Ginning: a way of measuring its specific impact on fiber quality

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International Cotton Conference, Bremen, March 2018
Seed-cotton collection => bales

Productivity & Quality depend on
Production conditions (variety, sowing date, crop management, crop protection, pests, diseases, weeds, soil, climate...)
Seed-cotton collection => bales

Productivity & Quality depend on
Production conditions + market organization...

Community seed cotton market

Grower 1
Grower 2
Grower n

Community seed cotton market

Grower A
Grower B
Grower X

Community seed cotton market

Grower I
Grower II

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Seed-cotton collection => bales

Productivity & Quality depend on
Production conditions + market organization + ginning conditions...

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Seed-cotton collection => bales

Productivity & Quality depend on
Production conditions + market organization + ginning conditions + characterization conditions

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Productivity & Quality depend on
Production conditions + market organization + ginning conditions + characterization conditions

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Source: www.intracen.org
Fiber quality: multi-scale interaction

Bale lots made up according to fiber quality to satisfy a specific requirement of buyers in the textile processing industry

Fiber quality: multi-scale interaction

Seed-cotton production and marketing

FIBRE ‘quality’

Ginning

Fiber quality characterization

Bale lots made up according to fiber quality to satisfy a specific requirement of buyers in the textile processing industry

Characterization:
- Provides an overall view
- Results of an interaction

How to measure the specific impact of one source of variability on fiber quality?
Classing characterization results

Ginning mills: O: D  Δ: E  +: G  X: I

<table>
<thead>
<tr>
<th>UHML (mm)</th>
<th>Rd (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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We will use this chart later again
Ginning process: how to measure its specific impact on fiber quality?

Management and scientific issues:

• How to trace the ginning process from fiber characterization results (collected on fiber samples)?

• How varies the ginning impact over time?

• What is the impact of each ginning step in the process?

• How to limit negative ginning impacts at acceptable levels?
Material and methods: Ginning main sequences

Source: www.intracen.org

Material flow

Seed-cotton (SC) truck/module → Seed-cotton cleaners → Gin stand 1 → Gin stand 2 → Gin stand n → Lint cleaner 1 → Lint cleaner 2 → Lint cleaner n → Bales

Module feeder or telescope → Cleaner → Cleaner → Cleaner → Gin stand → Lint cleaning → Fibres → Bale press

Source: www.intracen.org
Material and methods: Experiment 1

Industrial ginning mills A to M, on various given dates

Material flow

Seed-cotton (SC) truck/module → Seed-cotton cleaners → Gin stand 1, Gin stand 2, Gin stand n → Lint cleaner 1, Lint cleaner 2, Lint cleaner n → Bales

Micro-ginning in randomized order (include controls)

Seed-cotton (SC) fed by handfuls → homogenization → micro-ginning → Micro-gin R → $F_{out}(SC_{in})$

Samples at each of n consecutives bales for each date

Characterization in two randomized blocks (including controls)

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Togola M. et al. (2017). Feasibility study: A new way to check the stability of industrial ginning along the season, TRJ
Material and methods: Experiment 1

- **Material flow**
  - Seed-cotton (SC) truck/module → Seed-cotton cleaners → Gin stand 1 → Gin stand 2 → Gin stand n → Lint cleaner 1 → Lint cleaner 2 → Lint cleaner n → Bales

- **Length, color and trash parameters measured by SITC**
  - Micro-ginning in randomized order (include controls)
  - Seed-cotton fed by handfuls → micro-ginning → homogenization

- **Samples at each of n consecutives bales for each date**
  - Characterization in two randomized blocks (including controls)

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* Togola M. et al. (2017). Feasibility study: A new way to check the stability of industrial ginning along the season, TRJ

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*SC*<sub>in</sub>
Results: Experiment 1

Industrial ginning mill G

Solid line = $F_{out}$
Dashed line = $F_{out}(SC_{in})$

Togola M. et al. (2017). Feasibility study: A new way to check the stability of industrial ginning along the season, TRJ
Results: Experiment 1

\[ \Delta = F_{\text{out}}(SC_{\text{in}}) - F_{\text{out \: in \: Rd}} (\%) \]

Industrial ginning mill G

Togola M. et al. (2017). Feasibility study: A new way to check the stability of industrial ginning along the season, TRJ
Global impact demonstrated.

Coming from which ginning stage: SC cleaning? Ginning? Lint-cleaning?

\[ \Delta = F_{out(SC_{in})} - F_{out \ in \ Rd \ (%)} \]
Material and methods: Experiment 2

Industrial ginning mills D, E, G, I on various given dates

Material flow

Seed-cotton (SC) truck/module

Seed-cotton cleaners

Gin stand 1
Gin stand 2
Gin stand n

Lint cleaner 1
Lint cleaner 2
Lint cleaner n

Bales

Samples at each of n consecutives bales for each date

Material and methods: Experiment 2

Micro-ginning in randomized order (include controls)

Seed-cotton (SC) truck/module

Seed-cotton (SC) fed by handfuls

Micro-gin R

Characterization in two randomized blocks (including controls)

Seed-cotton (SC) truck/module

Seed-cotton (SC) fed by handfuls

Micro-gin R

References:

