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COTTON LINT QUALITIES AS AFFECTED BY HARVESTER TYPE IN 10 AND 30-INCH PRODUCTION SYSTEMS

M. Herbert Willcutt and Eugene Columbus
Agricultural and Biological Engineering
Mississippi State, MS
Thomas D. Valco
Director Ag Research, Cotton Incorporated
Raleigh, NC
(Currently with USDA-ARS, Stoneville, MS)
Patrick Gerard
MAFES, Experimental Statistics Unit
Mississippi State, MS

Abstract

Spindle pickers and brush and finger strippers were used to harvest in 30 inch and 10 inch cotton production systems. Samples were ginned on the USDA Cotton Ginning Lab micro gin using one and two lint cleaners. HVI and AFIS analysis were run on the lint samples. Harvester type was found to affect the AFIS fiber properties that would be of concern to textile mills, namely neps/gram, short fiber content by weight, visible foreign matter and immature fiber content. Stripper harvesters were about equal in their adverse influence on these properties whether or not bur extractors were operating. While hand and spindle harvesting produced measurable (improved) differences in both AFIS and HVI measurements, bale value computed from USDA AMS loan schedules (1999) was found to be lowest for the spindle harvester. Yields were not considered in this analysis due to row unit harvesters harvesting an unequal number of drills through the plots.

Introduction

Economics of cotton production have dictated that producers exercise every cost cutting means available to remain viable. Harvesting equipment, especially spindle harvesters are expensive to purchase and operate. They have replaced hand harvesting and established the standards for lint quality by which all other harvesters are judged. However, they are very restrictive in the row spacing that can be harvested, somewhat slow in harvesting and expensive to maintain.

Interest in ultra narrow row production of cotton in the mid south has again resurfaced. Most projections of savings in production costs have been based on the premise that harvesting cost will be lower with finger stripper harvesters coupled with equal or greater yield and better lint quality. Nelson, et al. (2000) et al. compared harvesting costs for west Texas conditions and yields with a maximum 30 day harvesting period and found spindle pickers to be only slightly higher in cost per pound of lint harvested than brush strippers without bur extractors, but lower than strippers with bur extractors when looking at the total harvesting system and ginning costs.

Marketing contracts with mid-south producers have reflected price discounts for stripper-harvested lint of $.03 to $.05 per pound plus any reductions for bark, trash, or preparation. This reduces the attractiveness of UNRC to the producer.

Several studies have been run where the production system with a particular harvester type have been evaluated for lint properties. Sappenfield (1984) evaluated 30 inch production systems with a comparison of spindle harvesters to brush strippers and found that fiber was lower in uniformity, slightly lower in micronaire but 16 % more fiber from brush harvester. Anthony, et al. (1998 and 1999) reported on fiber quality comparisons for production systems designed specifically for spindle pickers and finger strippers throughout the mid-south and southeast. HVI data for the conventional and UNR systems were essentially the same although the UNR samples from three of the six locations received bark classifications. Higher levels of short fiber content and neps were found in the UNR samples. Vories, et al. (1999) found similar results with HVI micronaire being significantly different for the UNR cotton systems. No effort was made to determine if harvester type or production system influenced other lint qualities .

Brashears, et al. (1985) found that stripper harvesters did harvest lint samples that have greater concentrations of dust and neps that adversely affected mill performance.

Kerby, et al. (1982) compared 30 inch brush stripping and 40 inch spindle picker production systems in California's San Jauquin Valley. He reported that the 30inch stripper harvested cotton was slightly shorter in staple and a weaker fiber.

Luckett, et al. (1975) compared a finger stripper and a modified spindle picker (Ben Pearson cotton combine) harvesting 13, 26 and 40 inch plantings. They concluded that row spacing did influence fiber properties. Namely, cotton grown in 40 inch rows produced longer staple; that planted in 26 inch rows produced a higher reflectance; and that grown in 13 inch rows produced a higher strength. El-Zik, et al. (1981) found similar results when looking at Acala cultivars in 30 and 40 inch systems in California.

