

# **When the seed breaks, when the fibre sticks...**

## **Some contaminants of cotton**

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*Centre for International Cooperation in Agricultural Research for Development*

*Montpellier (France)*

# When the seed breaks, when the fibre sticks...

## Some contaminants of cotton

- **Some words about CIRAD**
- Cotton contamination
- Seed-coat fragments
- Stickiness
- Conclusion

# Some words about CIRAD

## In a nutshell

- French Agricultural Research Centre for International Development
- A public establishment (*under the joint authority of the Ministry of Higher Education, Research and Innovation and the Ministry for Europe and Foreign Affairs*)
- A staff of 1,800 incl. 800 researchers in 33 research units
- Goal: sustainable development of tropical and Mediterranean regions
- Activities: life sciences, social sciences and engineering sciences, applied to agriculture, food, the environment and territorial management
- Main topics: food security, climate change, natural resource management, reduction of inequalities and poverty alleviation





**Cotton**



**Sugarcane**



**Cocoa**



**Coffee**



**Rice & sorghum**



**Fruits & vegetables**



**Bananas & plantains**



**Oil palms**



**Livestock production**



**Fisheries production**



**Hevea**



**Forest species**

# When the seed breaks, when the fibre sticks...

## Some contaminants of cotton

- Some words about CIRAD
- **Cotton contamination**
- Seed-coat fragments
- Stickiness
- Conclusion



# Cotton contamination

In which products?

- In seed-cotton or in cotton fibre



© CIRAD

# Cotton contamination

## What is it (in the broad sense)?

- Exogeneous material = **Foreign matter** (anything that is not part of the cotton plant): non-cotton fibres, strings, yarns and fabrics, organic and inorganic matters (grass, sand...), chemicals...



© CIRAD



# Cotton contamination

What is it (in the broad sense)?

- Endogeneous material = Parts of the cotton plant: trash, seeds, organic matters, abnormal fibers





# Cotton contamination

## Which origins?

- Endogeneous {
  - Vegetal: physiological sugars, cotton fibre (*neps, short, immature, dead, bleached...*), cotton seeds (*complete, broken, aborted=motes, seed-coat fragment*), trash (*leaf, bract, grass, bark, non-cotton seeds*), fungi (*sooty mould*)...
- Exogeneous {
  - Animal: honey dew, feather, hair, pest...
  - Mineral: stone, sand, soil, dust...
  - Human: plastic (*woven, film*), natural fibre/fabric (*jute, hessian, cotton, wool...*), paper, leather, metal, wire, rust, stamp color, tar, grease, oil, rubber...

# Cotton contamination

## Which possible consequences?

- At seed-cotton level: → more intensive cleaning  
→ higher ginning cost  
→ more fibre or seed damages  
→ lower fibre and seed quality
- At fibre level: → more intensive cleaning  
→ higher spinning cost  
→ more fibre damage  
→ more processing problems  
→ lower productivity

# Cotton contamination

## Which possible consequences?

- At yarn level: → defects (neps, thin & thick places)  
→ lower quality

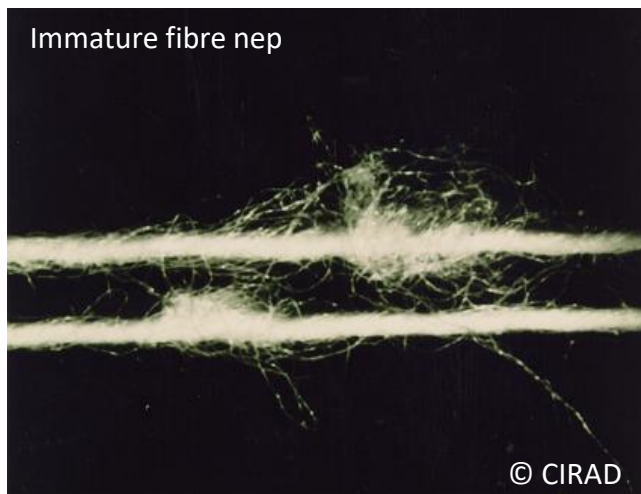


© CIRAD



# Cotton contamination

## Which possible consequences?



# Cotton contamination

## Which possible consequences?

- At fabric level: → defects  
→ lower quality



© CIRAD

# Cotton contamination

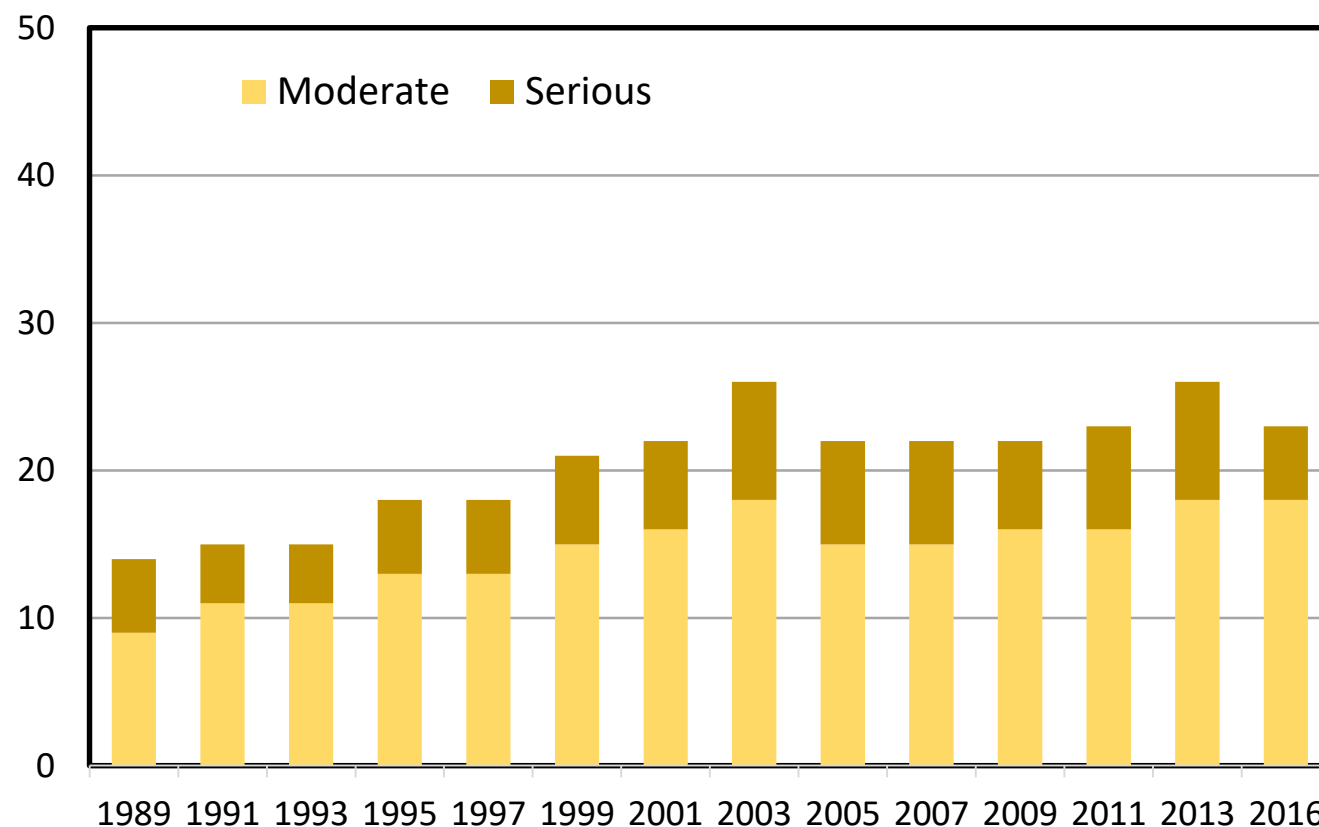
## What figures are available?

- Cotton Contamination  
Surveys from 1989 to 2016  
by ITMF (International Textile  
Manufacturers Federation)

→ nearly 1/4 of cottons  
evaluated are contaminated  
by foreign matter

## Contamination (foreign matter)

% of all cottons evaluated





# Cotton contamination

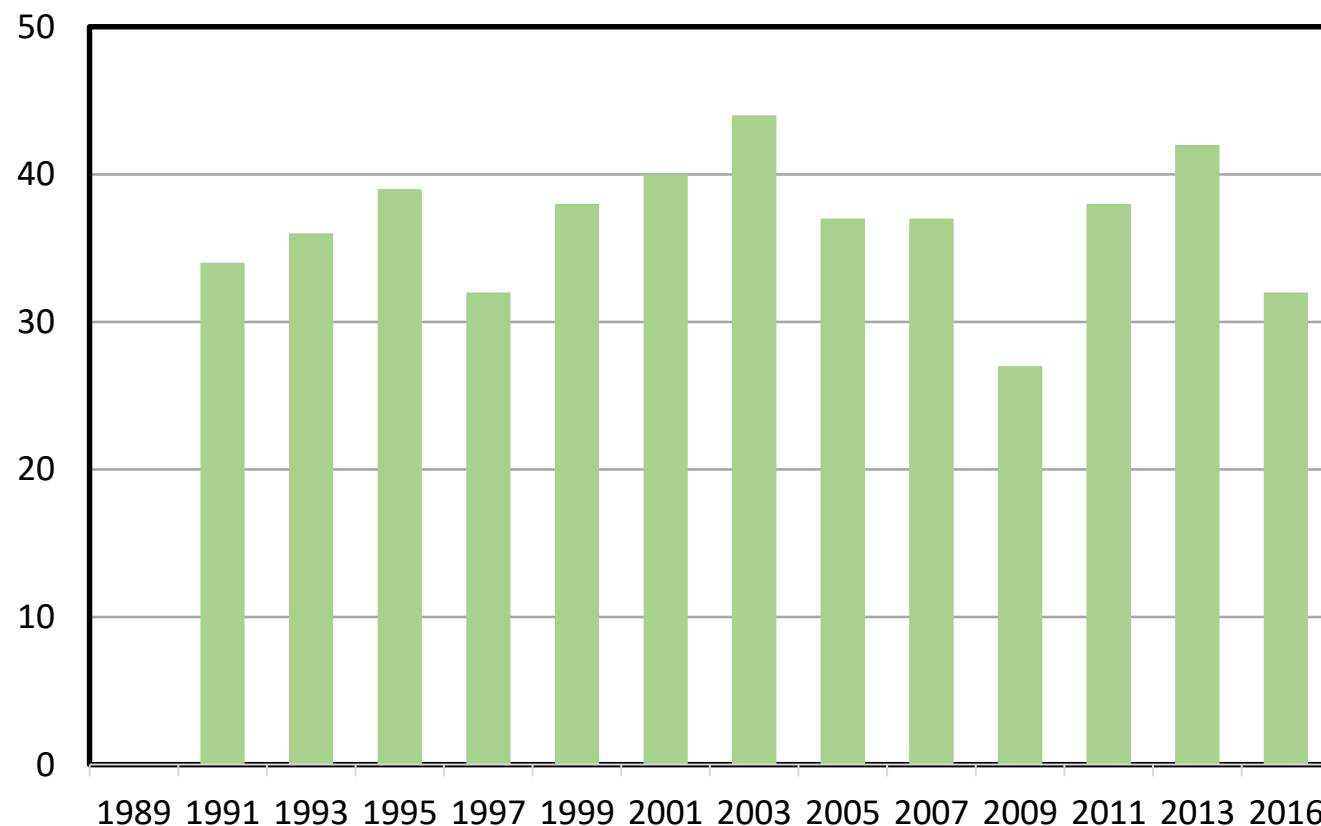
## What figures are available?

- Cotton Contamination Surveys from 1989 to 2016 by ITMF (International Textile Manufacturers Federation)

→ nearly 1/3 of cottons evaluated contain SCF

## Seed-coat fragments

% of all cottons evaluated



# Cotton contamination

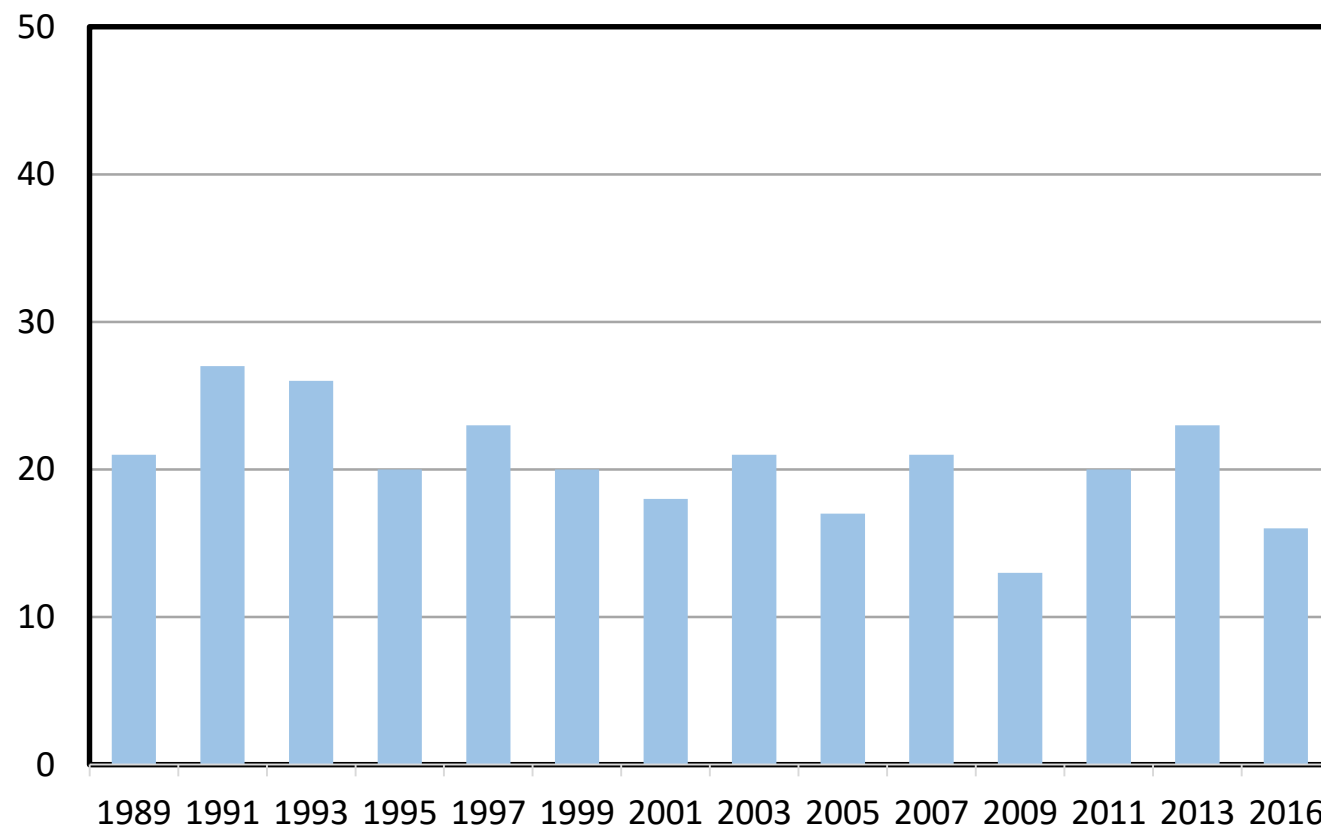
## What figures are available?

