**MODULE AVERAGING VERSUS INDIVIDUAL BALE CLASSIFICATION: SOME EVIDENCE FROM LOUISIANA**

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## Abstract

Module averaging of cotton lint quality measures has been increasing in recent years as the date for making the procedure mandatory nears. This paper examines the distribution of selected quality measures under both the traditional individual bale method of classing and the module averaging method. Strength and micronaire readings were analyzed for the two methods of measuring quality. Results indicated that micronaire readings were significantly different ten percent of the time while strength measures were different only two percent of the time. In terms of value, module averaging produced significantly lower discounts for micronaire.

## Introduction

Cotton classification has undergone tremendous change since quality standards were first applied to cotton in 1909. The U. S. Cotton Futures Act of 1914 set the official standards which were eventually implemented in the market place. These standards were then revised in the U.S. Cotton Standards Act of 1923. This act forced the use of these standards in cases where the cotton was sold interstate or internationally.

Introduction of High Volume Instruments (HVI) to measure cotton character-istics such as strength, length, and micronaire has dramatically changed the process of classifying cotton. One of the main concern has been with the consistency of the HVI readings. For example, the same bale sampled at different points in time might yield different readings. Some of the causes for this difference have been explained as operator error, humidity variation, or that the cotton is not necessarily consistent throughout a bale much less a module. All of these explanations and others are continuously researched.

Discount and premium schedules are used to calculate the value of each bale of cotton. This value is determined by giving discount or premium points for the various HVI readings. For example, a strength reading between 26.5 and 27.4 returns a premium of 25 points based on the 1994 CCC loan premium and discount strength schedule. While a reading between 22.5 and 23.4 returns a discount of 50 points. Each of the HVI readings utilizes its own schedule, and the combination of the discounts and premiums are applied to the base loan rate for the CCC loan program to determine the value of each individual bale of cotton. Table 1 shows the discount and premium values used in this analysis for the strength; while Table 2 shows values for the micronaire readings.

Module averaging was introduced to provide a more consistent estimate of strength values for the cotton. Each module receives a value based upon the average measures of the individual bales within the module. For example, if a module contains 15 bales of cotton and the average strength reading of the individual bales with in the module is 25.2, the module is assumed to have a strength reading of 25.2. This strength value is then applied to every individual bale within the module. By using this average, repeatability (a reading which stays with in two standard deviations of this mean) is assumed to increase. Even if repeatability is improved, two questions need to be addressed: 1) Is an average representative of the individual bales within the module, and 2) Does module averaging significantly effect the income producers receive?

## Problem Statement

The push for classifying cotton by averaging module or trailer measurements is based upon the assumption that these readings have an increased repeatability. Theoretically, when the cotton is retested, the measurement will fall with in two standard deviations of the mean. With this occurance, the new measurement is considered to be the same, "statistically". The problem which arises is that the discount or premium applied to the cotton may be very different within the two standard deviation range.

## Justification

The USDA is rapidly pushing for the classification of cotton using the module or trailer averaging method. Currently, more gins are gradually adapting this method of classing. This process must be analyzed to examine if a difference exists financially for the players involved in the transactions. Further, if a difference does exist, how does this difference effect the players involved.

## Objectives

The general objective of this research is to examine the differences between module averaging and individual bale measurements. Specifically, the focus will be upon:

1) Determine if a statistical difference exists between measurements utilizing the averaging method as opposed to the individual method,

2) Examine the financial differences between the module averaging method and the individual method of applying a discount or premium to cotton,

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3) Examine the economic impact of the two different measurements.

## Literature Review

This section briefly summarizes some of the research reports addressing questions surrounding module averaging. One of the areas of primary concern is repeatability. When cotton is retested for strength, variation is likely to occur. Meredith discusses some of the reasons why this variation occurs. Two of the primary causes in the variation are the cotton bale's strength is not uniform and/or fluctuations are due to the measuring instrument. Module averaging is offered to help combat these two dilemmas. Meredith shows that repeatability is more likely when module averaging is applied. He further discusses some limitations and advantages of module averaging. Some of the limitations include loss of individual bale information, large causes of poor repeatability are not addressed, and increased logistics for the ginner. Some of the advantages include possible increased repeatability, outlier retesting, and buyers perceive it as more efficient than individual bale classification.

Backe raises some issues from the spinners perspective. These concerns focus mainly upon the accuracy of the readings. Among them are concerns over the accuracy of the measurements due to seasonal employees, who perform most of the testing, may lack sufficient training; atmospheric conditions between laboratories may cause fluctuations in the readings; and particular concerns about the inaccuracies of the HVI instruments which measure strength. Additional apprehensions include fluctuations in the value of the cotton since it is not consistent from plant to plant and increased costs due to handling logistics.

