Challenges of Fibre Quality

Axel Drieling, Faserinstitut Bremen e.V., Germany

Presented at the ICAC Plenary Mumbai, December 2023
Fibre Quality – Content

- What is quality
- Different demands on quality
- Changing prerequisites
- Spinners Survey
- Retailer Survey
- Where/how to influence cotton quality
- Conclusions

Image: Cotton fibres in Scanning Electron Microscope [FIBRE]
Cotton Quality in Trading

- Basic Parameters for Trading
  - Origin
  - Staple Length (MC) – Upper Half Mean Length (Inst)
  - Color Grade (both) - Reflectance and Yellowness (Inst)
  - Leaf Grade (both) – Trash Area% (Inst)
  - Micronaire (Inst)

- Additionally often important
  - Strength (Inst)

- Unusual
  - Extraneous matter (MC)
  - Uniformity, Short Fibre Index (Inst)
  - Stickiness (Inst)
  - Preparation (MC)

MC = Manual Classing
Inst = Instrument Testing
Cotton Quality in Instrument Testing

- Cotton quality in ICAC - CSITC definition: High Volume Testing
  - Micronaire
  - Tenacity/Strength
  - Upper Half Mean Length, Length Uniformity
  - Color Reflectance and Yellowness
  - (Short Fibre Index)
  - (Trash Area% and Trash Count)

- Other instruments for additional properties
  - Stickiness
  - Nep Content
  - Gravimetric Trash
  - Fineness, Maturity
Cotton Quality – Spinners‘ Full View

- **Fineness / cross section related properties**
  - Micronaire
  - Fineness
  - Maturity

- **Length related properties**
  - UHML / UQL / Staple length
  - Average / mean length
  - Uniformity / Length CV%
  - Short fibre content / SFI

- **Strength related properties**
  - Strength/Tenacity
  - Elongation
  - Work to break

- **Colour related**
  - Color Grade
  - Reflectance (Rd)
  - Yellowness (+b)
  - UV stability

- **Trash**
  - Leaf / trash amount
  - Leaf / trash size
  - Bark / grass content

- **Other contaminants**
  - Stickiness
  - Neps / twists / knots
  - Seed coat fragments
  - Dust
  - Odour
  - Fungal infestation
  - Foreign matter

- **(Others)**
  - Wax content
  - Frictional behaviour
  - Electrostatic behaviour
  - Water absorption
  - Wet tenacity
  - Opening behaviour
  - Cleanability
  - Dyeability
  - …
“Cotton fibers are natural hollow fibers; they are soft, cool, known as breathable fibers and absorbent. Cotton fibers can hold water 24–27 times their own weight. They are strong, dye absorbent and can stand up against abrasion wear and high temperature. In one word, cotton is comfortable.”

[S.A. Hosseini Ravandi, M. Valizadeh, in „Improving Comfort in Clothing“, 2011]

Some problems for cotton seen by the final users:
- Long time needed for drying
- Wrinkling
- Missing dimensional stability
- More expensive than synthetics
- Typically mentioned sustainability issues

The view from garment and its users is totally different than from production or spinning view.

→ Additional properties, which should be considered from the first steps on.
→ It could even be possible to breed properties that are for the direct, feelable benefit of the consumers.
Quality Demands – Textile View

Cotton Fibres

Spinning process
- Waste
- Cleaning efficiency
- Spinning efficiency (ends down)
- Productivity
- ...

Yarn quality
- Evenness
- Imperfections
- Appearance
- Dyeability
- Hairiness
- Strength
- Elongation
- Friction
- ...

Fabric quality
- Appearance
- Dyeability
- Barré
- Neppiness
- Hand
- Drapeability
- Dimensional stability
- Strength
- Elongation
- Dynamometric properties
- ...

Garment quality
- Color
- Color stability
- Dimensional stability
- Durability
- Cleanability
- Pilling, abrasion
- Water absorption
- Softness
- ...

