EFFECTS OF MULTIPLE LINT CLEANING ON THE VALUE AND QUALITY OF STRIPPER HARVESTED COTTON

R. V. Baker and A. D. Brashears
USDA ARS Cotton Harvesting and Ginning Laboratory
Lubbock, TX

Abstract

Measurements were made over a five-year period to evaluate the effects of multiple stages of lint cleaning on the quality and value of stripper harvested cotton. Twenty four test cottons representing five commercial stripper-type cotton varieties were used in these evaluations. Bale loan and market values and fiber quality measurements by the HVI system and AFIS are presented for samples collected before and after one, two and three stages of standard saw-type lint cleaning.

Introduction

Lint cleaning is one of the most important steps in the modern ginning process (Baker et al 1992). If the ginner uses too little lint cleaning, the farmer's cotton will receive lower than desired leaf and color grades, and these low grades will adversely affect the cotton's value in the marketplace. Too much lint cleaning, on the other hand, results in over cleaned cotton and lower bale weights. Over cleaning can also lower the cotton's value in the marketplace as well as at the textile mill (Lalor and Baker 1985). The trick in lint cleaner management, of course, is to apply just enough lint cleaning to maximize the value of farmer's cotton. Unfortunately, this is easier said than done.

Ginners may rely on their experience and judgement to make these decisions, or they may employ some of the new automated control technology for this purpose (Anthony 1990). In either case, good, up-to-date lint cleaner performance information is needed to obtain the desired results.

A number of basic lint cleaner performance trials have been conducted for various types of cotton in the past (Gillum et al. 1986; Baker et al. 1989; Mangialardi 1992; Mangialardi 1996; Bennett et al. 1997). Unfortunately, much of the data from such trials have a limited shelf life because of continual changes in cotton varieties, new lint cleaner designs and operating capacities, changes in premiums and discounts in the marketplace, and changes in the ways cotton is graded.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1391-1393 (1999)
National Cotton Council, Memphis TN

Beginning in 1993, ginning research personnel at Lubbock began to update the ginning laboratory's lint cleaner data files by initiating additional annual performance trials that have continued through 1998. This report presents a five-year summary of the results for crop years 1993/94 through 1997/98.

Procedures

Each year 4 to 7 test cottons were obtained from local farms within a 20-mile radius of the laboratory for these studies. A total of 24 cottons were tested over the five-year period. These cottons represented 5 standard stripper cotton varieties that were being produced in the area during this time frame. Most if the test cottons (19) were harvested with conventional brush strippers without the use of field cleaners. Five of the test cottons, however, were field cleaned. Each test cotton consisted of 4 to 6 bales which were ginned in our full-size gin plant using a typical seedcotton cleaning system for stripper cotton and 3 stages of saw-type lint cleaning (16-inch-diameter saw cylinders).

Five lint samples were collected from each bale before and after each lint cleaner and analyzed for quality by means of standard HVI classing at the USDA AMS Lubbock Classing Office and by AFIS and Shirley Analyzer measurements at the International Textile Research Center, Texas Tech University. Lint cleaner waste was collected, weighed and sampled for determination of trash and lint contents by the Shirley Analyzer method.

Results

While lint cleaning results varied slightly from cotton to cotton, for the purposes of this report the data was averaged across all 24 test cottons to illustrate general trends in lint cleaner performance. These average results are summarized in Tables 1-3.

HVI Classing

Lint cleaning had positive effects on HVI measurements dealing with trash level and color, negative effects on fiber length measurements, and no effect on measurements related to maturity and strength Table 1. Also, the positive effects of lint cleaning on color and trash measurements were greatest for the first stage of lint cleaning. Subsequent lint cleaning produced substantially lower benefits. For example, the first lint cleaner reduced trash area from 0.62 % to 0.24%, which represented an average reduction in trash level of about 61%. Trash reductions due to the second and third lint cleaner, however, averaged only 38% and 20%, respectively. Leaf grades followed a similar trend. The first lint cleaner produced a two-grade improvement in leaf grade, while the second and third lint cleaner only produced average improvements of about 0.6 and 0.4 leaf grade, respectively.

Lint cleaning tended to improve color measurements, especially the Rd color values related to reflectance of the sample. As with the trash improvements, however, the magnitude of the reflectance improvements tended to decline with additional lint cleaning. Lint cleaning also had some effect on the +b color readings. The first and second lint cleaners tended to increase these measurements slightly. The HVI color grade, which is determined directly from the Rd and +b color readings, improved one full grade for each of the first two stages of lint cleaning. The third stage of cleaning produced no further improvements in this parameter. The color grade code assigned by the classer also improved with lint cleaning. The first digit of this grade code improved by 0.79, 0.37 and 0.15 grade for the first, second and third lint cleaners, respectively. The second digit of the color grade code was also improved by the first lint cleaner. The second digit indicates, in this case, whether the cotton was classed as 'white' or 'light-spotted'. Before lint cleaning about 18 percent of the cotton samples were classed 'light-spotted'. After the first lint cleaner only about 3% of the samples were light-spotted in color, and additional lint cleaning had no further effect on this measurement.

