# CLEANING EXPERIENCES WITH STRIPPER-HARVESTED COTTONS

**John B. Price, Cotton Technologist**
**USDA-ARS, Southern Regional Research Center**
**New Orleans, LA**
**Roy V. Baker, Agricultural Engineer**
**USDA-ARS, Cotton Ginning Laboratory**
**Lubbock, TX**

## Abstract

Stripper-harvested cottons, varying in trash content as a result of differences in growing season and ginning treatment, were processed from bale to silver, collecting and weighing wastes and determining their non-lint contents. The results show that the waste extracted from a cleaning machine, or combination of such machines, operating on impact principles bears a linear relationship with the non-lint content of the cotton supplied. The comparable relationship for filter waste, which includes flat strips from the carding operation, is almost constant, explaining the apparent tendency for card cleaning performance of a cleaning machine, or a group thereof, is shown to be dependent upon the non-lint content of the bale and independent of ginning treatment, season, bale compression, or the level of bark assigned during cotton classification.

## Introduction

Stripper-harvester cottons, almost entirely produced in West Texas, account for about 25% of the U.S. Cotton crop annually. The method of harvesting is aggressive in that the vigorous action removes large quantities of plant parts, particularly burs and stems, with the seed cotton. The higher proportion of foreign material invites the use of more cleaning machinery at the gin. The greater mechanical action increases the opportunity for damage, not only to the fiber, but to the entrained plant parts. In particular, fragments tend to survive the gin's line cleaning processes and the opening, cleaning and carding processes of the textile mill, to cause interruptions in the spinning process with consequent loss in production and increase in yarn costs.

The presence of bark in cotton is cause for penalties in the U.S. classification system. Since stripper-harvested cotton is a significant proportion of the crop, and is particularly prone to discounting for this reason, considerable research efforts have been expended to assess whether or not the discounts are justified. One of several such studies has been reported by Baker[1].

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1460-1463 (1996)
National Cotton Council, Memphis TN

This study is an analysis of data generated at the erstwhile International Center for Textile Research and Development, Lubbock, Texas, using the bales of cotton produced by Baker[1], in which the same variety of cotton,, harvested in three consecutive years, was processed into bales via different combinations of seed cotton and lint cleaning machinery at the U.S.D.A.'s Cotton Ginning Laboratory, Lubbock, Texas. These cottons provided a wide range of trash contents over the three years of production and each was subjected to a number of different cleaning treatments using textile mill machinery at constant settings. As an additional source of data, the results from two other cleaning studies were included, in which cottons of approximately similar properties were obtained from commercial sources to provide a range of trash contents and levels of bark. Since selection of the latter cottons was made primarily on grade, there was no control of the cotton used, the growth location or ginning procedures. Furthermore, the bales obtained commercially were compressed to a greater density than those produced at the ginning laboratory.

## Experimental

The cottons used in this study provided a wide range of properties. Fiber strength (Stelometer, 3.2mm gauge) varied from 21.4 to 26.9b/tex. Micronaire value ranged from 2.5 to 4.2 and the non-lint content varied from 1.7 to 14.5. Those cottons which were obtained from commercial sources provided a range of properties within the range obtained with the cottons ginned at the USDA laboratory. Quantities did not always permit the same combination of cleaning treatments to be performed on all the cottons, particularly those obtained commercially. The general procedure was as follows.

About 50kg (110 lb) of cotton were taken from each bale to form a lot. Each lot was processed in random order via one of three combinations of blowroon equipment, and converted into silver using a single card. The different combinations of mill cleaning equipment (shown diagrammatically in Figure 1) were

- (I) Rieter Monocylinder
- (ii) Monocylinder and Rieter ERM equipped with a "nose" beater
- (iii) As (ii) followed by a second ERM fitted with a cleaning roll of saw tooth wire.

Carding was performed at a production rate of 45kg/hr (100 lb/hr) using a Rieger C4 card running at a cylinder speed of 450rpm. The resultant card silver was then drawn twice and used as feedstock for the production of yarn by rotor-spinning. The ERM cleaners were adjusted to deliver stock for about 85% of the operational time.

