# HOW DIFFERENT QUALITY ATTRIBUTES CONTRIBUTE TO THE PRICE OF COTTON IN TEXAS AND OKLAHOMA?

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## Abstract

This study measures the average contribution of color, staple, strength, micronaire, and cleanliness to the price of cotton using the Daily Price Estimation System (DPES) data, maintained and operated by the department of Agricultural and Applied Economics, Texas Tech University for cotton produced and sold in Texas-Oklahoma region between 1993 and 1998. The study found on the average, color had the highest contribution in the price of cotton, i.e., 30% of the price of cotton was due to the effect of color. Micronaire and cleanliness contributed 22 and 23%, respectively, to the price of cotton, and the contribution of staple was about 20%. The average contribution of strength was the lowest among all quality attributes at about 5%.

## Introduction

Cotton embodies a diverse set of quality characteristics that are currently being objectively measured by the high volume instrument (HVI) technology. An official grade is assigned to each bale of cotton marketed in the U.S. based on the average quality of its cotton fiber. The classing of cotton characteristics is performed by the Cotton Division, Agricultural Marketing Service (AMS), United States Department of Agriculture (USDA). The USDA recognizes eight official cotton quality attributes: fiber strength, length uniformity, micronaire, trash content, color grade, extraneous matter, and preparation. Availability of quality characteristic information has made it easier for cotton buyers to discriminate between cotton lots based on their quality combinations. Textile mills, based upon their processing needs, pay more for cotton with higher levels of desirable characteristics, and penalize cotton for containing less desirable characteristics. In the spot market, however, cotton is traded in "packages" of attributes, i.e., premiums and discounts for quality differentials are not directly observed in the market. Therefore, market participants cannot themselves identify the value of the attributes, but must rely on information provided to them.

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Several studies have estimated the marginal value (implicit price) of cotton fiber attributes based on market data both at the producer and at the textile manufacturers' level (Ethridge and Chen, 1997; Chen et al. 1997; Brown et al., 1995; Brown and Ethridge, 1995; Bowman and Ethridge, 1992; Ethridge and Neeper, 1987). Most of these studies used the hedonic price theory approach (Rosen, 1974) to estimate a non-linear relationship between price of cotton and its quality attributes. The hedonic approach describes the price of cotton based on the embodied fiber quality and may be used to calculate the premiums and discounts for deviations from the 'base' quality (color grade 41, staple length 34, leaf grade 4, micronaire 3.5-4.9, and strength 24-25).

While the marginal (or incremental) contribution of quality to price has been well documented, there is a lack of information as to the relative (or percentage) contribution of each quality attribute toward the final price of cotton. This information is of interest to those wanting to know the relative value of the quality attributes. This study is the first attempt to analyze the relative contribution of the various quality attributes to the price of cotton. It measures the average contribution of color, staple, strength, micronaire, and cleanliness to the price of cotton using the Daily Price Estimation System (DPES) data, maintained and operated by the department of Agricultural and Applied Economics, Texas Tech University (Brown et al., 1995) for cotton produced and sold in Texas-Oklahoma region between 1993 and 1998.

## Methods and Procedures

Determining the contribution of each fiber quality attribute to the price of cotton is complicated by the fact that most quality attributes have negative and/or non-linear relationships with price. The intuitive approach adopted in this study measures the price differential between the "best" and the "least" combinations of quality attributes for cotton available in a given year. The contribution of each quality attribute to the overall variation in the price of cotton is derived by disaggregating the price differential between the "best" and the "least" combination of quality attributes. An average of these contributions across the crop years under study provides the overall average contribution of each fiber quality attribute.