- Cotton Contamination Surveys from 1989 to 2016 by ITMF (International Textile Manufacturers Federation)

→ nearly 1/5 of cottons evaluated are sticky

## Stickiness

% of all cottons evaluated



# When the seed breaks, when the fibre sticks...

## Some contaminants of cotton

- Some words about CIRAD
- Cotton contamination
- **Seed-coat fragments**
- Stickiness
- Conclusion



# Seed-coat fragments

## Back to the 30's – 50's

- Pearson, N. L. (1937). Naps, neps, motes, and seed-coat fragments. A description of certain elements of cotton quality. [Technical Bulletin. Washington, D.C. \(USA\), USDA, Bureau of Agricultural Economics: 7 p.](#)
- Pearson, N. L. (1939). Relation of the structure of the chalazal portion of the cotton seed coat to rupture during ginning. [Journal of Agricultural Research 58\(11\): 865-873.](#)
- Pearson, N. L. (1955). Seed coat fragments in cotton - an element of yarn quality. [Technical Bulletin. Washington, D.C. \(USA\), USDA: 17 p.](#)

**SCF « are bits of tissue from either motes or seeds with tufts or fibers attached »**

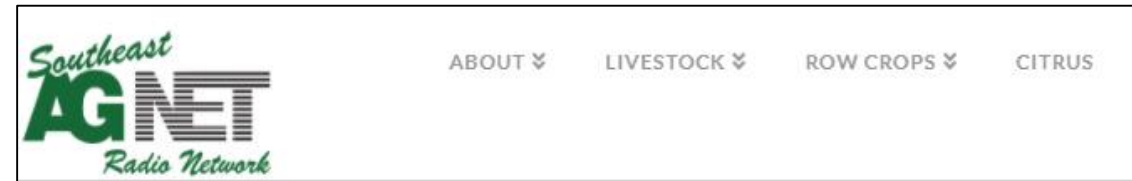
# Seed-coat fragments

## More publications from the 60's

- Gupta, P. S. and M. Radhakrishnan (1961). Some observations on seed coat nep proneness in relation to lint index
- ASTM (1963). Standard test methods for seed coat fragments and funiculi in cotton fiber samples
- Mangialardi, G. J. J. and J. V. Shepherd (1968). Seed Coat Fragment and Funiculus distribution in ginned lint as affected by lint cleaning
- Perkins, H. H. J. (1971). Determination of seed-coat fragments in cotton by solvent-extraction and infrared spectrophotometric analysis
- Barger, J. D. and T. H. Garner (1987). Predicting seed-coat fragment contamination in cotton
- Anthony, W. S., *et al.* (1988). Seed-coat fragments in ginned lint: the effect of varieties, harvesting, and ginning practices
- ...

# Seed-coat fragments

And still a problem in 2020...



**UF** | IFAS Extension  
UNIVERSITY of FLORIDA

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## Cotton Seed Coat Fragments – A Serious Issue for Panhandle Farmers in 2020

by external | Jan 22, 2021 | Cotton, Field Crops, Weather

## Seed Coat Fragments Another Problem for Alabama Cotton Producers

📅 JANUARY 8, 2021 /



A trained cotton classer opening samples to inspect for extraneous matter. Credit: AMS Cotton & Tobacco Program.

**USDA** Agricultural Marketing Service  
U.S. DEPARTMENT OF AGRICULTURE

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## Statement Regarding Seed Coat Fragments in Cotton Produced in the Southeast

Overview

Our Leadership

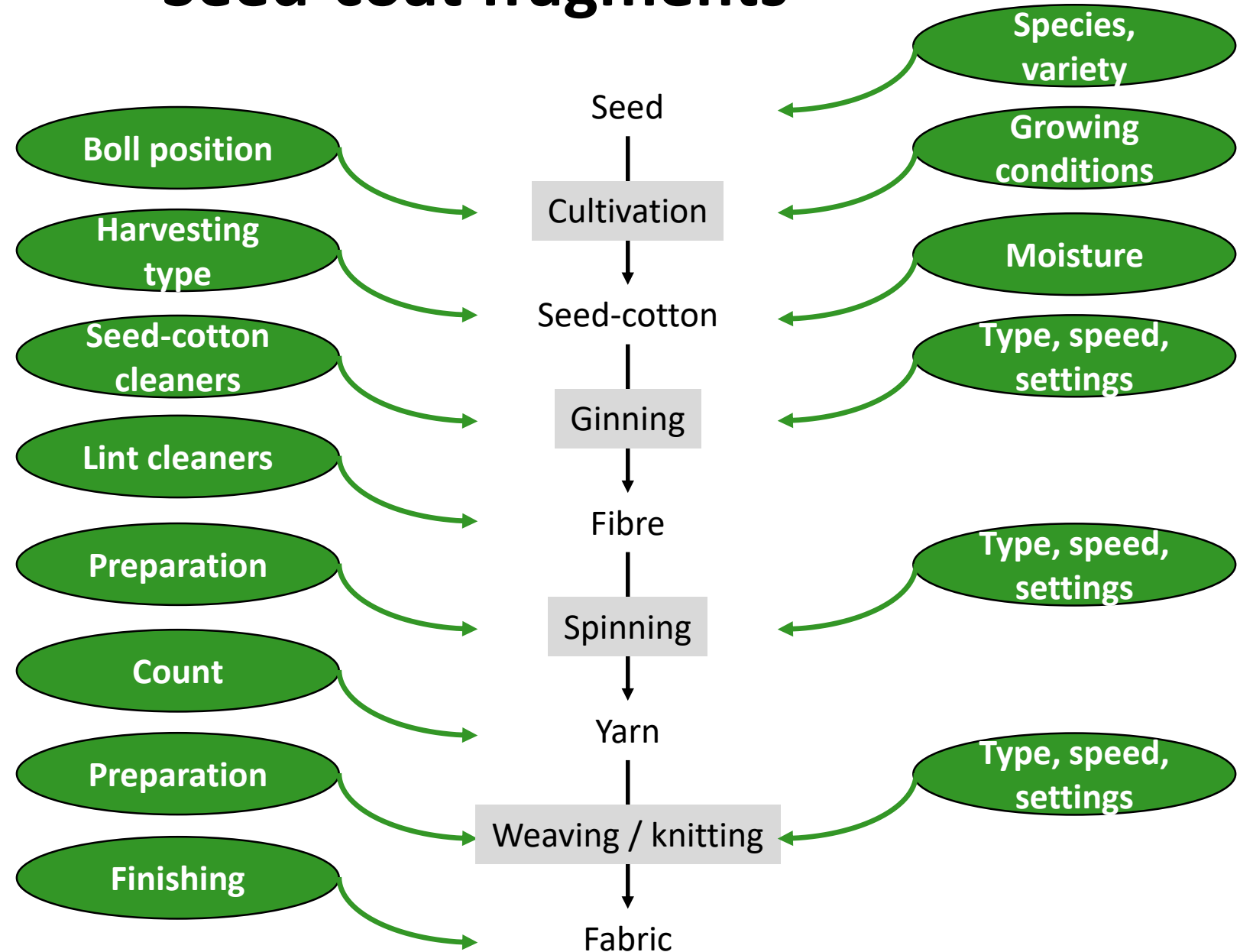
[HOME](#) > STATEMENT REGARDING SEED COAT FRAGMENTS IN COTTON PRODUCED IN THE SOUTHEAST

