TRASHCAM: A NEW INSTRUMENT FOR COTTON BREEDERS

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INTRODUCTION

Seed coat fragments (SCF) are small pieces of cotton seed coats that are torn off during the ginning process. Some cotton lint generally remains attached to these fragments, assuring that ginned lint will be contaminated by them. SCF contamination is a major cause of reduced productivity in textile manufacturing and of lower yarn and fabric quality (Curran 1992).

During the past decade, research has increased into the causes and the measurement of SCF, in order to find ways to alleviate this problem. Anthony (1988) demonstrated the ginning effect on SCF content and Mangialardi (1988) demonstrated that the SCF count was greatly affected by variety and growing location effects. Frydrych (1989) developed a technique for counting SCF on yarn with an existing evenness tester; it required a visual examination to classify defects into the different categories (fiber neps, SCF, sticky neps, etc.).

In 1995, the first generation of the Trashcam was developed at the *Centre de Coopération Internationale en Recherche Agronomique pour le Développement* (CIRAD), Montpellier, France (Gourlot et. al., 1995). It was originally intended to count and determine the sizes of SCF in card webs, in order to predict the tendency for neps at early stages of cotton breeding programs. The technique was further developed (Giner, et. al., 1997; Gourlot, et. al., 1998; Krifa, et. al., 1998). The latest generation of Trashcam also counts and sizes SCF on yarn boards (Frydrych, et. al., 1999). In the current generation of Trashcam, the image of a card web or yarn board is captured by a scanning device, then analyzed by computer to provide the count and the size distribution of SCF.

During a three-year project, the Trashcam was used on card webs in a breeding program (Bachelier, 1998; Krifa, et. al., 1998), resulting in a significant improvement in selection to avoid seed coat fragments in new cotton varieties. Results also indicated that the level of SCF in card webs is a heritable characteristic.
Thus, the Trashcam promised to be an efficient tool in cotton breeding programs.

Since 1998, the CIRAD has been collaborating with the International Textile Center (ITC), in order to validate the usefulness of Trashcam readings on yarn boards and to check the between-machine reproducibility. This article is to report on preliminary results obtained to date.

PROCEDURES

Variety evaluation tests were performed at the ITC during the 1998-99 crop year. Eighteen U.S. Upland cotton varieties were represented. Each variety was grown in two locations and two replicated samples were taken at each location. Therefore, a total of 72 cotton samples were collected (18 x 2 x 2).

The cotton fibers from each variety were processed through the Short Staple Spinning Laboratory at the ITC and were made into both ring-spun and rotor-spun yarns of different sizes. Exhibit 1 provides an outline of the mechanical process for all the cottons included in the analysis.

After processing, the yarn was wound on a white board. Two yarn boards were made and tested for each sample. Each face of the boards was scanned using a HP Scanjet 4C scanner. After capture of the images, they were automatically processed using the custom software produced by CIRAD. The average of the four readings was calculated and appropriate statistical analysis was done on the averages.

A preliminary experiment was done with an independent set of samples, in order to determine the length of yarn to be wound around the boards. Twenty cotton samples were selected, then 50 Ne ring-spun yarn was produced. Two lengths of yarn were tested: 56 meters and 96 meters. As shown in the Exhibit 2, the correlation between the two lengths of yarn tested is very high ($r = 0.98$). Furthermore, the slope and offset are not statistically different from 1 and 0 (Exhibit 3). The conclusion was that the SCF measurements were the same for the two boards;

therefore, the 56-meter board was selected for use.

RESULTS

A brief statistical summary of fiber and yarn properties (mean, minimum and maximum values) is given in Exhibit 4. A more detailed discussion of results obtained follows.

Ring-spun Yarns (50 Ne)

Exhibit 5 shows the number of SCF obtained on the ring-spun yarns for the eighteen varieties tested in the two locations. Clearly the number of SCF is repetitive across the two locations. Given that the cotton was harvested in the same manner in both locations and was ginned on the same system, the differences observed are primarily due to the genetic variability across the varieties. As would be expected, statistical analysis of the results (Exhibit 6) shows highly significant effects for both varieties and locations. However, the interaction effects between varieties and locations are not statistically significant.

Rotor-spun Yarns (36 Ne)

Exhibit 7 shows the number of SCF on the rotor-spun yarns for the eighteen varieties tested in the two locations. As expected, rotor spinning is less sensitive to increased SCF levels; accordingly, variations in SCF counts between the two locations are greater for the rotor-spun yarns than for the ring-spun yarns. Nevertheless, the highly repetitive pattern across the two locations leads to the conclusion that differences observed are primarily due to the genetic variability across the varieties. The statistical analysis of the results (Exhibit 6) shows a highly significant effect for both varieties and locations, with the interaction term again being nonsignificant.

