USDA REPORT ON MODULE AVERAGING - 1995

J. Jerome Boyd, Deputy Director
USDA, AMS, Cotton Division
Memphis, TN

Abstract

The USDA, AMS, Cotton Division has offered module/trailer averaging to the cotton industry since 1991. The program initially averaged High Volume Instrument (HVI) measurements for strength only, but, following positive industry response, was expanded to include additional HVI measurements in the following years. Participation in the module/trailer averaging program increased from 99 gins in 1991 to 252 gins in 1995.

For each crop year, reproducibility data indicate that the laboratory-to-laboratory reproducibility of fiber property measurements is improved by assigning the module or trailer average fiber property measurement to each bale in the module or trailer.

Introduction

The module/trailer averaging program was first implemented on a voluntary basis in 1991 in response to a recommendation made by the Secretary of Agriculture's Advisory Committee on Cotton Marketing. Because strength reproducibility was more variable than other fiber properties, this measurement was the first fiber property for which module/trailer averaging was offered. The success of the 1991 project resulted in increased industry participation and the expansion of module/trailer averaging to include length, length uniformity and micronaire in addition to strength in 1992. After being reviewed by the Secretary's Advisory Committee, the fiber property measurements available for module/trailer averaging in 1993 were expanded to include strength, length, length uniformity, micronaire, color (Rd), color (+b) and trash (percent area). In keeping with a majority of industry recommendations, the 1994 and 1995 module/trailer averaging programs were limited to strength, length, length uniformity and micronaire.

Module Averaging Monitoring Programs and Results

The USDA, AMS, Cotton Division has monitored the module/trailer averaging program since its inception in 1991. Monitoring procedures include the calculation of basic descriptive statistics, the determination of reproducibility percentages for each module averaged fiber property and the monitoring of outlier bales. In 1995, two additional monitoring programs were conducted: the complete testing of each bale in randomly selected modules, and a test project involving 11 merchant, manufacturer and industry cooperators across the US.

Basic Descriptive Statistics

Module/trailer averaging program participation figures were recorded each year the program was offered. These figures included the number of gins participating in the program, the total number of bales module/trailer averaged and the corresponding percentage of the total number of bales classified from 1991 through 1995. Module averaging classification data was further categorized by growth region.

A total of 252 gins participated in the 1995 program. These gins submitted samples representing 3.4 million bales which accounted for about 22 percent of the total number of bales classified by USDA as of December 20, 1995. These figures, as well as those for 1991 through 1994, are shown in table 1 and further categorized by growth region in table 2.

Basic descriptive statistics were calculated using a computer program developed by the USDA, AMS, Cotton Division. This program compiled weekly classification information by classing office for bales included in the module/trailer averaging program and computed statistics including ranges and standard deviations. Summary statistics for the Division as a whole were calculated by using individual office statistics and weighting them to prevent bias.

Summaries of these basic descriptive statistics for each fiber property from 1991 through 1995 are shown in tables 3 and 4. For 1995, the average number of bales per module was 12.82 and the average number of bales per trailer was 7.75. The average range of strength measurements was 3.43 grams per tex within modules and 2.96 grams per tex within trailers. The within module and within trailer standard deviations were 1.05 grams per tex and 1.03 grams per tex, respectively. The average range of 1995 length measurements was .054 inches within modules and .047 inches within trailers. The within module standard deviation was .016 inches and the within trailer standard deviation was .017 inches. The average range of length uniformity measurements was 2.69 percent within modules and 2.30 percent within trailers. Standard deviations were .86 percent within module and .84 percent within trailer. Micronaire measurements ranged on average from .35 units within modules to .33 units within trailers in 1995. Standard deviations were .11 units within modules and .12 units within trailers.

Fiber Property Reproducibility

Reproducibility percentages for each crop year were determined using two basic methods: single test and module average. The single test method compared a single test conducted in the classing office to a single test conducted in the Quality Control Section (QCS). The

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module average method compared the module average assigned to the bale by the classing office to a single test conducted on the bale in QCS. The reproducibility tolerances for 1991 through 1995 are shown in table 5.

Reproducibility results for 1995 were determined by comparing classing office and QCS results on 26,244 samples representing 19,408 modules and trailers containing 256,163 bales. Figures 1 through 4 illustrate the reproducibility results for strength, length, length uniformity and micronaire for 1992 through 1995. Additionally, figures 5 through 8 illustrate the 1995 reproducibility results by fiber property for each growth region.