Using the yearly DPES cotton price models (available upon request from the authors) for the West Texas and East Texas/Oklahoma regions (Hudson, Brown, and Ethridge, 1994; Hudson and Ethridge, 1995; Floeck, Hudson, and Ethridge, 1996; Hoelscher, Hudson, and Ethridge, 1997; Hoelscher, Ethridge, and Misra, 1998; and Chakraborty et al., 1999), two price estimates for cotton were derived for each year; one using the "best" quality attributes and another using the "least" quality characteristics that were available in

each year at 95% range of the variable. For leaf and first digit of the color grade, depending on the range of data available, lower value represents the "best" and higher value represents the "least" quality of cotton. For the second digit of the color grade, any value above the base represents "least" quality. Lower values for staple and strength represent the "least" and the higher values for the "best" quality of cotton. For micronaire, the "best" and the "least" quality is jointly determined by the quadratic relationship it has with the price of cotton and its availability in that year. For example, the high value of micronaire tends to vary with years and the lowest value of micronaire could be a high or low level of micronaire, depending on the price relationship for the year and the availability of micronaire in that year. The discounts may be higher in the lower range of the data than it is at the higher range, hence for micronaire, the possible contender in calculating the "least" price for cotton would be either the lower or higher range of micronaire.

The formula used for calculating price contribution of various fiber quality attributes is relatively simple, except for those attributes that have a negative relationship with the price of cotton and when the yearly DPES model used dummy variables for some attributes. The formula used for calculating the price contribution of an attribute whose higher value signifies higher contribution is :

$$Con_{STA} = \frac{\beta_1(STA_B - STA_L) + \beta_2(STA_B^2 - STA_L^2)}{P_B - P_L} * 100$$

where $Con_{STA}$ is the price contribution of staple, superscripts are for the quadratic terms in the model, subscripts B and L represent the "best" and the "least" quality attribute considered in the estimation, P is for the price of cotton (cents/lb.), and $\beta$'s are the DPES yearly parameter estimates for those attributes.

For measuring the price contribution of leaf and first digit of the color grade, the lower and upper range of the data are used to calculate the "best" and the "least" cotton prices. The procedure adopted in measuring the contribution of those quality attributes that were used as dummy variables in the DPES econometric model is somewhat different. For example, in some crop years the DPES econometric model used dummy variables for the second digit of the color grade. Dummies $D_0$, $D_1$, $D_2$, and $D_3$ were used to identify the second digit of the color grade if it is equal to 1, 2, 3, and 4, respectively. In order to measure the contribution of second digit of the color grade, the "best" cotton price is the one that has second digit of the color grade equal to 1, which is also the base (i.e., $D_0$=1) for comparison. The "least" price is estimated subtracting the coefficient of D2 from the "best" price calculated earlier. The coefficient of D2 was used because 95% data range for the second digits of the color grade in 1994, 1995, and 1996 crop years were below 3. For measuring contribution of bark and other extraneous matters, the "best" and the "least" prices are estimated setting those attributes to its lower and upper ranges, respectively.

## Results and Discussion

Appendix Table 1 reproduces the 95% population range and the mean of the quality attributes used in the DPES yearly models for West Texas and East Texas/Oklahoma for the 1993 to 1998 crop years. Table 1 presents the yearly average price, the "best," and the "least" prices of cotton based on the DPES yearly parameter estimates. Table 2 presents the price contribution of the quality attributes by crop year and the overall average contribution. The price contributions of the first and the second digits of the color grade are reported together as color and that of leaf, level 1 & 2 bark, and level 1 & 2 other extraneous matters are reported together as cleanliness. Figure 1 depicts the contribution of each 'base' quality attribute in the price of cotton for 1993 through 1998 crop years.

It is evident from Table 2 that the portion of total value explained by specific quality attributes varies across years. This is not surprising after having observed market values of quality attributes that fluctuate substantially since the DPES was initiated in 1989. Note that of the years included in this analysis, the average micronaire was the lowest (3.66) in 1995 crop year; during that year higher micronaire in the market was scarce, which led to its high value in the price contribution. In the 1994 crop year, the second digit of the color grade was relatively higher than in any other years under study; the scarcity of whiter cotton in the market that year led to its higher value, and greater contribution to average price.

Table 2 and Figure 2 show that, on an average, color had the highest contribution in the price of cotton, i.e., 30% of the price of cotton was due to the effect of color. Both micronaire and cleanliness contributed about 23% each to the price of cotton, and the contribution of staple was about 20% of the value of cotton. The average contribution of strength was the lowest among all quality attributes at about 5%. It should be noted that the average contributions of the quality attributes reported here should not be confused with the marginal values of these attributes. The average and marginal values could differ considerably. For example, while the average contribution of strength was found to be the lowest among all quality attributes, its marginal value was considerably higher than that of color.