Relationship between SCF Counts in Ring- versus Rotor-spun Yarns

The data from the two locations with 2 replications per location were averaged to calculate the linear regression between ring and rotor spinning. Since the yarn size of the rotor-spun yarn is 36 Ne while the ring-spun yarn is 50 Ne, we should expect to see a SCF-count difference between the two yarns. Also, as previously indicated, the rotor-spun yarn structure tends to hide the SCF on the inside (due to the centrifugal force applied during the yarn formation); however, the ring-spun yarn structure tends to put the SCF on the outside. Furthermore, it appears that the opening rollers of rotor spinning remove a significant amount of SCF from the fiber, while the ring-spinning technology does not remove this contamination. Therefore, the expectation is to find a high linear correlation between the two sets of results obtained, but not the same level of SCF between ring- and rotor-spun yarns. Accordingly, Exhibit 8 does show a good linear relationship between the two types of yarn with a coefficient of correlation of 0.92.
It will be of interest to compare the size distributions of the SCF for each spinning system, because it may be that the opening rollers of the rotor spinning frame tend to break the large SCF particles into smaller particles. This will be studied in another experiment.

Relationship between SCF Counts at CIRAD versus ITC

Measurements were taken at both laboratories and the data averaged over locations and replications were used to calculate the linear regression between the two laboratories. Exhibit 9 shows a linear relationship with an excellent coefficient of correlation (r=0.97). However, the slope and offset are different from 1 and 0, which means that the prototype instruments are not properly calibrated. This issue must be investigated in the months ahead.

CONCLUSION

These results corroborate earlier results showing that the number of SCF is highly heritable. For given environments and ginning treatments, SCF is highly related to cotton varieties.

Results to date indicate that the Trashcam is fast, reliable, and simple to use. The level difference between the instruments at the two laboratories needs to be resolved. However, cotton breeders are generally interested in ranking new genetic lines versus a control, rather than using an absolute number. Therefore, the Trashcam could be (and is being) used to guide the variety selection decisions of some cotton breeders.

The SCF problem is an important contamination issue that has received inadequate focus by cotton breeders. The Trashcam offers potential to be a convenient measurement tool that is sensitive enough to guide the variety selection process.

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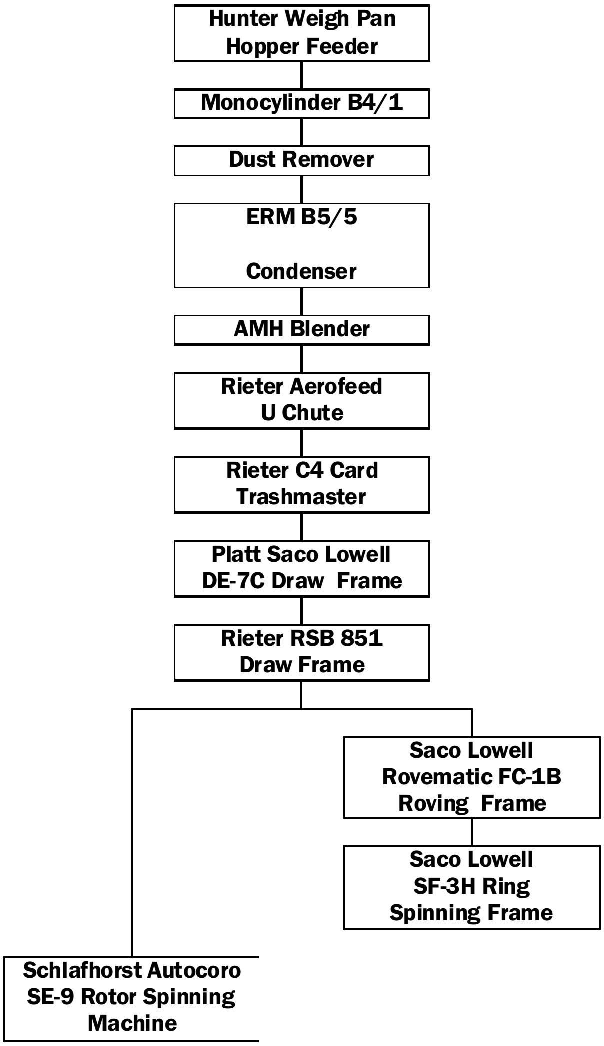
Exhibit 1: Outline of Mechanical Processes