Data for the 1995 crop showed that all fiber properties exhibited increases in reproducibility when the module average was used for comparison purposes. Strength rose from 69 percent to 80 percent, an increase of 16 percent. Length increased by the same 16 percent at 74 percent for the single test method and 86 percent for the module average method. Length uniformity reproducibility was 80 percent for the single test method and 90 percent for the module average method; a 12.5 percent increase. Micronaire increased 5 percent from 74 percent for the single test method to 78 percent for the module average method. These figures are shown in table 8.

Outlier Bales

Outlier bales were determined through the use of tolerances established based on classification data standard deviations for each fiber property. After all bales in a module or trailer were classified, each bale was compared to the module or trailer average. Any bale with fiber properties that exceeded the established tolerances shown in table 6 was excluded and retained its individual classification. Fiber properties for the remaining bales were then averaged and the average value for each fiber property was assigned to each bale in the module/trailer.

Outlier bales comprised only 2.24 percent of the 3.4 million bales module averaged in the 1995 module/trailer averaging program. Table 7 lists the number and percentage of outliers by fiber property. Collectively, these individual fiber property outlier percentages exceed the total percentage of outliers. This is because 5,152 bales were classified as outliers based on more than one fiber property as also shown in table 7.

Complete Module Testing Program

Complete testing of each bale in a module was conducted for selected modules in each classing office. Classing office computers randomly chose one module per day for this program. Once a module was selected, a sample from each bale in that module was sent to QCS. These samples were retested in QCS and the QCS single test on each bale was compared to the module average assigned to each bale by the respective classing offices. The reproducibility tolerances used for the above comparison are those shown for 1995 in table 5.

As of December 20, 1995, a total of 4,208 bales representing 407 modules/trailers had been retested in QCS as part of the complete module testing program. Figure 9 illustrates the increases in reproducibility achieved by using the module average assigned to the bale rather than the single test readings for micronaire, strength, length and length uniformity. Single test reproducibility was 76 percent for micronaire compared to a module average reproducibility of 79 percent. Strength was 67 percent reproducible when using the single test and 78 percent reproducible when using the module average. The single test reproducibility was 74 percent and the module average reproducibility was 85 percent for length. Length uniformity reproducibility increased from 79 percent for the single test method to 90 percent for the module average method. Table 8 contains percent increases in reproducibility for each fiber property; further illustrating the improvements in reproducibility achieved with the use of the module average.

Cooperator Module Testing Program

In 1995, a test project was conducted with 11 merchant, manufacturer and industry cooperators across the US. In keeping with the terms of cooperator participation, individual cooperators will not be identified by USDA. Each cooperator was sent approximately 500 samples of cotton that had been randomly selected as checklots in each classing office. These bales were from modules, had been retested in QCS, and were mixed to represent the percentage of bales from each growth region that were module averaged. Every week for 5 weeks, 100-bale lots were sent to each cooperator for testing. Each cooperator used its own high volume instrument or instruments when conducting the testing and followed its own procedures for sample conditioning, instrument calibration and sample testing. Fiber property measurements for each bale were returned to USDA for analysis. Two comparisons were made between the cooperators and USDA. The first was a comparison between the single test values assigned to the bales by both the cooperators and the classing offices. The second was a comparison between the single test values assigned to the bales by the cooperators and the module average assigned to those bales by the classing offices. Reproducibility tolerances used were the standard tolerances shown in table 5.

A total of 5,277 bales was tested by the group of cooperators, or roughly 480 bales per cooperator. Figure 10 shows the overall increases in reproducibility seen for mike, strength, length and length uniformity when using the module averages rather than the single test readings assigned to the bales. Micronaire reproducibility results were 72 percent for the single test and 77 percent for the module average. Strength percentages were low although the expected increase in reproducibility, 48 percent to 54

percent, was seen when the module average was used. Length reproducibility was 64 percent for the single test method and 71 percent for the module average method. Uniformity also showed an increase with the use of the module average; 71 percent for the single test and 79 percent for the module average.

Figures 11 through 14 illustrate the improvements in reproducibility for each fiber property for each cooperator seen as a result of module averaging. Table 8 contains the percent increases in reproducibility achieved for each fiber property for all cooperators combined. Figures 11 through 14 also illustrate the wide range of single test and module average reproducibility percentages between the cooperators observed for mike, strength, length and length uniformity. For micronaire the percentages ranged from 64 to 78 for the single test and from 66 to 87 for the module average. Strength exhibited much lower percentages for both the single test and the module average; from 37 to 65 percent and from 40 to 75 percent, respectively. Length reproducibility ranged from a low of 52 percent to a high of 75 percent for the single test and from a low of 58 percent to a high of 82 percent for the module average. Length uniformity percentages ranged from 64 to 83 for the single test and from 69 to 92 for the module average.