[see also: Gourlot, Bachelier, ICAC Plenary 2018, Côte d'Ivoire.
Producing fiber quality that spinners desire: Look from final consumer]

ICAC, Mumbai, December 2023

Drieling - Challenges of Fibre Quality
## Quality Demands – Textile View from Yarn to Fabric

### Yarn properties

<table>
<thead>
<tr>
<th>Yarn properties</th>
<th>Appearance</th>
<th>Dimensional stability</th>
<th>Thickness</th>
<th>Hand/Drape</th>
<th>Pilling</th>
<th>Warp and weft breakage rate</th>
<th>Holes, Knitting</th>
<th>Spirality</th>
<th>Dyeability / color intensity, fastness</th>
<th>Wash and wear properties</th>
<th>Strength</th>
<th>Elongation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass variation</td>
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<td>Neps</td>
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<td>Trash, Dust</td>
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</tbody>
</table>

[Source: Uster Training]
### Quality Demands – Textile View from Fibre to Yarn

<table>
<thead>
<tr>
<th>Fiber properties</th>
<th>Micronaire/Fineness</th>
<th>Maturity</th>
<th>Length</th>
<th>Short Fiber Content</th>
<th>Strength</th>
<th>Elongation</th>
<th>Appearance</th>
<th>Dyeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on the yarn quality characteristics</td>
<td>Evenness CVm</td>
<td>Thick places</td>
<td>Thin places</td>
<td>Neps</td>
<td>Hairiness</td>
<td>Strength</td>
<td>Elongation</td>
<td>Appearance</td>
</tr>
<tr>
<td>Micronaire/Fineness</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td>Maturity</td>
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</tr>
<tr>
<td>Short Fiber Content</td>
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<td>Strength</td>
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<td>-</td>
<td>XX</td>
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</tr>
<tr>
<td>Elongation</td>
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<td>-</td>
<td>XX</td>
<td>XX</td>
<td>-</td>
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<tr>
<td>Nep Content</td>
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<td>-</td>
<td>XX</td>
<td>-</td>
<td>-</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>Dust &amp; Trash Content</td>
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<td>XX</td>
<td>X</td>
<td>XX</td>
<td>-</td>
<td>XX</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Color / color deviation within lot</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>UV Value / UV deviation within lot</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>-</td>
</tr>
</tbody>
</table>

[Source: Uster Training]
Quality Demands – Spinning Method

Different spinning types produce different kinds of yarns with different properties and with different demands on fibre quality.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Ring Spinning (Including Compact Spinning)</th>
<th>Rotor Spinning</th>
<th>Air Jet and MVS Spinning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length and Length Uniformity</td>
<td>Micronaire, Fineness</td>
<td>Length and Length Uniformity</td>
</tr>
<tr>
<td>2</td>
<td>Strength</td>
<td>Strength</td>
<td>Short Fiber Content</td>
</tr>
<tr>
<td>3</td>
<td>Micronaire, Fineness</td>
<td>Length and Length Uniformity</td>
<td>Strength</td>
</tr>
<tr>
<td>4</td>
<td>Trash Content</td>
<td>Trash, Dust, and Seed Coat Fragments</td>
<td>Trash Content</td>
</tr>
</tbody>
</table>

[Source: Uster Training]
Quality Demands – Harvesting/Ginning

- High ginning outturn
- Low fibre breakages
- And low adhesion between fibre and seed
  - So that the length distribution can be preserved
- …
Quality and Economic Efficiency

Farmers:
Cotton Quality
↔
Cotton Quantity: Yield potential and actual yield

Achievable price per kg
(related to quality)

Achievable income per ha
(related to quantity AND quality)

Spinners:
Cotton Quality
↔
Input material costs

The spinners need a minimum, assured quality for the specific purpose
↔
But spinners will avoid paying for quality beyond the necessary level

Best quality is not the only demand on cotton!
Finally, everyone in the cotton and textile value added chain has to take care for the economic, but also for the ecologic and the social responsibility.
Challenges for Quality: Prerequisites with Impact on Quality and Quality Demands (1)

- Cotton production
  - Environmental challenges / climatic changes
    - Higher temperatures – increased stress
    - El Ninjo
    - Example: Recent Australia Color Grade changes due to rain
    - Example: Floods in Greece, reducing the harvested amount AND the quality (color, strength…)
  - New pest infestations
    - Like Jassid / Leaf Hopper in West Africa

- Harvesting
  - Hand-picking vs. Machine harvesting
  - Picker vs. stripper

- Ginning
  - Faster ginning.
  - New, highly efficient methods
Changing Prerequisites with Impact on Quality and Quality Demands (2)