Roll Speed = 750 rpm

R20/10 Beater Speed = 850 rpm

Production Rate = 75 lb/hr
Sliver Weight = 60 gr/yd

Delivery Speed = 570 ft/min
Sliver Weight = 55 gr/yd

Delivery Speed = 1320 ft/min
Sliver Weight = 55 gr/yd

Roving = 1 hank

Spindle Speed = 1425 rpm
TM = 3.8

Rotor type = T 231 D
Rotor Speed = 100,000
Opening roller type = B 174 DN
Opening roller speed = 7,400
Novel type = KN-4 + 1.5mm Washer
Torque device = TS-37
TM = 4.80

Exhibit 2. Influence of the Number of Meters Wound around the Board on the Trashcam Readings

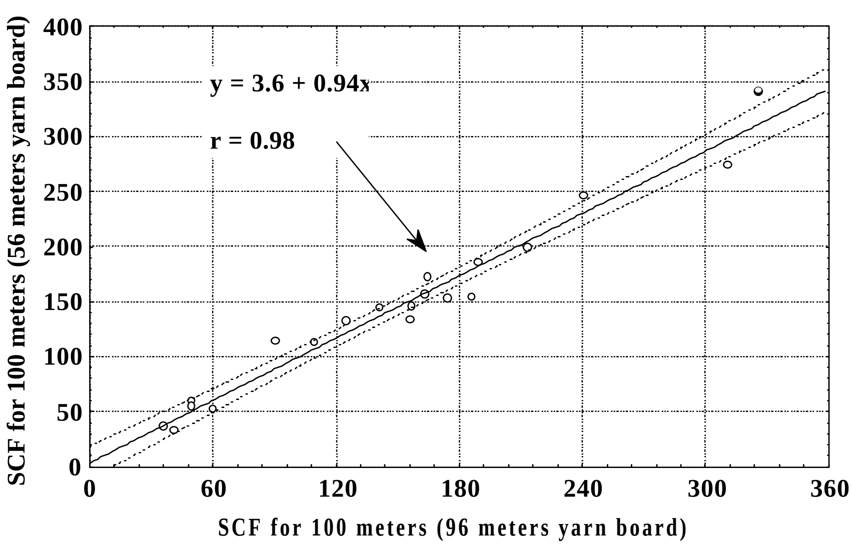


Exhibit 3. Parameter Estimates – Linear Regression Analysis – 96 Meters per Board vs. 56 Meters per Board

Effect	Parameter value	Std. Error	T - test	Probability	95% Confidence Limits Min.	Max.
Intercept	3.61	7.159	0.50	0.6199	-11.43	18.65
Slope	0.94	0.042	22.42	0.0000	0.855	1.03

Exhibit 4. Raw Fiber Data and Yarn Data for 72 Cotton Samples

Instrument & Measurement	Units	Mean	Minimum	Maximum
Zellweger Uster HVI 900A				
Micronaire		4.37	3.90	5.10
Leaf Grade		3.28	2.00	4.00
Reflectance	%	75.1	72.7	77.7
Yellowness		7.8	7.3	8.4
Upper Half Mean Length	in	1.186	1.090	1.290
Uniformity	%	83.8	80.8	84.8
Strength	g/tex	35.1	30.3	37.5
Elongation	%	5.8	5.3	6.8
Zellweger Uster AFIS Multidata				
Mean Length (w)	.in	1.082	0.990	1.160
Short Fiber Content (w)	%	4.5	3.4	6.8
Upper Quartile Length (w)	in	1.273	1.190	1.380
Maturity Ratio		0.96	0.92	1.01
Immature Fiber Content	%	5.3	3.9	6.9
Fineness	mtex	171	157	194
Neps	cnt/g	208	98	344
Seed Coat Neps	cnt/g	33	16	54
Ring-spun Yarn 50Ne				
Count Strength Product	.	2707	2034	3277
Tensorapid Tenacity	cN/tex	17.19	13.48	18.96
Tensorapid Elongation	%	4.4	3.7	5.0
UT3 CV%	%	23.7	21.3	18.8
UT3 Thin Places	cnt/km	802	392	1595
UT3 Thick Places	cnt/km	1704	1104	2343
UT3 Neps	cnt/km	1281	735	1864
Hairiness		3.74	3.44	4.14
Trashcam Seed Coat Neps	cnt/100m	323	171	495
Rotor-spun Yarn 36Ne				
Count Strength Product	.	2299	2022	2555
Tensorapid Tenacity	cN/tex	14.70	12.85	16.40
Tensorapid Elongation	%	5.4	4.9	5.92
UT3 CV%	%	17.1	16.2	18.3
UT3 Thin Places	cnt/km	127	56	278
UT3 Thick Places	cnt/km	282	194	383
UT3 Neps	cnt/km	90	46	138
Hairiness		3.40	3.21	3.68
Trashcam Seed Coat Neps	cnt/100m	168	90	313