One stage of lint cleaning greatly reduced the classers' assessment of rough preparation. A very high percentage (87%) of uncleaned lint samples received the rough preparation call compared to only 2% after one stage of lint cleaning. There were no rough preparation calls after two or three stages of lint cleaning. The average market price discount for these rough preparation calls averaged 3.6 and 0.8 cent per pound for zero and one stage of lint cleaning. Bark was not a factor in most of these tests. Only two test cottons contained enough bark to penalized, and even in these tests only a portion of the samples were classed as barky.

HVI length measurements revealed a small, but progressive, deterioration in fiber length and length uniformity with increased levels of lint cleaning. These reductions in fiber length resulted in decreases in staple length of 0.3 to 0.4 unit (32^{nd} in.) per stage of lint cleaning.

Bale Weight and Value

Lint cleaning dramatically affected final bale weight, Table 2. Bale weights ranged from a high of about 518 lbs with no lint cleaning to a low of 480 lbs after three lint cleaners. One, two and three stages of lint cleaning reduced bale weight by 26.9, 33.9, and 38.4 lbs, respectively. Lint cleaner waste consisted of trash and wasted fiber. The wasted fiber averaged 6.0, 8.7 and 11.0 lbs per bale for the first, second and third stages of lint cleaning, respectively.

The first stage of lint cleaning tended to improve per pound loan rates and market prices, but additional stages of lint cleaning had only minor effects on these rates and prices. In most cases one stage of lint cleaning was able to produce middling color and leaf grades, which were good enough to produce near maximum loan rates or market prices. Further improvements in grade with additional lint cleaning produced very small increases in loan rates or market values that was further eroded by decreases due to losses in staple length. Consequently, average bale loan and market values topped out after one stage of lint cleaning. Actually, when bale values were analyzed separately for each test cotton, 21 of the 24 test cottons required only one stage of lint cleaning for maximum bale value while 3 test cottons required two stages of lint cleaning.

AFIS Properties

The length measurements obtained with AFIS tended to closely follow those obtained with the HVI classing system, Table 3. Basically, mean fiber length and UQ length measurements tended to be decreased by about 0.01 inch by each stage of lint cleaning. The first stage of lint cleaning had no statistically significant effects on short fiber content or length COV, but two and three stages adversely affected both of these parameters. Short fiber content was increased from 8.47 before lint cleaning to 9.04 and 9.77% by two and three stages of lint cleaning. Changes of these magnitudes represent percentage increases in short fiber contents of 6.7 and 15.3%.

As with the previously discussed HVI data, fiber maturity measurements were not affected by lint cleaning. The AFIS measurements of fineness, percentage of immature fiber and maturity ratio remained unchanged with increases in lint cleaning level.

Fiber nep size and count increased with increased amount of lint cleaning. One stage of lint cleaning increased nep counts per gram of fiber from 253 to 314, a percentage increase of 24%, while two and three stages of lint cleaning produced percentage increases in nep counts of 57 and 92%, respectively. Nep size also increased slightly with each additional stage of lint cleaning. Seedcoat neps, however, were not greatly affected by lint cleaning. Lint cleaning had no significant effect on seedcoat nep size, and only the difference in seedcoat nep count between no lint cleaning and three stages was large enough to be statistically significant.

Lint cleaning, as one would expect, had large effects on dust and trash counts. Each stage of lint cleaning significantly reduced dust counts, but only the first and second stages significantly reduced trash counts. The total trash count (dust and trash) ranged from a high of 1185 per gram for no lint cleaning to a low of 301 after three stages of lint cleaning, or a percentage count reduction of about 75%. Similar percentage reductions by the first and second stages of lint cleaning averaged 48 and 66%, respectively. Mean trash size also varied with lint cleaning level. Mean trash size increased from 293 microns before lint cleaning up to 337 microns after three lint cleaners.

AFIS data also includes an estimated visible foreign matter (VFM) content that is predicted from the dust and trash count data. As a point of reference, the corresponding Shirley Analyzer VFM data is also presented. The AFIS estimates of VFM were substantially lower than those measured by the Shirley Analyzer, especially for cotton receiving no lint cleaning. The amount of trash removed by the lint cleaners as measured by the lint cleaner waste data, Table 2, corresponds more closely with the Shirley VFM than with the AFIS VFM. For example, a difference in AFIS VFM between no lint cleaning and one stage of cleaning averages 1.38 percentage points, or about 8 lbs of trash per bale. A similar calculation using the Shirley VFM yields first stage trash removal of 27 lbs. The actual trash removal rate for the first stage of lint cleaning was about 21 lbs/bale.