## Summary and Conclusion

This study represents a first analytical attempt in disaggregating the final price of cotton into average contribution of each fiber quality attribute. The analysis

suggests that, between 1993 and 1998, of the average price of approximately 62 cents/lb. of cotton in the Texas-Oklahoma region, 18.6 cents was due to color, 12.3 cents was due to staple, 3.2 cents was due to strength, 13.9 cents was due to micronaire, and another 14.0 cents was due to cleanliness of cotton. It should be noted that conclusions and implications to be drawn from this study are limited by the geographical coverage of the study. Further, attempts to apply the results of this study to management/marketing decisions should be exercised with caution because the reported fiber quality values are averages for the 1993 to 1998 crop years.

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Table 1. Producers Price estimates using the DPES data for Cotton Produced in Texas-Oklahoma Region from 1993 to 1998 Crop Years.

| | Year | | | | | |
|---|---|---|---|---|---|---|
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** |
| Average Price | 52.62 | 71.67 | 75.18 | 63.48 | 57.99 | 51.14 |
| Best Price[a] | 56.53 | 75.14 | 79.21 | 67.68 | 62.16 | 55.98 |
| Least Price[b] | 44.46 | 60.48 | 64.38 | 45.75 | 49.03 | 38.13 |

[a]Best prices are estimated using the best quality attributes available in the data set. [b]Least prices are estimated using the worst quality attributes available in the data set.

Table 2. Price Contribution of Quality Attributes by Crop Year from 1993 to 1998.

| | Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **Average** |
| Average Price | 52.62 | 71.67 | 75.18 | 63.48 | 57.99 | 51.14 | 62.03 |
| | % Contribution to Price | | | | | | |
| Color | 27.84 | 49.06 | 19.49 | 32.40 | 35.43 | 16.13 | 30.06 |
| Staple | 20.18 | 19.47 | 16.52 | 10.69 | 13.62 | 38.35 | 19.81 |
| Strength | 6.63 | 4.81 | 8.29 | 2.72 | 4.01 | 4.63 | 5.18 |
| Micronaire | 15.17 | 11.60 | 40.56 | 33.49 | 13.64 | 19.63 | 22.35 |
| Cleanliness | 30.19 | 15.06 | 15.15 | 20.70 | 33.30 | 21.26 | 22.61 |

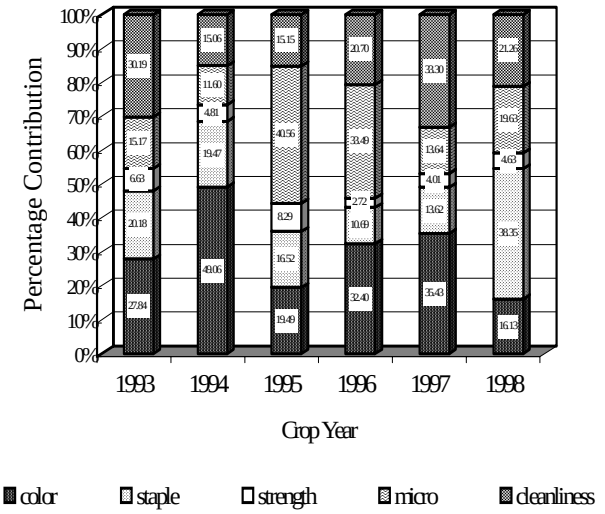


Figure 1. Contribution of Quality Attributes to Average Cotton Price, by Year.

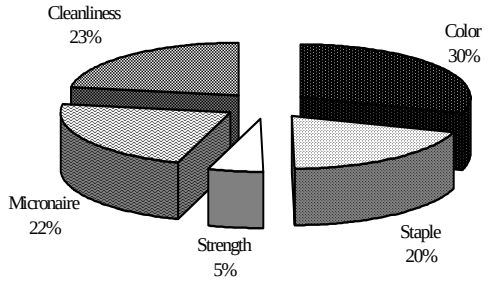


Figure 2. Average Price Contribution of Quality Attributes (1993-1998).