Forrester and Boyd discuss USDA findings on module averaging for 1991 and 1992 respectively. Forrester states that repeatability of strength values increases from 55% to 71% when the average is used to represent a bale. While Boyd finds that repeatability increases from 72% to 80% when the module average is used for strength readings. Boyd also evaluates micronaire readings and finds that repeatability of the measurements increases from 72% to 78% when the module averaging approach is utilized. While repeatability seems to increase with the use of averaging, the question remains if the average is a representative reading for bales in the module. For example, within a module 5 bales can reveal readings of 23.0 and 5 could read 26.0 where the average is 24.5. Is an average of 24.5 a fair representation of this module?

## Methods

This study focuses upon two elements of the module averaging method of measuring cotton quality. Since, one of the function of module averaging is to improve the repeatability of strength observations, the first analysis focuses upon a comparison of strength readings for module averaged bales compared to strength readings of individual bales within the module. This analysis also incorporates micronaire readings. The question being addressed is whether the module average is a representative reading for the individual bales. To answer this question, the examination concentrates upon analyzing the distribution of the readings. In order to test the data, the samples need to be the same size. To do this a bale is chosen at random from each module and compared to the module average. A paired t-test examines the mean and the variance of the differences. Variation in the analysis may occur due to the randomness of the individual bales. To account for this, the test is conducted 100 times. The second analysis in this paper, compares the value of cotton priced using quality parameters from individual bales as compared to cotton priced with quality parameters determined by module averaging.

HVI data was provided by the USDA cotton classing office in Rayville LA. Data were for the 1993 and 1994 years and included both individual bale and module average readings for each bale in the sample. The observations were taken from six gins located throughout Louisiana to account for any geographical variation in quality. Since the data set contained standardized quality measures, the Ginnet for Windows software package was used to estimate values for the cotton. The data contained observations on micronaire, strength, length, UNI, trash, RD, and plus b. Ginnet calculates a total loan price for the cotton which is broken down into a base loan and a discount /premium value.The micronaire and strength values are individualized into a discount/premium chart. The base loan is calculated using the rest of the HVI data and is the same for the module averages and the individual bales. The variation lies in the discount/premium value between the module averages and the individual bales. This variation is analyzed using the paired t-test analysis.

The paired t-test is performed by analyzing the differences between the module average and individual bale values on a per bale basis for micronaire, strength, and the total discount or premium for the cotton. The mean and the variance of the differences are needed to calculate the t-statistic. The formula for this paired t-test is as follows:

$$t = d / \sqrt{(} s_d^2 / n)$$

where:

t is the paired t-statistic,
d is the mean of the sample differences, $d_i$,
$s_d^2$ is the estimated variance of the differences, and
n is the number of gins sampled.

To conduct this analysis, Ginnet calculates a base loan value of the cotton for the module averages and individual bales for each gin. Ginnet then calculates the discount or premium contributed to the micronaire and the strength readings as well as calculating the total discount or premium the cotton receives. These values are then transferred to Quattro Pro for Windows where the paired t-statistic values were calculated.

## Analysis

This study is divided into two forms of analysis. The first is a comparison of strength and micronaire readings for module averages and individual bales. The test attempts to determine if an average is a representative reading for individual bales within a module. The second is a comparison of the value generated using the module average compared to the individual bale method of measuring the cotton quality.

Table 3 provides the values used to calculate the t-test upon the strength and micronaire readings for the module and individual bales for one of the gins. Micronaire readings showed a significant difference 10% of the time; while the strength readings are significant 2% of the time. The range of t-values for the micronaire tests was from -0.77 to 3.45. This finding suggests that module average measurements tend to be higher. The range of t-values for the strength test was from -2.03 to 1.81. This finding shows that individual bale readings tend to be higher when a significant difference exists. Figure 1 graphically shows the relationship of strength readings between the module averages and individual bales as a whole. The distribution for each is fairly normal though a dip does exist with the module average distribution. Also, notice that the module average tends to centralize the readings.

Figure 2 suggests that the micronaire readings for the module averages are the same as those for the individual bales. However, this graph is a representation of all of the readings. It does not show the relationship of an average to the individual bales within the module. The paired t-test illustrates this relationship. The results of the t-test show that the module average is not a representation of the bales. In fact, the module average tends to overestimate the value of the bales within the module.

The previous finding suggests that micronaire readings between module averaging and individual bales are sufficiently different; they are statistically the same for the strength readings. When cotton is priced using discount/ premium schedules, the results can possibly be different. The second portion of this paper examines the value of the cotton when subjected to the USDA discount/premium schedule. Table 4 shows the results of the paired t-test of the cotton valued on a per bale basis.

