HIGH VOLUME TESTING RESULT VARIATION – RESULTS FROM THE CSITC ROUND TRIALS

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Abstract

The ICAC Task Force on Commercial Standardization of Instrument Testing of Cotton (CSITC) was created to achieve reliable instrument test results for the global cotton trade, including micronaire, strength, length, uniformity and color. Two main results from the Round Trials are a) the inter-laboratory and within laboratory result variation and its influences and b) a dependable evaluation of the capability of cotton testing facilities to produce reliable test results, given in an aggregated rating number. Besides, the test results of each laboratory are used to give a detailed analysis to the laboratories regarding accuracy and precision, so that laboratories will be able to improve their performance. The results of the CSITC Round Trials for the 3 years since its start in 2007 and the conclusions are given in the text.

Introduction

The demands for objective and reliable cotton fiber test results are increasing rapidly, and major cotton importing countries are integrating instrument based data in trade. Cotton with insufficient verification of its quality will result in price discounts for the producers or exclusion from the market. Developed cotton growing countries, like the USA, have already built up their national cotton quality assessment systems, and instrumental classification has resulted in a competitive advantage for the USA in global marketing. It is obvious that the establishment of an adequate instrumental cotton testing system based on High Volume Instruments for the cotton producing countries in Africa and elsewhere would facilitate their access to the global cotton market. But, up to now, there is no adequate international verification over the world of test laboratories and of their results. The availability of high volume cotton testing instruments solely is not enough to produce reliable test values – examples from all over the world show that without certified testing procedures the results will be disregarded and therefore are worthless. The results have to be reliable and at an internationally agreed level.

For the purpose of achieving reliable instrumental test results for the global cotton trade, the ICAC Task Force on Commercial Standardization of Instrument Testing of Cotton (CSITC) brought together international representatives of spinning mills, traders, cotton producers and research. This group has made several recommendations to build a worldwide system for classifying cotton productions and encourages the use of "Standardized Instrument Testing for Cotton" as it can provide reliable results that can be used in trade.

One of the most important missions of the CSITC Task Force is to check the reliability of cotton testing laboratories and the test results provided by the laboratories. Since 2007, specific CSITC Round Trials allow the laboratories to demonstrate their capability to meet recommended standards, although certification cannot guarantee the accuracy of individual results. Additionally, CSITC Round Trials help them to achieve more accurate results.

Testing for CSITC purposes is fixed on the following prerequisites:

- Fixed calibration with Universal Standard Material (HVICCS etc.)
- A limited number of suitable parameters with sufficiently low result variation. At present this is
  - Micronaire
  - Strength
  - Length: UHML
  - Uniformity Index
  - Color Rd
  - Color +b
- Suitable instrument types
  - Instruments have to conform to Universal Standard Material results and calibration
  - Instruments have to show no systematic deviations
  - Instruments have to show no extended result variability

There was a consensus in the CSITC Task Force that current technology for measuring other parameters such as trash, short fibers, neps, fineness/maturity or stickiness are either not fast enough or not sufficiently reproducible to include them in an international system at this time. It was recognized that these measurements should be added to the international instrument testing system as soon as an acceptable, reliable measurement system can be authenticated.

CSITC Round Trial Basics

The defined aims of the CSITC Round Trial system are:

A. Evaluation of the test methods / test result variation
- inter-laboratory variation
- within-laboratory variation
- possible additions as the variations between instrument types etc.

B. Evaluation / rating of the participating laboratories, based on the accuracy of the results

C. Detailed analysis of laboratory results to achieve more accurate results, based on accuracy and precision

For this purpose, a specific CSITC Round Trial system has been created and started in 2007. The Round Trial system was developed in co-operation between the Bremen Fiber Institute (FIBRE) and the USDA-AMS. It is headed by the International Cotton Advisory Committee (ICAC), and it is conducted regularly in co-operation between the USDA-AMS and the Bremen Fiber Institute (FIBRE).

The CSITC Round Trial system cannot replace the existing round trials, but adds significantly. A comparison of the existing round trials is given in table 1. The major advantages of each round trial system are underlined.

Table 1. Comparison of international round trial systems on cotton

Attribute	**USDA HVI Checktest**	**Bremen Cotton Round Test**	**CSITC Global Round Trial**
Number of participants	50 to 80 HV instr.	150 HV instr.	70-95 HV instr.
Kinds of instruments	Restricted to High Volume	**Every kind**	Restricted to High Volume
Cottons: Origin and type	USA; Upland	World; broad range of prop.	4 US Upland; 1 international
Costs	Yearly fee	**Free of charge**	Yearly fee: 2010: 600 USD
Frequency	**12 times/year each 2 samples**	4 times/year each 1 sample	**4 times/year each 5 samples**
Number of tests per sample	Asked for 12 tests per sample	Proposed: 6 tests per sample	**30 tests per sample**
Aim	Information for the laboratory	Information for the laboratory	**Official laboratory evaluation and detailed analysis for the laboratory**
Evaluation of	Laboratory average	Laboratory average	**Laboratory average and all single data**
Evaluation of	Accuracy only	Accuracy only	**Accuracy and precision**

In 2009, 75 testing facilities registered for the CSITC Round Trials and participated in at least one of them, 18 of these in Asia, 17 in North America, 16 in South America, 11 in Europe, 9 in Africa and 4 in Australia. The most important countries were USA (17 labs), Brazil (14 labs) and India (9 labs). The development of participation is given in figure 1, showing an increase in participating laboratories from approx. 50 to more than 60 per round trial, and an increase of instruments from approx. 70 to 90 per round trial. The most important change for 2010 will be the addition of all SIFAT labs in Uzbekistan. Additionally Brazil is on the way to enforce its laboratories to participate.