Appendix Table 1. Population Ranges and Means[a] for the Quality Attributes by Crop Year, for The Texas-Oklahoma Region.[b.]

| Attributes | Year | | |
|---|---|---|---|
| | 1993 | 1994 | 1995 |
| Average Price | 52.62 | 71.67 | 75.18 |
| Price Range | 43.59 - 61.91 | 59.64 - 83.68 | 71.47 - 78.89 |
| Leaf Grade | 1.3 - 5.3 | 1.39 -5.39 | 1.40 - 4.40 |
| | (3.30) | (3.39) | (2.90) |
| First Digit of the | 1 - 3.97 | 1.34 - 4.58 | 1.29 - 3.53 |
| Color Grade | (2.47) | (2.47) | (2.41) |
| Second Digit of | 1 - 2.85 | 1 - 2.67 | 1 - 2.61 |
| the Color Grade | (1.55) | (1.66) | (1.55) |
| Staple | 31 - 36 | 29.84 - 35.88 | 30.53 - 35.74 |
| | (33.3) | (32.86) | (33.13) |
| Strength | 23.5 - 32.5 | 22.89 - 32.49 | 23.10 - 32.75 |
| | (28.02) | (27.69) | (27.92) |
| Micronaire | 3.32 - 5.08 | 3.15 - 5.09 | 2.75 - 4.57 |
| | (4.2) | (4.12) | (3.66) |
| Level 1 Bark | 0 - 96.68 | 0 - 56 | 0 - 58.07 |
| | (33.10) | (12.45) | (26.70) |
| Level 2 Bark | 0 - 2.51 | 0 - 2 | 0 - 3.50 |
| | (0.03) | (0.03) | (0.07) |
| Level 1 Other | 0 - 14.23 | 0 - 22 | 0-15.18 |
| | (1.15) | 2.07 | (1.17) |
| Level 2 Other | 0 - 5.51 | 0-6.2 | 0-4.42 |
| | (0.14) | (0.17) | (0.10) |

[a]Source: Texas-Oklahoma Producer Cotton Market Summary various years. [b]Mean values are in parenthesis, printed below the range.

Appendix Table 1 (Continued)

| Attributes | Year | | |
|---|---|---|---|
| | 1996 | 1997 | 1998 |
| Average Price | 63.48 | 57.99 | 51.14 |
| Price Range | 56.01 - 70.96 | 49.87 - 66.10 | 44.05 - 58.23 |
| Leaf Grade | 1.48 - 4.87 | 1.37 - 5.43 | 1.40 - 5.18 |
| | (3.18) | (3.40) | (3.29) |
| First Digit of the | 1.34 - 3.91 | 1.06 - 3.91 | 1.58 - 4.09 |
| Color Grade | (2.62) | (2.48) | (2.84) |
| Second Digit of | 1 - 2.56 | 1 - 3.15 | 1 - 2.25 |
| the Color Grade | (1.46) | (1.70) | (1.37) |
| Staple | 31.87 - 36.59 | 31.31 - 35.83 | 30.86 - 35.56 |
| | (34.23) | 33.57 | (33.21) |
| Strength | 23.80 - 30.86 | 25.49 - 31.87 | 25.30 - 30.06 |
| | (27.33) | (28.68) | (27.70) |
| Micronaire | 2.71 - 4.83 | 3.08 - 4.83 | 3.25 - 5.10 |
| | (3.77) | (3.95) | (4.17) |
| Level 1 Bark | 0 - 85.75 | 0 - 80.57 | 0 - 49.67 |
| | (26.14) | (22.74) | (11.90) |
| Level 2 Bark | 0 - 3.12 | 0 - 8.95 | 0 - 0.37 |
| | (0.06) | (0.95) | (0) |
| Level 1 Other | 0 - 12.64 | 0-11.09 | 0-4.00 |
| | (0.87) | (0.86) | 0.30 |
| Level 2 Other | 0 - 5.36 | 0-7.71 | 0-0.47 |
| | (0.12) | (0.48) | (0) |

[a]Source: Texas-Oklahoma Producer Cotton Market Summary various years. [b]Mean values are in parenthesis, printed below the range.