Samples of each bale were taken for analysis. The wastes from each major collection point were collected, weighed, and their non-lint contents determined using a Shirley Analyzer. The major collection points were those beneath the three cleaning machines, the lickerin or undercard area, and the filter base of the air filtration system treating the exhaust air from the card and opening line machinery. Whereas wastes collected at other points were extracted by primarily centrifugal and gravitational forces, that collected in filters arose from a combination of pneumatic fractionation and the transport of wastes, namely flats strips, produced by the carding action.

The non-lint content of the waste and the proportion of waste produced from the material supplied to the cleaner were used to calculate the quantity of trash extracted as a proportion of the input material. Furthermore, this value was used to calculate the cleaning efficiency and the non-lint content of the output of the machine, at the risk of introducing systematic errors. However, the huge testing workload was significantly reduced by eliminating the collection of samples of the machine output.

(Note: Within this paper, the term 'waste' is used to describe the material which a cleaning point removes from the cotton supplied to it, as opposed to the 'trash' (non-lint material) and so-called 'good fiber' which comprise the extracted matter.)

## Results and Analysis

The database in this study is a total of 196 lots, of which twenty-eight were provided by the commercially-acquired cotton bales. Unfortunately, Shirley Analyzer data were not available for the waste produced from sixteen of the "commercial" bales, reducing the database to 180 in certain circumstances. The analysis of the performance of machines, both individually and collectively, lead to the following general statements on cleaning performance

### Waste Extracted

First, there is a linear relationship between the waste produced by a cleaning machine and the non-lint content of the input material, as shown in Table 1. The exception was filter waste, extracted primarily by pneumatic forces, whose quantity was largely independent of the non-lint content of the material fed.

Second, because the quantity of waste extracted bore a linear relationship with the non-lint content of the bale, as shown in Table 2.

Third, inspection of the distribution of the data when plotted around the regression line indicates that the performances of cleaning machines were not markedly influenced by changes in the input material from year to year, or by source (ginning laboratory or commercial gin).

Fourth, there is a non-linear relationship between non-lint content and the non-lint content of the input material which is adequately explained by a logarithmic equation. Table 3 gives the regression data for the full data set, indicating the improvement in explanation by using a logarithmic form equation.

Fifth, despite the fact that the relationship between the non-lint contents of waste and input material is apparently logarithmic in nature, the relationship between the proportion of trash removed and the waste removed, both expressed as a percentage of the material supplied, is approximately linear.

Table 4 presents the regression data. The slopes of the equations are less than unity. This means that as the quantity of waste increased the proportion of trash decreases. In other words, when cottons of high trash content are processed, the increase in trash removed also incurs an increase in good fiber loss. Presumably this arises as a result on entrainment.

### Cleaning Efficiency

Sixth, cleaning efficiency, defined as the percentage of trash removed from the input material, will therefore be expected to have an approximately linear relationship with the non-lint content of the input material. Despite the considerable scatter in the data, this is corroborated by the regression data for the first two cleaners. Cleaning efficiency plotted against input non-lint content showed little positive gradient in the data for the third cleaner and a negative slope was content of the bale of cotton. From the aspect of bale value, it would seem wrong to identify and penalize as a result, a bale of cotton whose sample is seen to contain bark on the assumption that a barky bale will generate more waste in the opening room and at the cards. It would seem to be more accurate to assign a value to the bale which is in direct relation with the quantity of trash therein. Any penalties, therefore, should reflect losses in value which arise in the spinning process (and beyond) which can be attributed directly to bark as opposed to trash content per se. Furthermore, it remains to be seen whether or not the performance of picked cottons differs from stripped cottons in this regard.

## Conclusions

For the operating conditions used in this study, the following conclusions are drawn:

1. The waste extracted by a mill cleaner, or combination of cleaners, operating on impact principles, is linearly related to the non-lint content of the material fed to it.
2. The non-lint content of the waste extracted by a cleaner varies with the logarithm of the non-lint content of the input.

3. The quantity of trash extracted by a cleaner varies with the waste extracted in a manner which is approximately linear.
4. The cleaning efficiency of a cleaner, or combination of cleaners, increases with the input non-lint content in an approximately linear manner.
5. Card filter waste, comprising pneumatically extracted matter and the waste produced by carding elements, is almost independent of the input non-lint content. Consequently, the calculated cleaning efficiency decreases with the reciprocal of non-lint content.
6. There was no evidence of dissimilar behavior between groups of cotton. All stripper harvested cotton, whether graded barky or not, behaves in a similar manner when passing through a cotton cleaning line, and bale compression has no discernable effect on cleaning performance.