This paper discusses the field research conducted in 1999 at Perthshire Farms in Gunnison, MS, where six harvester configurations were forced to operate in both 10 inch and 30 inch drill planting systems. Yield was not measured due to the higher than normal harvesting losses experienced with spindle picking and brush stripping in the 10 inch drill areas. HVI and AFIS lint quality factors and bale value computed from the HVI data were determined.

Field Test

Plot areas were selected from four fields of cotton planted to a common variety on Perthshire Farms in 1999. Table 1 provides a list of locations and harvester treatments that were used in this test. The experimental design included four locations, six harvester treatments replicated three times for each harvester treatment and each replication sub sampled three times for all quality and moisture sampling. All selected fields yielded between 1.5 and 2.5 bales per acre. Plots were selected to be representative of the total field area, measured and marked before any harvesting was initiated.

Locations 1, 2 and 3 were defoliated with Def/Prep combination followed by sodium chlorate (label rates) 10 days later with harvest beginning approximately 7 to 10 days after desiccation. Location 4 only received Def/Prep at label rate and was harvested October 4. Locations 1, 2 and 3 were harvested in early November after a light frost.

Plot areas were determined from the expected yield and number of drills that were to be harvested in order to collect approximately 100 lb of seed cotton from each harvester. A harvester run for the drill type harvesters of 218 feet was decided upon. Since some harvesters harvested adjacent drills that were not intended, samples ranged as high as 130 lb and as low as 69 lb. Further, it was decided to use the finger header to cut alleys between the plot areas and the remainder of the field was harvested later (Figure 1). The seed cotton harvested was used as the finger harvested samples.

The third row, out of every three drills for the spindle picker plot, were cut and removed from the area. This effectively left "twin" drills (10 inches apart) on 30inch centers for the spindle harvester. The brush harvester was operated with all three drills standing, yet only two drills entering the brush rolls at any given time (Figure 2). Operating speeds for each harvester were as close as possible to what would be attained in a conventional production system for the harvester, typically 3.5 mph for the spindle picker, 3.5 mph to 4.5 mph for the brush stripper and 4 to 5 mph for the finger stripper. Hand harvesting was accomplished at about 75 lb of seed cotton per person per day.

Hand picking of three 15 ft by 80 ft blocks (yielding approximately 80 lb of seed cotton) within a plot area in the four field locations was completed prior to the mechanical harvesters being operated (Figure 3). The finger stripper was used to harvest alleys between the plots operating with or without the bur extractor and the samples were saved for ginning. Each harvester was operated in the three different replications in each field location. Seed cotton was dumped into a trailer, sampled for moisture content, and immediately sacked and tagged for later ginning at the USDA Cotton Ginning Laboratory in Stoneville, MS.

No measurable rainfall occurred during the six-week duration of preparing and harvesting of the plots. Plant heights ranged from 16 to 18 inches tall to approximately 4 ft tall in some locations and replications. Fields used for locations 1, 2 and 3 were late planted and some plants were still producing white flowers on October 1.

Samples were stored in a cotton trailer under an open sided shelter until February 4, 2000, when they were conditioned and ginned in the USDA-ARS Cotton Ginning Laboratory Micro Gin in Stoneville, MS. Machinery sequences were six cylinder cleaner, stick machine, Trashmaster™, extractor/feeder, gin stand and one and two saw type lint cleaners for hand and spindle harvested cottons and an additional stick machine following the Trashmaster™ for stripper harvested samples. Lint samples were collected after one and two lint cleaners for all samples. All samples were sub sampled for seed cotton moisture, wagon and feeder fractionation, lint moisture, HVI and AFIS quality analysis, lint turnout, trash removed from the overhead cleaning equipment, and lint cleaner trash and motes removed. Lint samples were sent to the AMS Cotton Classing Office, Dumas, AR, and Cotton Incorporated, Raleigh, NC for classing and AFIS measurements.

Statistical analysis was performed first by looking at all locations as one test, then as each individual location as a test.

Results and Discussion

Analysis Over All Locations

Tables 2 through 4 represent the analysis over all locations, replications and treatments. Only those variables that were statistically significant and point to meaningful differences between locations and harvester treatments will be discussed. Several variables yielding location by harvester treatment interactions were found to be significantly different. These variables are reported in Table 4. These interactions are felt to be a result more of harvester types being influenced by plant characteristics such as height, maturity, etc which were not measured, than by actual location and were not considered in this paper.