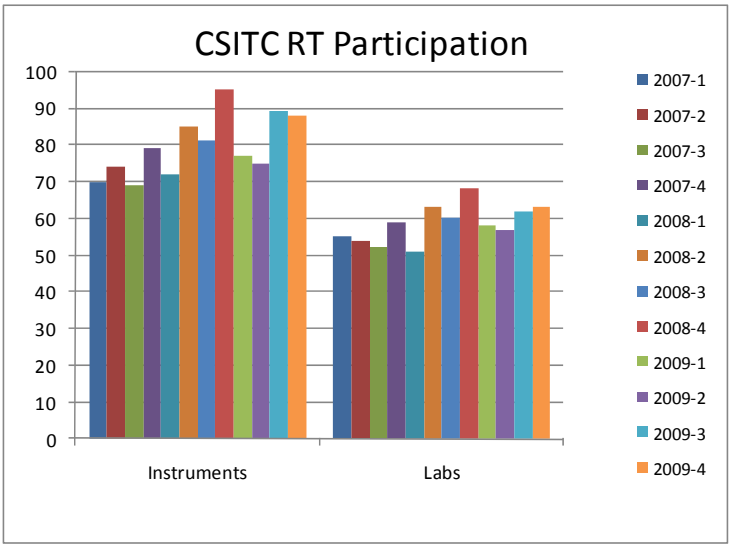

Figure 1. Participation in the CSITC Round Trials

A list of those participating labs that do not refuse to be identified is published at www.icac.org and www.csitc.org. Test results and evaluations are confidential and are only given to the individual participants.

The CSITC Round Trials are conducted 4 times per year and each single Round Trial includes 5 cotton samples. Four cottons are Upland type and are well pre-tested for homogeneity. A 5th cotton with different behavior is included in the Round Trial for information purposes, e.g. from a different origin or with different processing or different behavior. This cotton is not taken for the evaluation of laboratories, but for the overall evaluation of laboratory performance on different kinds of cotton samples.

Round Trial testing has to be done on 5 days to enable reliable evaluation of accuracy and precision (see figure 2). 6 tests have to be done on each day and for each cotton. So there are 30 tests on each cotton sample.

	Cotton 1	Cotton 2	Cotton 3	Cotton 4		*Cotton 5*
day 1	6 tests	6 tests	6 tests	6 tests		*6 tests*
day 2	6 tests	6 tests	6 tests	6 tests		*6 tests*
day 3	6 tests	6 tests	6 tests	6 tests		*6 tests*
day 4	6 tests	6 tests	6 tests	6 tests		*6 tests*
day 5	6 tests	6 tests	6 tests	6 tests		*6 tests*
Sub Total	30 tests	30 tests	30 tests	30 tests		*30 tests*
Total	150 tests for each Round Trial					

Figure 2. Test scheme for each CSITC Round Trial

All measurements have to be done in compliance with the Universal Calibration Standards (e.g. HVI-CCS and USDA Color Calibration Tiles). Each test consists of

- 1 measurement for micronaire,
- 2 measurements for length/strength
- 2 measurements for color

The laboratories are asked to strictly follow the Round Trial procedure, implying e.g. the accurate number of tests per day and per sample. Every single test result is used for the evaluation, so that it is possible to calculate the accuracy as well as the precision of the results.

The laboratory results are compared to reference results that are based on the interlaboratory average. These reference results are always compared to the USDA established results of these samples (results see below).

As outlying results are detrimental to the evaluation,

- Results outside wide fixed limits (e.g. Micronaire 1.5 to 8) are not accepted and automatically deleted (step 1)
- For the calculation of interlaboratory averages and interlaboratory standard deviations, Grubbs' Method for the detection of outliers was chosen in order to achieve statistically stable results without influence of single outliers (step 2).
- For the laboratory evaluation, all results after step 1 are taken.

Interlaboratory Test Result Variation

The interlaboratory variation of test results is given with three different parameters:

- Interlaboratory Standard Deviation between instruments based on 30 tests per instrument [SD interlab (30)]
- Interlaboratory Standard Deviation between instruments based on 6 tests on 1 day [SD interlab (6)]
- Interlaboratory Standard Deviation between instruments based on single tests [SD interlab (1)]

Whereas the SD interlab (30) is showing the true interlaboratory variation, the SD interlab (1) is commercially important, as most bales are only tested one time for trading purposes. An example for three typical distributions is given in figure 3.

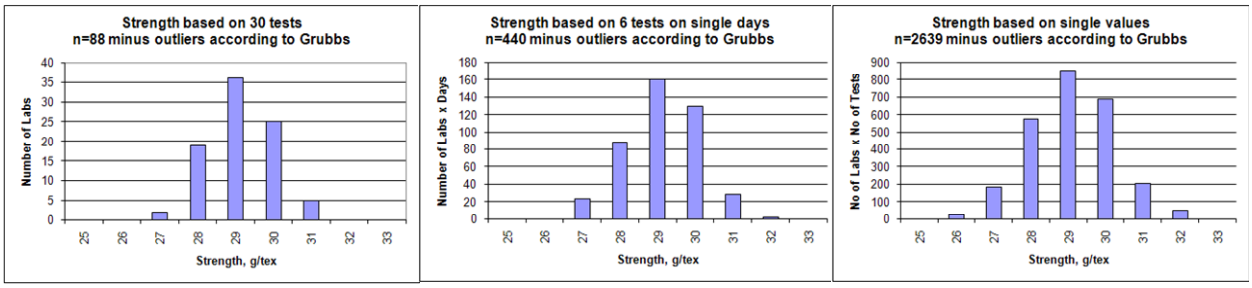

Figure 3. Exemplary interlaboratory Standard Deviations for strength on one cotton sample:
SD interlab (30) – left
SD interlab (6) – center
SD interlab (1) – right

Besides the interlaboratory variation, a second set of parameters that can be calculated from the Round Trials reflect the within-laboratory variation. These are:

- Within-laboratory Standard Deviation between different days (where each day is represented by its average test result) [SD within (between days)]
- Within-laboratory Standard Deviation between single tests on one day (where the SD is the average of the SDs of 5 days) [SD within (between single tests)]
- Within-laboratory Standard Deviation between all 30 tests on one sample [SD within (between all tests)]

The within-laboratory SDs can be calculated for each instrument.