## References


1. Baker, R.V., Price, J.B., and Robert, K.Q., Gin and Mill Cleaning for Rotor Spinnng, Transactions of the ASE 37(4), 1077-1082 (1994).

2. Schlichter, S., Baker, R.V., Bragg, C.K., and Farber, C., Improved Treatment of Cotton from Harvest to Spinning. Proceedings of the Beltwide Cotton Conference, San Antonio, TX, 1995 2,1451-1458.


## Acknowledgments


To Carl Cox, erstwhile Director of the Texas Food and Fiber Commission, Dallas, Texas, for funding a considerable proportion of this work.

To the Plains Cotton Improvement Program administered by the Plains Cotton Growers, Inc, Lubbock, Texas, for permission to utilize some of the data generated in their sponsored studies of barky cotton performance.


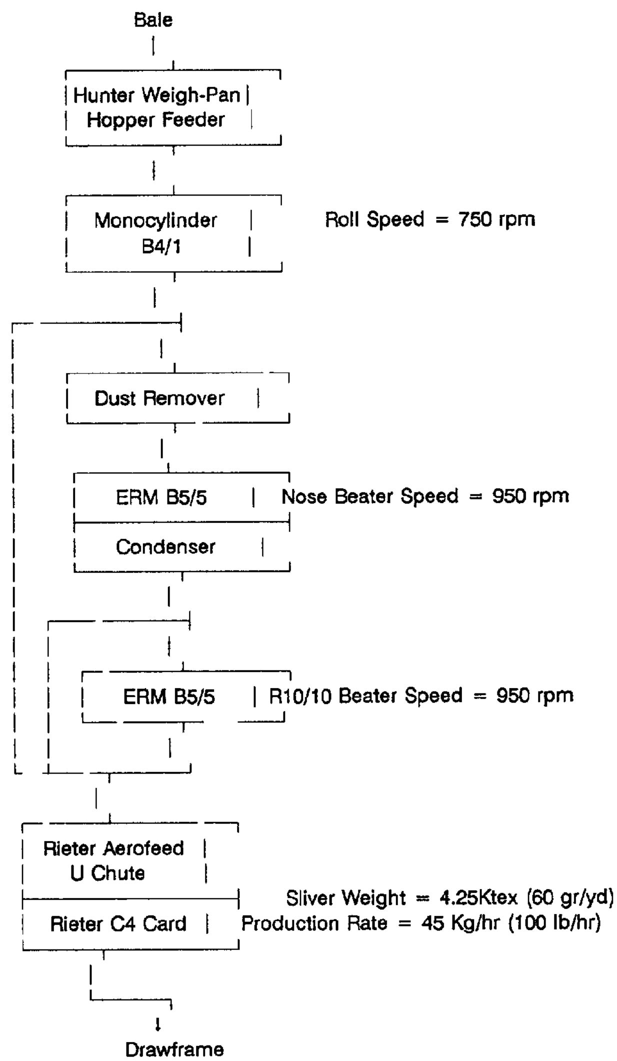


Figure 1

OUTLINE OF CLEANING MACHINERY SEQUENCE

TABLE 1

Regression Equations for Waste(w) on Input Non-Lint Content

| Machine | n | Equation | Coefficient of Determination | Residual Standard Deviation |
|---|---|---|---|---|
| Monocylinder | 180 | $w = -0.353 + 0.367C_B$ | 0.914 | 0.37 |
| ERM 1 | 138 | $w = +0.098 + 0.360c_m$ | 0.879 | 0.34 |
| ERM 2 | 75 | $w = +0.321 + 0.171c_1$ | 0.776 | 0.16 |
| Lickerin | 180 | $w = +0.366 + 0.373c_2$ | 0.620 | 0.54 |
| Filter | 180 | $w = +2.601 + 0.081c_l$ | 0.036 | 0.61 |