- **Spinning**
  - Utilization of new spinning methods
  - Increased quality demands for yarns
  - Improved cleaning possibilities

- **Textile production**
  - Increased competition to man-made fibres
    - synthetic fibres (price, new properties)
    - cellulosic fibres (comparable properties to cotton, but some advantages)

- **Changing customer demands**
  - Sustainable production
Surveys as the Basis for this Presentation

Bremen Survey on Cotton Quality Demands 2020/21
“SPINNERS SURVEY”
- Focus / Questions
  • Mainly on cotton quality
  • Additionally on Cotton Identity Programs
- 2nd implementation in 2020/2021
- *(1st implementation in 2016/2017)*
- Worldwide
- Implemented by
  • Faserinstitut Bremen eV.
  • Bremer Baumwollboerse
  • ITA Academy

Bremen Retail/Brand Survey 2020/21
“RETAIL SURVEY”
- Focus / Questions
  • Cotton Quality
  • Sustainability
  • Supply Chain Transparency
- 1st implementation 2020/2021
- Focus on German Retail/Brands
- Implemented by
  • Bremer Baumwollboerse
Bremen Spinners Survey 2020/21: Participants

• Respondents 2020/21: 249
• (Respondents 2016/17: 179)
• Mainly from spinning (71%, but also including other company activities)
• Countries / Regions – covering most important regions
  • Europe 40
  • Brazil 39
  • East Asia 26
  • India 24
  • Turkey 22
  • USA 16
  • China 15
  • Pakistan 12
  • Other 55
Bremen Spinners Survey 2021/21: Participating Spinners

- Daily yarn production of the respondents from spinning is between < 10 tons to > 100 tons – evenly distributed
- Produced yarn counts from < Ne15 to > Ne 60 (with a slight focus for Ne 15-30)
- Spinning technologies (multiple answers)
  - 84% Ring spinning
  - 55% Compact ring spinning
  - 63% Rotor spinning
  - 27% Air jet spinning
  - 16% Wrap spinning / core yarns
- Processed materials
  - Cotton 100%
  - PES 48%
  - Cellulosics 44%
  - Other natural 48%
  - Other man-made 65%
Retail Survey: Participants

31 ANSWERS FROM 24 COMPANIES:
BIEDELACK
BONPRIX
CAMP DAVID
FRUIT OF THE LOOM
JEANS FRITZ
KIK
OLYMP
ORSAY
OTTO
SEIDENSTICKER
S.O.LIVER
TCHIBO
TOM TAILOR
WASCHBÄR
WITT WEIDEN
...AND MORE

ICAC, Mumbai, December 2023  Drieling - Challenges of Fibre Quality
## Bremen Spinners Survey 2020/21: Reasons for Choosing Sources

### Reasons for choosing cotton sources [% of respondents]

<table>
<thead>
<tr>
<th>Reasons for choosing sources</th>
<th>Very important</th>
<th>Important</th>
<th>Less important</th>
<th>Not important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>55</td>
<td>18</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Availability / reliability</td>
<td>47</td>
<td>22</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Price</td>
<td>42</td>
<td>27</td>
<td>14</td>
<td>13</td>
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<tr>
<td>Sustainability</td>
<td>29</td>
<td>27</td>
<td>22</td>
<td>13</td>
</tr>
</tbody>
</table>

→ **First!**

→ **Less important !?**
Important yarn properties [up to 3 answers; % of respondents]

Those cotton properties have to be given that assure that the demanded yarn quality parameters can be achieved.
What are the defects or deficiencies of cotton fibres that affect yarn properties [Multiple answers; % of respondents]

- Micronaire: 77%
- Fineness: 68%
- Maturity: 62%
- Average length / staple length: 64%
- Length uniformity / CV%: 78%
- Short fibre content / Short fibre index: 77%
- Strength / Tenacity: 55%
- Elongation: 49%
- Yellowness (+b): 56%
- UV stability: 55%
- Leaf / trash amount: 60%
- Leaf / trash size: 52%
- Bark / grass content: 55%
- Stickiness (Sugar / Seed Oil): 42%
- Seed coat fragments: 42%
- Dust: 28%
- Fungal infestation: 16%
- Odour: 21%
- Foreign matter: 53%
- Other: 8%