**Date:** Tuesday, January 5, 2021 - 2:30pm



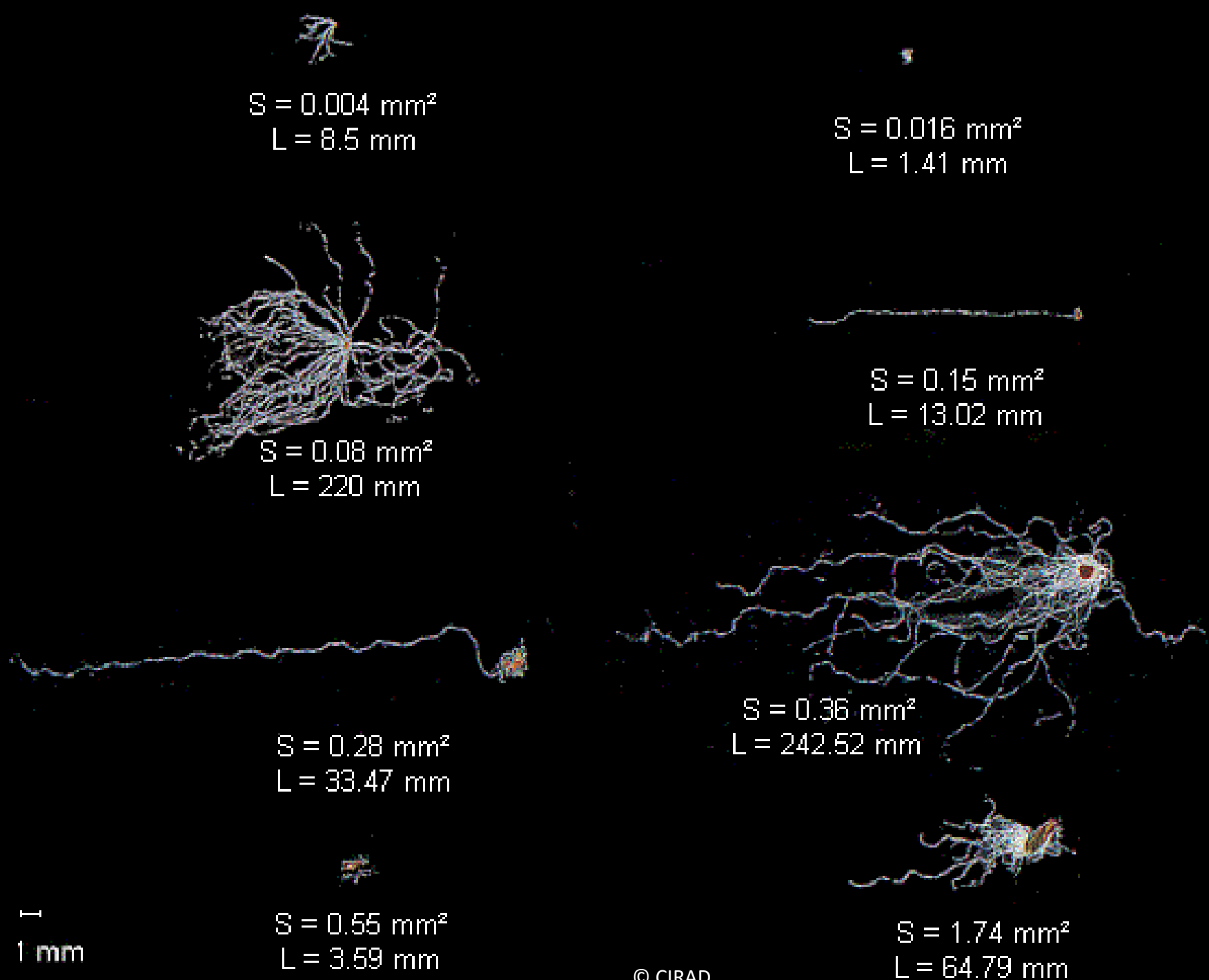
# Seed-coat fragments

Many sources  
of variability



## Variability of fibres attached to SCF

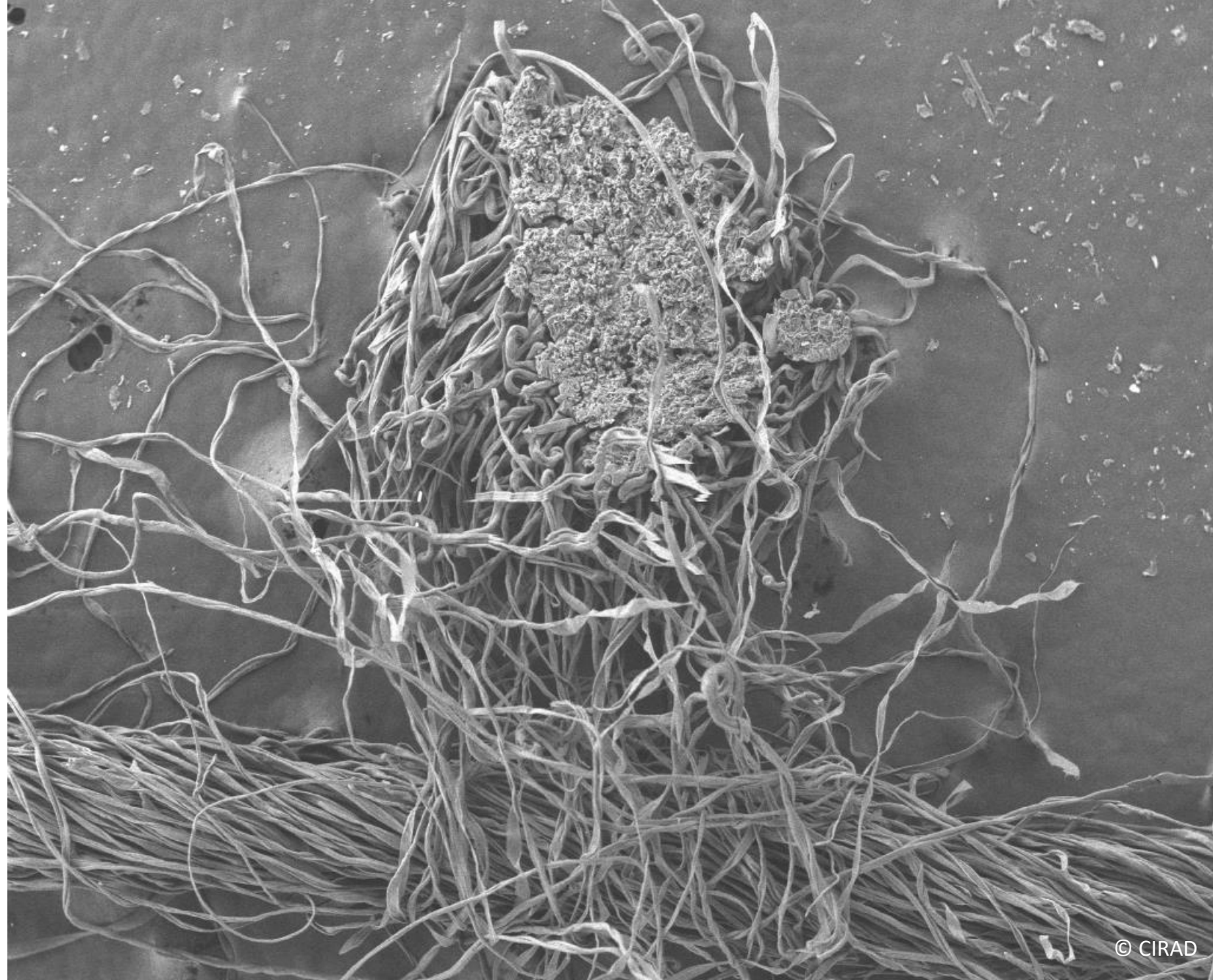
From Krifa *et al.*, 2002



SCF outside the yarn

→ SC nep

From Krifa, 2001



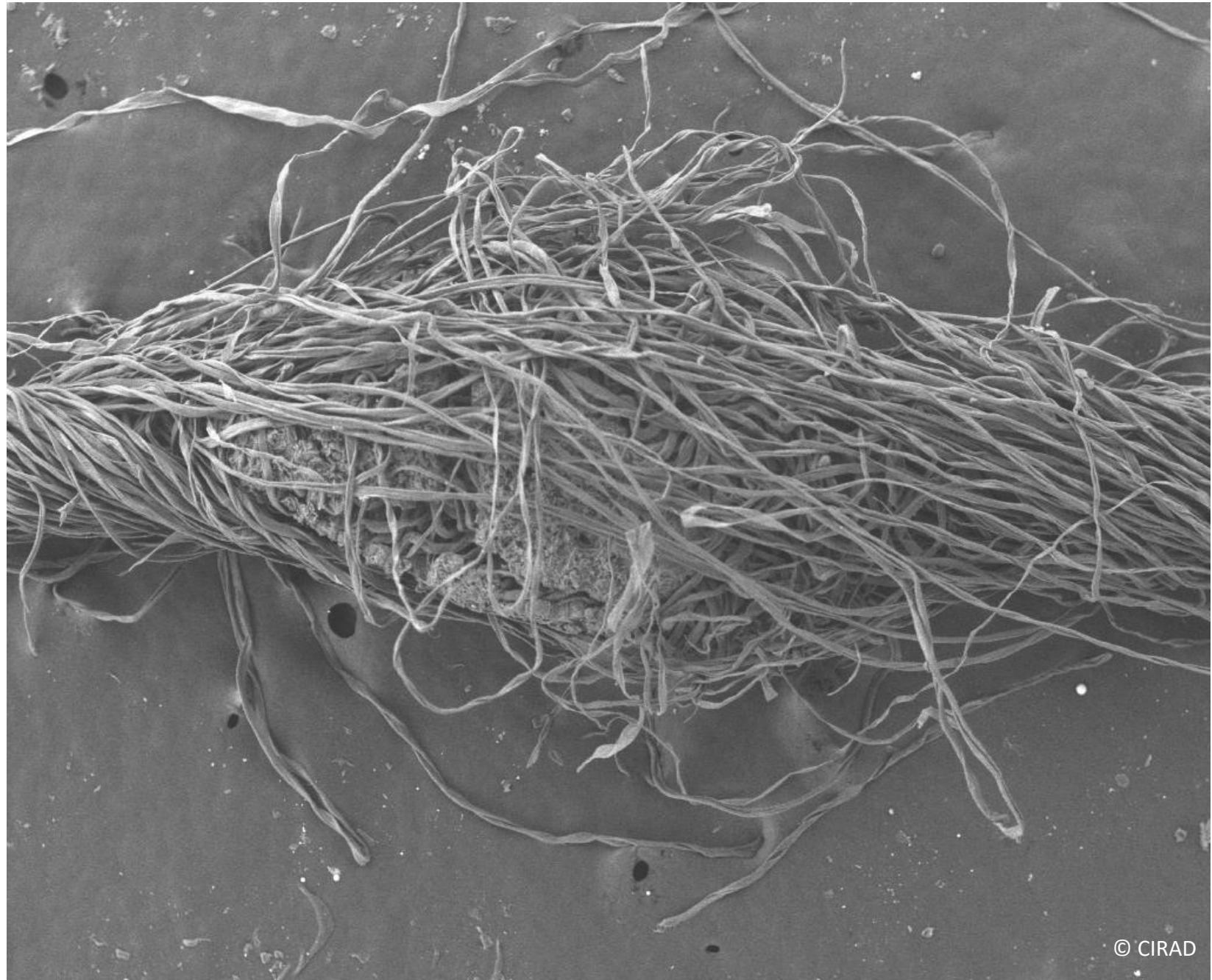
© CIRAD



SCF inside the yarn

➔ Thick place

From Krifa, 2001





# Seed-coat fragments

## Histological examination



© CIRAD

Chalaza

Seed-coat

Micropile



© CIRAD

# Seed-coat fragments

Seed-coat breakage  
at chalaza



© CIRAD

Chalaza after delinting



© CIRAD



# Seed-coat fragments

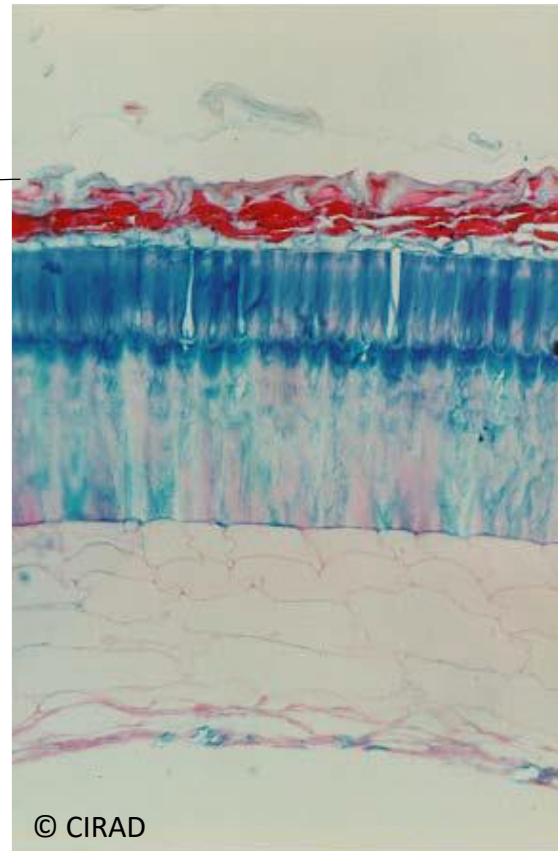




# Seed-coat fragments

## Histological examination

Lateral face  
of the seed



External  
mesophyl

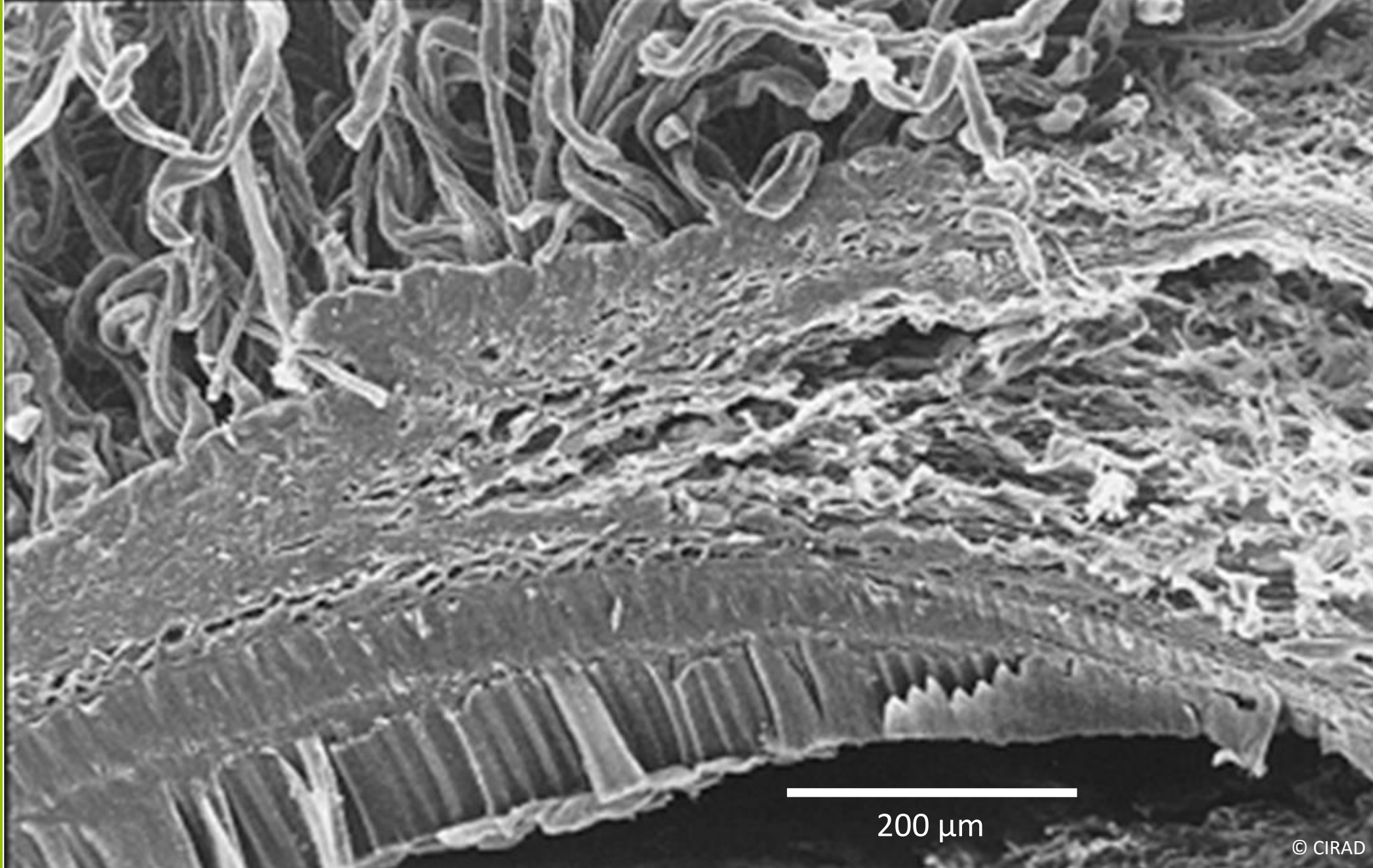


Internal  
mesophyl

Chalaza

200  $\mu$ m

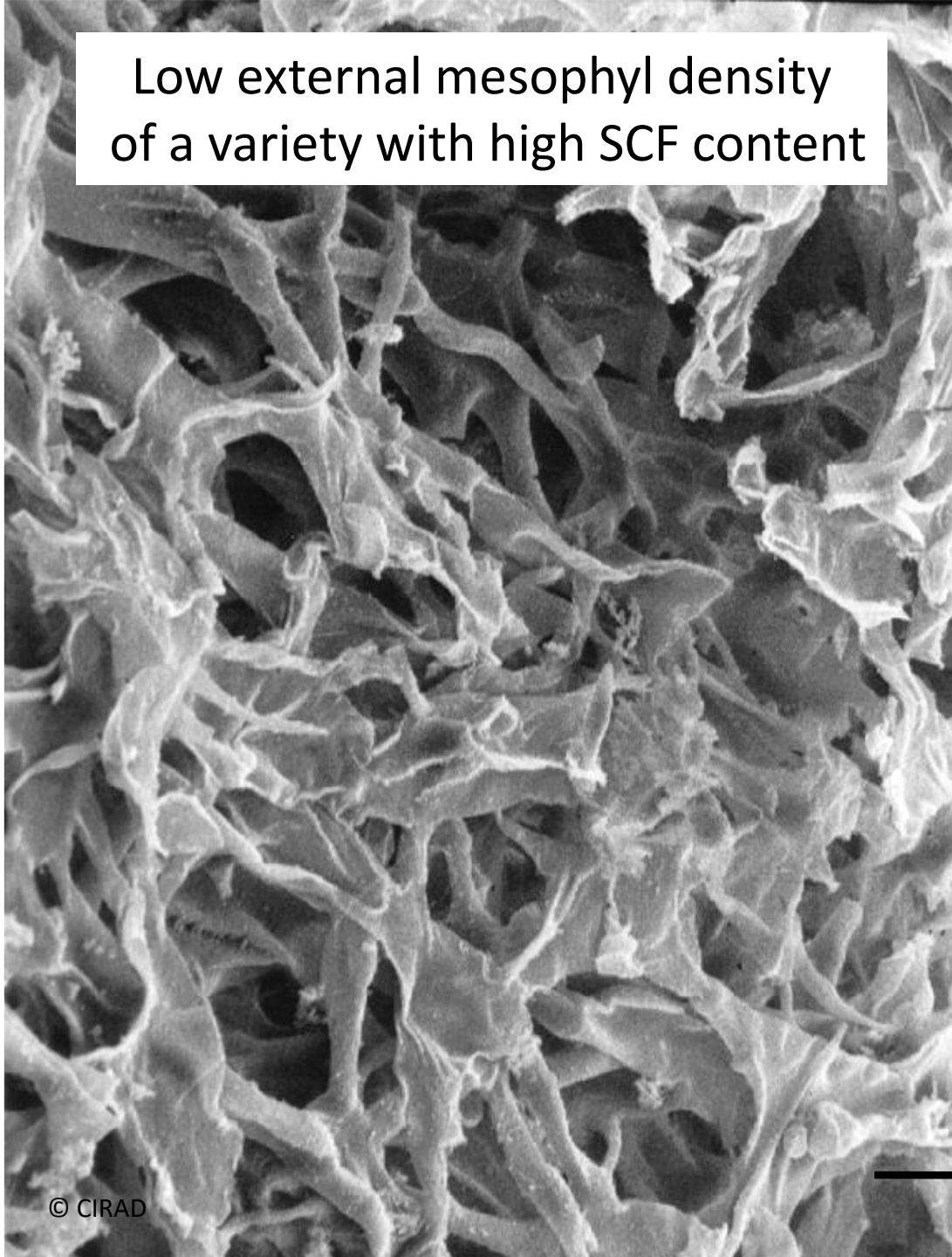




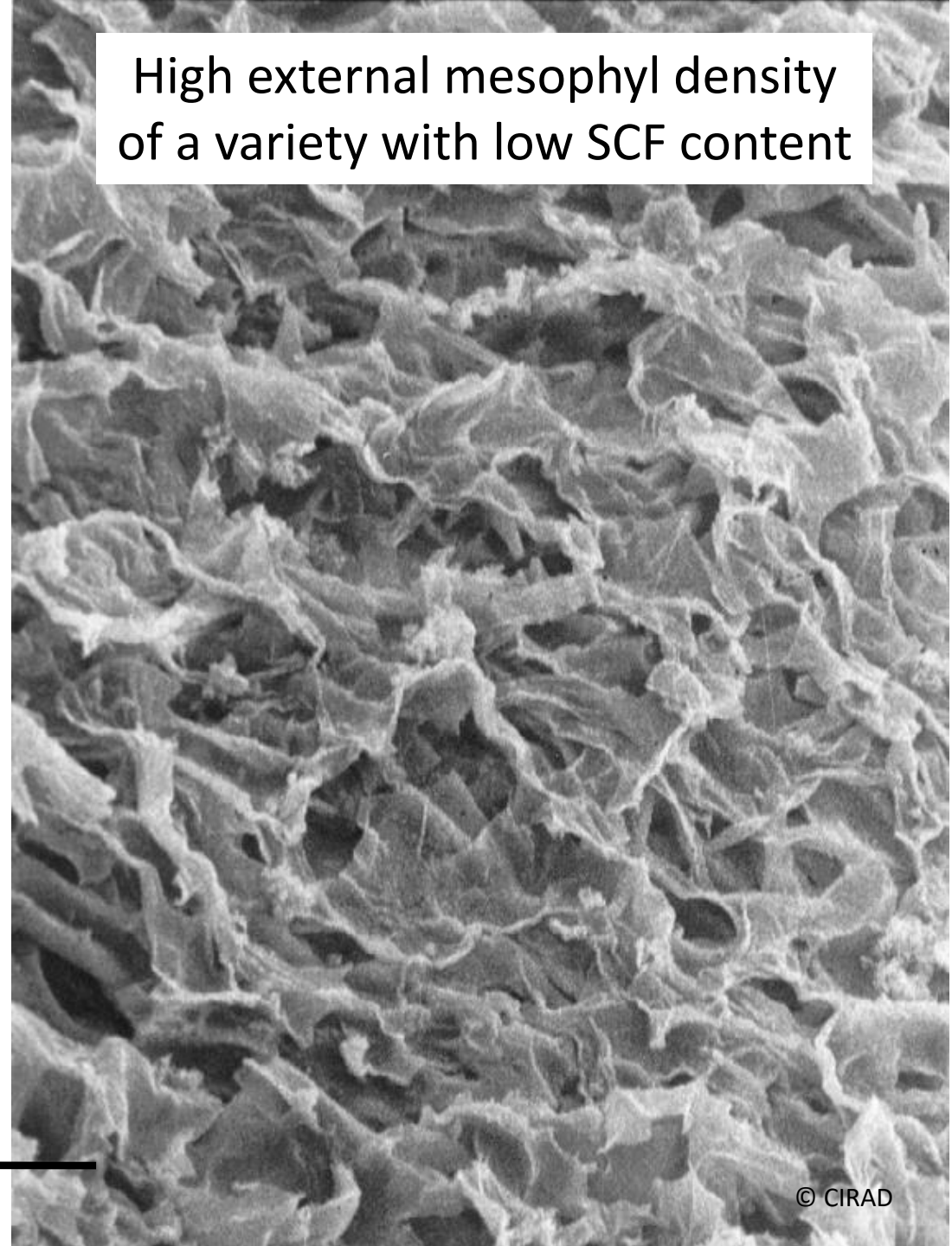
External  
mesophyll  
at chalaza  
level