The paired t-test for the total discount is -6.027 which is significant at the 95% level. This finding suggests that the discount for the cotton calculated using the module averaging method is significantly lower than the discount calculated utilizing the individual bale method. The discount attributed to the micronaire observations is also found to be significantly different between the measurement methods.

## Conclusions

The purpose of measuring cotton with the module averaging technique is to improve repeatability in the strength readings. This study concluded that measuring the strength characteristic with the module average is statistically the same as measuring the individual bales. Previous studies (Meredith, Boyd, and Forrester) have shown that repeatability is increased with module averaging. Repeatability of the micronaire readings may exist with module averaging as well, but this analysis found that individual bale readings were significantly lower which suggests that module averaging is not a sufficient method to measure these readings. Further, when the cotton was valued with each method, the discounts received for the module average cotton were significantly lower than the discounts received for the individual bales. This difference could be attributed to the micronaire readings.

## Acknowledgements

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## References

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Table 1. Strength discount and premium schedule.

| Strength Reading | Discount/ Premium |
|---|---|
| | Points |
| 18.5-19.4 | -270 |
| 19.5-20.4 | -235 |
| 20.5-21.4 | -140 |
| 21.5-22.4 | -100 |
| 22.5-23.4 | -50 |
| 23.5-25.4 | 0 |
| 25.5-26.4 | 5 |
| 26.5-27.4 | 25 |
| 27.5-28.4 | 40 |
| 28.5-29.4 | 60 |
| 29.5-30.4 | 85 |
| 30.5 & Above | 105 |

Table 2. Micronaire discount and premium schedule.

| Micronaire | Staple Length | |
|---|---|---|
| Range | 32 & Shorter | 32 & Longer |
| | Points | |
| 24 & Below | -1540 | -1540 |
| 25-26 | -1155 | -1215 |
| 27-29 | -750 | -900 |
| 30-32 | -300 | -450 |
| 33-34 | -145 | -220 |
| 35-36 | 0 | 0 |
| 37-42[A] | 5 | 10 |
| 43-49 | 0 | 0 |
| 50-52 | -330 | -260 |
| 53 & Above | -490 | -405 |

[A] Premium only applies to colors 11-41, leaf 1-6; color 51, leaf 1-5; colors 12-32, leaf 1-5; color 42, leaf 1-4; & color 52, leaf 1-3.

Table 3. Results of calculated t-tests for Micronaire and Strength Readings, Louisiana 1993-94.

| Item | Micronaire | Strength |
|---|---|---|
| Avg. Mean Difference | 0.0102 | -0.003 |
| Avg. Variance Difference | 0.164 | 0.9532 |
| Highest Pooled t-test | 3.4530 | 1.8125 |
| Lowest Pooled t-test | -0.7748 | -2.0251 |
| % Significant @ 95% level | 10 | 2 |

Table 4. Results of paired t-tests on the level of discount or premium for micronaire and strength, module average vs individual bale classification, Louisiana, 1993-94

| Discount/ Premium | Mean of Difference[a] | Variance of Difference | Paired T-test |
|---|---|---|---|
| | (Cents/ pound) | | |
| Micronaire | -0.298 | 0.025 | -4.660 |
| Strength | -0.021 | 0.017 | -0.651 |
| Total | -0.319 | 0.017 | -6.027 |

[a] Differences expressed in cents per pound of cotton lint for module average compared to individual bale. Negative numbers indicate module averaged discounts were lower than individually classed bales.

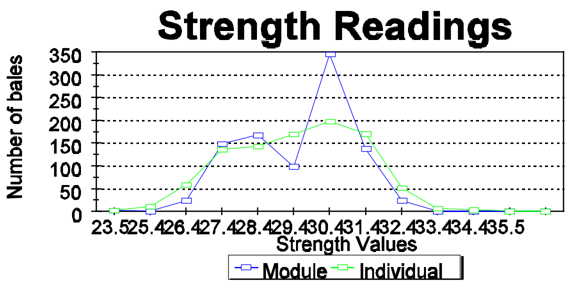


Figure 1. Strength readings for module averages and individual bales.

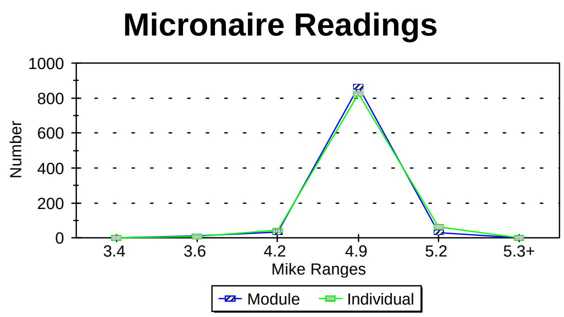


Figure 2. Micronaire readings from the cotton for module averaging and individual bales.