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MODULE AVERAGING - A NEW PERSPECTIVE

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Abstract

The USDA, AMS, Cotton Program has offered module/trailer (module) averaging on a voluntary basis since 1991. When analyzing the historical results of module averaging for gins across the country, the Cotton Program has concluded that the reproducibility of quality measurements is significantly higher for bales assigned the module average compared to that of the bales assigned the individual readings. This increase in reproducibility denotes less variability in the fiber measurements and a more stable data product. This is advantageous to all segments that utilize the Cotton Program's classification data. In addition, analysis of all gins that participated in module averaging during 2002, representing 3,121,351 bales, has shown that it was more advantageous, on average, for gins to utilize module averaging when comparing the monetary value of individual bales to that of module averaged bales when using the government loan program as the basis for the monetary analysis. In 2002, the Cotton Program implemented a new policy of assigning all outlier bales within a module, with the exception of the first and last bales, the module average without requiring a review classification. This was done because historical data and studies have proven that outliers, when retested, virtually always approach the module average within acceptable testing parameters. The first and last bales were excluded because they occasionally prove to be true outliers resulting from the overlapping of modules or trailers having varying fiber properties. The Cotton Program is encouraging all gins not currently participating in the module-averaging program to try the program to investigate these potential advantages.

Introduction

Module averaging is a voluntary program offered by the USDA, AMS, Cotton Program at no additional charge to its customers. Through the program, all individual High Volume Instrument (HVI) measurements for fiber length, strength, length uniformity, and micronaire are taken for a participating module or trailer and averaged. The average for each of these factors is then assigned to all of the bales within that module or trailer with the exception of first or last bales in the module that qualify as outliers.

The module-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. Due to strength reproducibility being more variable than other fiber properties, this measurement was the first property for which module/trailer averaging was offered. The success of the 1991 project resulted in increased industry participation and the expansion of module averaging to include length, length uniformity, and micronaire in addition to strength in 1992. The program was expanded in 1993 to include color (Rd), color (+b), and trash (percent area) but as a result of industry recommendations, the program was limited to strength, length, length uniformity, and micronaire from 1994 to the present.

Participation in Module Averaging

Participation in the module-averaging program has been consistent over the years with an average of 203 gins representing approximately 3.1 million bales or 19 percent of the overall crop (Table 1.) The gin participation peaked in 1994 with 304 gins and has remained very consistent over the last 5 years at approximately 180 participating gins.

The Cotton Program handles and classifies module-averaged bale samples exactly the same as traditional samples. They are received, prepared, HVI-tested, and classified the same as all of the approximately 17.5 million samples received in the Program's 12 classing offices each year. The testing parameters are the same and the manner in which randomly selected samples (checklot samples) are pulled and submitted to the Program's Quality Assurance Branch in Memphis for retesting is also the same. The process of averaging the fiber measurement data is performed by the Program's database computer system after all of the bales are classified.

Many gins and producers have been apprehensive to try module averaging due to uncertainty or lack of understanding. It has been perceived that module averaging can actually be detrimental by reducing premiums or adding discounts to bales when assigning the module average. Although that may be the case in coincidental instances, it is not typical. Rather, history has shown that the tendency is for value to increase slightly for module averaged bales when looking at the entire amount of cotton submitted from a gin. In addition, the reproducibility for each quality factor becomes much higher and more stable.