Low external mesophyll density  
of a variety with high SCF content

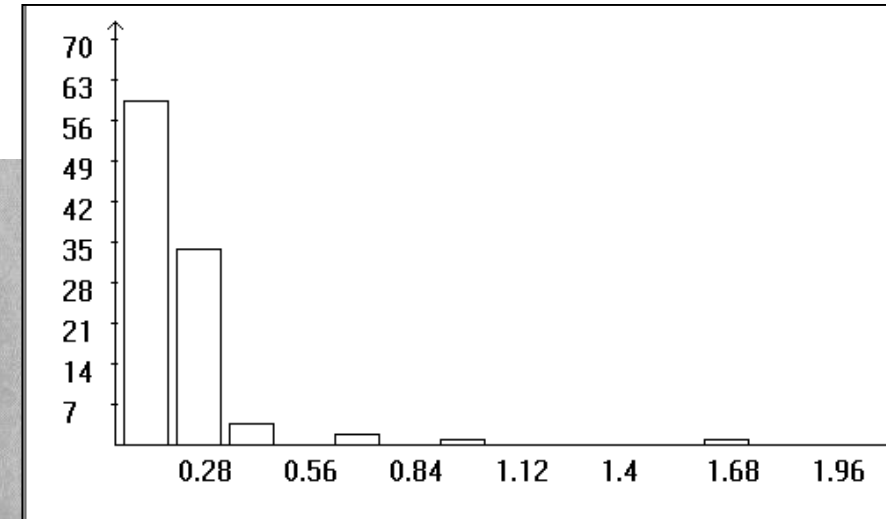
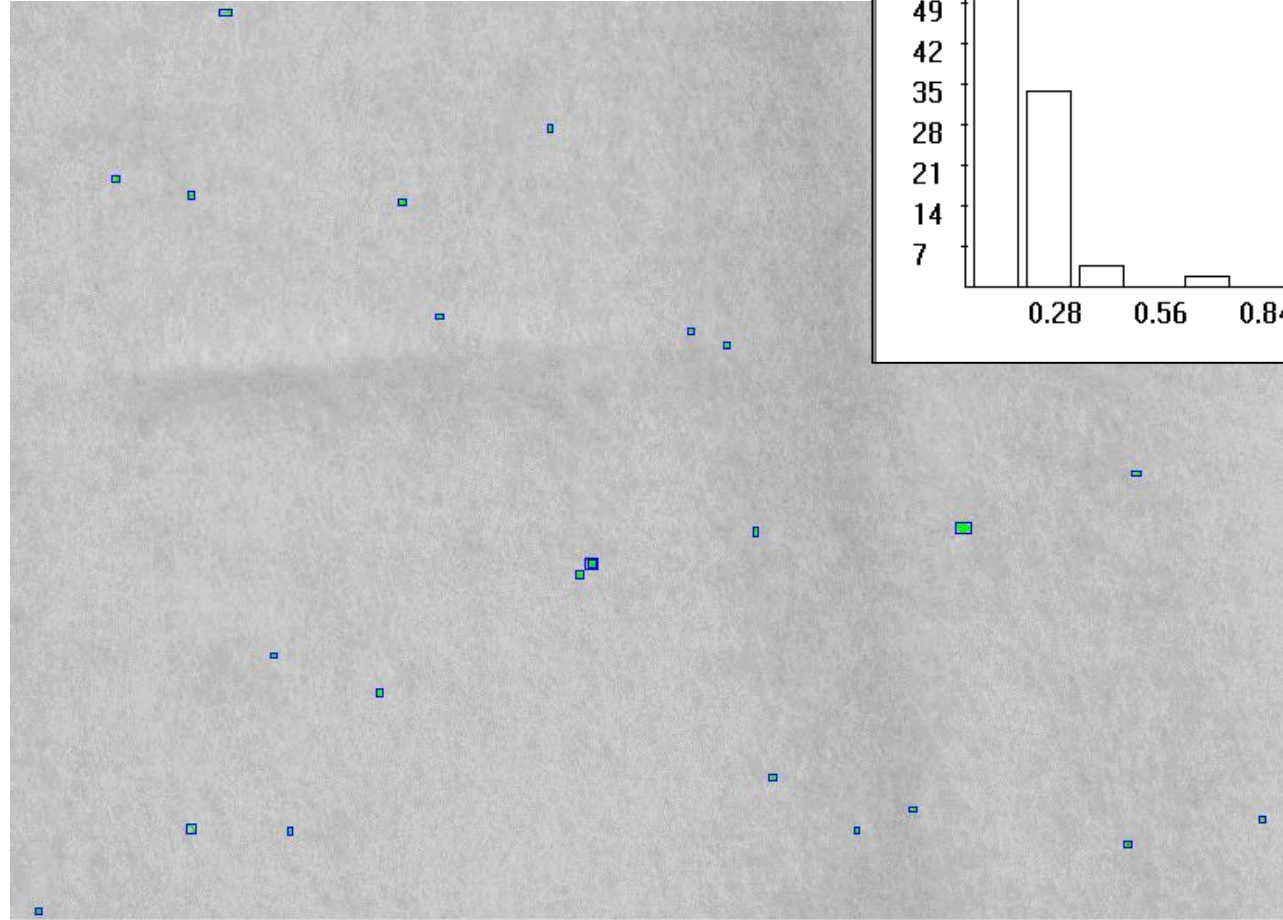


High external mesophyll density  
of a variety with low SCF content



# Seed-coat fragments

## Counting and sizing on card fleece

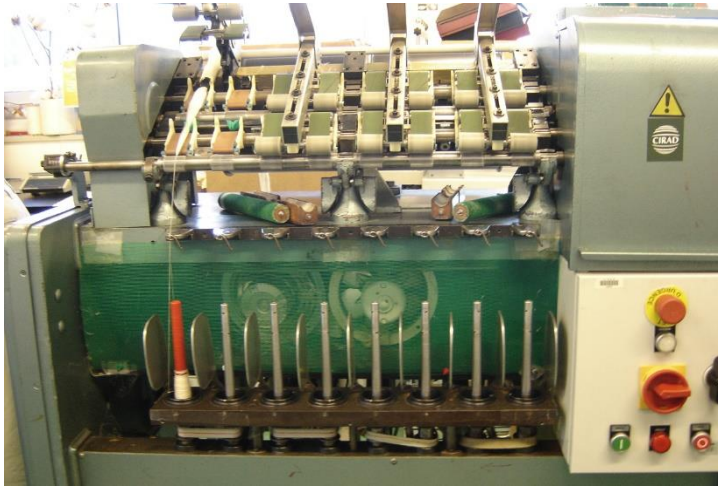


Minicard + scanner + image analysis  
(TRASHCAM software developed by CIRAD)

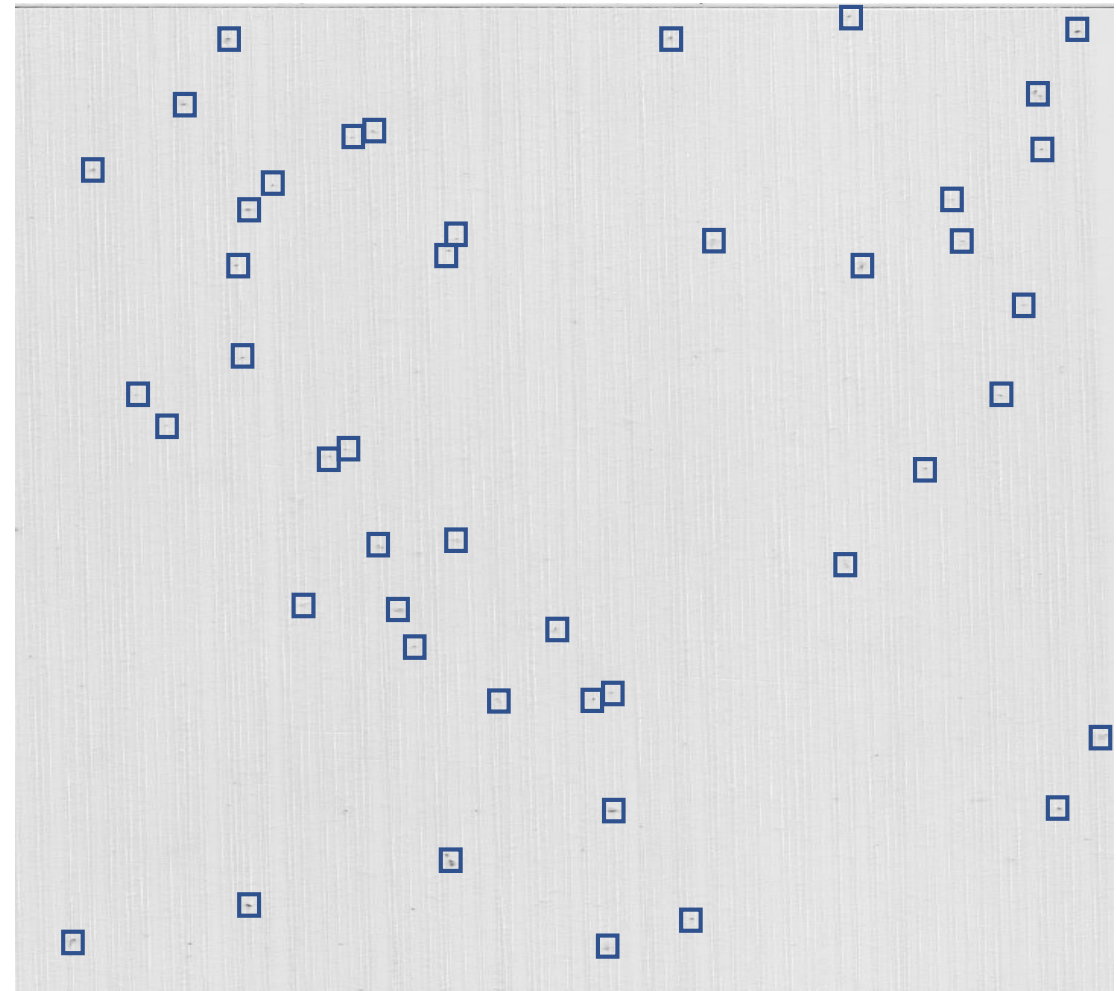


# Seed-coat fragments

## Counting and sizing on yarn



Ring spinning (RS)



Open-end spinning (OE)

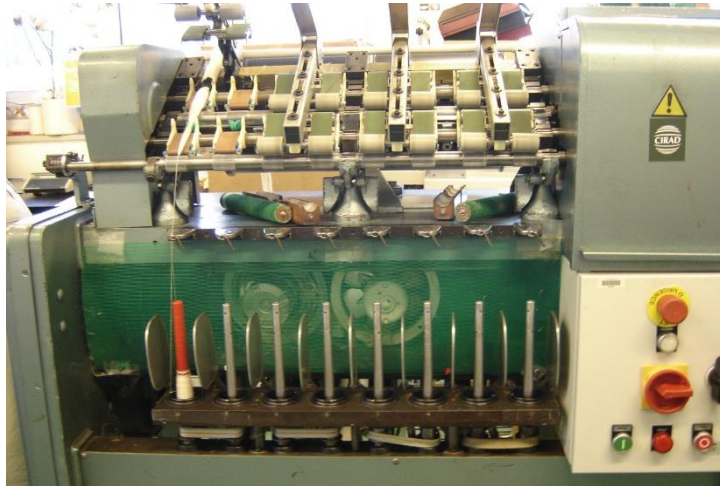


Microspinning + scanner + image analysis (TRASHCAM software)



# Seed-coat fragments

## Counting and sizing on yarn



Ring spinning (RS)



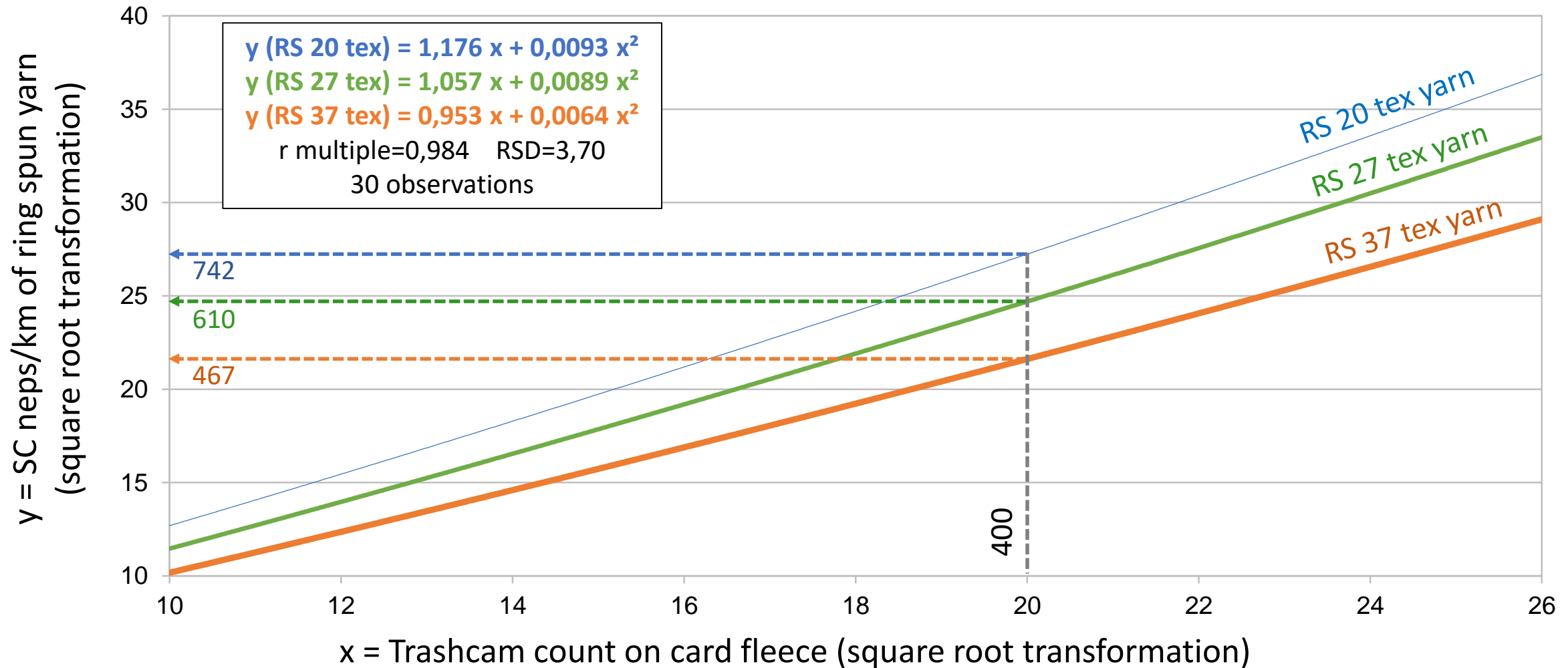
Open-end spinning (OE)



Microspinning + Uster Tester 3

# Seed-coat fragments

## Relationship between Trashcam count on fibre and SCF count on yarn



# Seed-coat fragments

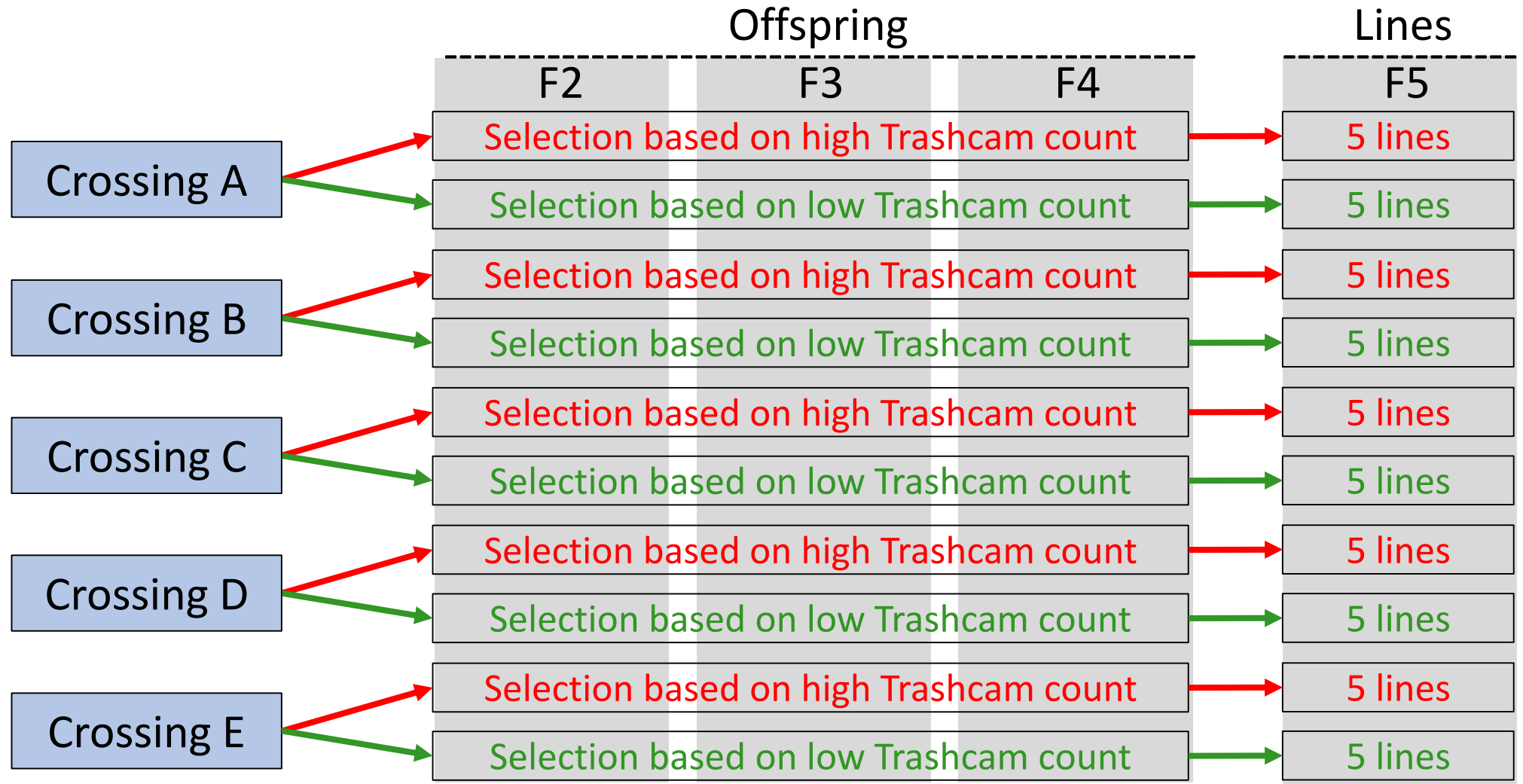
## Genetic control of Trashcam count on fibre