Summary

Measurements were made over a 5-year period to evaluate the effects of multiple stages of lint cleaning on the quality and value of stripper harvested cotton. In general, increased amounts of lint cleaning tended to improve HVI color and leaf grades and corresponding loan and market premiums. Beyond one stage of lint cleaning, however, these increases in grade premiums were very small and partially offset by discounts due to shorter staple lengths. Consequently, in these studies 21 of the 24 test cottons required only one stage of lint cleaning to maximize bale loan or market value. The other 3 test cottons required two stages of lint cleaning for maximum value.

While multiple stages lint cleaning tended to adversely affect fiber length, short fiber content, and nep level, the adverse effects from the first lint cleaner were relatively small and often statistically insignificant. Also, these modest changes in fiber length and nep level were offset to a large degree by large improvements in trash content. Two, and especially three, stages of lint cleaning resulted in greater levels of fiber damage with only modest improvements in trash content and grade level. While one stage of lint cleaning was the obvious choice for most of the cottons evaluated in this series of tests, it should be noted that some of the cotton did require two stages of cleaning to obtain maximum bale value. The initial trashiness of the cotton, the condition of a gin's lint cleaners, and the premiums and discounts in the market place will ultimately dictate the proper amount of lint cleaning to be employed.

Acknowledgment

The partial funding of this research by Cotton Incorporated is gratefully acknowledged.

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Table 1. Average HVI classing data for crop years 1993/94 - 1997/98.

HVI Properties	No LC	1 LC	2 LC's	3 LC's
Color Grade Code:				
First Digit	3.37a*	2.58b	2.21c	2.06d
Second Digit	1.18a	1.03b	1.03b	1.04b
Leaf Grade Code	5.11a	3.11b	2.52c	2.13d
Staple Length, 32nd inch	34.4a	34.0b	33.7c	33.4d
Micronaire Value	4.18a	4.10b	4.10b	4.11ab
Strength, g/tex	28.8a	29.0a	29.0a	28.8a
Rd Color Value	75.6d	77.9c	78.9b	79.4a
+b Color Value	8.20c	8.54b	8.63a	8.65a
HVI Color Grade Code	41a	31b	21c	21c
Trash Area, %	0.62a	0.24b	0.15c	0.12c
Rough Prep., % of spls.	87a	2b	0b	0b
Bark, % of spls.	1a	2a	1a	2a
HVI Length, inch	1.071a	1.058b	1.050c	1.043d
Length Uniformity, %	82.6a	81.9b	81.4c	81.4c

** Averages of 475 samples across 24 test cottons.

* Means for a given fiber property followed by the same letter are not significantly different at the 0.05 level of significance.

Table 2. Lint cleaner waste and bale value data, 1993/94 - 1997/98.

Measurement	No LC	1 LC	2 LC's	3 LC's
Lint Cleaner Waste:				
Trash, lb/bale	0.0	20.9	25.2	27.4
Fiber Waste, lb/bale	0.0	6.0	8.7	11.0
Total, lb/bale	0.0	26.9	33.9	38.4
Bale Weight, lbs	518.4	491.5	484.6	480.0
Loan Rate, cent/lb*	43.88	51.46	51.35	51.09
Bale Loan Value, $	227.47	252.93	248.84	245.23
Market Price, cent/lb**	55.17	60.84	61.13	61.12
Bale Market Value, $	286.00	299.03	296.24	293.38

* 1997/98 CCC loan rates for Lubbock, TX.

** 1997/98 market prices for West Texas area estimated from Daily Price Estimation System, Dept. Of Agri. Econ., Texas Tech Univ.

Table 3. Average AFIS fiber quality measurements*, 1993/94 - 1997/98.

Measurement	No LC	1 LC	2 LC's	3 LC's
Mean Length, inch	0.925a**	0.916ab	0.906b	0.893c
COV, %	32.8b	32.9b	33.0b	33.5a
UQ Length, inch	1.110a	1.102ab	1.091bc	1.082c
Short Fibers, %	8.47c	8.66c	9.04b	9.77a
Fineness, mTex	173a	172a	173a	172a
Immature Fibers, %	7.8a	8.1a	8.0a	8.0a
Maturity Ratio	0.89a	0.88a	0.88a	0.87a
Nep Size, um	782d	792c	801b	810a
Nep Count, cnt/g	253d	314c	397b	485a
Seedcoat Nep Size, um	1003a	986a	990a	993a
Seedcoat Neps, cnt/g	33a	31ab	31ab	27b
Mean Trash Size, um	293c	315b	324b	337a
Dust <500um, cnt/g	1022a	521b	337c	247d
Trash >500um, cnt/g	163a	97b	66c	54c
Total Trash, cnt/g	1185a	617b	403c	301c
Est. AFIS VFM, %	3.18a	1.80b	1.24c	1.02c
Shirley Anal. VFM, %	8.05a	2.90b	1.81c	1.31d

* Each value represents the average of 1735 determinations.

* Means for a given fiber property followed by the same letter are not significantly different at the 0.05 level of significance.