Concept of Module Averaging

The concept of module averaging is that for a given module or trailer, the averages for the measurements of length, strength, length uniformity, and micronaire is a more representative measurement than the individual measurements. In the early 1990's the problem with high variability in the strength measurement prompted the Secretary of Agriculture's Advisory Committee on Cotton Marketing to initiate a plan to address the problem. The USDA, AMS, Cotton Program (then "Division") performed several extensive studies to investigate the validity of using an average for the bales within a module as a possible solution to the variability problem. Studies were also performed to investigate the degree of blending that cotton goes through as it is picked, deposited into a module or trailer, removed from the module or trailer at the gin, and subsequently ginned and baled. It was concluded that cotton within a module or trailer undergoes significant blending throughout these processes. Therefore, it stood to reason that a bale from within a given module or trailer would be statistically representative of that module or trailer. Subsequent studies were performed to test this theory. These studies involved extensive testing of all bales from within given modules and trailers to determine if the variability for a module or trailer was greater than that of an individual bale within the module. The studies showed that the variability was no greater for the module than for the bales within the module. Further, the studies concluded that any one bale from a module would be statically representative of that module and that when retested several times, the bales' values would always approach the average of the module's values.

A follow-up study was performed using "cooperators" from various cotton industry segments, research agencies, and educational institutions in which cotton was sent to be HVI-tested using both the module averaging criteria and the individual bale testing criteria. The results of the cooperators' study showed that even with different instruments, testing environments, operators, etc, the module-averaging concept was verified and proved to be more repeatable than traditional single-bale tests.

Reproducibility of Single Bale vs. Module Bale Testing

Since 1991, the reproducibility of the quality factors within module-averaged bales has been recorded and analyzed. Reproducibility percentages are calculated each year using two methods: classing office single test and classing office module average. The single test method compares a single test conducted in the classing office to a double-run test performed in the Quality Assurance Branch in Memphis. The double-run test in Quality Assurance consists of the same sample being HVI-tested on two different instruments and the results averaged.

The module average method compares the module average value assigned to each bale by the classing office to the double-run test conducted in the Quality Assurance Branch. The reproducibility tolerances are shown in Table 2. In every case since 1991, the reproducibility for module averaging each of the four quality factors has been significantly higher than that of the individual single tests for the bales (Figures 1-4). Higher reproducibility equates to less variability between classing offices and thus, a much more stable and reliable measurement for all data users. Since 1992, the average reproducibility for fiber length between the classing laboratories using module averaging has been 89% versus 78% for individual testing. Since 1992, strength reproducibility for module averaging has been 81% compared to 69% for individual testing. For length uniformity, the comparison since 1992 has been 94% for module averaging versus 84% for individual testing. Likewise, the comparison for micronaire since 1992 has been 89% for module averaging versus 78% for individual testing (Figure 5).

In looking at the same statistics for the last five years, the results are even more impressive. Since 1998, the reproducibility for length improved from 79% to 91%; strength improved from 75% to 89%; length uniformity improved from 85% to 95%; and micronaire improved from 80% to 86% (Figure 6).

Outliers

Outlier bales are defined as any bale in a module or trailer average that falls outside of acceptable tolerances for testing as determined by statistical methods. These acceptable tolerances are shown in Table 3. After all bales within a module or trailer are tested, each bale's individual measurements are compared to the average. If the difference exceeds the allowable tolerance for a particular quality factor, the bale is removed from the average calculation and the fiber properties for the remaining bales are re-averaged and that value is assigned to all of the bales within the module or trailer.

Outlier bales represent only a very small percentage of the total amount of bales module averaged each year (Table 4). These outliers have been thoroughly analyzed over the years to determine their primary cause. When re-testing outlier bales, it has been found in virtually every instance that the retest value always approaches the module average within the acceptable tolerances. This indicates that the measurement that created the outlier was somehow flawed or more variable than the others. For this reason, the Cotton Program implemented a new policy in 2002 whereby all outliers, with the exception of first and last bales in a module or trailer, were assigned the module average without requiring a review classification, as was the case in the past. Historically, when an outlier surfaced, its individual fiber properties would be assigned to it. If a sample were resubmitted to the Cotton Program as a review bale (a sample to be re-classified to verify the original class), the sample would be classified at no cost to the customer. Based on the historical trend that in virtually every case, the outlier would re-test within the tolerances of the module average values, it was concluded that the outliers should be assigned the values automatically rather than burden the customers with the task of sending in a re-cut sample for review class.

