	36.69	37.38	11.83	30.30	14.42	6.88	9.52
MSE	0.409	0.198	20.04	16.40	6.59	0.44	0.44	0.36	0.97
CV	12.47	6.55	54.64	43.89	55.73	1.45	3.05	5.24	10.15
R-Square	0.625	0.22	0.30	0.46	0.74	0.10	0.08	0.18	0.28

*Indicates significance at the 5% probability level.
**Indicates significance at the 1% probability level.

Table 5. Analyses of variance for data collected during textile processing – continued.

Source of variation	Evenness: Neps/ 1000 yards	Evenness: Thick places/ 1000 yards	Evenness: Thin places/ 1000 yards	Evenness: Irreg. C.V.	Evenness: Irreg. Card Sliver	Evenness: Irreg. Finish Draw	Classimatt: Major faults	Classimatt: Minor faults	Classimatt: Long Thick	Classimatt: Long Thin
Variety	612.56 ns	3660.25 ns	0.563 ns	0.023 ns	0.001 ns	0.001 ns	0.250 ns	155433.06**	0.563 ns	26978.06ns
Grid bars	517.56 ns	4096.00 ns	85.563 ns	0.023 ns	0.012 ns	0.076 ns	6.250 ns	2376.56 ns	14.063 ns	64643.03ns
Variety*gridbars	248.06 ns	2025.00 ns	1.563 ns	0.040 ns	0.006 ns	0.001 ns	1.000 ns	798.06 ns	0.563 ns	69300.56ns
Error	431.44	4478.04	544.31	0.221	0.225	0.067	5.708	14959.27	20.27	24362.65
Mean	266.69	593.38	75.69	18.00	2.62	3.36	4.00	769.94	6.81	259.31
MSE	20.77	66.92	23.33	0.47	0.13	0.26	2.39	122.31	4.50	156.09
CV	7.79	11.28	30.82	2.61	5.01	7.74	59.73	15.89	66.09	60.19
R-Square	0.21	0.15	0.013	0.03	0.08	0.09	0.10	0.47	0.06	0.36

*Indicates significance at the 5% probability level.
**Indicates significance at the 1% probability level.

Table 5. Analyses of variance for data collected during textile processing – continued.

Source of variation	Shirley Analyzer Visible						Shirley Analyzer Invisible					
	Raw Stock	**Opener motes**	**GBRA**	**Axi-flo**	**RN**	**Card Waste**	**Raw Stock**	**Opener motes**	**GBRA**	**Axi-flo**	**RN**	**Card Waste**
Variety	0.0001ns	3.151ns	58.14**	49.00*	11.56ns	0.076ns	0.106**	0.003ns	0.001ns	0.276**	0.006ns	0.090ns
Grid bars	3.803**	20.03**	184.28**	320.41**	57.76**	2.81ns	0.001ns	0.090ns	0.010ns	0.006ns	0.006ns	0.123ns
Variety*gridbars	0.203ns	0.106ns	0.856ns	2.40ns	0.16ns	2.48ns	0.006ns	0.003ns	0.003ns	0.015ns	0.006ns	0.160ns
Error	0.113	1.18	5.76	6.12	4.77	7.54	0.011	0.085	0.022	0.015	0.014	0.182
Mean	3.85	7.26	38.54	58.36	67.78	23.66	0.944	1.65	1.84	2.04	1.36	3.81
MSE	0.34	1.09	2.40	2.47	2.18	2.75	0.103	0.29	0.15	0.12	0.12	0.43
CV	8.73	14.99	6.23	4.24	3.22	11.61	10.922	17.71	8.09	6.03	8.58	11.19
R-Square	0.75	0.62	0.78	0.84	0.55	0.06	0.467	0.08	0.05	0.62	0.09	0.15

*Indicates significance at the 5% probability level.