Exhibit 5. Seed Coat Fragment Counting at Two Test Sites – Ring-spun Yarns 50 Ne

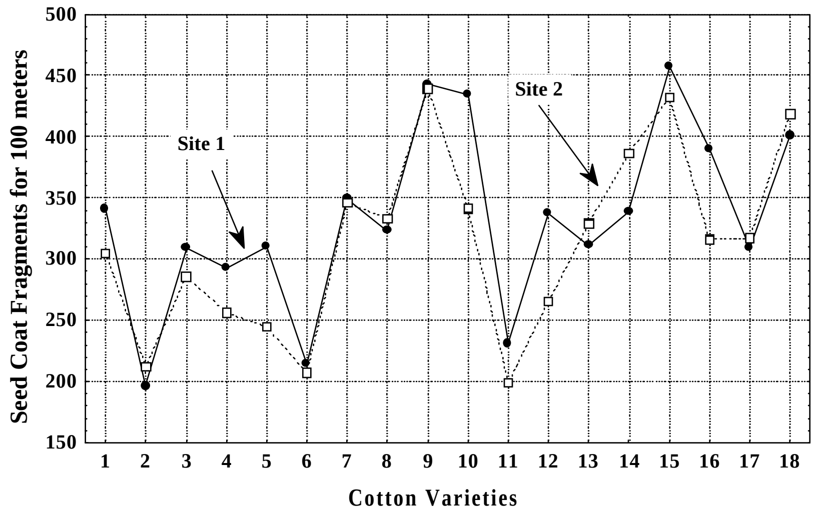


Exhibit 6. Part a. SCF Analysis of Variance – Visual General Linear Model
Sigma-restricted Parameterization

Effect	df	Ring SS	Ring F test	Ring Prob	Rotor SS	Rotor F test	Rotor Prob
Intercept	1	7,507,812	8,428.6	0.0000	2,039,479	2387.7	0.0000
Variety	17	349,614	23.1	0.0000	82,921	5.7	0.0000
Location	1	6,945	7.8	0.0083	17,915	21.0	0.0000
Var x Loc	17	24,797	1.6	0.1051	13,865	0.9	0.5237
Error	36	32,067			30,749		
Total	71	413,423			145,450		

Exhibit 6. Part b. Analysis of Variance – Newman-Keuls Test.
Homogeneous Group, Alpha = 0.05

Ring-spun yarns 50 Ne								Rotor-spun yarns 36 Ne					
Variety	Mean	1	2	3	4	5	6	Variety	Mean	1	2	3	4
2	204.5	**						11	110.5	**			
6	210.9	**						2	111.2	**			
11	215.2	**						6	115.8	**	**		
4	274.6		**					5	148.2	**	**	**	
5	277.4		**					3	150.4	**	**	**	
3	297.3		**	**				4	150.9	**	**	**	
12	301.6		**	**				1	151.1	**	**	**	
17	313.2		**	**				8	160.9	**	**	**	**
13	320.1		**	**				12	169.2	**	**	**	**
1	323.2		**	**				17	173.0	**	**	**	**
8	328.1		**	**	**			16	174.6	**	**	**	**
7	347.8			**	**			14	180.8	**	**	**	**
16	352.9			**	**			10	185.7		**	**	**
14	362.7			**	**	**		7	192.9			**	**
10	387.7				**	**		18	193.3			**	**
18	409.8					**	**	13	211.6			**	**
9	440.8						**	15	221.7			**	**
15	444.6						**	9	227.7				**