Figure 4 shows the interlaboratory Micronaire result variation for all 48 US upland cotton samples from Round Trial 2007-1 to 2009-4, with an average SD interlab (30) of 0.075 mic, and an average SD interlab (1) of 0.090.

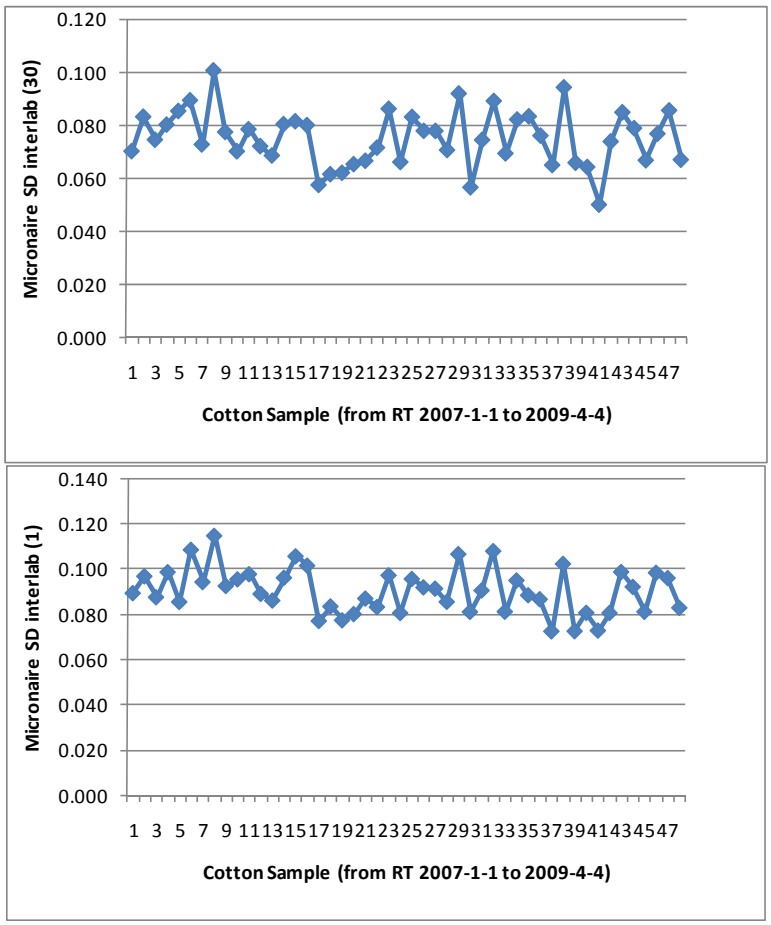

Figure 4. Interlaboratory Micronaire Standard Deviations for all 48 Upland cotton samples in the CSITC Round Trials since 2007
SD interlab (30) – above
SD interlab (1) - below

The interlaboratory Standard Deviations for all six evaluated parameters are given in table 2. These results are very useful, as they give a reliable estimation of the interlaboratory variation of test results based on typical instruments / laboratories in the world. The results are the best available basis for developing commercial trade limits.

Table 2. Interlaboratory Standard Deviations for the six evaluated parameters; averages for 48 US Upland cottons from 2007 to 2009

Property / Parameter	SD interlab (30)	SD interlab (1)	Trend from 2007 to 2009
Micronaire	0.075	0.090	constant
Strength, g/tex	1.08	1.33	slight decrease
UHML, inches	0.012	0.017	constant
Uniformity Index	0.52	0.82	constant
Color Rd	1.04	1.11	increase
Color +b	0.32	0.41	increase

From the CSITC Task Force point of view, a decrease in the variation from 2007 to 2009 is strived for, but this is not given at this stage. A trend might be given by either an improvement of the given instruments, or by the inclusion of additional instruments.

From Round Trial 2009-3 on, Short Fiber Index and Maturity were included in the Round Trials for information purposes, but not for evaluating laboratories. Efforts are done to reduce the variation of these results, so that they might in future be considered for trading.

Effects on the Test Result Variation

The interlaboratory standard deviations are influenced by excluding outliers. Figure 5 shows the SDs based on different kinds of looking at outliers for one micronaire example: either including all results or excluding outliers based on Grubbs' method (see ISO 5725), or taking 90% trimmed results. The figure shows how important it is to base on one constant, robust outlier detection.

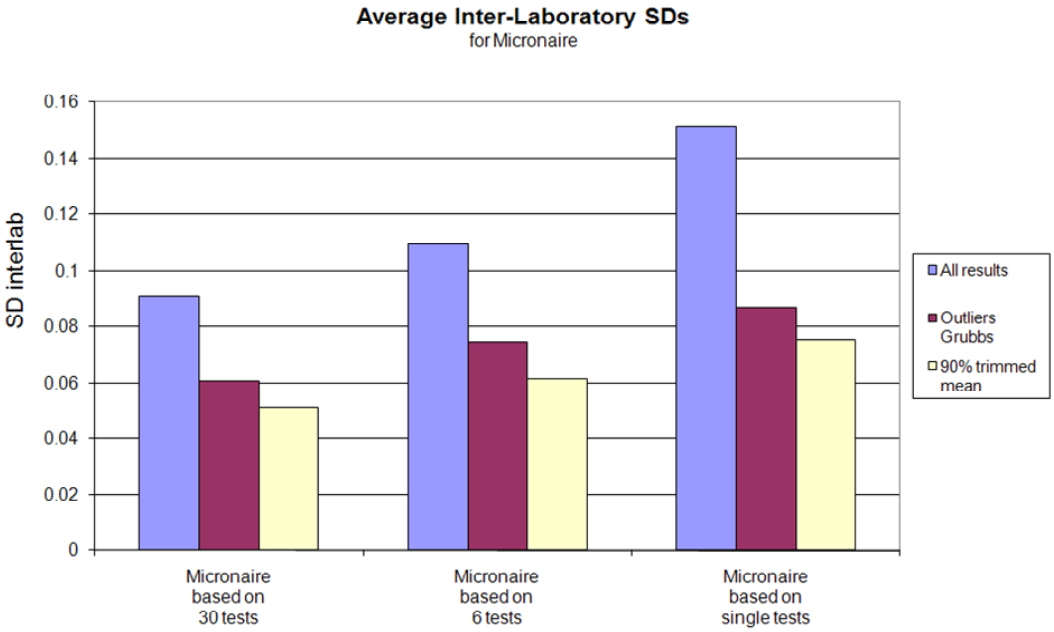

Figure 5. Example for Interlaboratory Micronaire Standard Deviations based on different kinds of evaluating outliers.