**Indicates significance at the 1% probability level.

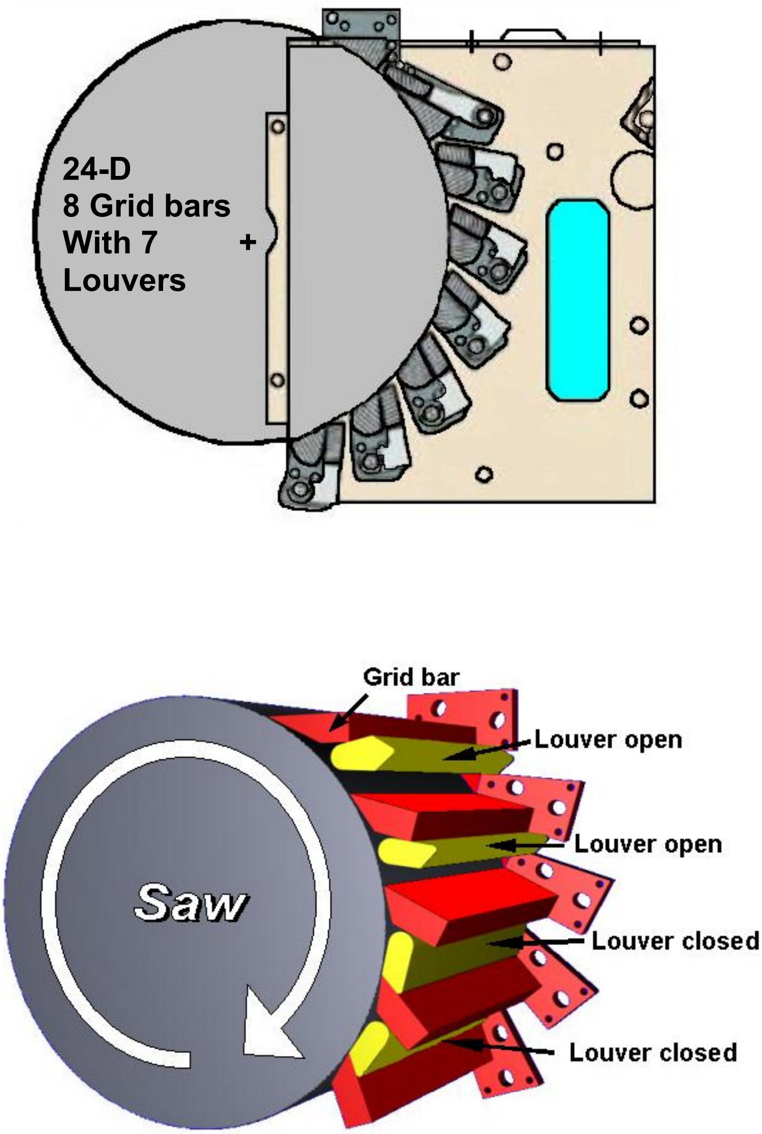

Figure 1. Continental Eagle version top for a 24D lint cleaner, and ARS version below for a 16D lint cleaner.

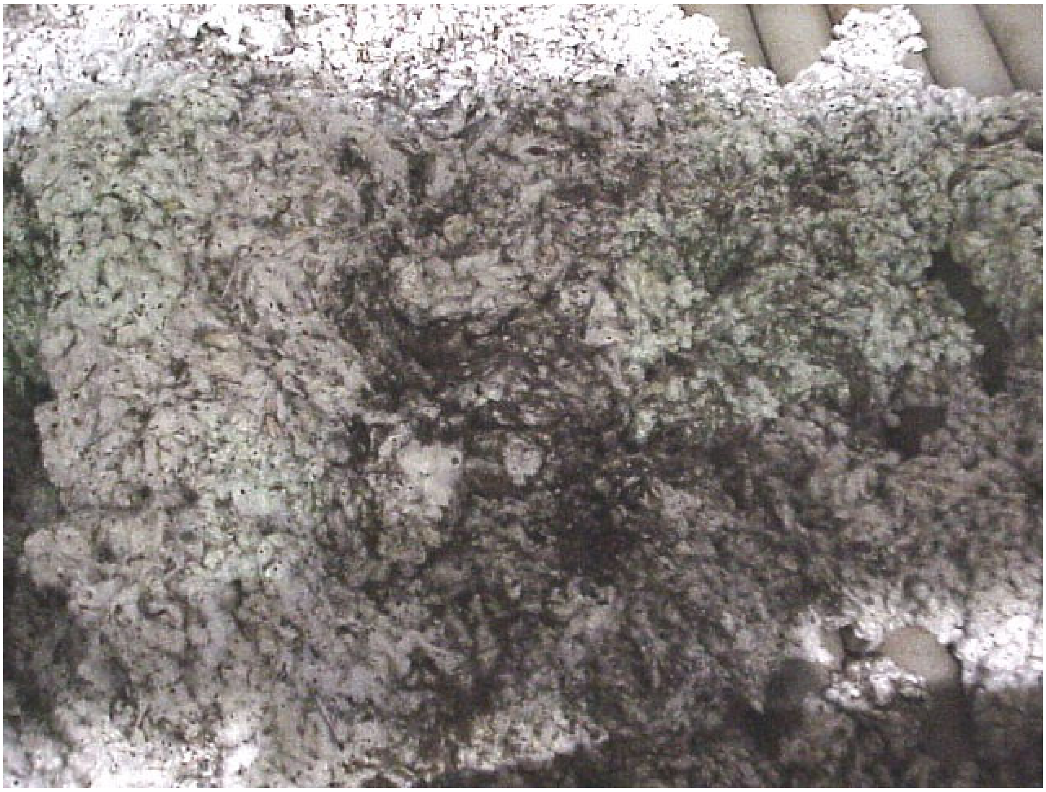

Figure 2. Seed cotton used in the experiment.

Figure 3. Typical appearance of the rather trashy cotton for the test.