Exhibit 7. Seed Coat Fragment Counts at Two Test Sites – Rotor-spun Yarns 36 Ne

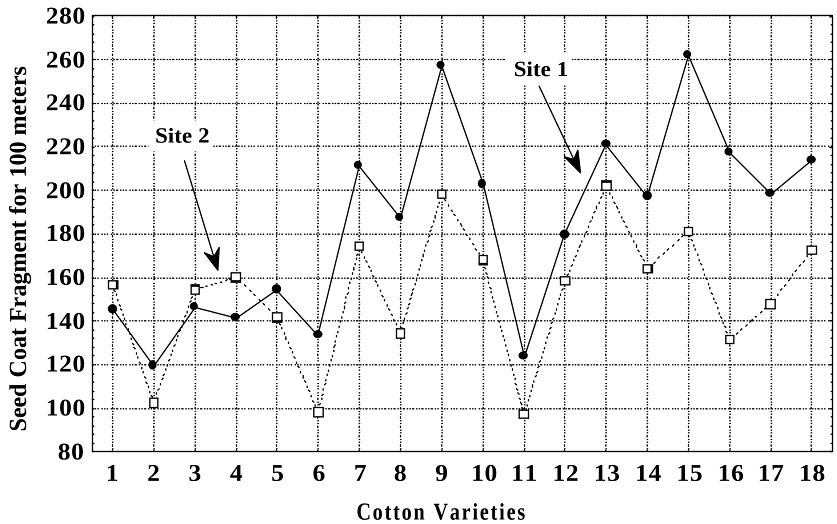


Exhibit 8. Part a. SCF Count: Ring-spun vs. Rotor-spun Yarns

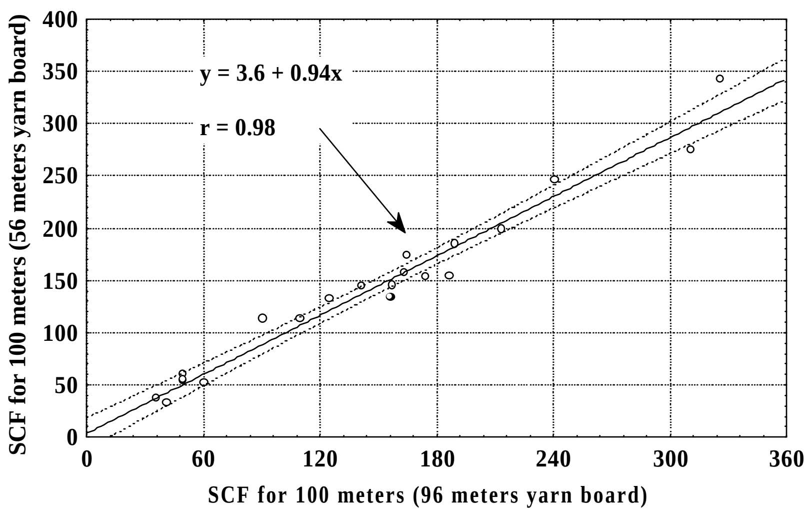


Exhibit 8 Part b. Parameter Estimates – Linear Regression Analysis – SCF Count in Ring-spun Yarns vs. SCF Count in Rotor-spun Yarns

Effect	Parameter value	Std. Error	T - test	Probability	95% Confidence Limits Min.	Max.
Intercept	24.42	16.23	1.50	0.1520	-9.99	58.83
Slope	0.45	0.05	9.07	0.0000	0.34	0.55

Exhibit 9.Part a. SCF Count in CIRAD vs. SCF Count in ITC – Ring-spun Yarns 50 Ne

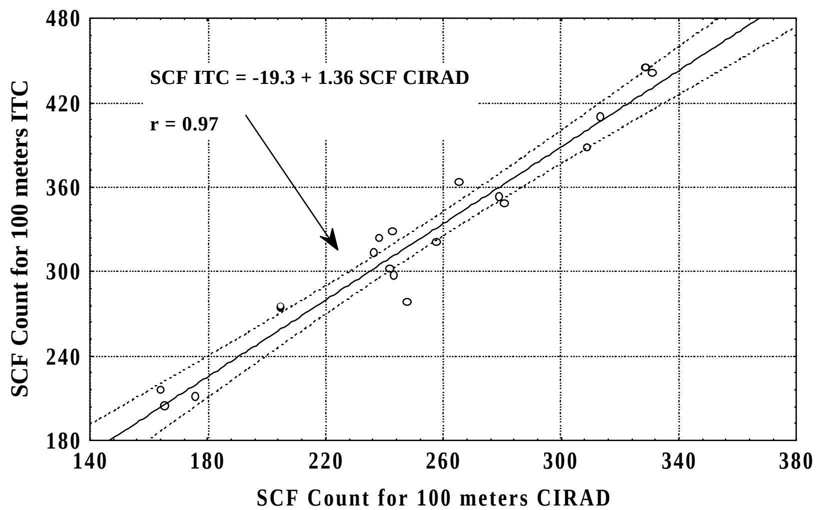


Exhibit 9. Part b. Parameter estimates – Linear Regression Analysis – CIRAD SCF Count vs. ITC SCF Count – Ring-spun Yarns 50 Ne

Effect	Parameter value	Std. Error	T - test	Probability	Confidence Limit -95%	Confidence Limit +95%
Intercept	-19.30	20.21	-0.95	0.3539	-62.15	23.55
Slope	1.36	0.08	17.26	0.0000	1.19	1.53

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