It is evident that the Interlaboratory Standard Deviations can be reduced by improving laboratories or by choosing the best laboratories. For quantifying this, a calculation was done, choosing only 50% of the best laboratories, based on their overall Round Trial evaluation in each CSITC Round Trial, and taking their results for a separate evaluation. The calculation was done for 6 Round Trials with in sum 24 cotton samples. Table 3 shows the results of choosing the best laboratories. It can be seen that an improvement of the Interlaboratory Standard Deviation is given for each property. The typical reduction is approx. 20%, ranging from 16 to 24%.

Table 3. Reduction of the Interlaboratory Standard Deviations [SD interlab (1)] for the six evaluated parameters by choosing 50% of the best laboratories

Property / Parameter	All laboratories	50% best laboratories
Micronaire	0.092	0.074
Strength, g/tex	1.40	1.13
UHML, inches	0.017	0.014
Uniformity Index	0.81	0.68
Color Rd	1.03	0.80
Color +b	0.38	0.29

From this evaluation it can be concluded that the improvement of laboratories will have an effect on the result variation, but it will not be possible to reduce the given high data variation for e.g. Short Fiber Index by just choosing the best laboratories.

Besides the 48 US Upland cottons provided by the USDA-AMS, cotton samples from some other origins were included in the Round Trials for information purpose. It can clearly be seen, that the same participating labs in the same calculation result in different interlaboratory Standard Deviations. For the example of an Indian roller ginned cotton, the SD interlab (1) for Micronaire was found to be 0.17 units instead of 0.09 units for the USDA samples. This information is not meant to discriminate Indian roller ginned cottons, but to show that the interlaboratory Standard Deviations cannot easily be transferred from one origin to another. On the other hand, cotton origins with comparable conditions (machine harvesting, saw ginned) resulted in similar results as the US Upland samples.

Effects on the Test Result Level

The CSITC Task Force decided that for an evaluation of the laboratories, the interlaboratory average results for the used cotton samples shall be taken and not the USDA-AMS established results. Therefore it is important to compare the interlaboratory averages to the USDA established results. Figure 6 shows the differences between the Round Trial averages and the USDA established results for Micronaire and for Length UHML. It can be seen that the interlaboratory averages for Micronaire are systematically lower than the USDA established results on a level of 0.05 units.

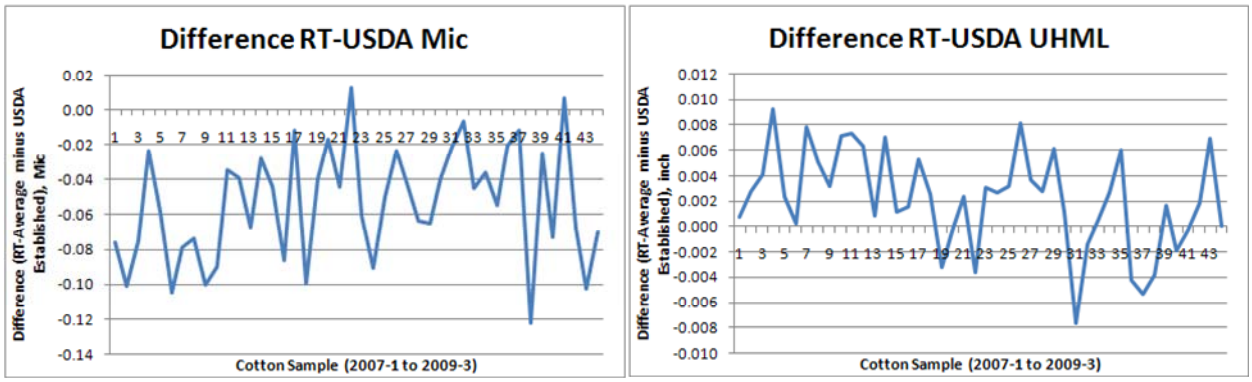

Figure 6. Differences between Round Trial averages and USDA established results for cotton samples from 2007-1 to 2009-3.

Table 4 shows the differences for all 4 properties that are given by USDA-AMS. Compared to the Standard Deviations of the differences, it can be seen that the most important deviation is given for Micronaire, whereas there is nearly no deviation in strength.

Table 4. Result level differences between Round Trial averages and USDA established results; averages for 44 US Upland cottons from 2007-1 to 2009-3

Property / Parameter	Difference: RT Average minus USDA established	Difference: SD of differences	Trend from 2007 to 2009
Micronaire	-0.05	0.03	
Strength, g/tex	-0.03	0.5	
UHML, inches	0.002	0.004	decreasing
Uniformity Index	0.12	0.2	

For the work of the CSITC Task Force it is important to monitor the deviations, so that measures can be initiated to reduce them as soon as they are commercially important. Hence the first question is to find reasons. Typically reasons for deviating from USDA established results are given by using calibration material that is not conforming to the latest USDA standard material.

Participation in the CSITC Round Trial is not restricted to one instrument manufacturer or type, but open for all types. Whereas the number of Uster HVI 1000 increased from 11 to 30 instruments, typically 20 to 30 Uster HVI 900s, 15 to 20 Uster Spectrum and 5 to 16 Premier instruments participate. With this background, result levels of different instruments can be evaluated, and it is possible to recognize systematic deviations.

The deviations are not inherently based on the instruments themselves, but might be caused by the surrounding, as e.g. the used calibration material or the typical conditions of the laboratories.