Conclusion

The USDA, AMS, Cotton Division has conducted module averaging monitoring programs since module averaging was first offered to the cotton industry in 1991. For each year of the module averaging program, improvements in laboratory-to-laboratory reproducibility have been achieved by assigning to the individual bales in a module or trailer, the average test result for all bales in that module or trailer. For crop year 1995, the traditional USDA quality control checklot program produced increases in reproducibility, with the use of the module average, of 16 percent for both strength and length, 12.5 percent for uniformity and 5 percent for micronaire.

In 1995, USDA expanded its monitoring programs by conducting a complete module testing program as well as a cooperator module testing program. The complete module testing program illustrated three key concepts. First, the percent increases in reproducibility for each fiber property achieved with the use of the module average are very similar in magnitude to the percent increases observed for the same fiber properties in USDA's standard quality control module averaging checklot program at 16 percent for strength, 15 percent for length, 14 percent for length uniformity and 5 percent for micronaire. Secondly, fiber property reproducibility percentages themselves are virtually the same in this program as those in USDA's standard quality control module averaging checklot program. This shows conclusively that a module averaging program that relies on random retesting of module averaged bales is fully as reliable as a module averaging program in which 100 percent of the samples are retested.

The cooperator module testing program presented further evidence of the usability of the module average for industry purposes. The results of this program showed the expected increase in overall cooperator reproducibility for each fiber property when the module average rather than the individual bale readings was used. Strength exhibited a 12.5 percent increase, length an 11 percent increase, an 11 percent for length uniformity and a 7 percent for micronaire.

Regardless of which USDA monitoring program is considered, the one prevailing trend for all programs from 1991 through 1995 is the increase in laboratory-to-laboratory reproducibility of high volume instrument fiber property measurements achieved with the use of the module average.

Table 1. Program Participation and Volume Averaged.

Crop Year	Number of Gins	Number of Bales Module or Trailer Averaged	Percentage of Crop
1991	99	1.3 million	8
1992	212	2.3 million	15
1993	242	3.1 million	20
1994	304	4.4 million	24
1995	252	3.4 million	22

Table 2. Program Participation by Growth Region.

Growth Region	1991 Crop Year	1992 Crop Year	1993 Crop Year	1994 Crop Year	1995 Crop Year*
South East	56,446 bales	118,623 bales	236,994 bales	422,058 bales	234,182 bales
Mid-South	426,648 bales	741,505 bales	827,705 bales	1,539,675 bales	1,340,975 bales
South West	139,384 bales	245,072 bales	508,228 bales	680,500 bales	552,599 bales
Far West	637,575 bales	1,189,240 bales	1,538,192 bales	1,800,416 bales	1,280,236 bales
TOTAL	1,260,053 bales	2,294,440 bales	3,111,119 bales	4,442,649 bales	3,407,992 bales

*Through December 20, 1995.

Table 3. Descriptive Statistics for Modules from 1991 through 1995.

				AVERAGE RANGE				
Crop Year	Avg. # per Module	Strength g/p tex	Length inches	Unif. percent	Mike units	Color Rd units	Color +b units	Trash percent area
1991	12.40	3.71	--	--	--	--	--	--
1992	12.85	3.36	.057	2.74	.34	--	--	--
1993	12.69	3.33	.056	2.79	.35	2.57	.78	.30
1994	12.76	3.35	.055	2.75	.35	--	--	--
1995	12.82	3.43	.054	2.69	.35	--	--	--
				STANDARD DEVIATION				
Crop Year	Avg. # per Module	Strength g/p tex	Length inches	Unif. percent	Mike units	Color Rd units	Color +b units	Trash percent area
1991	12.40	1.17	--	--	--	--	--	--
1992	12.85	1.03	.017	.87	.10	--	--	--
1993	12.69	1.02	.017	.89	.11	.86	.25	.10
1994	12.76	1.03	.017	.88	.11	--	--	--
1995	12.82	1.05	.016	.86	.11	--	--	--

Table 4. Descriptive Statistics for Trailers from 1991 through 1995.