However, the first and last bales of the module were excluded from this policy to prevent the chances of cotton carrying over from one module or trailer to the next potentially affecting the overall average if the fiber properties between the two are significantly different. In these cases, the outlier would retain its original single-bale classification properties and not receive the module/trailer average. As before, if these samples are re-submitted for review classification, the Cotton Program will provide this service at no charge to the customer.

Value of Module Averaging

The Cotton Program has been faced over the years with justifying the benefits and value of module averaging. One of the reasons that we feel the participation is not higher in the program is the lack of understanding of the benefits of the program to the industry. The primary value of module averaging is in the area of improved fiber testing accuracy. It has been proven since its inception in 1991 that the laboratory-to-laboratory reproducibility is much higher with module averaging than with traditional single-bale testing. This correlates into much more dependable and reliable data for all users of the classing data. The inherent value is in the peace of mind and confidence that the values given with the module averaged bales will always circulate around the mean of that module if retested again and again. It is better for the producer of the cotton, the agents and handlers of the cotton, and ultimately the mill or manufacturer that utilizes the fiber to know with the highest certainty available that the values given for the four quality factors are stable and reliable. Module averaging provides that certainty that the average of the four factors is a better representation of the whole module than the individual bales within it.

The other potential value with module averaging is a financial one. Over the past few years, the Cotton Program has performed analyses using the government loan schedule as the basis for calculating if gins using module averaging faired better financially for their module-averaged bales versus if the bales had been submitted to the loan based on their individual fiber properties. For example, in 2002, a total of 180 gins were identified across the Cotton Belt that utilized the module-averaging program. These gins varied in size and the number of bales submitted to the Cotton Program for classification. A total of 3,121,351 bales were identified from the gins and submitted into a computer program that calculated loan prices for the bales. The average improvement for all of the bales against the loan schedule was $0.42 per bale. Some gins varied in cost benefit over others but virtually all of the gins received financial benefit to some degree using module averaging. It should be noted that this was the result found for 2002 and the benefits realized with subsequent years could vary up or down depending upon many variables affiliated with the status of the cotton market and the cotton spot market quotations.

Conclusions

Since its inception in 1991, the module/trailer averaging program has been a successful method of reducing variability in the measurements of cotton fiber length, strength, length uniformity, and micronaire. The reproducibility between classing laboratories calculated since 1991 has shown that, without exception, the accuracy is higher for all four of the quality factors each and every year over the traditional single-bale method of testing. The Cotton Program has always taken a proactive approach in implementing any method that could provide a more reliable data product to its customers. For that reason, it has continually strived to further implement the module average program nationwide. The lack of increase in participation appears to be related to a lack of understanding or confidence in the program. Therefore, the Cotton Program is re-committed to better educating its customers and the cotton industry in the benefits of utilizing module averaging. In conclusion, the Cotton Program plans to conduct numerous meetings and presentations in the coming months in an effort to provide the most informative and valuable information to the cotton industry in hopes of increasing participation in the module average program in the future.

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Table 1. Participation in Module/Trailer Average Program.

Crop Year	**Number of Gins**	**Number of Module/Trailer Averaged Bales**	**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	251	3.7 million	22%
1996	229	3.8 million	21%
1997	198	3.6 million	20%
1998	173	2.4 million	18%
1999	174	3.0 million	19%
2000	188	3.4 million	21%
2001	186	3.7 million	19%
2002	180	3.0 million	18%
Average	203	3.1 million	19%

Table 2. HVI Reproducibility Tolerances.

HVI Reproducibility Tolerances

Length (inches)	Strength (gms/tex)	Length Uniformity (percent)	Micronaire (units)
± 0.02	± 1.5	± 1.0	± 0.1

Table 3. Outlier Tolerances.

Outlier Tolerances

Length (inches)	Strength (gms/tex)	Length Uniformity (percent)	Micronaire (units)
± 0.06	± 3.3	± 3.0	± 0.40

Table 4. Outlier Statistics.