Typical observations for the cotton samples from Round Trial 2007-1 to 2009-3 were (see figure 7):

- HVI 1000 showed a slightly higher Micronaire result level than the average of all instruments. This correlates to the finding above (RT averages compared to USDA established results), as it can be assumed that HVI 1000 instruments were delivered in recent years, and therefore new calibration material has been delivered, too.
- HVI 1000 showed color Rd results slightly higher than the average of all instruments. USDA, Uster and the CSITC Task Force addressed this problem.
- HVI 1000 showed color +b results slightly higher than the average of all instruments.
- HVI 900 showed strength results slightly higher than the average of all instruments.

These statistics are based on the average of all participating instruments from one type, but it can definitely not be followed that single instruments behave accordingly.

Again the conclusion is to find reasons for deviations and to minimize the deviations based on this knowledge as soon as commercial importance is given.

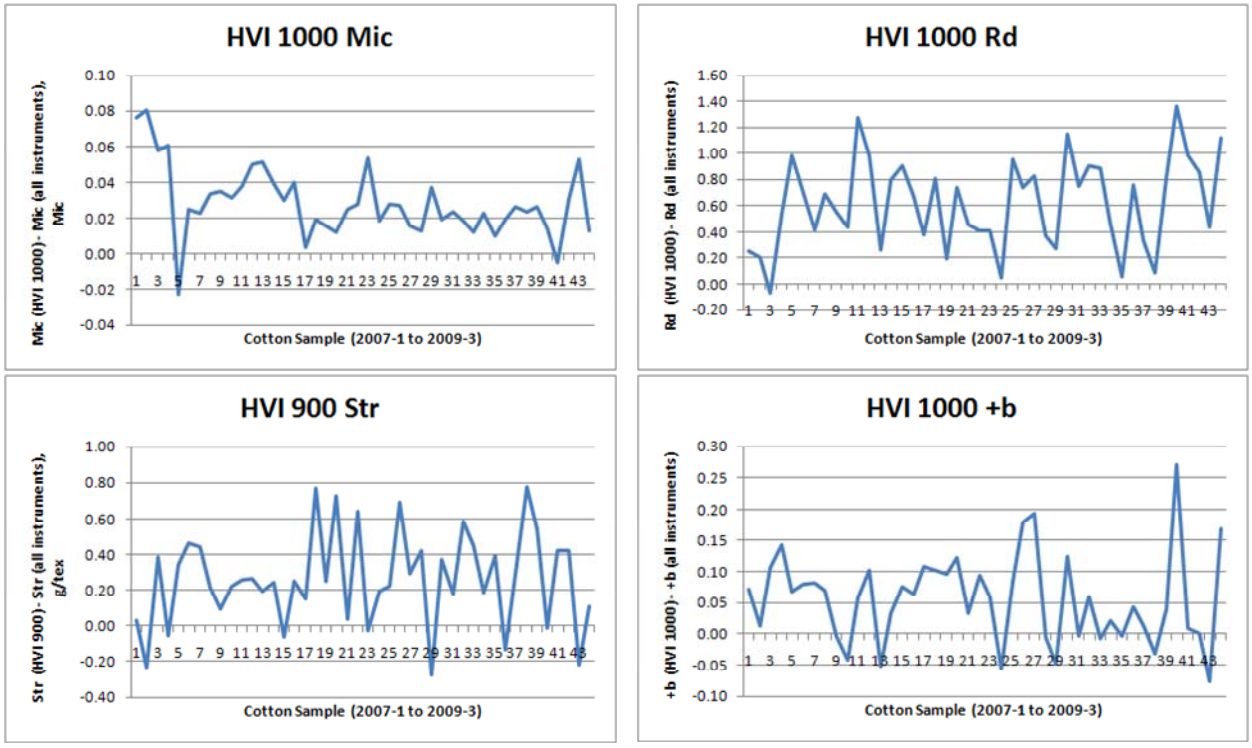

Figure 7. Exemplary differences between Round Trial averages for specific instrument types and the average of all instruments for cotton samples from 2007-1 to 2009-3
Left/top: Micronaire HVI 1000
Left/bottom: Strength HVI 900
Right/top: Color Rd HVI 1000
Right/bottom: Color +b HVI 1000

Within Laboratory Test Result Variation

The within-laboratory variation is reflected by the following parameters:

- Within-laboratory Standard Deviation between different days (where each day is represented by its average test result) [SD within (between days)]
- Within-laboratory Standard Deviation between single tests on one day (where the SD is the average of the

SDs of 5 days) [SD within (between single tests)]
- Within-laboratory Standard Deviation between all 30 tests on one sample [SD within (between all tests)]

The within-laboratory SDs can be calculated for each instrument. The median of all instruments represents a "typical" within-laboratory SD. Table 5 summarizes the average median SDs that were found in the 48 US Upland cotton samples from Round Trial 2007-1 to 2009-4. This data is valuable information for laboratories, as it allows comparing their within-laboratory SD with the typical SD of all other labs.

Table 5. Within-laboratory Standard Deviations for the six evaluated parameters; averages of the median SD for 48 US Upland cottons from 2007 to 2009

Property / Parameter	SD within lab (between days)	SD within lab (between single tests)	SD within lab (between all 30 tests)
Micronaire	0.02	0.04	0.05
Strength, g/tex	0.4	0.6	0.7
UHML, inches	0.006	0.010	0.012
Uniformity Index	0.3	0.5	0.6
Color Rd	0.3	0.3	0.4
Color +b	0.12	0.11	0.17

Evaluation of the Laboratory Performance for Each Laboratory

For all users of instrument test results, it is helpful to know about the reliability of cotton testing laboratories, their instruments and their test results. For this, the CSITC Round Trials include an objective and summarizing evaluation of the instrument accuracy. The evaluation results for the instruments in a testing facility is very beneficial

- for the testing facility, as it can prove its good performance
- for the customers of the testing facilities and for users of the instrument test results, as they can get an objective information about the reliability of the testing facility and its results
- for cotton associations to choose their arbitration laboratory based on the quality of the laboratory.