				AVERAGE RANGE				
Crop Year	Avg. # per Trailer	Strength g/p tex	Length inches	Unif. percent	Mike units	Color Rd units	Color +b units	Trash percent area
1991	7.50	3.03	--	--	--	--	--	--
1992	7.99	2.87	.051	2.42	.30	--	--	--
1993	7.66	2.82	.051	2.41	.32	2.41	.66	.30
1994	7.77	3.00	.048	2.42	.33	--	--	--
1995	7.75	2.96	.047	2.30	.33	--	--	--
				STANDARD DEVIATION				
Crop Year	Avg. # per Trailer	Strength g/p tex	Length inches	Unif. percent	Mike units	Color Rd units	Color +b units	Trash percent area
1991	7.50	1.19	--	--	--	--	--	--
1992	7.99	1.02	.018	.89	.11	--	--	--
1993	7.66	1.00	.018	.89	.12	.93	.25	.12
1994	7.77	1.05	.017	.88	.12	--	--	--
1995	7.75	1.03	.017	.84	.12	--	--	--

Table 5. Reproducibility Tolerances for 1991 through 1995.

Crop Year	Strength gram/tex	Length inches	Length Uniformity percent	Mike units	Color (Rd)	Color (+b)	Trash percent area*
1991	± 1.5	--	--	--	--	--	--
1992	± 1.5	± 0.02	± 1.0	± 0.10	--	--	--
1993	± 1.5	± 0.02	± 1.0	± 0.10	± 1.0	± 0.5	± 0.1/0.2
1994	± 1.5	± 0.02	± 1.0	± 0.10	--	--	--
1995	+ 1.5	+ 0.02	+ 1.0	+ 0.10	--	--	--

*± 0.1 for percent area of .5 and below and ± 0.2 for percent area above .5.

Table 6. Outlier Tolerances for 1991 through 1995.

Crop Year	Strength gram/tex	Length inches	Length Uniformity percent	Mike units	Color (Rd)	Color (+b)	Trash percent area
1991	± 3.9	--	--	--	--	--	--
1992	± 3.9	± 0.06	± 3.0	± 0.30	--	--	--
1993	± 3.9	± 0.06	± 3.0	± 0.40	± 3.9	± 1.0	± 0.5
1994	± 3.3	± 0.06	± 3.0	± 0.40	--	--	--
1995	+ 3.3	+ 0.06	+ 3.0	+ 0.40	--	--	--

Table 7. 1995 Outliers by Fiber Property.

Strength		Length		Length Uniformity		Micronaire	
30,008 bales	0.88%	8,183 bales	0.24%	2,213 bales	0.06%	41,024 bales	1.20%

81,428 bales . . . . Total Number of Outliers for all Fiber Properties Combined

76,276 bales . . . . Total Number of Outliers

5,152 bales . . . . Total Number of Outlier Bales Due to More Than One Fiber Property

Table 8. Percent Increases in Reproducibility Achieved With Module Averaging.

	USDA Checklot Program	Complete Module Testing Program	Cooperator Module Testing Program
Strength	15.9 percent	16.4 percent	12.5 percent
Length	16.2 percent	14.9 percent	10.9 percent
Uniformity	12.5 percent	13.9 percent	11.3 percent
Micronaire	5.4 percent	3.9 percent	6.9 percent

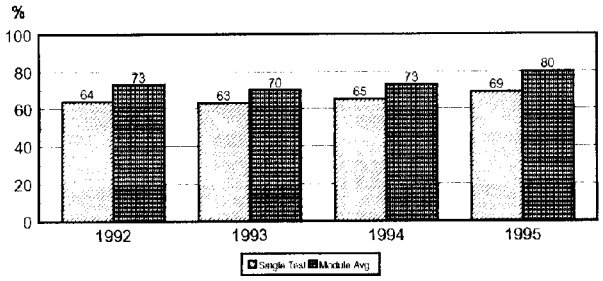

Figure 1. Strength reproducibility for 1992-1995 (+/- 1.5 grams per tex)

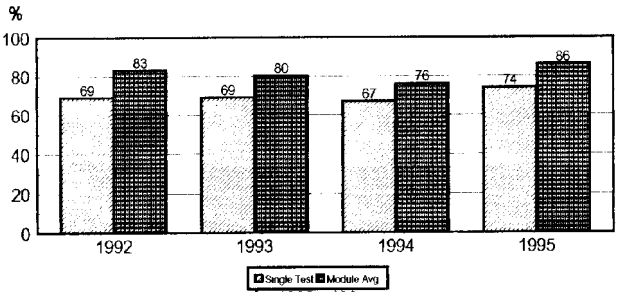

Figure 2. Length Reproducibility for 1992-1995. (+/- .02 inches)