Outlier Statistics

Crop Year	Total Bales	Length		Strength		Length Uniformity		Micronaire	
	Module Averaged	Bales	% of Total MA	Bales	% of Total MA	Bales	% of Total MA	Bales	% of Total MA
1994	4,086,938	6,852	0.17%	22,524	0.55%	1,987	0.05%	43,549	1.07%
1995	3,761,923	8,183	0.24%	30,008	0.88%	2,213	0.06%	41,024	1.20%
1996	3,824,237	8,282	0.22%	34,253	0.90%	1,628	0.04%	49,892	1.30%
1997	3,635,025	12,346	0.34%	29,898	0.82%	2,140	0.06%	49,351	1.36%
1998	2,443,411	8,267	0.34%	25,588	1.05%	920	0.04%	32,184	1.32%
1999	3,061,970	16,524	0.54%	43,439	1.42%	1,490	0.05%	44,996	1.47%
2000	3,430,372	9,434	0.28%	35,117	1.02%	1,664	0.05%	29,461	0.86%
2001	3,749,910	11,775	0.31%	37,696	1.01%	1,032	0.03%	37,906	1.01%
2002	3,211,928	2,765	0.09%	5,102	0.16%	98	0.00%	9,309	0.29%

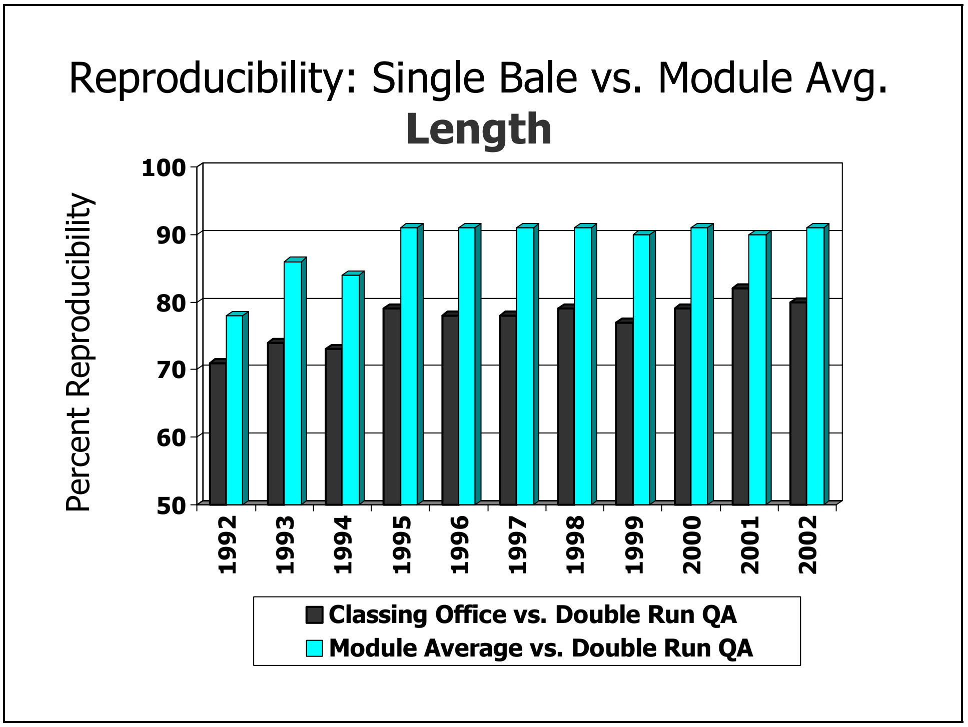

Figure 1. Reproducibility of Length 1992-2002.