2016/17: 78 62 72 62 79 82 48 59 65 55 64 58

ICAC, Mumbai, December 2023
Bremen Spinners Survey 2020/21: Property Improvements

If one property could be improved, which one should [1 answer; % of answers]

<table>
<thead>
<tr>
<th>Property</th>
<th>2016/17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fineness related</td>
<td>14%</td>
</tr>
<tr>
<td>Length related</td>
<td>46%</td>
</tr>
<tr>
<td>Strength related</td>
<td>19%</td>
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<tr>
<td>Colour related</td>
<td>4%</td>
</tr>
<tr>
<td>Trash related</td>
<td>5%</td>
</tr>
<tr>
<td>Other contaminants</td>
<td>11%</td>
</tr>
<tr>
<td>Foreign matter</td>
<td>n.m.</td>
</tr>
</tbody>
</table>
If one property could be improved, which one should it be [1 answer; % of answers]
### Bremen Spinners Survey 2020/21: Spinning Technologies

What capacity shares to you expect in 10 years for the different spinning technologies [% of respondents]

<table>
<thead>
<tr>
<th>Spinning Technology</th>
<th>More</th>
<th>No change</th>
<th>Less</th>
<th>I don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring Spinning</td>
<td>18</td>
<td>32</td>
<td>31</td>
<td>19</td>
</tr>
<tr>
<td>Compact Ring Spinning</td>
<td>43</td>
<td>22</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>Rotor Spinning</td>
<td>27</td>
<td>33</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Air Jet Spinning</td>
<td>45</td>
<td>19</td>
<td>11</td>
<td>22</td>
</tr>
</tbody>
</table>
Which fibre properties to improve for Airjet Spinning [multiple answers; % of respondents]

<table>
<thead>
<tr>
<th>Property</th>
<th>% of Respondents</th>
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</thead>
<tbody>
<tr>
<td>Micronaire</td>
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<td>Fineness</td>
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<td>Maturity</td>
<td>41</td>
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<tr>
<td>UHML / UQL / staple length</td>
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<td>Average length / mean length</td>
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<td>Length uniformity / Length CV%</td>
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<td>Short fibre content / Short fibre index</td>
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<td>Strength / Tenacity</td>
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<tr>
<td>Elongation</td>
<td>55</td>
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<tr>
<td>Work to break</td>
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<td>Reflectance (Rd)</td>
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<tr>
<td>Yellowness (+b)</td>
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<tr>
<td>UV stability</td>
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</tr>
<tr>
<td>Leaf / trash amount</td>
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<tr>
<td>Leaf / trash size</td>
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<tr>
<td>Bark / grass content</td>
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<td>Stickiness (Sugar Seed Oil)</td>
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<tr>
<td>Neps / twists / knots</td>
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<tr>
<td>Seed coat fragments</td>
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<tr>
<td>Dust</td>
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<td>Odour</td>
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<tr>
<td>Fungal infestation</td>
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<tr>
<td>Foreign matter</td>
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<tr>
<td>Other</td>
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</tr>
</tbody>
</table>
Bremen Spinners Survey 2020/21: Spinning Technologies

• Summary of answers for cotton improvements for Air Jet Spinning.
  • All length parameters are of highest importance, higher than for other spinning technologies.
  • Strength is less important than for other spinning methods, but elongation is staying as important as before.
  • Fineness here seems to be more important than maturity.
  • Trash and other contaminations create more problems than for other technologies.
  • Colour is even less important than for other spinning technologies, the percentages are recuced to 1/2.
Which are today the top 3 properties of man-made fibres [3 answers; % of respondents]

- High Tenacity: 71%
- High Elongation: 48%
- Low shrinkage: 31%
- Water absorbency: 27%
- Filament count: 22%
- Service temperature: 15%
- Melting temperature: 14%
- UV stability: 11%
- Low electr. conductivity: 8%

Cotton: ✗ ✗ ✓ ✓ ( ) ✓ ✓ ✓ ✓
Both Surveys 2020/21: Competing Fibres

Spinners Survey: Fibres in competition with cotton in future [3 answers; % of respondents]

- PES/PET: 55%
- Polypropylene (PA6/PA6.6): 8%
- Polyacrylcs: 15%
- Cellulosic fibres: 73%
- Other: 5%

2016/17: 75% 63%

Retailer Survey: Competing fibres [Multiple answers / % of respondents]