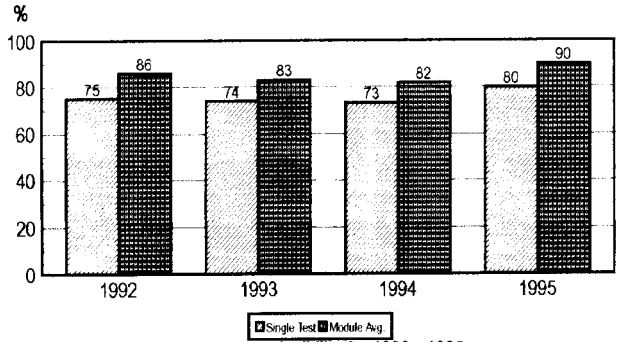

Figure 3. Length Uniformity Reproducibility for 1992-1995. (+/- 1.0 percent

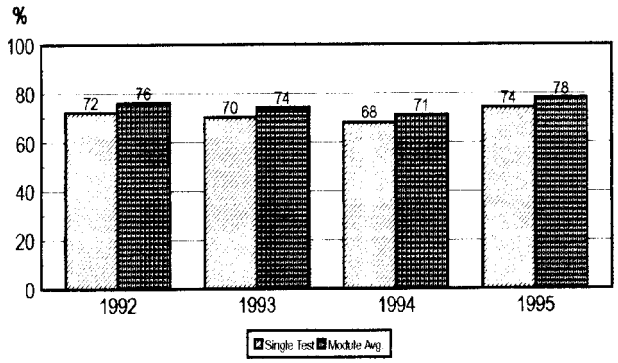

Figure 4. Micronaire Reproducibility for 1992-1995. (+/- 1.0 percent)

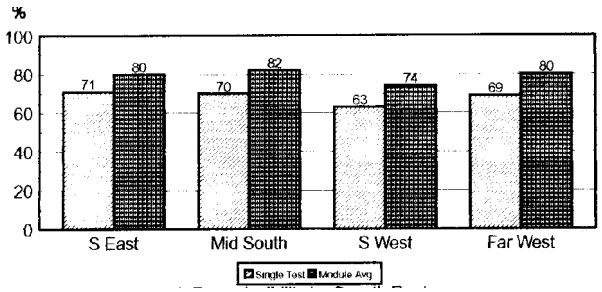

Figure 5. 1995 Strength Reproducibility by Growth Region.
(+/- 1.5 grams per tex)

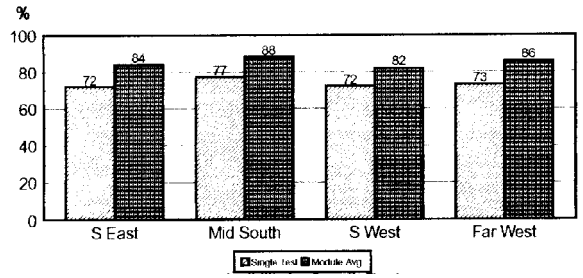

Figure 6. 1995 Lenght Reproducibility by Growth Region.
(+/- .02 inches)

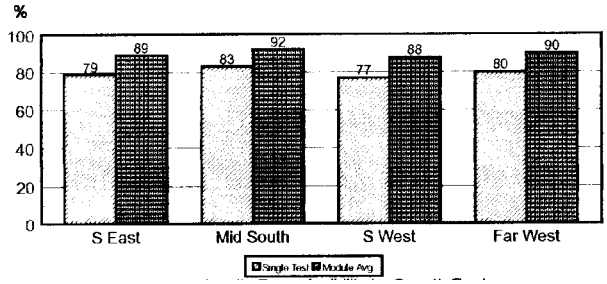

Figure 7. 1995 Length Uniformity Reproducibility by Growth Region.
(+/- .10 inches)

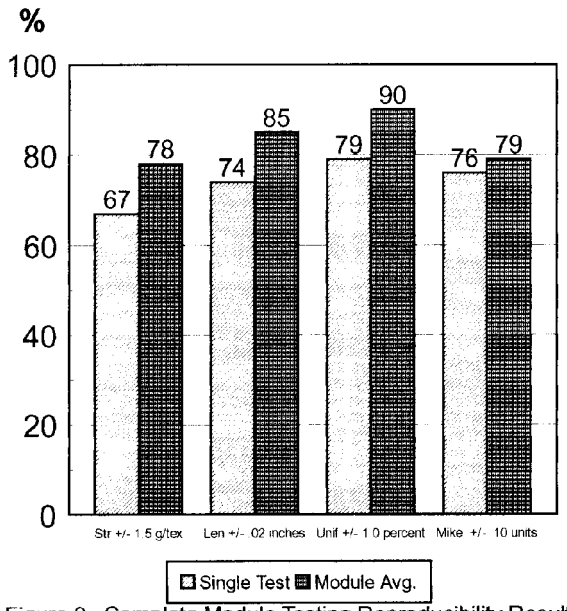

Figure 9. Complete Module Testing Reproducibility Results.