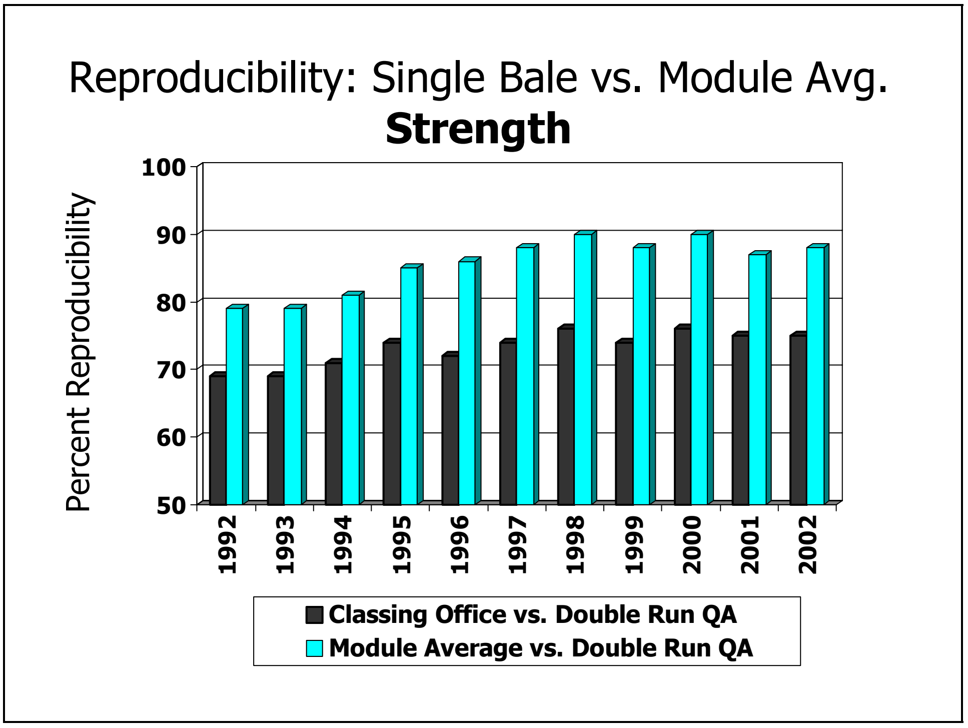

Figure 2. Reproducibility of Strength 1992-2002.

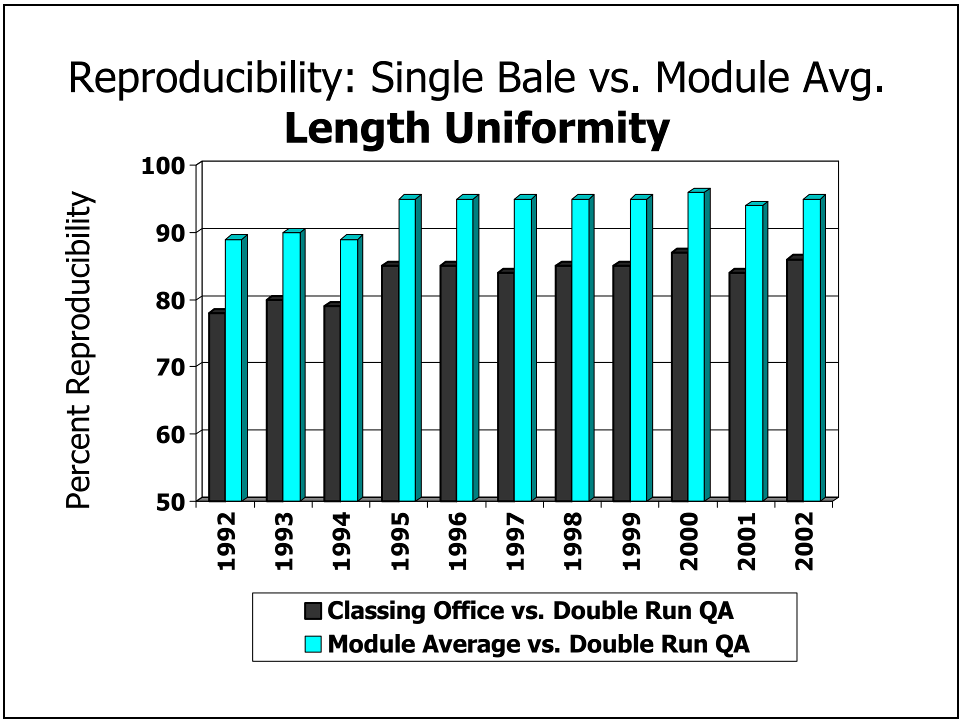

Figure 3. Reproducibility of Length Uniformity 1992-2002.