This information is the leading aim of the CSITC Task Force activities. With the information about the reliability of the test results of a testing facility, results can be used for commercial purposes.

The evaluation of the participating laboratories/instruments is solely done regarding the trueness of the instrument test results; precision is not taken into account. The procedure for the analysis is easy to follow, and it is useful to understand the evaluation process. Therefore the steps of evaluation for one exemplary instrument are shown in figure 8. The steps are:

- Step 1: The evaluation is done in comparison to the reference results, which were calculated from the inter-laboratory averages.
- Step 2: For each cotton and each parameter, the average result of all tests for all days of this instrument is calculated (average of 30 test results).
- Step 3: For each cotton and each parameter, the distance between the laboratory result and the reference result is calculated.
- Step 4: For each parameter, the average absolute distance of all cottons is calculated.
- Step 5: For each parameter, the mean absolute distance is divided by a “Scale Factor”. This step allows a comparison between the parameters. The scale factors are based on the USDA Reproducibility Limits in 2000. For Rd this result was slightly enlarged regarding the decision of the CSITC Task Force due to the increased variability of these results. The result of this step is a Summary Evaluation for Each Property.
- Step 6: Based on the evaluations for each property, the Combined Summary Evaluation of All Properties is calculated by averaging the results of each property. (Additionally it is possible to apply different relevance factors for each property, but at this stage this is not done.)

Performance of Laboratory 115							
		Micronaire	Strength	Length	Uniformity	Color Rd	Color +b
Reference Values	Cotton 1	3,83	32,82	1,207	82,42	76,31	12,14
	Cotton 2	5,17	28,22	1,136	81,90	78,06	11,53
	Cotton 3	4,40	25,54	0,948	78,53	74,86	10,86
	Cotton 4	3,81	32,89	1,177	83,65	76,08	10,98
Laboratory Average of All Days	Cotton 1	3,80	33,62	1,207	82,71	75,37	11,38
	Cotton 2	5,23	28,50	1,134	81,44	76,05	10,82
	Cotton 3	4,36	26,11	0,969	76,13	73,62	10,41
	Cotton 4	3,79	32,72	1,182	83,83	75,29	10,17
Rel. Distance to Reference	Cotton 1	-0,03	0,80	0,000	0,29	-0,94	-0,76
	Cotton 2	0,06	0,28	-0,003	-0,46	-2,00	-0,71
	Cotton 3	-0,04	0,57	0,021	-2,40	-1,24	-0,45
	Cotton 4	-0,02	-0,18	0,005	0,18	-0,79	-0,81
Mean Absolute Distance to Reference		0,04	0,46	0,007	0,83	1,24	0,68
Scale Factor (Based on USDA Reproducibility Limits except Rd)		0,10	1,50	0,02	1,00	1,50	0,50
Summary Evaluation for Each Property (=Mean Abs. Distance divided by Scale Factor)		**0,38**	**0,31**	**0,36**	**0,83**	**0,83**	**1,37**
Relevance of Property		1,00	1,00	1,00	1,00	1,00	1,00
Summary Evaluation of All Properties (=Average of all properties)		**0,68**					

Figure 8. Example for the steps of evaluation for a single instrument (#115)

The Combined Summary Evaluation Result of All Properties is a parameter that allows a comparison between different instruments/laboratories. The lower the Summary Evaluation Result, the better the accuracy of the instrument/laboratory.

Figure 9 is showing the typical distribution of the evaluation with combined properties. This example is for Round Trial 2009-3. The best instruments usually have an evaluation result of 0.2 to 0.3. Typically about 50% of the instruments show an Evaluation Result below 0.5. The major part of all instruments is below or up to 0.9. And there are usually some outliers showing an evaluation result far higher than 1.

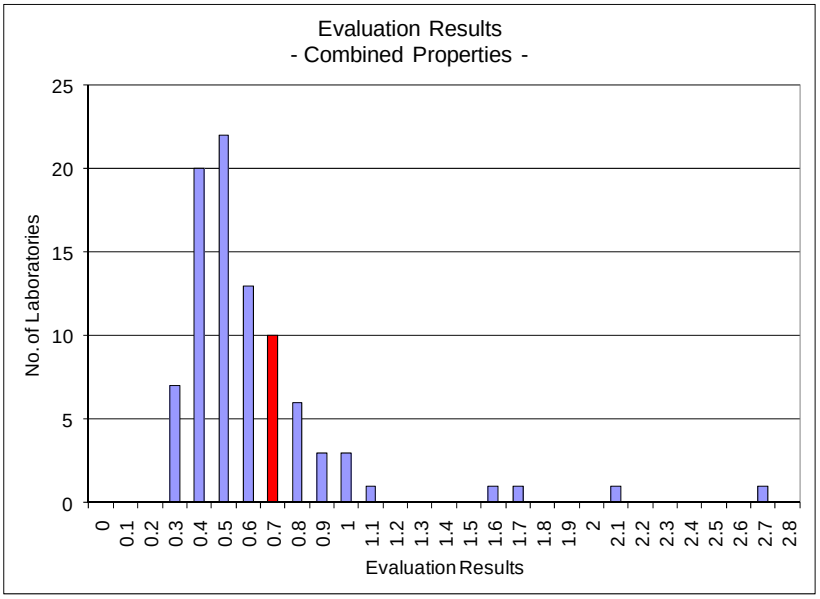

Figure 9. Evaluation result of the exemplary instrument #115 (marked in red) in comparison to the distribution of evaluation results for all instruments in Round Trial 2009-3

For looking at the consistency of the evaluations, the median evaluation results of all instruments are given in figure 10. It shows that the median evaluation is highly consistent, varying between 0.45 and 0.53. On the one side, it is good to see the consistency, on the other side, the CSITC aims should lead to an improvement of laboratories, expressed by a decreasing median evaluation result, which is not given at the moment.