Moisture of lint and seed cotton taken during ginning and seed cotton taken during harvesting reflected very small differences and were not felt to be important or affect fiber properties.

Table 3 lists the variables found to be significant for harvester differences. The AFIS variables considered in this analysis were neps/gram, short fiber content by weight, visible foreign matter and immature fiber content; all of which were significantly better for hand harvesting and spindle picking compared to stripper harvesting methods. The finger stripper with bur extractor had slightly fewer neps than the brush stripper with cleaner.

Seed cotton from strippers equipped with bur extractors had higher short fiber content than strippers that did not use the bur extractors. Hand picking resulted in approximately half the visible foreign matter than the mechanical harvesters. Spindle picker treatment was lower in visible foreign matter than the strippers. Bur extractors made no appreciable difference in VFM content. Immature fiber content (IFC) was lower for hand and spindle picking treatments.

Turnout and wagon and feeder fraction data reflected the differences one would expect from the different harvesting systems. Turnout ranged from 24.2% for the brush stripper without bur extractor to 33.8% for the hand picked samples. For both strippers, the bur extractor increased turnout by 4%. The finger stripper produced slightly higher turnout than the brush stripper with bur extractor.

Classer staple, HVI length, uniformity and strength all showed no significant differences or were not meaningful.

Bale value was computed from the USDA loan schedule (1999) taking into account the premiums and discounts for micronaire, strength, length, color and remarks. Bale value ranged from $308.91 for hand picked to $304.23 for the spindle picked or a difference of only $4.68 per bale. Lower Rd and plus b values for the spindle picked samples indicate that color was probably the determining factor in the lower bale values. On-board bur extractors did not adversely affect lint quality or bale value. They did significantly improve lint turnout percent.

Overhead trash reflected the amount of trash removed by the gin's seed cotton cleaning machinery as a percentage of the total material processed and ranged from only 7.67% for the hand picked samples to 33.20% for the finger stripper without bur extractor. Like the other indicators of the trash content, no surprises were identified.

Table 4 shows the significant variables for one and two lint cleaners over all harvesters. As expected, the second lint cleaner increased neps, short fiber content, immature fiber content, and reflectance but only slightly reduced visible foreign matter. Bale value was raised only $1.54, which would not offset the extra lint lost (approximately 10 lb/bale for spindle harvested cotton) during the second stage of cleaning (Mangialardi, 1972).

Neps per gram were lowest for the 30 inch row location (216 for 30 inch vs. 266 for 10 inch drill) and for the hand and spindle picked samples (224 neps/g). Strippers produced the greatest number of neps, the highest being the brush stripper with field cleaner (296 neps/g).

Analysis by Location

Tables 5 through 18 contain the means and differences for each location, for selected variables, at individual locations. Initial clean seed cotton and total trash percentages, feeder clean seed cotton and total trash percentages, percent turnout and trash removed by seed cotton cleaners are given in tables 5 through 10 respectively. Turnout ranged from about 34% for hand and spindle harvesting to 27.6% for stripper harvesters with cleaners to about 23% for stripper harvesters without field bur extractors (Table 9). Similarly, the percentage trash removed by the seed cotton cleaning equipment ranged from less than 10% of the total weight of the sample for the hand and spindle harvested samples to about 20% for the stripper harvesters with field bur extractors to about 35% trash for the stripper harvesters without field bur extractors (Table 10).

Classer color grade was analyzed using actual classer grades rather than converting to a continuous variable. Hand harvesting produced grades that were about one color grade higher than from the mechanical harvesters. There appeared to be no real differences in any of the color grades from the mechanically harvested samples. Trash and bark reductions were evident in the stripper-harvested samples. Bale values were computed using the 1999 CCC loan schedule and the grades for each harvest treatment samples (base grade of 41 color, 34 staple, 3.8 to 4.2 mic and 26 grams/tex strength). All treatments were within a $7.00 per bale range. Significant differences were found; however, there was no consistently best mechanical harvesting treatment over all locations. Slightly higher bale values were found for stripper harvesters without field bur extractors.