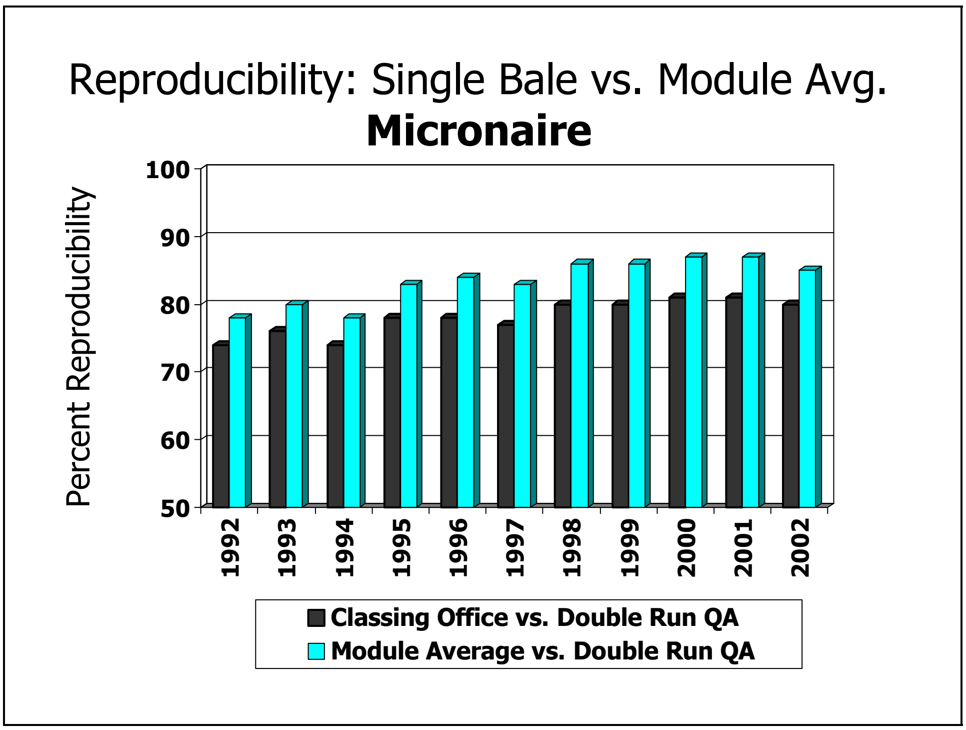

Figure 4. Reproducibility of Micronaire 1992-2002.

