SAMPLING VARIANCE WITHIN WEST AFRICAN COTTON BALES

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Introduction

World cotton trade is impacted by changes in fiber classing :

Change from manual / visual classing to instrument classing with “Standardized Instruments for Testing Cotton” (SITC).

50% of the cotton traded in the world classed with SITC for Micronaire, Length (UHML), Uniformity (UI), Strength (STR), Reflectance (Rd) and Yellowness (+b).

Precision of these measurements depend on the within-bale variability

Larger within bale variability
=> lower precision of the measurements
=> higher litigation risk.

West African production conditions differ from those in USA : cotton farms are smaller => each bale includes fiber produced in different farms under different field conditions

Transposing the USA methods as is verbatim in other countries could lead to increased litigation risks

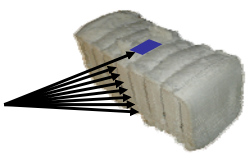
There is a need to study within bale variability of technological characteristics of cotton fibers in West African conditions to set sampling and testing operating methods.

OBJECTIVE

Quantify the level of within bale variability as measured by SITC to deduce:

1- Number of samples per bale of West African cotton
2- Number of replicates per sample for each technological characteristic : Micronaire, UHML, UI, STR, Rd, +b

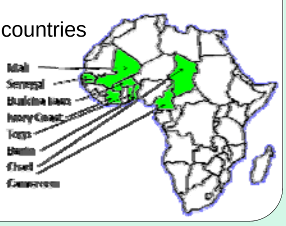
Sampling design



8 samples per bale

1 bale sampled out of every 20 bales
10 bales were sampled / Gin in season 1
5 bales were sampled / Gin in season 2

2-3 gins / country
in 8 West African countries



Sample testing

1720 fiber samples from 215 bales were analyzed in controlled conditions with SITC USTER Technologies model HVI-1000 in a laboratory fully complying with the international recommendations.

Each replicate was carried out according to ASTM 5867 requirements with one measurement of Micronaire and two measurements of the Length/ Uniformity Index, Strength, Color Rd and Yellowness.

Data analysis

The model for analyzing the acquired results was the following: for any result Y_{ijk} acquired in bale *I*, layer *j*, replicate *k* :

Y_{ijk} = fixed effect (m_i) of bale *i*
+ random effect (A_{ij}) of layer j within bale (i)
+ block effect ($B_{i,k}$) (insignificant)
+ experimental error (E_{ijk})

This model is:

$$Y_{i,j,k} = m_i + A_{i,j} + E_{i,j,k}$$

The two random terms retained as variability sources (*A* and *E*) are supposed independent :

σ_A^2 is the variance of the random layer effect,

σ_E^2 is the variance of the residual error

From the estimation of σ_A^2 and σ_E^2 we can deduce the sampling variance σ_M^2

$$\sigma_M^2 = \frac{\sigma_A^2}{J'} + \frac{\sigma_E^2}{J'K'} \quad \text{for separate samples}$$

J’ layer samples, each tested K’ times

$$\sigma_M^2 = \frac{\sigma_A^2}{J'} + \frac{\sigma_E^2}{N'} \quad \text{for mixed samples}$$

J’ layer samples mixed, tested *N’* times overall

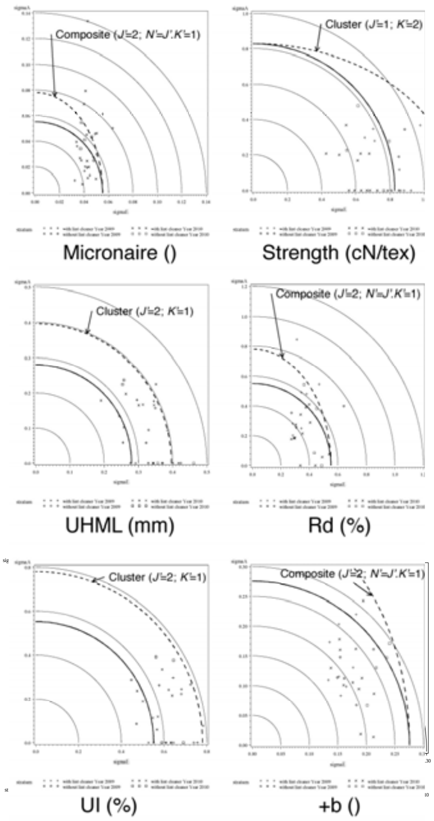
Parameters for choosing sampling and testing conditions

The objective is to comply with commercial usual tolerances with less than 10% litigation risk balewise

Characteristic	Commercial tolerance
Micronaire	± 0.1 unit
UHML	± 0,508 mm
UI	± 1%
STR	± 1.5 g/tex
Rd	± 1 %
+b	± 0.5 unit

Results

Design of iso-variance envelope curves for determining:
1- the number and type of sample (separate or mixed) per bale
2- the number of measurements per bale and the type of testing (composite or cluster) of each technological characteristic tested.



One dot = one gin

CONCLUSION

Number of samples per bale and number of measurements per sample in USA and in our new proposition for West Africa

Characteristic	Nb of samples per bale	Type of testing	Nb of replicates	Nb of meas. per sample	Total Nb of meas. per bale
			USA		
Micronaire	2	Composite	1	1	1
UHML	2	Cluster	1	1	2
UI	2	Cluster	1	1	2
STR	2	Cluster	1	1	2
Rd	2	Cluster	1	2	4
+b	2	Cluster	1	2	4
		Proposition for West Africa			
Micronaire	2	Composite	1	1	1
UHML	2	Cluster	1	2	4
UI	2	Cluster	1	2	4
STR	2	Cluster	1	2	4
Rd	2	Composite	1	2	2
+b	2	Composite	1	2	2

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Full results are published in Textile Research Journal

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