Higher Reflectance (Rd) and lower yellowness (Plus b) values were observed for the less aggressive hand and spindle harvesters than for the stripper harvesters. These are believed to reflect the influence of higher trash levels from the more aggressive stripper harvesting systems.

AFIS neps per gram were highest for the finger and brush harvesters with field bur extractors and lowest for the hand and spindle picker harvested treatments. However, the highest nep count was only 322 with the average of about 250 neps per gram. Even though the hand and spindle harvested samples were generally lower in neps , location had a major influence in nep counts.

AFIS total trash, trash size and visible foreign matter (Tables 16, 17 & 18) were consistent with previously discussed trash level measurements and lower for the hand and spindle harvested treatments.

Summary and Conclusions

Harvester type was found to affect the AFIS fiber properties that would be of concern to textile mills, namely neps/gram, and visible foreign matter. Stripper harvesters were about equal in their adverse influence in these properties whether or not bur extractors (except for short fiber content which the bur extractor increased) were operating. While hand and spindle harvesting produced measurable (improved) differences in both AFIS and HVI measurements, bale value computed from USDA AMS loan schedules was found to be lowest for the spindle harvester. Yields were not considered in this analysis due to row unit harvesters harvesting an unequal number of drills through the plots.

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Table 1. Experimental Design.

	Description
Location	
1	30 Inch Rows
2	175,000 Plants/Ac in 10 inch drills
3	125,000 Plants/Ac in 10 inch drills
4	125,000 Plants/Ac in 10 inch drills, partially irrigated
Harvester	
1	Hand Picked
2	John Deere 7455 with finger header, with bur extractor
3	John Deere 7455 with finger header without bur extractor
4	Case IH 2055 five row spindle harvester for 30 inch rows
5	John Deere 7455 four row brush harvester set on 40 inch rows with bur extractor
6	John Deere 7455 four row brush harvester set on 40 inch rows without bur extractor
Lint Cleaning	
1	One stage of saw type lint cleaning
2	Two stages of saw type lint cleaning

Sub Samples: Three each of moisture, fractionation, AFIS and HVI.

Table 2. Means and Significance of Location Variables*.

	Location			
Variable	**1**	**2**	**3**	**4**
Neps, Number	732A	725B	725B	719C
Neps, Number / Gram	216B	262A	266A	274A
Short Fiber Content by weight, %	6.05C	7.31B	7.16B	8.80A
Visible Foreign Matter, %	1.93AB	2.17A	2.13AB	1.89B
Immature Fiber Content, %	5.21B	6.32A	6.17A	6.36A
Lint Moisture , %	5.3AB	5.4A	5.2B	5.1C
Seed Cotton Moisture, %	10.6A	10.4A	10.9A	10.9A
Lint Turnout, %	29.5B	28.7B	28.6B	31.4A
Classer Staple, 32nd inch	36.6A	36.3A	36.4A	35.6B
Micronaire	4.8A	4.3B	4.3B	4.3B
Strength, g/tex	29.3A	29.1AB	28.8B	27.5C
Bale Value, $	$306.21A	$306.38A	$306.48A	$302.84B
Reflectance, Rd	7.5	7.5	7.5	7.4
Yellowness, Plus b	8.2	8.1	8.3	8.1
HVI Length, 100th inch	114A	113A	114A	111B
Uniformity, %	83.2A	82.8B	82.6B	82.1C
Wagon Fraction Cleaned Seed Cotton , %	83.3B	83.9B	83.4B	86.2A
Feeder Fraction Cleaned Seed Cotton, %	95.3	95.1	94.7	95.0
Overhead Trash, %	19.3A	18.8A	18.1AB	17.1B

*Variables followed by different letters indicate significant difference at 5%.

Table 3. Means and Significance of Harvester Variables*.