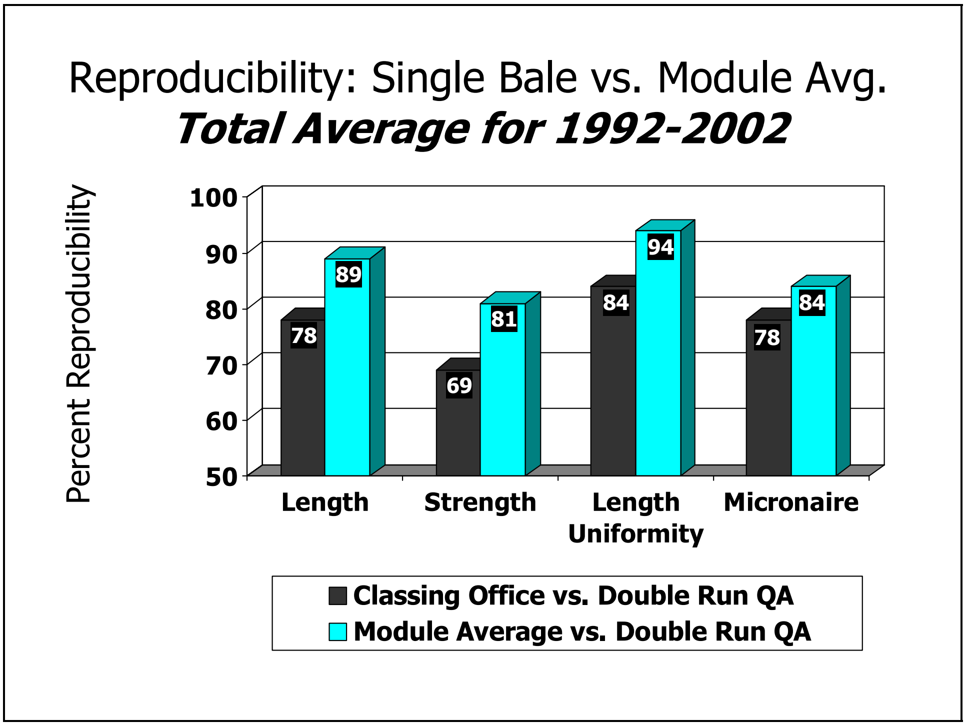

Figure 5. Total Average Reproducibility of Four Factors 1992-2002.

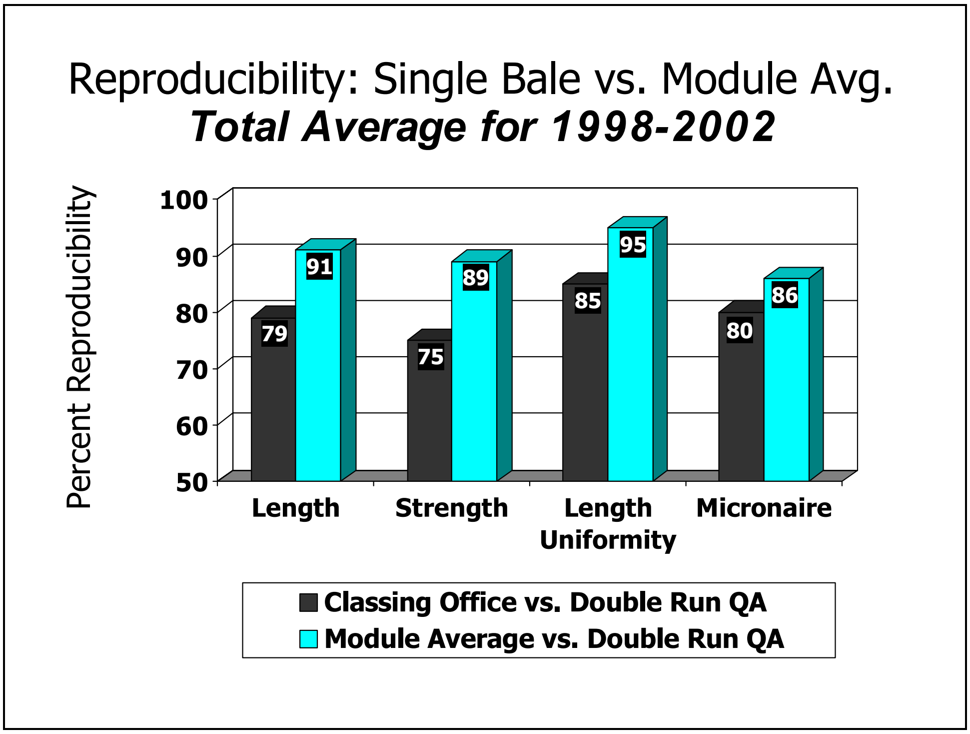

Figure 6. Total Average Reproducibility of Four Factors 1998-2002.