- Evaluation using a diallel analysis (8 parents)
- Genetic variance: mainly due to additive effects
- Phenotypic variance: reciprocal effects > combining abilities (general and specific)
- Transmission to offspring: maternal effects > paternal effects
- Low but significant heritability
- High expectation of genetic gain, up to an almost 50% reduction in SCF

**→ Basis for improvement by plant breeding**

# Seed-coat fragments

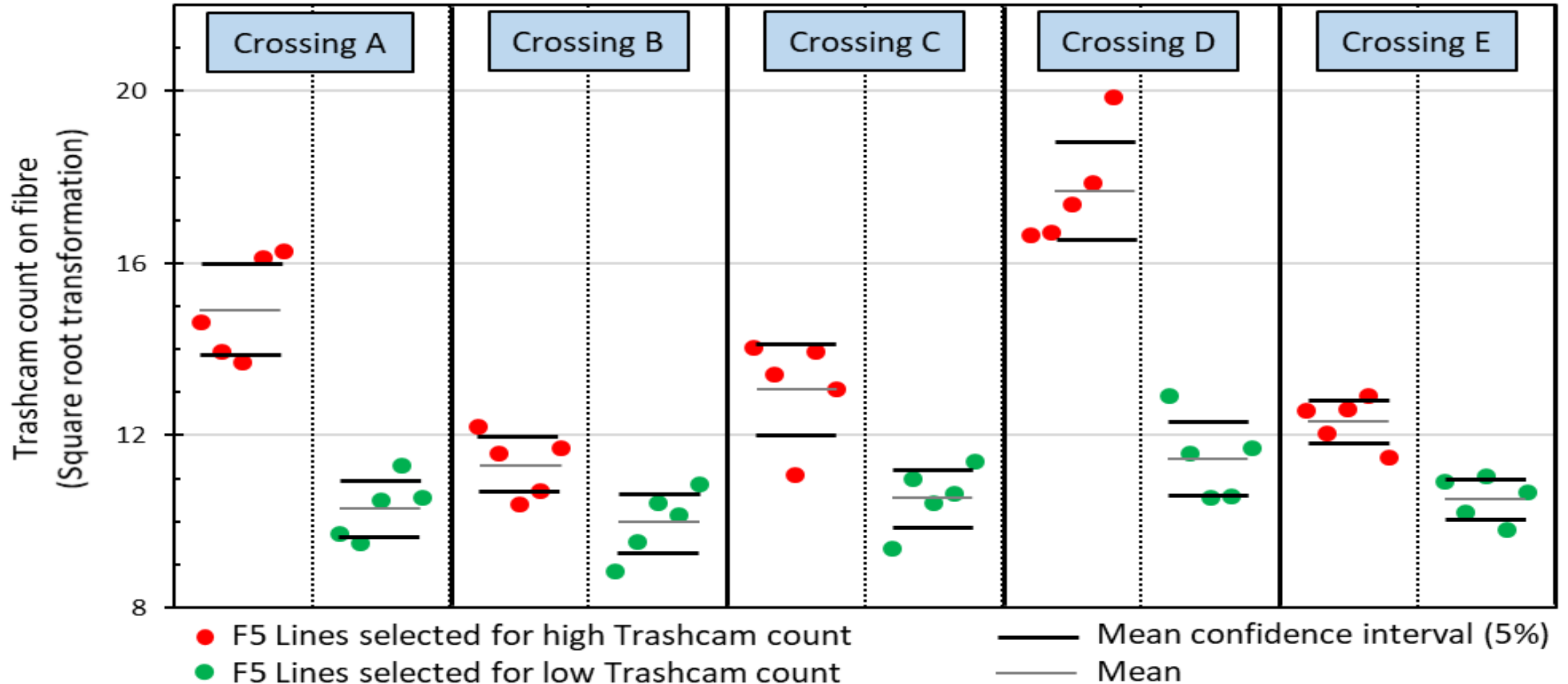
## Application in breeding: divergent selection





# Seed-coat fragments

## Application in breeding: divergent selection



# Seed-coat fragments

## Application in breeding: divergent selection

Correlations between Trashcam count on fibre and some fibre characteristics

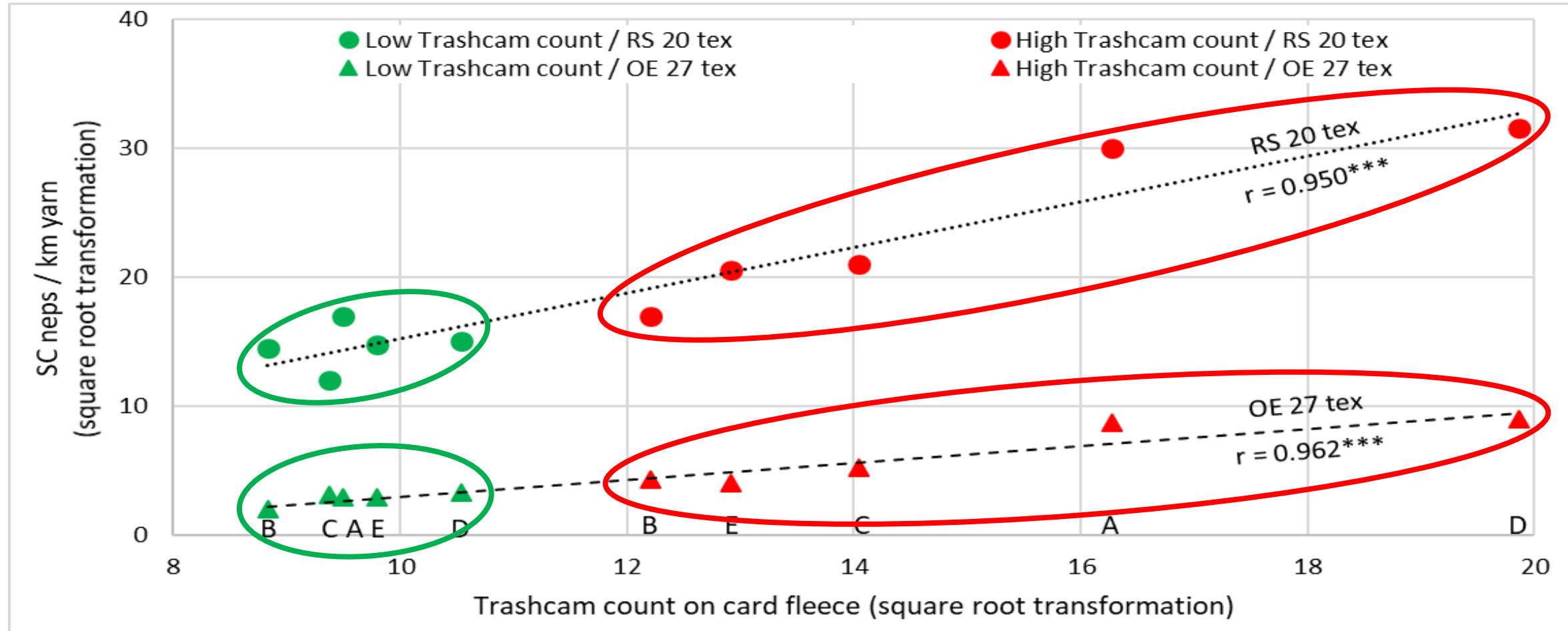
	F5 lines with low Trashcam count	F5 lines with high Trashcam count
GOT (%)	ns	0,58 **
SL2,5 (mm)	ns	ns
SL50 (mm)	ns	0,62 **
UR (%)	ns	<b>0,65 ***</b>
T1 (g/tex)	ns	<b>0,79 ***</b>
E1 (%)	ns	ns
IM	ns	0,60 **
Rd (%)	-0,45 *	<b>-0,66 ***</b>
+b	ns	ns
Area	0,53 **	0,51 **
Count	0,60 **	0,55 **
Leaf	0,49 *	0,51 **
SI (g)	ns	ns
Linter (%)	ns	ns
Nb lines	25	25

ns: not significant    \*, \*\*, \*\*\*: significant at 5%, 1%, 1%

# Seed-coat fragments

## Application in breeding: divergent selection

Relationship between Trashcam count in fibre and SC neps in yarn



# When the seed breaks, when the fibre sticks...

## Some contaminants of cotton

- Some words about CIRAD
- Cotton contamination
- Seed-coat fragments
- **Stickiness**
- Conclusion



# Stickiness: what is it, what are the incidences?

- Deposits from insect honeydew mainly onto fibers; composed by several individual sugars



Pictures by Cirad

Insect	Trehalulose	Melezitose
<i>A. gossypii</i>	1.1 %	38.3 %
<i>B. tabaci</i>	43.8 %	16.8 %

Hendrix, 1992

➔ differentiated practical behaviors during processing stages

Hequet, 2004

# Stickiness: what is it, what are the incidences?

- Fibers + honeydew stick on machine parts such as cylinders at spinning with yarn quality (un-evenness) and productivity (lower turnout) incidences

Contents in individual sugars

Material thickness

Ambient air conditions

Fiber and honeydew conditions (MC%,...)

Duration, pressure and machine parts temperature...



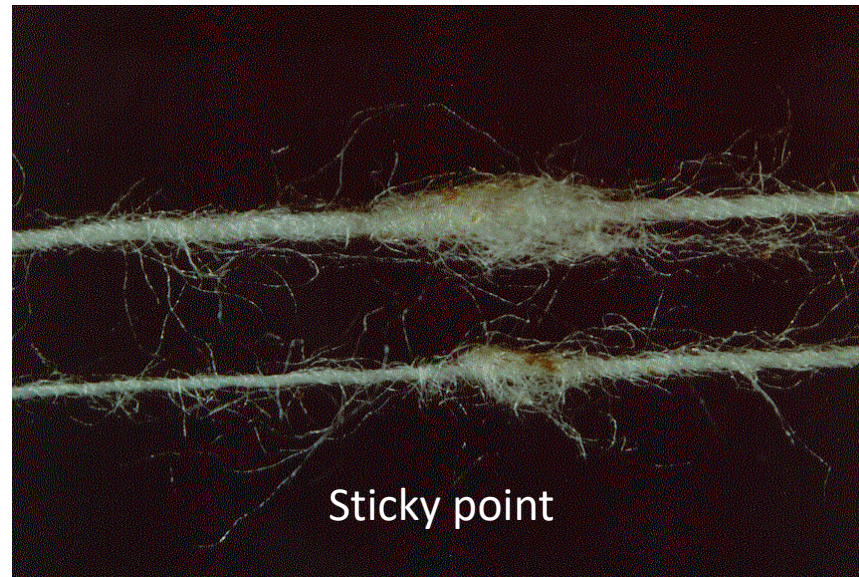


# Stickiness: what is it, what are the incidences?

- Fibers + honeydew stick on machine parts such as cylinders at spinning with yarn quality (un-evenness) and productivity (lower turnout) incidences
- Economical incidences (claims, discounts, reputation)

Counted  
as neps in  
evenness testers

Hequet E. & Frydrych R., 1992



Sticky point



Sticky point



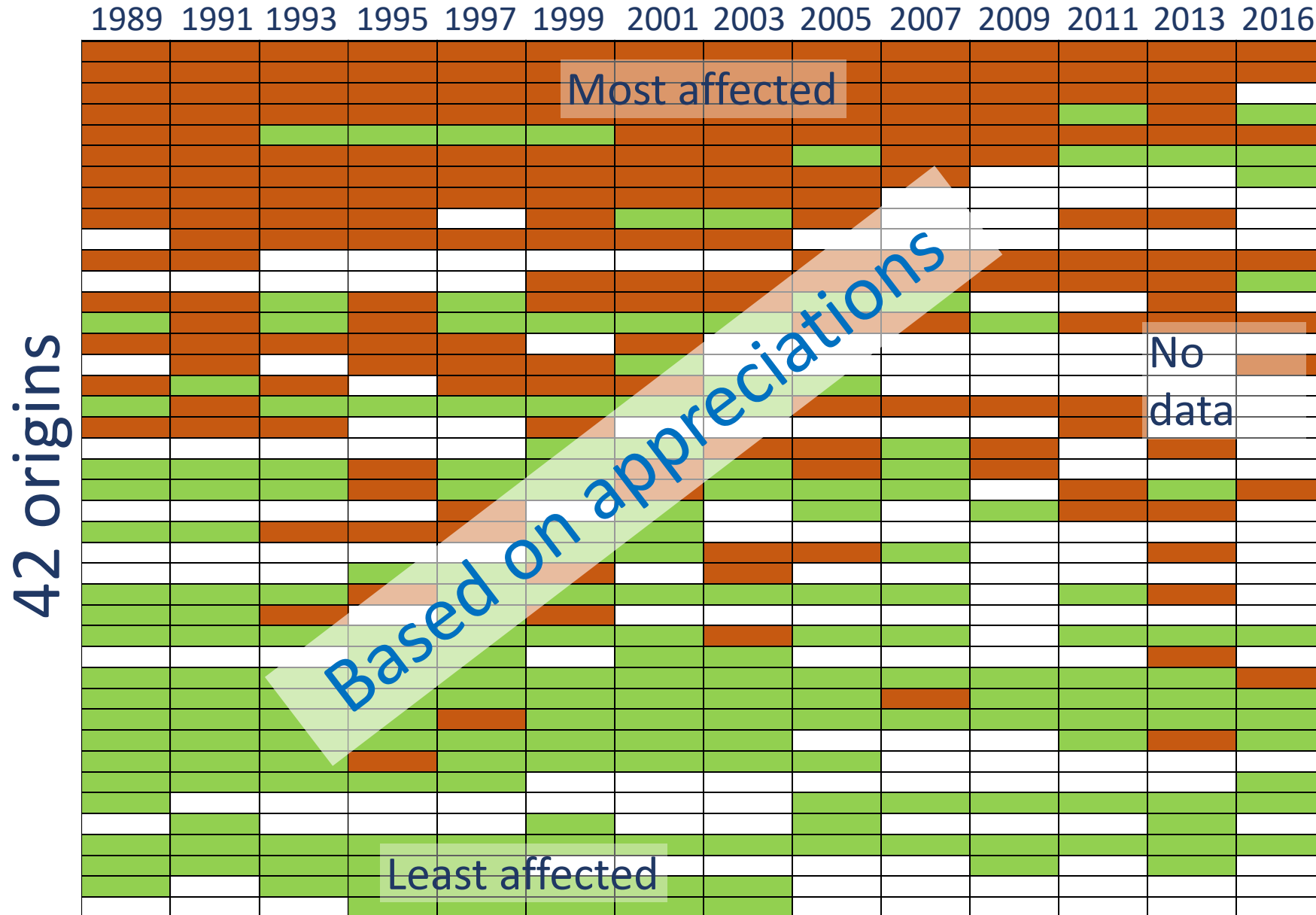
# Stickiness: what is it, what are the incidences?