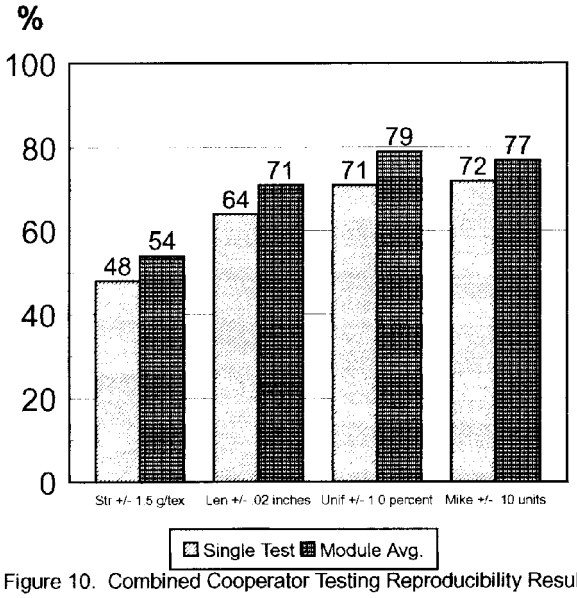

Figure 10. Combined Cooperator Testing Reproducibility Results.

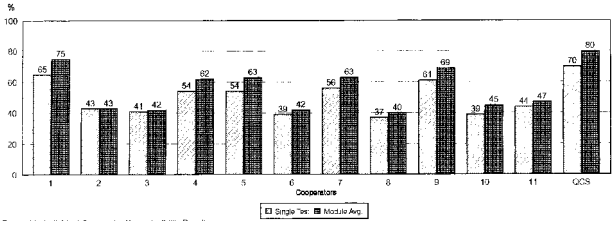

Figure 11. Individual Cooperator Reproducibility Results
Strength (+/- 1.5 grams per tex)
Participants vs Classing Offices

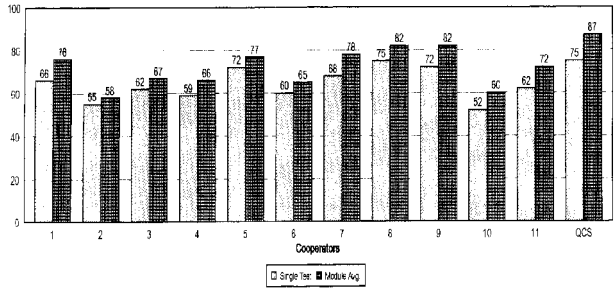

Figure 12. Individual Cooperator Reproducibility Results
Length (+/- .02 inches)
Participants vs Classing Offices

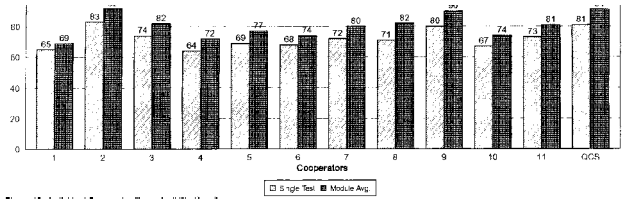

Figure 13. Individual Cooperator Reproducibility Results
Uniformity (+/- 1.0 percent)
Participants vs Classing Offices

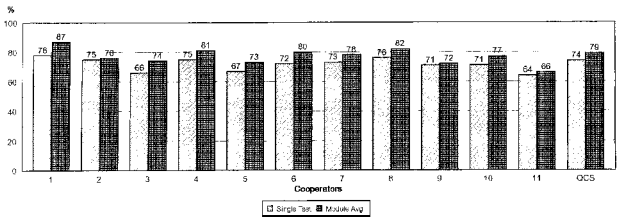

Figure 14. Individual Cooperator Reproducibility Results.
Micronaire (+/- .10 units)
Participants vs Classing Offices