		Finger			Brush	
Variable	Hand Picked	With Cleaner	Without Cleaner	30 Inch Spindle	With Cleaner	Without Cleaner
Neps, number	725	727	731	729	725	726
Neps, number /gram	224C	276B	288AB	225C	296A	286AB
Short Fiber Content, %	7.2D	7.7AB	7.5ABC	7.3CD	7.6AB	7.3CD
Visible Foreign Matter, %	1.26D	2.38B	2.57A	1.72C	2.49B	2.54AB
Immature Fiber Content, %	5.79B	6.24A	6.15A	5.90B	6.26A	6.24A
Lint Moisture (%)	5.4AB	5.4AB	5.3BC	5.2C	5.3BC	5.3BC
Seed Cotton Moisture (%)	10.5B	11.0A	11.2A	10.4B	10.9AB	11.0A
Lint Turnout (%)	33.8A	28.1C	24.5E	32.7B	26.8D	24.2E
Classer Staple, 32nd inch	36	36	36	36	36	36
Micronaire	4.6A	4.4B	4.4B	4.5AB	4.2D	4.3C
Strength, g/tex	28.69AB	28.64AB	28.57AB	28.93A	28.52B	28.73AB
Bale Value, $/480 lb	$308.91A	$306.25B	$305.71B	$304.23C	$305.33B	$305.40BC
Reflectance, Rd	7.7A	7.5B	7.5B	7.3C	7.5B	7.5B
Yellowness, Plus b	8.1B	8.2A	8.2A	8.1B	8.2A	8.4A
HVI Length, 100th inch	112.19C	112.13C	112.63BC	113.26AB	113.14AB	113.77A
Uniformity, %	82.63	82.71	82.58	82.67	82.64	82.69
Initial Fraction Cleaned Seed Cotton, %	95.9A	80.1C	69.4F	93.0B	78.4D	70.9E
Feeder Fraction Cleaned Seed Cotton, %	97.2A	93.6C	92.6D	96.4B	93.6C	93.7C
Overhead Trash, %	7.7E	22.0 C	33.2A	10.3D	23.6B	32.0A

*Variables followed by different letters indicate significant difference at 5%.

Table 4. Means and Significance of Lint Cleaner Variables*.

Variable	1 Lint Cleaner	2 Lint Cleaners
Neps, number	735a	717b
Neps, number/gram	246a	264b
Short Fiber Content by weight, %	7.15a	7.51b
Visible Foreign Matter, %	2.20a	1.87b
Immature Fiber Content, %	5.94a	6.09b
Classer Staple, 32nd inch	36	36
Micronaire	4.4	4.4
Strength, grams/tex	28.57a	28.79b
Bale Value, $/480 lb	$304.71a	$306.25b
Reflectance, Rd	7.4a	7.5b
Yellowness, Plus b	8.2	8.2
HVI Length, 100th inch	113	113
Uniformity,%	82.6	82.7

*Variables followed by different letters indicate significant difference at 5%.

Table 5. Initial Fractionation, Clean Seed Cotton, %.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	95.3a[1]	95.7a	95.6a	97.0a
30 Inch Spindle	93.0a	93.3b	93.5a	92.1b
Finger W/Cleaner	79.2b	81.2c	80.5b	79.3cd
Brush W/Cleaner	80.0b	82.1c	81.7b	69.9e
Finger WO/Cleaner	68.8c	65.6d	64.6c	78.8d
Brush WO/Cleaner	66.4c	67.2d	66.4c	83.5c
R^2	0.98	0.99	0.98	0.95
Significance	**	**	**	**
LSD	3.0	2.3	3.4	4.3

[1] Means in a column followed by the same letter are notsignificantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.

Table 6. Initial Fractionation, Total Trash[1], %.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	3.3	4.5	2.9	1.8
30 Inch Spindle	5.6	5.0	5.1	6.5
Finger W/Cleaner	19.5	14.6	18.5	19.6
Brush W/Cleaner	18.5	18.5	17.1	29.0
Finger WO/Cleaner	30.1	33.2	34.2	19.9
Brush WO/Cleaner	32.3	28.2	32.4	15.4
LSD	5.0	7.7	7.6	4.9

[1] Statistics run on individual components of total trash only.