RT	Median Evaluation
2007-1	0.50
2007-2	0.51
2007-3	0.47
2007-4	0.49
2008-1	0.51
2008-2	0.45
2008-3	0.53
2008-4	0.53
2009-1	0.49
2009-2	0.51
2009-3	0.52
2009-4	0.53
Average	0.50

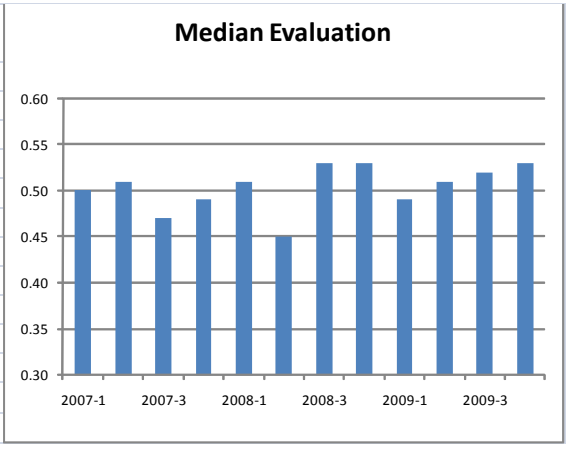

Figure 10. Median evaluation result of all participating instruments from Round Trial 2007-1 to 2009-4

A second view has to be taken on the summary evaluation results, regarding the consistency of the results for single instruments. It is difficult to name objective parameters for this. Hence, a selection of instruments is shown in figure 11. Each graph represents a different testing facility. It can typically be seen that

- for instruments with a “good” evaluation result, the results are quite constant for all the Round Trials (examples on the top of figure 11)
- for instruments with less good evaluation results, the results are varying between the Round Trials (examples on the bottom of figure 11)
- Results from different instruments in the same testing facility typically show comparable results, although there might be residual differences

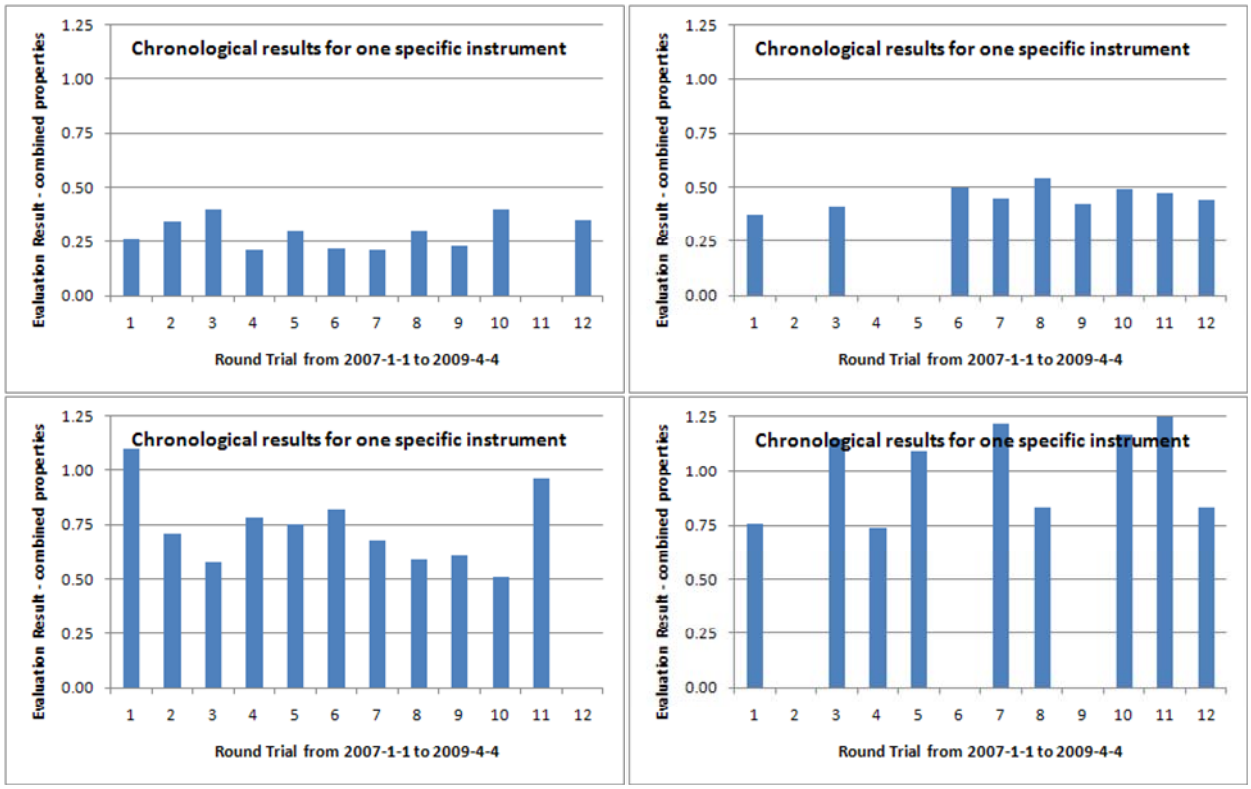

Figure 11. Evaluation results for chosen instruments over time
Left/top: the best performing instrument in the CSITC Round Tests
Right/top: a well performing instrument
Left/bottom: an instrument with inferior performance
Right/bottom: an instrument with inferior performance and high variation of its performance

Detailed Analysis of Round Trial Results for Each Laboratory

For improving their performance, laboratories need more detailed analyses of their results, given by:

a) Evaluation of each property
b) Evaluation of the accuracy over the property range
c) Evaluation of the precision

a) Evaluation of each property

The instrument's performance may be based on suitable test results for some properties and insufficient performance for others. Hence, the participants get an evaluation for each property – each time compared to the statistics of all instruments in the Round Trial. Figure 12 shows an instrument with insufficient accuracy mainly for color Rd and +b, whereas the strength and length results are very good.