TABLE 2

Regression Equations for Waste(w) on Bale Non-Lint Content($c_b$)

| Machine | n | Equation | Coefficient of Determination | Residual Standard Deviation |
|---|---|---|---|---|
| Monocylinder | 196 | $w = -0.335 + 0.361c_b$ | 0.901 | 0.39 |
| ERM 1 | 146 | $w = +0.266 + 0.265c_b$ | 0.913 | 0.28 |
| ERM 2 | 83 | $w = +0.415 + 0.093c_b$ | 0.851 | 0.13 |
| Lickerin | 180 | $w = +0.582 + 0.204c_b$ | 0.585 | 0.57 |
| Filter | 180 | $w = +2.578 + 0.041c_b$ | 0.048 | 0.61 |
| Blowroom | | | | |
| n = 1 | 42 | $w = -0.093 + 0.324c_b$ | 0.878 | 0.29 |
| n = 2 | 63 | $w = -0.109 + 0.625c_b$ | 0.943 | 0.56 |
| n = 3 | 75 | $w = -0.202 + 0.755c_b$ | 0.948 | 0.61 |

TABLE 3

Regression Equations for Waste Non-Lint Content($c_x$) on Input Non-Lint Content

| Machine | n | Equation | Coefficient of Determination | Residual Standard Deviation |
|---|---|---|---|---|
| Linear equations | | | | |
| Monocylinder | 180 | $c_x = 30.78 + 4.20c_b$ | 0.749 | 8.0 |
| ERM 1 | 138 | $c_x = 28.66 + 4.64c_m$ | 0.605 | 9.5 |
| ERM 2 | 75 | $c_x = 24.99 + 6.39c_1$ | 0.519 | 11.0 |
| Lickerin | 180 | $c_x = 56.60 + 1.98c_2$ | 0.160 | 8.4 |
| Filter | 180 | $c_x = 18.79 + 0.74c_l$ | 0.058 | 4.4 |
| Logarithmic equations | | | | |
| Monocylinder | 180 | $c_x = 17.09 + 24.15 \ln c_b$ | 0.798 | 7.2 |
| ERM 1 | 138 | $c_x = 19.04 + 22.40 \ln c_m$ | 0.625 | 9.3 |
| ERM 2 | 75 | $c_x = 19.38 + 24.58 \ln c_1$ | 0.550 | 10.7 |
| Lickerin | 180 | $c_x = 54.57 + 7.91 \ln c_2$ | 0.189 | 8.3 |

TABLE 4

Regression Equations for Extracted Trash (t,% of Input) on Waste (w,% of Input)

| Machine | n | Equation | Coefficient of Determination | Residual Standard Deviation |
|---|---|---|---|---|
| Monocylinder | 180 | $t = -0.32 + 0.840w$ | 0.977 | 0.165 |
| ERM 1 | 138 | $t = -0.41 + 0.800w$ | 0.940 | 0.198 |
| ERM 2 | 75 | $t = -0.35 + 0.898w$ | 0.919 | 0.093 |
| Lickerin | 180 | $t = -0.17 + 0.767w$ | 0.963 | 0.133 |
| Filter | 180 | $t = -0.17 + 0.271w$ | 0.612 | 0.134 |
| Blowroom | | | | |
| n = 1 | 42 | $t = -0.21 + 0.721w$ | 0.898 | 0.204 |
| n = 2 | 63 | $t = -0.77 + 0.827w$ | 0.980 | 0.204 |
| n = 3 | 75 | $t = -1.12 + 0.855w$ | 0.978 | 0.331 |

TABLE 5

Regression Equations for Machine Cleaning Efficiency(E) on Input Non-Lint Content(c)

| Machine | n | Equation | Coefficient of Determination | Residual Standard Deviation |
|---|---|---|---|---|
| Monocylinder | 180 | $E_m = -5.8 + 1.57c_b$ | 0.581 | 4.4 |
| ERM 1 | 138 | $E_1 = 11.7 + 1.36c_m$ | 0.282 | 5.5 |
| ERM 2 | 75 | $E_2 = 10.9 + 0.40c_1$ | 0.024 | 4.5 |
| Lickerin | 180 | $E_l = 35.2 - 1.15c$ | 0.026 | 13.0 |
| Filter | 180 | $E_f = 53.0 - 9.71c_l$ | 0.268 | 22.8 |
| Filter | 177 | $E_f = 3.4 - 44.14(c_l)^{-1}$ | 0.732 | 8.4 |
| Blowroom | | | | |
| n = 1 | 42 | $E = 6.6 + 1.57c_b$ | 0.303 | 5.8 |
| n = 2 | 63 | $E = 16.3 + 2.11c_b$ | 0.562 | 6.8 |
| n = 3 | 75 | $E = 26.0 + 2.28c_b$ | 0.438 | 8.9 |