Table 7. Feeder Fractionation, Clean Seed Cotton, %.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	97.6a	96.9a	96.9a	97.3a
30 Inch Spindle	97.2a	96.6a	96.3a	95.5b
Finger W/Cleaner	93.8bc	93.9b	93.7b	93.1c
Brush W/Cleaner	93.0bc	94.2b	93.8b	93.4c
Finger WO/Cleaner	92.8c	92.6c	91.9c	93.0c
Brush WO/Cleaner	94.3b	93.5b	92.4bc	94.3bc
R^2	0.88	0.93	0.85	0.79
Significance	**	**	**	**
LSD	1.5	0.9	1.7	1.7

[1] Means in a column followed by the same letter are not significantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.

Table 8. Feeder F raction, Total Trash[1], %.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	2.1	2.8	3.3	2.8
30 Inch Spindle	2.6	3.5	3.8	4.1
Finger W/Cleaner	7.8	7.5	7.2	8.3
Brush W/Cleaner	8.8	6.8	7.8	8.2
Finger WO/Cleaner	9.2	9.5	10.4	8.6
Brush WO/Cleaner	7.0	7.9	10.3	6.7
LSD	2.2	2.0	2.9	2.8

[1] Statistics run on individual components of total trash only.

Table 9. Turnout, %.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	35.5A	32.6a	32.3a	34.8a
30 Inch Spindle	33.2A	31.4a	32.6a	33.5a
Finger W/Cleaner	28.6B	27.7b	27.4b	28.8b
Brush W/Cleaner	26.6Bc	28.2b	27.7b	24.8c
Finger WO/Cleaner	23.6Cd	22.5c	21.9c	30.1b
Brush WO/Cleaner	22.7D	23.0c	21.2c	29.9b
R^2	0.88	0.93	0.91	0.88
Significance	**	**	**	**
LSD	3.1	2.4	3.0	2.6

[1] Means in a column followed by the same letter are not .significantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.

Table 10. Trash Removed by Seed Cotton Cleaners, % of Total Seed Cotton.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	6.5f	9.3d	8.6c	6.3e
30 Inch Spindle	10.1e	10.5d	9.6c	10.9d
Finger W/Cleaner	20.2d	21.1c	20.9b	25.6b
Brush W/Cleaner	23.7c	18.0c	19.5b	33.1a
Finger WO/Cleaner	34.0b	40.7a	33.9a	24.1b
Brush WO/Cleaner	39.8a	34.0b	35.3a	19.0c
R^2	0.99	0.96	0.92	0.98
Significance	**	**	**	**
LSD	2.3	5.0	6.8	2.9

[1] Means in a column followed by the same letter are not significantly different ("t test" at the 95% level).
** Prob F<.01
* Prob F < .05

Table 11. Classer Grade (Not Continuous Variable).

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	28b	34c	30b	30c
30 Inch Spindle	40a	42a	40a	43a
Finger W/Cleaner	40a	37bc	38a	38b
Brush W/Cleaner	36a	40ab	38a	38b
Finger WO/Cleaner	40a	38abc	39a	38b
Brush WO/Cleaner	40a	40ab	37ab	33c
R^2	0.81	0.62	0.52	0.91
Significance	**	*	ns	**
LSD	4	4	7	3

[1] Means in a column followed by the same letter are not.significantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05ns Not Significant.

Table 12. Bale Value Based on 1999 Loan Schedule, $/480lb.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	$309.33a	$308.46a	$309.00a	$308.86a
30 Inch Spindle	$307.13b	$302.93bc	$306.73b	$300.13c
Finger W/Cleaner	$306.53b	$307.33a	$306.80b	$304.33b
Brush W/Cleaner	$304.20c	$305.46ab	$304.93bc	$306.73ab
Finger WO/Cleaner	$306.00b	$307.00a	$304.20c	$305.66ab
Brush WO/Cleaner	$302.40d	$306.26a	$305.06bc	$307.86a
R^2	0.94	0.61	0.77	0.76
Significance	**	*	**	**
LSD	$1.18	$3.06	$1.88	$3.47

[1] Means in a column followed by the same letter are not .significantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.