		Evaluation Overall
Your Laboratory	005-01	1. 13
Statistics	Average	0. 57
	Median	0. 53
	Best Lab.	0. 21
	Worst Lab.	1. 13

Comments:

Evaluation of Each Property

		Evaluation Micronaire	Evaluation Strength	Evaluation Length	Evaluation Uniformity	Evaluation Color Rd	Evaluation Color +b
Your Laboratory	005-01	0.78	0.16	0.18	0.56	3.25	1.86
Statistics	Average	0.61	0.50	0.46	0.37	0.78	0.72
	Median	0.56	0.42	0.39	0.32	0.55	0.59
	Best Lab.	0.07	0.11	0.05	0.09	0.07	0.10
	Worst Lab.	2.10	1.17	2.08	1.22	3.25	2.74

Figure 12. Evaluation of each property for one example

b) Evaluation of the accuracy over the property range

The detailed analysis of the accuracy over the property range is a very good tool to analyze the biases caused by e.g. problems in calibration. Figure 13 shows an instrument with accurate results for long cotton samples, but insufficient behavior for short cotton samples.

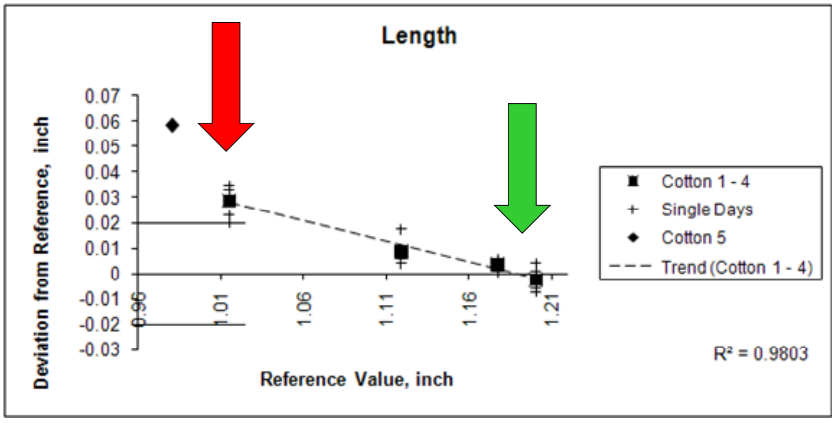

Figure 13. Evaluation of the accuracy over the property range for one example

c) Evaluation of the precision

Besides the accuracy, the precision of the test results is important, too. With the Round Trial results, the laboratory can compare the within-lab variations of its instrument to the median within-lab variation of all participating instruments. The instrument in figure 14 shows extremely high result variation for its strength results. This can be seen in the result table as well as in the graph, where the test results of each day are marked with a "+". Strength test results on the same sample deviate up to 5 g/tex on the different days.

Strength						
			Cotton 1	Cotton 2	Cotton 3	Cotton 4	Average
Reference Values for Evaluation			27.804	29.164	33.455	31.947	
Typical In-Lab. Variation (Median)	between different days with each 6 tests	SD	0.373	0.369	0.445	0.458	0.411
	between single tests on one day	SD	0.564	0.529	0.622	0.632	0.587
	between all tests on different days	SD	0.678	0.640	0.759	0.769	0.712
In-Lab. Variation (Your Lab.)	between different days with each 6 tests	SD	2.061	1.738	1.594	2.134	1.882
	between single tests on one day	SD	1.225	1.159	0.779	1.463	1.157
	between all tests on different days	SD	2.229	1.950	1.664	2.453	2.074

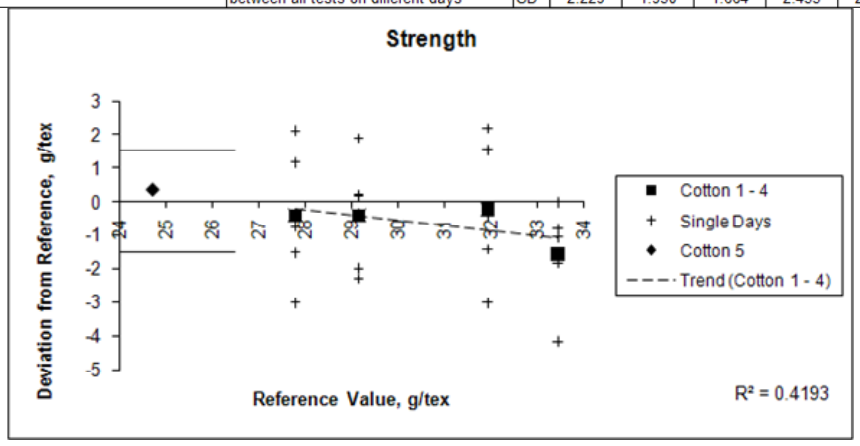

Figure 14. Evaluation of the precision for one example

Summary

The CSITC Round Trials, which are based on the work of the ICAC CSITC Task Force and conducted in cooperation between USDA-AMS and the Bremen Fiber Institute (FIBRE), are continuously performed since 2007. The Round Trials show very valuable, consistent data for interlaboratory variation of High Volume Instruments' test results as well as for the within-laboratory variation.

The CSITC Round Trial system is the first Round Trial with official grading of instruments – which is commercially important mainly for laboratories involved in the instrument testing of the cotton production. The evaluation results are significant and consistent.

Suitable detailed analyses according to accuracy and precision are provided in order to support laboratories in improving their data reliability.

Every cotton testing facility is invited to participate in the future CSITC Round Trials. For registration, please contact the ICAC:

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Washington DC 20006-1636.
Telephone: 202-463-6660
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More information about the CSITC Task Force and the Round Trials is given on www.icac.org → Instrument Testing.

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References

CSITC – Commercial Standardization of Instrument Testing of Cotton (CSITC), www.csitc.org, including the CSITC Round Trial database.

Drieling, A., Knowlton, J.L. 2007. Development of a regular CSITC Round Trial. Beltwide Cotton Conf., New Orleans, LA, Jan 9-16, 2007. Cotton Quality Measurements Conference.

ICAC – International Cotton Advisory Committee, www.icac.org, →Instrument Testing

- Commercial Standardization of Instrument Testing of Cotton (CSITC) Task Force meeting reports
- CSITC Round Trial results