Methods of within bale variability study for cotton produced in Africa

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Introduction

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• 50% of the cotton traded in the world classed with SITC measuring Micronaire, length, uniformity, Strength, Reflectance and Yellowness
• In Africa, few bales sold with instrumental result
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  - cropping system used
  - supply area of the ginning mill
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  - ginning equipment and practices
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• Sampling and testing procedures take the within bale variability into account to determine the precision and trueness of fibre characterization
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  => Each bale includes fiber produced on a larger number of farms under different field conditions than in USA

=> Need to study within bale variability of technological characteristics of cotton fibers in African conditions to set sampling and testing operating conditions
Objectives of the study

This study focused:

• The supply area of the ginning mills
• The ginning equipment

Goal: to quantify the level of within bale variability as measured by SITC to deduce the most appropriate sampling and testing procedures for African countries

• Bales from 14 African countries
14 countries involved in the study

- MALI
- SENEGAL
- BURKINA FASO
- IVORY COAST
- TOGO
- BENIN
- CHAD
- CAMEROUN
- SUDAN
- UGANDA
- TANZANIA
- ZAMBIA
- MOZAMBIQUE
- ZIMBABWE
Materials and methods

• Two seasons: 2008-2009 season 1 and 2009-2010 season 2

• Sixty three situations were studied for:
  – their seed-cotton supply areas,
  – ginning equipment (roller vs saw) and presence or absence of lint cleaners
  – Season 1, 28 situations were sampled
  – Season 2, 35 situations were sampled
  – Some situations remained the same in both seasons
  – Others were added in the 2nd season to extend the situations
Sampling cotton fiber for the characterization

• Assumption:
  – Cotton transported in different trucks came from various villages (this may induce different levels of variability)
  – One truck holds around 18 bales of 225 kg of fibres each
Sampling cotton fiber for the characterization

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  - Cotton transported in different trucks came from various villages (this may induce different levels of variability)
  - One truck holds around 18 bales of 225 kg of fibres each
- 1 bale sampled out of every 20 bales in each situation
- 10 bales were sampled in season 1 and 5 bales in season 2
- 8 samples were collected per bale
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- 10 bales were sampled in season 1 and 5 bales season 2

- 8 samples were collected per bale

=> Season 1: 280 bales and 2239 samples tested

=> Season 2: 175 bales and 1400 samples
Samples taken from a bale

8 samples per bale
3 gins/country
Samples taken for the study

Bale n

Bale n + 20

Chronological order of production

No sample taken

Samples taken in 8 layers
I need your help to explain in English this part.

Modeste; 29.05.2011
6 measured characteristics

Micronaire (Mic, Micronaire unit)
Upper Half Mean Length (UHML, mm)
Length Uniformity Index (UI, %)
Strength (Str, g/tex)
Reflectance (Rd, %)
Yellowness (+b, Yellowness unit)

• Uster Technologies model HVI 1000 were used according to CSITC Task Force recommendations.
• Statistical analysis: R software, SAS
Material and methods

Facts:

- One bale is the result of stacking successive layers.
- One sample from each of the eight layers was evenly distributed in each bale and measured twice.
Model for data analysis

The model for analysing the acquired results was the following:

Measured result $Y =$

- $m$ bale fixed effect
- $A$ layer random effect, with std deviation $\sigma_A$
- $B$ block effect
- $E$ experimental error, with std deviation $\sigma_E$
Model for data analysis

\[ Y_{i,j,k} = m_i + A_{ij} + E_{ij,k} \]

the measured result \( Y \) is:

- \( m_i \) mean of the bale \( i \)
- \( A_{ij} \) random effect of the layer \( j \) in the bale \( i \)
- \( E_{ij,k} \) measurement error of the replicate \( k \)
  of the layer \( j \) of the bale \( i \)

with \( i \) in 1…\( I \) bales

\( j \) in 1…\( J \) layers in each bale

\( k \) in 1…\( K \) replicates in each layer.
Planned mode of exploration of the data

The two retained random effects retained as variability sources ($A$ and $E$) as:

$$\sigma_A$$

is the variance of the random layer effect,

$$\sigma_E$$

is the variance of the residual effect

to measure the “overall sampling variance” due to the operational sampling and testing conditions using a SITC
Parameters for choosing sampling and testing conditions

Not exceed a 10% litigation risk on individual bales
Respect commercial usual tolerances

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Commercial tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHML</td>
<td>+/- 0.508 mm</td>
</tr>
<tr>
<td>UI</td>
<td>+/- 1 %</td>
</tr>
<tr>
<td>Strength</td>
<td>+/- 1.5 g/tex</td>
</tr>
<tr>
<td>Micronaire</td>
<td>+/- 0.1 unit</td>
</tr>
<tr>
<td>Rd</td>
<td>+/- 1 %</td>
</tr>
<tr>
<td>X.b (Yellowness)</td>
<td>+/- 0.5 unit</td>
</tr>
</tbody>
</table>
Iso-variance curves

Design of iso-variance envelope curves for determining:
- the number and type (single or combined) of samples per bale
- the number of measurements per bale and the type (composite or cluster) of testing
 Iso-variances curves

SigmaA vs SigmaE for Gin X

Increase samples

2 samples * 1 replicate each

1 sample, 1 replicate

Increase tests

stratum

* * * with lint cleaner Year 2009
S, S, S, without lint cleaner Year 2009
E, E, E, without lint cleaner Year 2010
Iso-variance curves for Micronaire

Many situations are included in the $J'=1$ and $K'=1$ circle.

Other situations are included inside the dotted circles with $J'$ layers sampled and $K'=1$ replicate.
Formulas underlying the graphs

From the estimation of standard deviations, we can deduce the variance of the error of estimation of the bale mean:

- For any sample made of \( J' \) layers, each tested \( K' \) times (cluster)
  
  \[
  \sigma^2_M = \frac{\sigma^2_A}{J'} + \frac{\sigma^2_E}{J'K'}
  \]

- For any combined sample from \( J' \) layers, and tested \( N' \) times (composite)
  
  \[
  \sigma^2_M = \frac{\sigma^2_A}{J'} + \frac{\sigma^2_E}{N'}
  \]

- Upon hypothesis for \( J' \), \( K' \) and \( N' \), study of the improvement of sigma M as a function of sample and test numbers
Possibilities in sampling and testing

Sampling in the bale

Sample taken in the layer at the top of the bale

Various layers in the bale

Combined sample

Sample taken in the layer at the bottom of the bale
Possibilities in sampling and testing

Sample testing

Sample analysis with one replicate of one measurement per sample

Composite testing

Cluster testing

{1 measurement (meas.)}

{1 meas.}

Sample analysis with one replicate of two measurements per sample

Composite testing

Cluster testing

{2 meas. OR 1 meas.}

{1 meas.}

{1 meas.}

{1 meas.}

Sample in the bale

Sample taken in the layer at the top of the bale

Sample taken in the layer at the bottom of the bale

Various layers in the bale

Combined sample
Operating methods to be decided by situation - prospects

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• The source of additional variations could be from
  • The effect of the crop season
  • The presence or absence of lint cleaner
  • The ginning equipments
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- The source of additional variations could be from:
  - The effect of the crop season
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  - The ginning equipments
- Else, adjustments may be necessary in the seed-cotton management practices from field to gin
Limitations of the study

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- Attention: General Rules of Cotton Associations have additional litigation risks, as lot litigation risk, than on the individual bales.
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Positive extension of the study: Periodical monitoring of the within-bale variability for each situation for adjusting / confirming sampling and testing settings while respecting the agreed commercial tolerances and the litigation risk level.
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Thank you for your attention

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