Table 13. Reflectance, Rd.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	7.9a	7.7a	7.8a	7.7a
30 Inch Spindle	7.5b	7.3c	7.4b	7.2c
Finger W/Cleaner	7.5b	7.5b	7.5b	7.5b
Brush W/Cleaner	7.4bc	7.5ab	7.4b	7.7ab
Finger WO/Cleaner	7.5b	7.5b	7.4b	7.5b
Brush WO/Cleaner	7.3c	7.5b	7.5b	7.7a
R^2				
Significance	**	*	*	**
LSD	0.1	0.2	0.2	0.1

[1] Means in a column followed by the same letter are notsignificantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.

Table 14. Yellowness, Plus b.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	7.7c	7.9	8.1bc	8.5a
30 Inch Spindle	8.0bc	8.3	7.7c	8.4a
Finger W/Cleaner	8.0b	8.3	8.3ab	8.4a
Brush W/Cleaner	8.9a	8.2	8.3ab	7.5b
Finger WO/Cleaner	8.2b	8.2	8.3ab	8.2a
Brush WO/Cleaner	8.7a	8.2	8.8a	7.7b
R^2	0.89	0.14	0.6	0.75
	**	ns	ns	**
LSD	0.3	0.6	0.6	0.5

[1] Means in a column followed by the same letter are not.significantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.

Table 15. AFIS Neps, number/gram.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	178c	228b	233b	260b
30 Inch Spindle	191c	231b	238b	241b
Finger W/Cleaner	223b	285a	287ab	310a
Brush W/Cleaner	281a	287a	294ab	322a
Finger WO/Cleaner	259a	309a	285ab	303a
Brush WO/Cleaner	223b	294a	320a	308a
R^2	0.88	0.69	0.45	0.78
Significance	**	**	*	**
LSD	28	46	74	34

[1] Means in a column followed by the same letter are not.significantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.
ns Not Significant.

Table 16. AFIS Total Trash, Count/gram.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	179c	199c	211d	149b
30 Inch Spindle	297b	327b	300c	325a
Finger W/Cleaner	469a	378ab	403b	341a
Brush W/Cleaner	482a	442a	402b	313a
Finger WO/Cleaner	470a	432a	440ab	337a
Brush WO/Cleaner	408a	422ab	484a	315a
R^2	0.88	0.78	0.9	0.67
Significance	**	**	**	*
LSD	76	97	66	101

[1] Means in a column followed by the same letter are not.significantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.

Table 17. AFIS Trash Size, microns.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	388c	433a	413c	458a
30 Inch Spindle	398bc	393b	413c	414b
Finger W/Cleaner	405abc	449a	435bc	463a
Brush W/Cleaner	424a	446a	450ab	449ab
Finger WO/Cleaner	417abc	444a	436b	465a
Brush WO/Cleaner	417abc	463a	459a	450ab
R^2	0.65	0.63	0.73	0.43
Significance	*	*	**	*
LSD	20	37	23	43

[1] Means in a column followed by the same letter are not.significantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.

Table 18. AFIS Visible Foreign Matter, %.

	Location			
Harvester	**I**	**II**	**III**	**IV**
Hand	1.0c	1.4cd	1.4c	1.2c
30 Inch Spindle	1.6b	1.7c	1.7c	1.9b
Finger W/Cleaner	2.2a	2.4b	2.4b	2.5a
Brush W/Cleaner	2.7a	2.7ab	2.5b	2.0ab
Finger WO/Cleaner	2.5a	2.6ab	2.6ab	2.5a
Brush WO/Cleaner	2.2a	2.8a	3.1a	2.0ab
R^2	0.83	0.88	0.84	0.75
	**	**	**	**
LSD	0.6	0.5	0.5	0.6

[1] Means in a column followed by the same letter are not .significantly different ("t test" at the 95% level).
** Prob F<.01.
* Prob F < .05.

30 Inch Conventional Plots (Rep 4)

174.25 ft	44 ft	217.75 ft	44 ft
	Finger With Cleaner		Finger Without Cleaner
		4 Row Brush Without Cleaner	
5 Row 30 Inch Row Conventional Spindle			
Hand (5 Rows)		4 Row Brush with Cleaner	

Figure 1. Example Harvester plot layout.

Figure 2. Brush Stripper cleaning up un-harvested rows in 10 inch drills.

Figure 3. Hand harvested plot 10 inch drill.