- Fibers + honeydew stick on machine parts such as cylinders at spinning with yarn quality (un-evenness) and productivity (lower turnout) incidences
- Economical incidences (claims, discounts, reputation)
- **Solutions exist**
  - Choose cottons
  - Blend origins
  - Change spinning mills conditions

**→ Need reliable measurement :**

... from appreciation to metrology ...

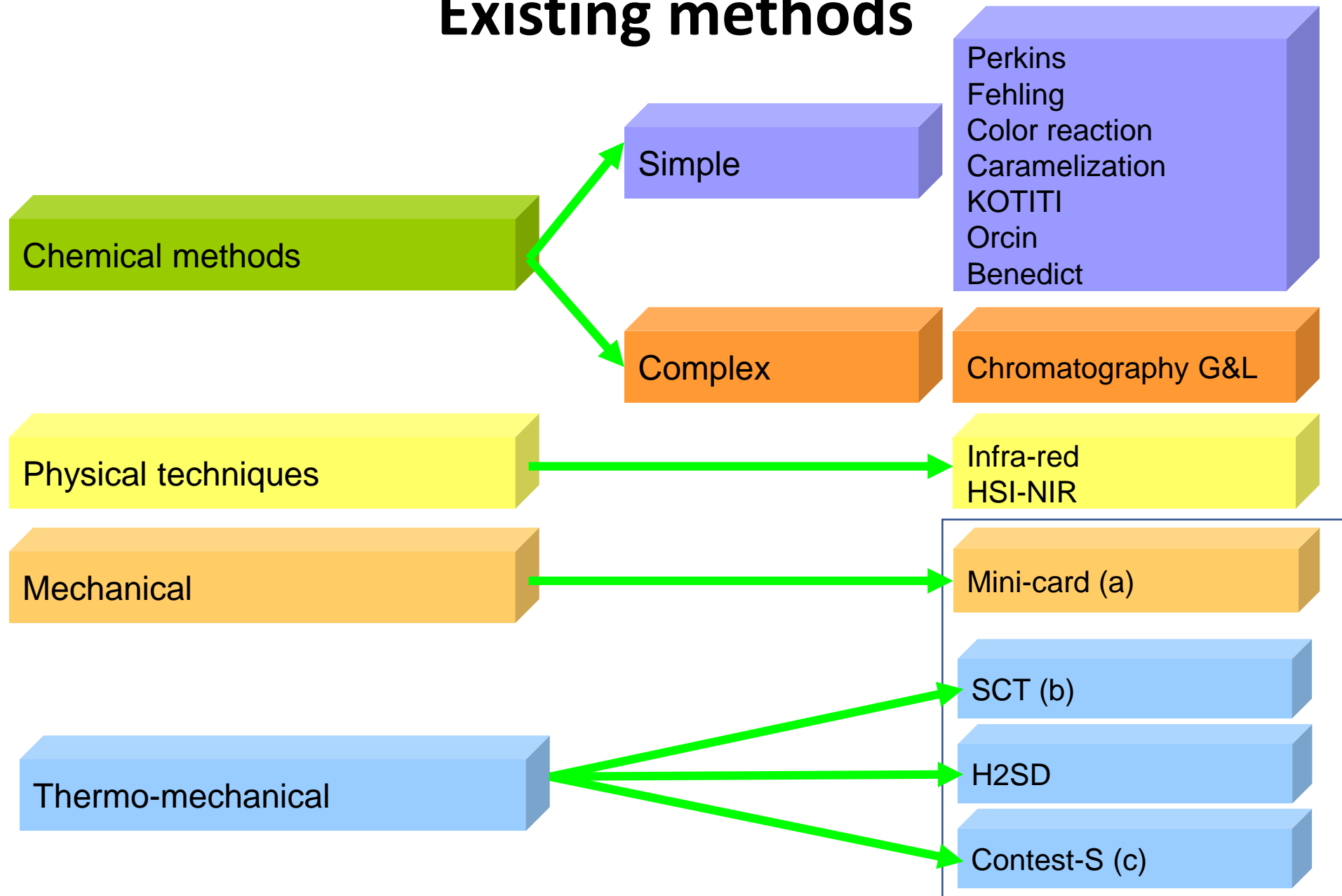
# ITMF Contamination Surveys over time



Stickiness:  
appreciations  
about origins not  
permanent nor  
stable

Presented in the  
International Cotton  
Conference, Bremen, 2021

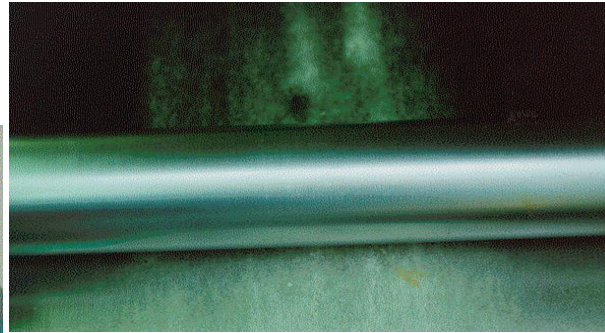
# Existing methods





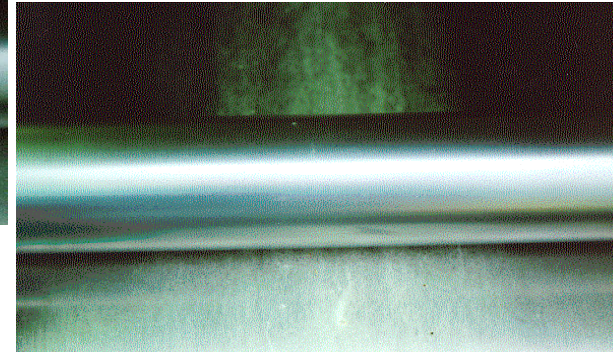
# Minicard grading: reference method

ITMF : 0



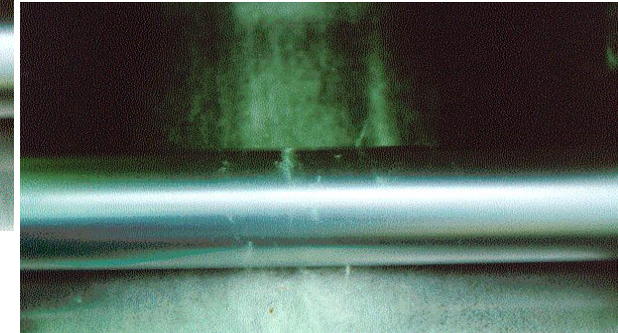
Cirad grade 1

ITMF : 0 - 1



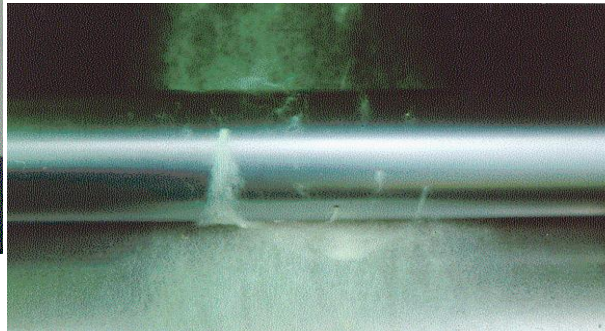
Cirad grade 2

ITMF : 1



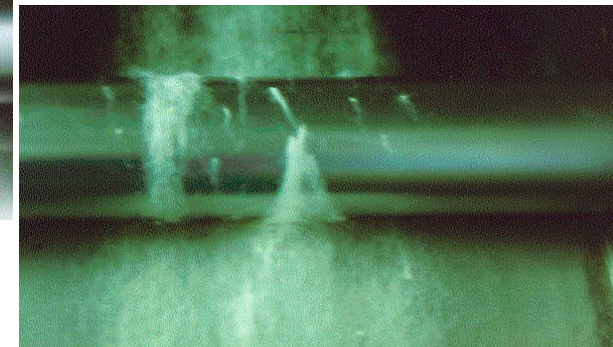
Cirad grade 3

ITMF : 1 - 2



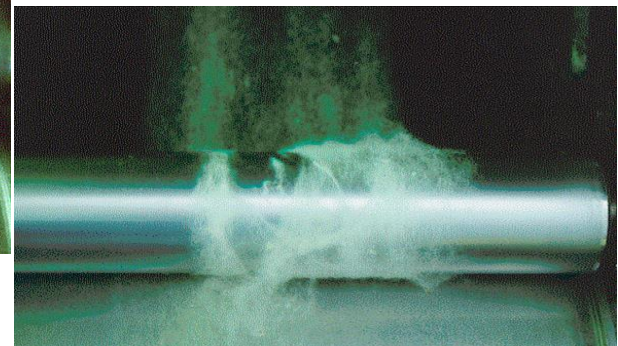
Cirad grade 4

ITMF : 2

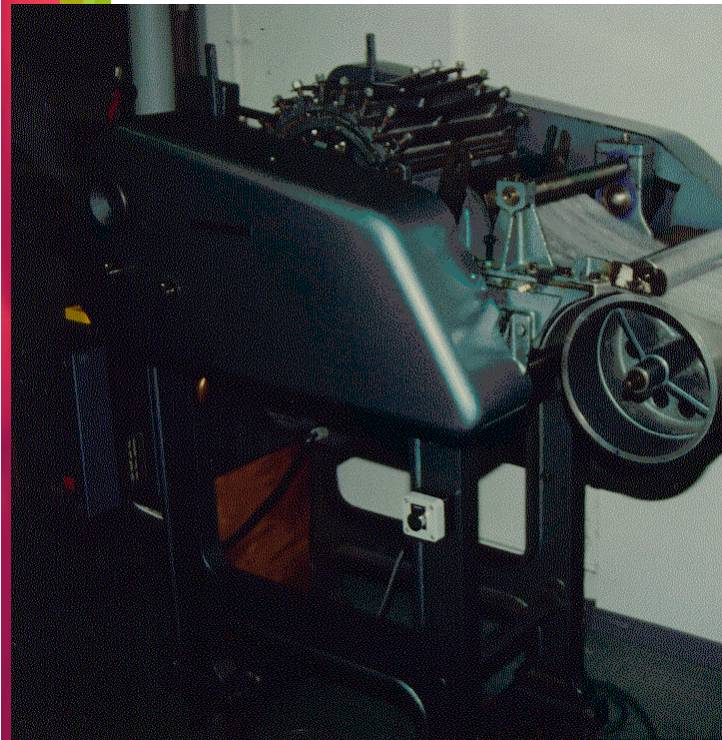


Cirad grade 5

ITMF : 3



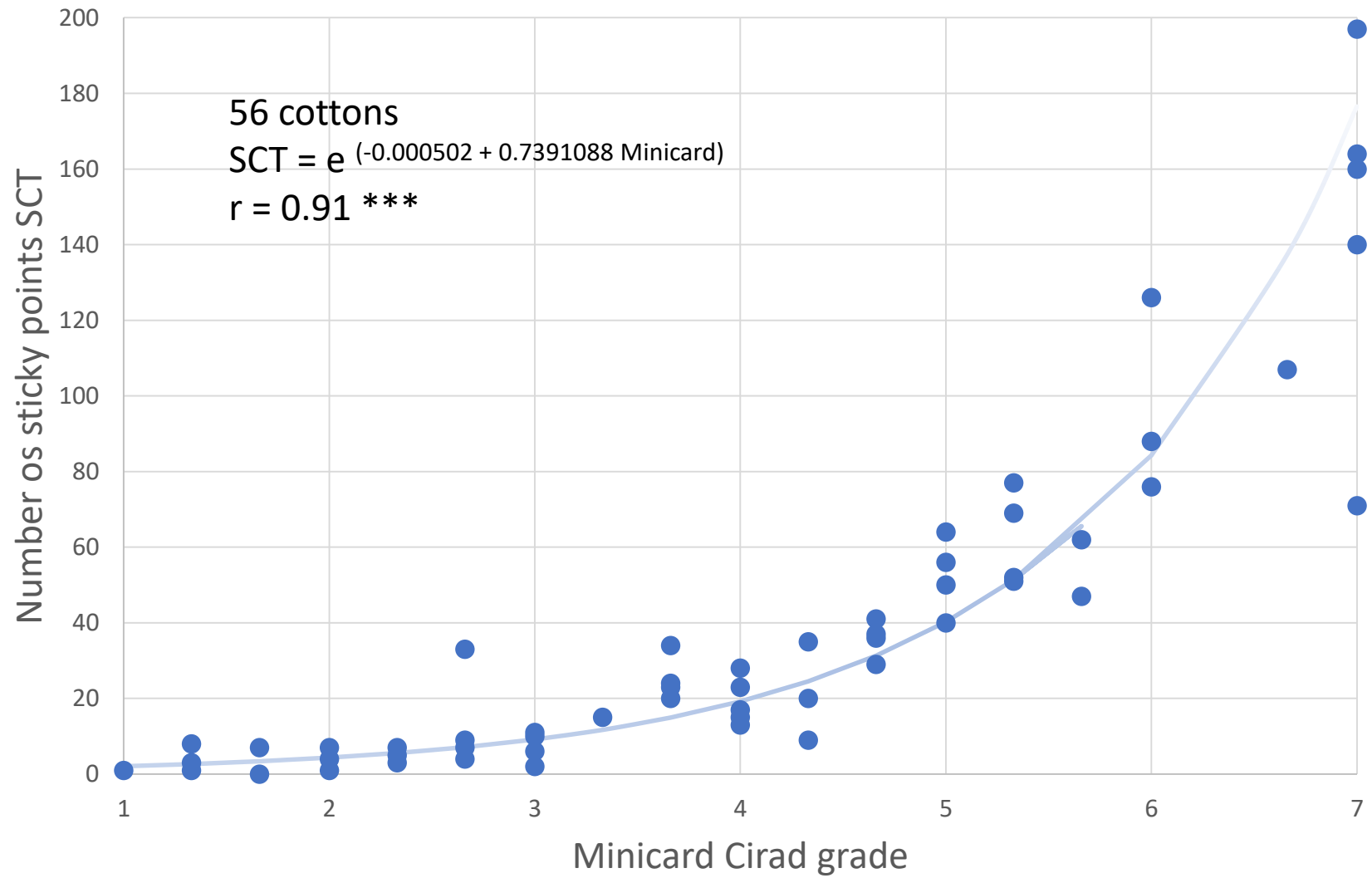
Cirad grades 6-7



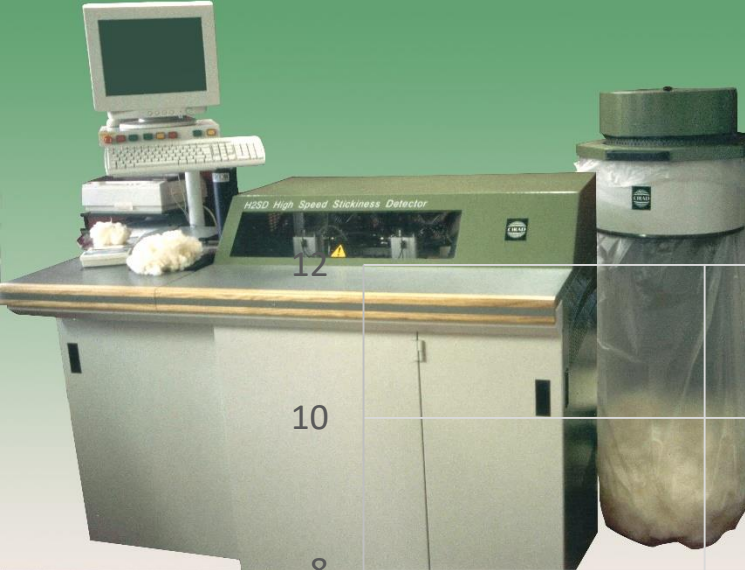




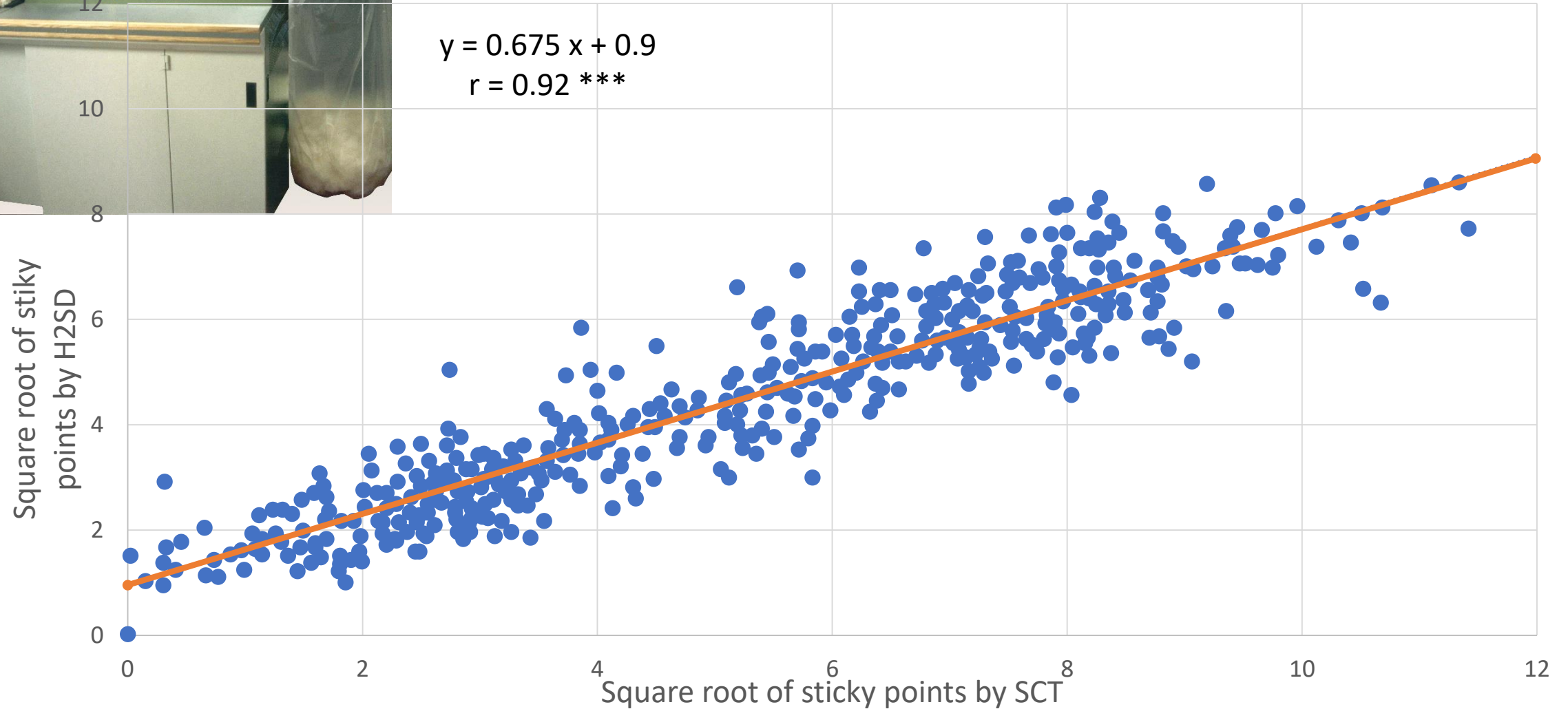
# SCT-Cirad® vs Minicard



# H2SD-Cirad® vs SCT-Cirad®



$$y = 0.675x + 0.9$$
$$r = 0.92 ***$$





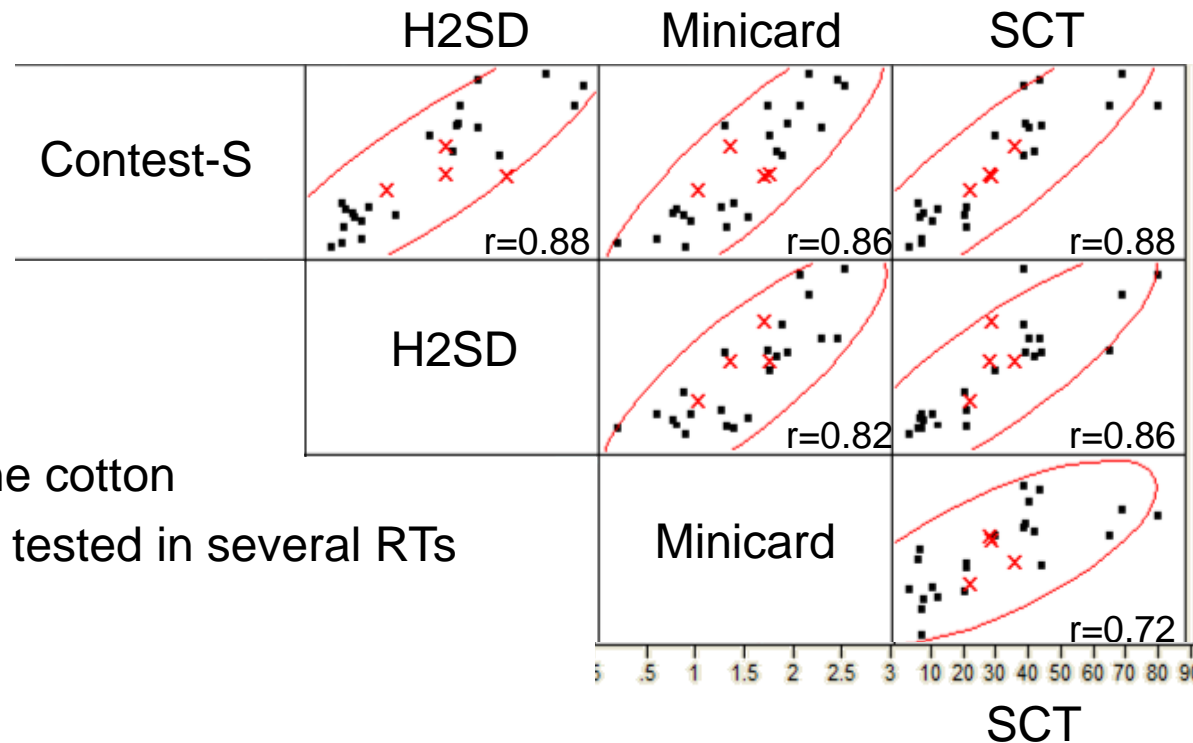
# ITMF-ICCTM stickiness task force

- Chair of the task force since 2006