Togola M. et al. (2017). PhD and paper under preparation for TRJ
Material and methods: calculations of quality $\Delta$s

Material flow

Seed-cotton (SC) truck/module

Seed-cotton cleaners

Gin stand 1

Gin stand 2

Gin stand n

Lint cleaner 1

Lint cleaner 2

Lint cleaner n

Bales

$S_{cin}$

$S_{cout}$

$F_{out}$

$F_{in}$

$F_{out}(SC_{in})$

$F_{out}(SC_{out})$

$\Delta_1$

$\Delta_2$

$(\Delta_3)$

$(\Delta_5 = \Delta_2 + \Delta_3)$

$\Delta_4 = \Delta_1 + \Delta_2$

$(\Delta_6 = \Delta_1 + \Delta_2 + \Delta_3) = \Delta$ of Experiment 1
Results: Experiment 2

Industrial ginning mill D

Delta1: $SC_{out} - SC_{in}$  
Delta2: $F_{in} - SC_{out}$  
Delta4: $F_{in} - SC_{in}$
Results: Experiment 2
Results: Experiment 2

Industrial ginning mill G

Delta Rd% vs Delta

Delta1: $S_{out} - S_{in}$
Delta2: $F_{in} - S_{out}$
Delta3: $F_{out} - F_{in}$
Delta6: $F_{out} - S_{in}$

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Results: Experiment 2

Industrial ginning mill G, 13/01/2015

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
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<tbody>
<tr>
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<tr>
<td>+b</td>
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<td>10.8</td>
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<tr>
<td>SqrTrCnt</td>
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<td>4.05</td>
<td>6.14</td>
<td>4.85</td>
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</table>

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Results: Experiment 2

Industrial ginning mill G, 09/03/2015

<table>
<thead>
<tr>
<th></th>
<th>F_out(SC_in)</th>
<th>F_out(SC_out)</th>
<th>F_in</th>
<th>F_out</th>
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</thead>
<tbody>
<tr>
<td>Rd%:</td>
<td>73.4</td>
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<td>73.7</td>
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<tr>
<td>+b:</td>
<td>11.0</td>
<td>11.5</td>
<td>11.2</td>
<td>11.2</td>
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<tr>
<td>SqrTrArea:</td>
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<td>0.68</td>
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<tr>
<td>SqrTrCnt:</td>
<td>5.27</td>
<td>4.40</td>
<td>5.57</td>
<td>4.43</td>
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</tbody>
</table>

Seed-cotton cleaning

Ginning

Lint cleaning
Results: Experiment 2

Results as they come from the classing office for Rd

Industrial ginning mill G, 09/03/2015

Is there anything special here (significant) … compared to here (non significant)
Experiments conducted in industrial conditions:

- Sampling done on-line
- Micro-ginning and testing were done off-line

⇒ Delays not allowing fast maintenance actions

Would require automated sampling and testing stations

- For lint, already exists (not all characteristics)
- For SC samples: including ginning tool in addition
Application of sampling and testing stations

A) Seed-cotton cleaning $\rightarrow$ Seed-cotton $\rightarrow$ Tested gin line 1 $\rightarrow$ Tested gin line 2 $\rightarrow$ Tested gin line n $\rightarrow$ Micro-ginning $\rightarrow$ LC 1 $\rightarrow$ LC 2 $\rightarrow$ LC n $\rightarrow$ F_out

- Sampling and testing station
- Material flows
- Optional material flows
- Chosen at purpose

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Application of sampling and testing stations

A) Seed-cotton cleaning → \( SC_{out} \)

B) Seed-cotton cleaning → \( SC_{out} \)

Material flows:
- Tested gin line 1
- Tested gin line 2
- Tested gin line \( n \)
- Micro-ginning
- LC 1
- LC 2
- LC \( n \)

Sampling and testing station

Material flows

Optional material flows

* Chosen at purpose
Application of sampling and testing stations

A) Seed-cotton cleaning → SC_{out}
   SC_{in} → Tested gin line 1 → LC 1
   Tested gin line 2 → LC 2
   Tested gin line n → LC n
   Micro-ginning

B) Seed-cotton cleaning → SC_{out}
   SC_{in} → Tested gin line 1 → LC 1
   Tested gin line 2 → LC 2
   Ref. gin line n* → LC n

C) Seed-cotton cleaning → SC_{out}
   SC_{in} → Ref. gin line 1*
   Gin line 2
   Tested gin line n*
   LC 1
   LC 2
   LC n
   Sequential tests

- Sampling and testing station
- Material flows
- Optional material flows
- Chosen at purpose

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Use of sampling and testing stations
Example of logic diagram to establish an on-line diagnosis

- Ginning stage (process)
  - Samplings + characterizations
  - Contextualized results (modules, time, ginning stage, sample ID...)

- Deltas (1 to 6)
  - Load set of limits for each Delta
  - Comparison of Deltas to limits

- Display list of possible corrective actions
  - no

- Comparison of Deltas to limits
  - no
  - Deltas within limits?
    - yes
      - Display « Conform »
    - no
      - Set of limits 1

- Set of limits 1
  - no
  - SC in trashy?
    - yes
      - Display list of possible corrective actions
    - no
      - Display « Conform »
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Thank you for your attention

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