- PES / PET: 39%
- Polyamide: 11%
- Polyacrylcs: 14%
- Viscose: 79%
- Other: 11%

ICAC, Mumbai, December 2023
Drieling - Challenges of Fibre Quality
Bremen Spinners Survey 2020/21: Fibre Blends

Important global trends for fibre use / blends [% of respondents]

Cotton and synthetic fibre blends will:

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>Stable</th>
<th>Decrease</th>
<th>I don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>47</td>
<td>27</td>
<td>11</td>
<td>13</td>
</tr>
</tbody>
</table>

Cotton and cellulosic fibre blends will:

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>Stable</th>
<th>Decrease</th>
<th>I don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>43</td>
<td>30</td>
<td>8</td>
<td>12</td>
</tr>
</tbody>
</table>
Both Surveys 2020/21: Fibre Blends

Spinners Survey: Reasons for blending cotton [3 answers, % of respondents]

- Quality consistency: 62%
- Customer request: 63%
- Processability: 49%
- Costs: 28%
- Other: 11%

Retailer Survey: Reasons for blending

- Price: 60%
- Easy Care: 43%
- Fitting: 43%
- Design / Color Options: 43%
- Quality Consistency: 50%
- Processability: 17%
- Durability: 50%
Where to Influence the Cotton Quality (1)

Cotton quality is influenced in every segment of the value added chain. Every segment has its own responsibility and can preserve or deteriorate the quality.

- Genome / breeding
- Agronomy / surrounding
  - Influenced by weather, irrigation, nutrients, pests and pest control...
- Harvesting
  - Influenced by harvesting time, hand picking vs machine picking, machine type
  - Influence on
    - Maturity
    - Trash content
    - Contaminations
    - Color, deterioration due to rain or microbial attack
    - Foreign matter
Where to Influence the Cotton Quality (2)

• Ginning
  – Influenced by type of gin, ginning speed, gin maintenance
  – Influence on
    • Fibre breakages / Length distribution / Short Fibre Content
    • Trash
    • Neps
    • Color, deterioration due to rain or microbial attack

• Testing
  – Only those properties that are suitably measured allow spinners to systematically utilize these properties
  – Only those properties that are suitably measured can be the basis for improvements
  – Only those properties that are suitable measured allow payments for the quality and hence improvements
  – Only those properties that are sufficiently harmonized allow to use these properties in trading

• Spinning / textile manufacturing
  – Spinning agents
  – Permanent finishes
  – Blending with man-made or other natural fibres
Conclusions (1)

- A very wide range of quality parameters is given already for spinning, more than those that are typically used for trading. And these should be considered and addressed.
- Each step in the value added chain has a different view on quality and its relation to the fibres. For breeding it is hence important to understand the textile process.
- It will even be useful to look at the quality demands of the final consumer, if/how their demands can be fulfilled.
- Quality is NOT the only aim, but is for farmers always in relation to the quantity → income per ha.
- One major aspect for improving cotton quality is suitable payments for the quality to the farmers.
- Spinners do not need the best quality but a minimum and assured quality for a considerable price.
- With changing prerequisites, the demand on the various quality parameters are changing.
- …
Conclusions (2)

- Survey:
  - Quality is still the most important factor for choosing cotton sources.
  - Although other properties are important, too, length is still the most important property group.
  - Length is defined as staple length plus uniformity plus short fibre content, being at least as important.
  - Besides length, strength related and cross-section related properties show the highest importance. But several contaminations are also important.
  - With the increasing use of new spinning technologies like air-jet spinning, the demands on cotton properties are changing. Length is getting even more important.
  - For fibres competing to cotton, cellulosic fibres are as important polyester.
  - Cotton blends with other fibres will increase, combining the benefits of all included fibres.
Conclusions (3)

- Man-made fibres show
  - The natural benefits of cotton
  - The importance of both strength and elongation
- Cotton properties can be influenced on many stages, not only breeding.
  - Every segment of the value added chain has its own responsibility and can preserve or deteriorate the quality that is potentially given in genes.
  - Measurements should be able to reflect all important quality parameters
Thank you very much for your attention!

My special thanks go to Jean-Paul Gourlot and Marc Giband at CIRAD and Jens Wirth and Karsten Fröse at the Bremen Cotton Exchange for the very good discussions on the topic.