- Organization of inter-laboratories round-tests
  - In 2013-14 with micro-spinning experiment
    - thermo-mechanic methods able to predict spinning behavior
  - Development of HarCoStic\* project, but no funding
  - Every 6 months since 2017, with FIBRE and BBB without micro-spinning
    - 2 RT / year since 2017
    - 3 to 5 cottons / RT covering a stickiness range
    - 10-12 methods used by 25-35 participating laboratories
    - 1 to 6 results per instrument and cotton
    - Reports on <https://www.itmf.org/committees/international-committee-on-cotton-testing-methods>
- Supervision (with R. Van Der Sluijs & A. Drieling) of the “ITMF-ICCTM Recognition” for the Contest-S method by Mesdan, Italy (2020)

\*: Harmonization of Cotton Stickiness Characterization

# Contest-S vs Minicard, SCT-Cirad® & H2SD-Cirad®...

Significant correlations  
\* between thermo-  
mechanical methods,  
Minicard.  
Good correlation to  
SIP.



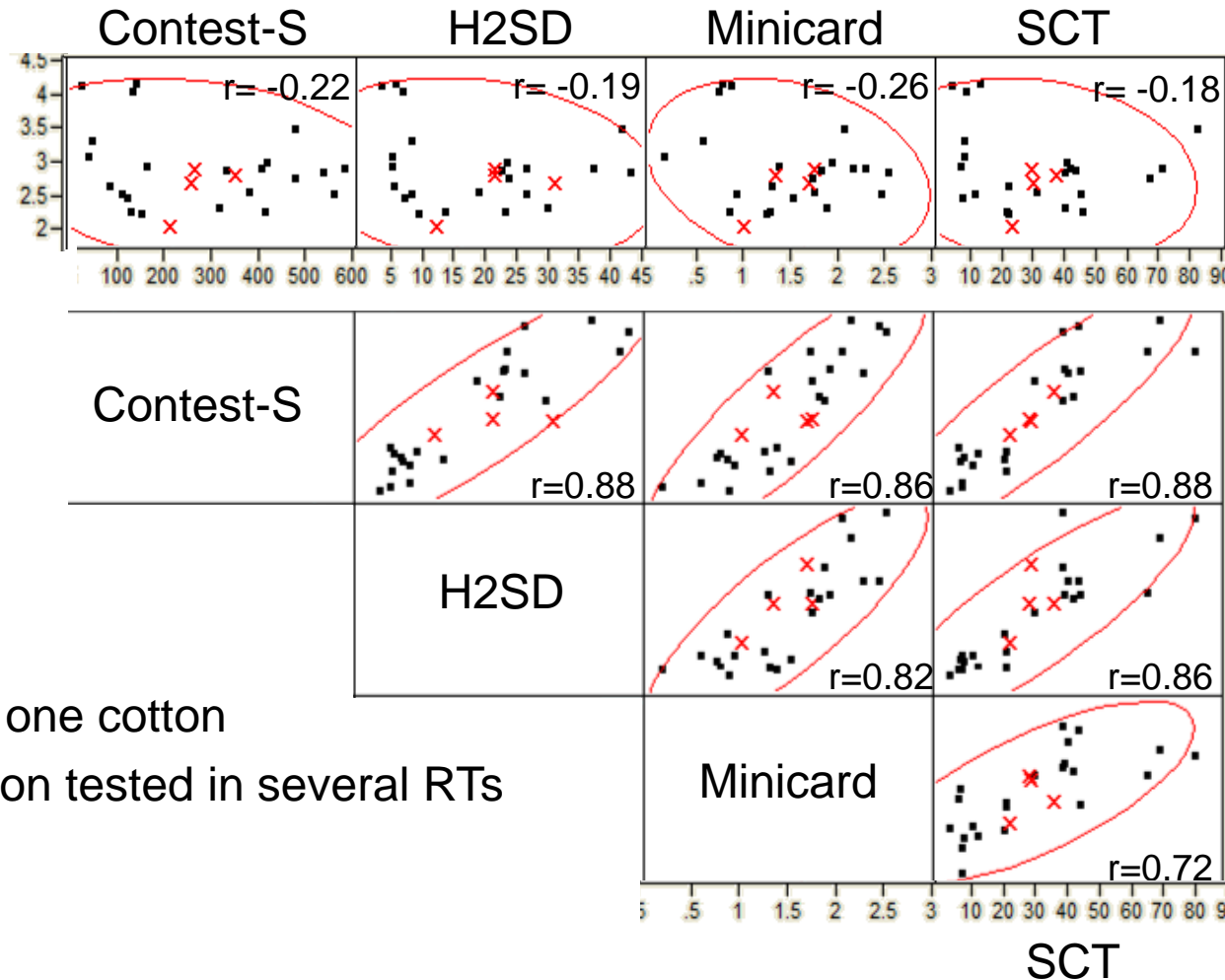
One point = one cotton

X = one cotton tested in several RTs

\*: All together 26 cottons, tests [2017-2 : 2019-2]

# Contest-S vs Minicard, SCT-Cirad® & H2SD-Cirad®...

Caramelization



One point = one cotton

X = one cotton tested in several RTs

Good correlations \*  
between thermo-  
mechanical methods,  
Minicard.  
Good correlation to  
SIP.

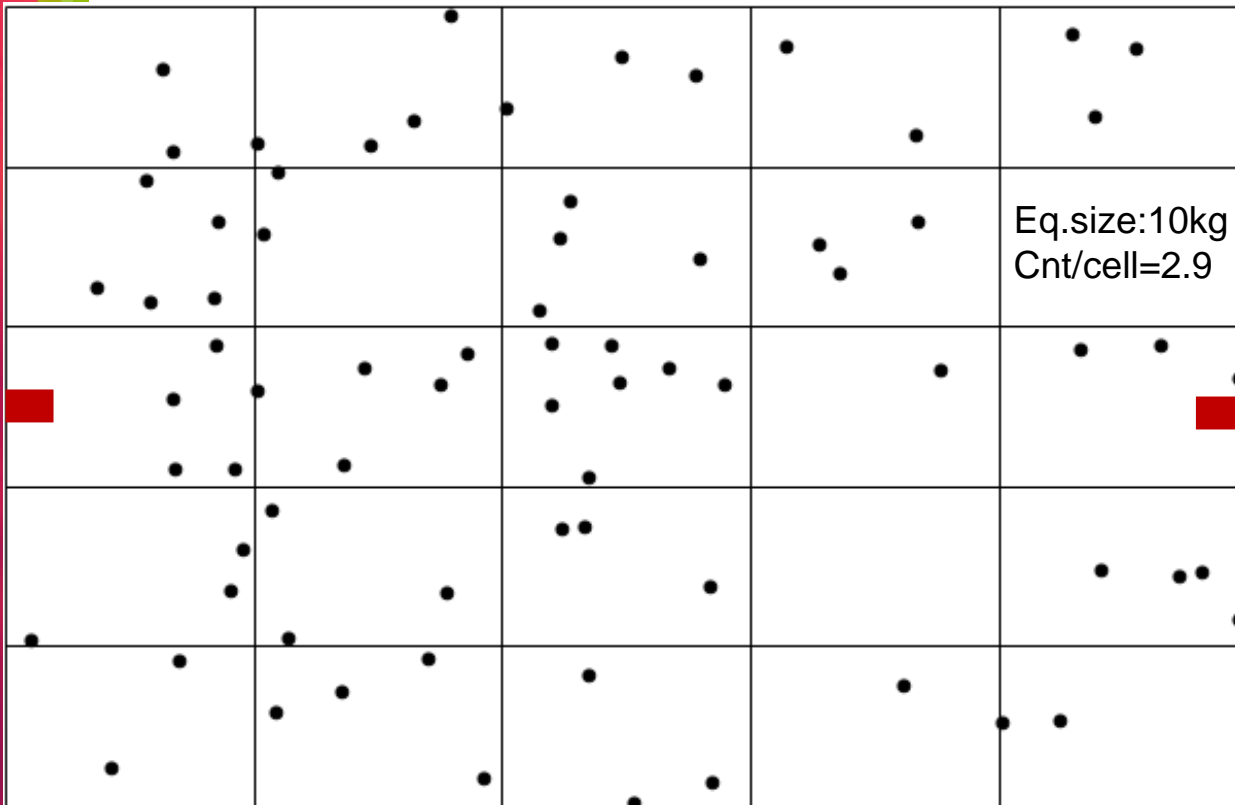
→ Methods kept for  
further harmonization

- Contest-S
- H2SD
- SCT
- Minicard

\*: All together 26 cottons, tests [2017-2 : 2019-2]



# Variability in results: two bales



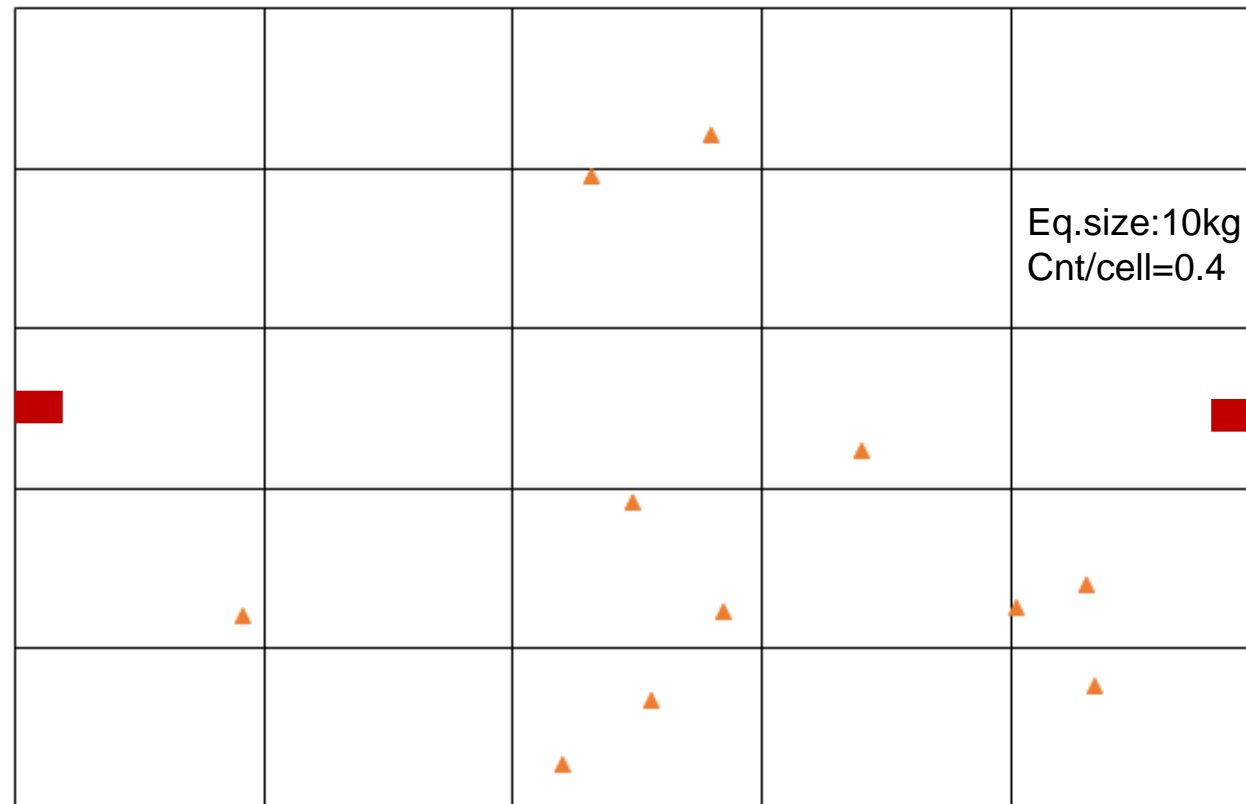
Bale A: 73 sticky points

■ Places of samples collected by the 'cutter' method

Eq.size:10kg  
Cnt/cell=2.9

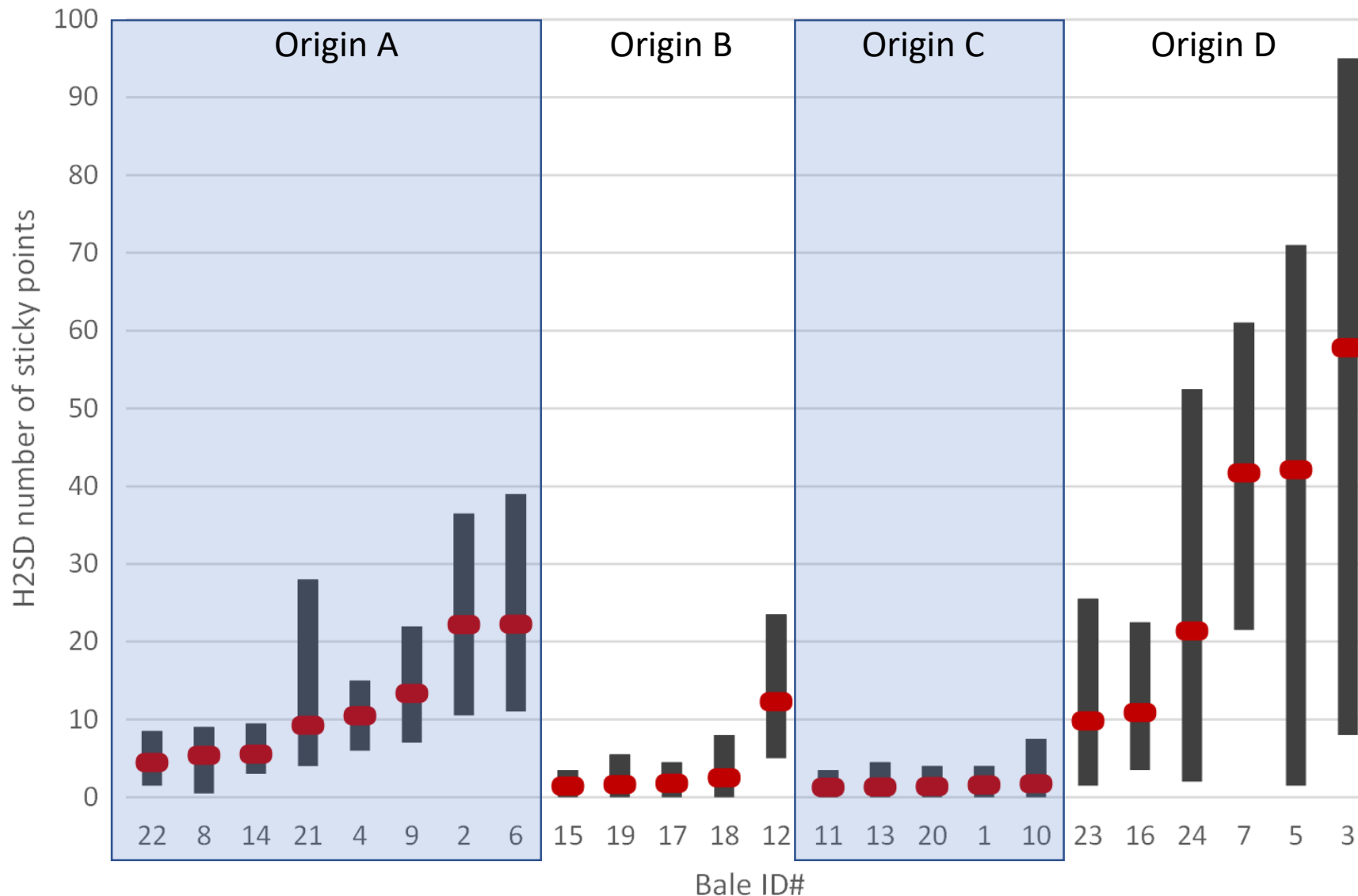
Honeydew distributed in bales  
Probability to find this honeydew in  
sample is quite low

Bale B: 11 sticky points



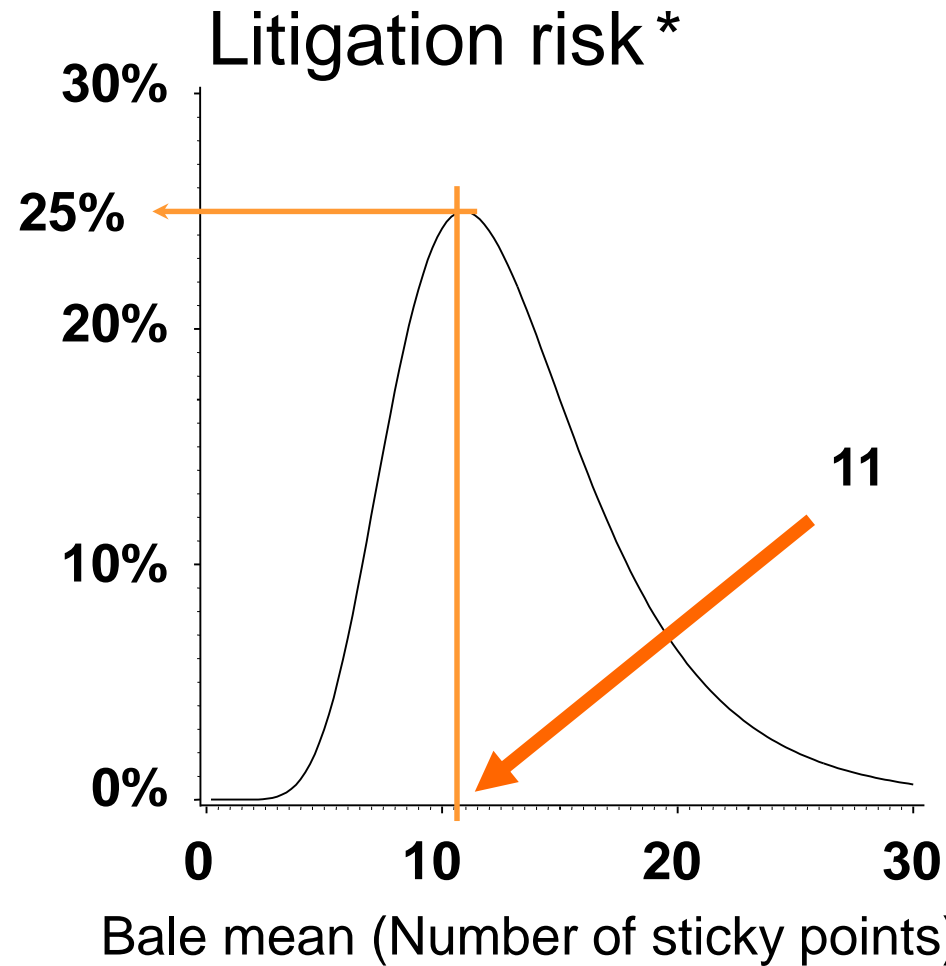
Eq.size:10kg  
Cnt/cell=0.4

# Distribution of stickiness within bales



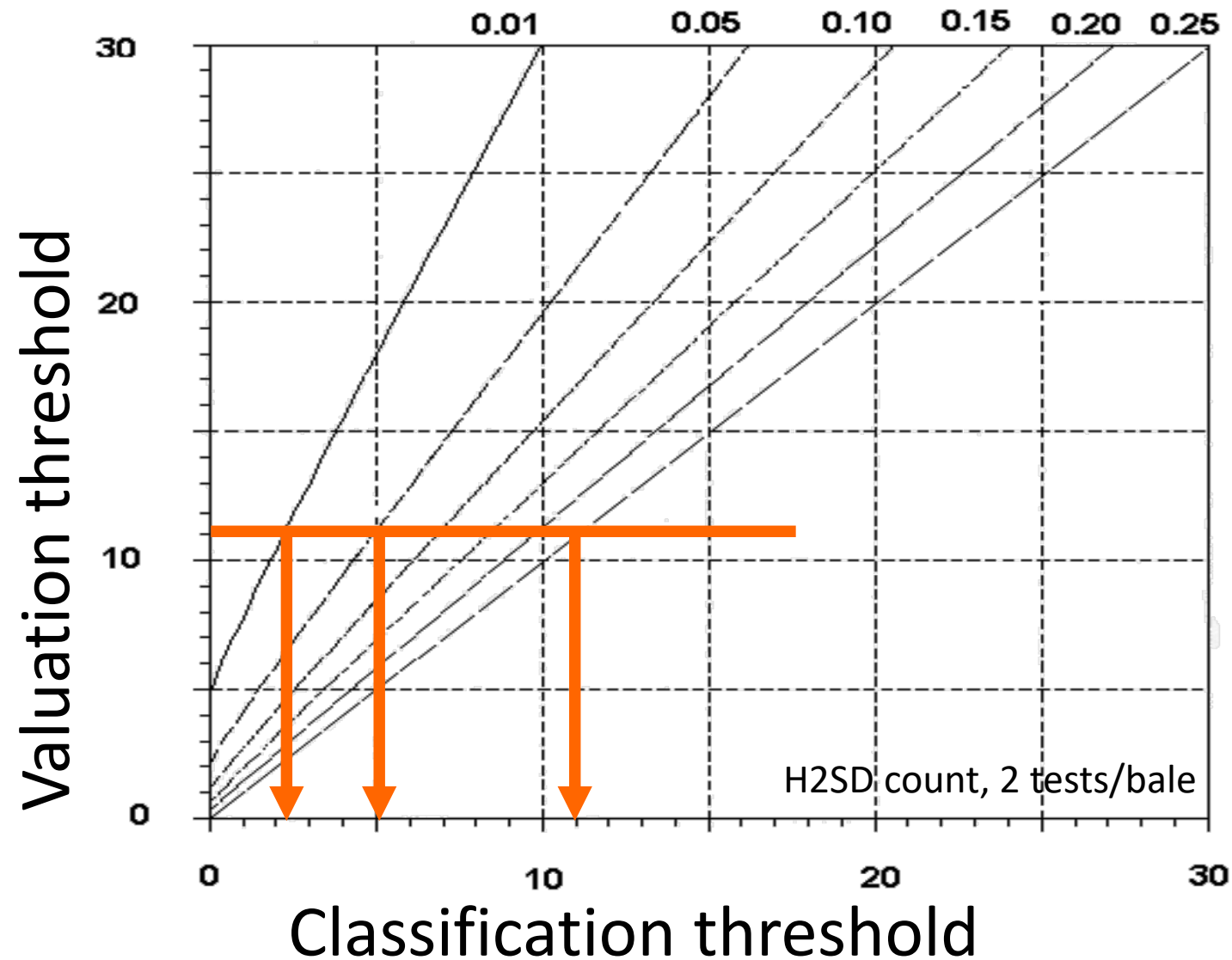
Extreme variation even within bales  
→ Difficulty to get representative samples

# Application: testing, litigation risk, classification, trading



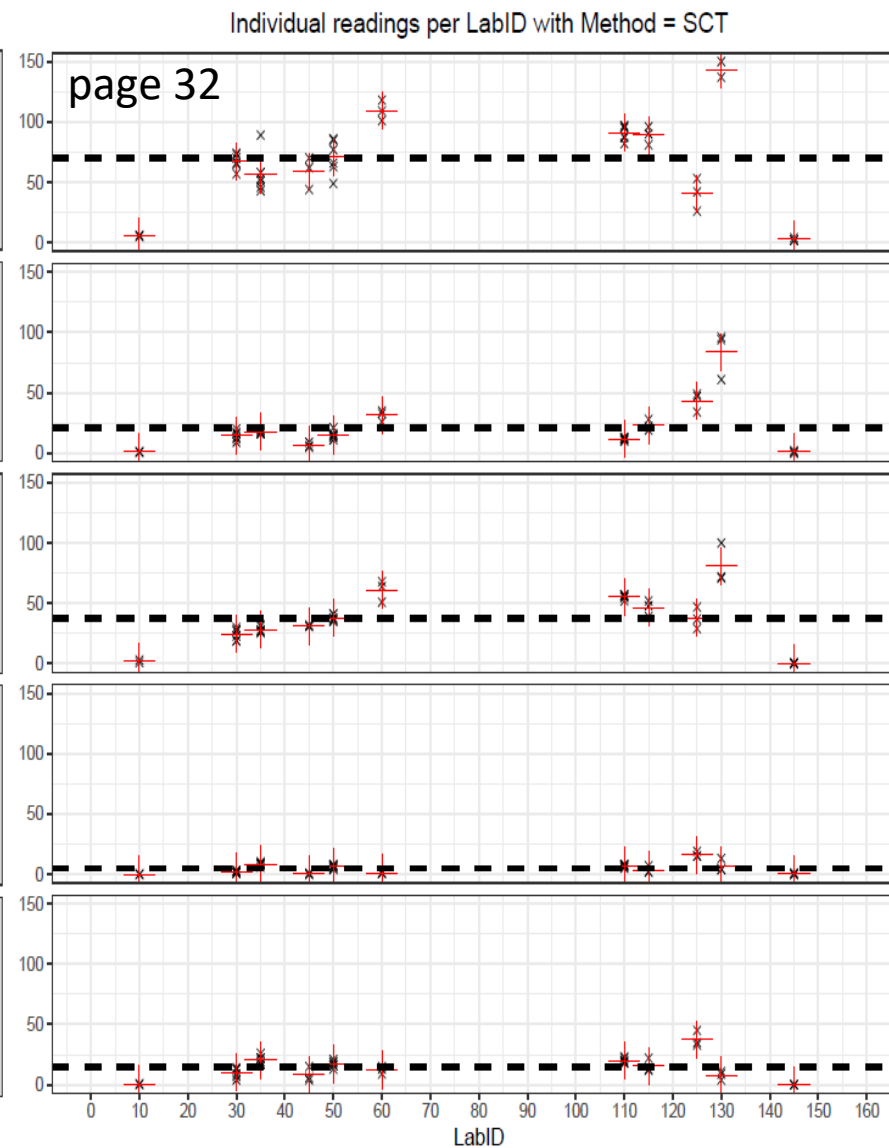
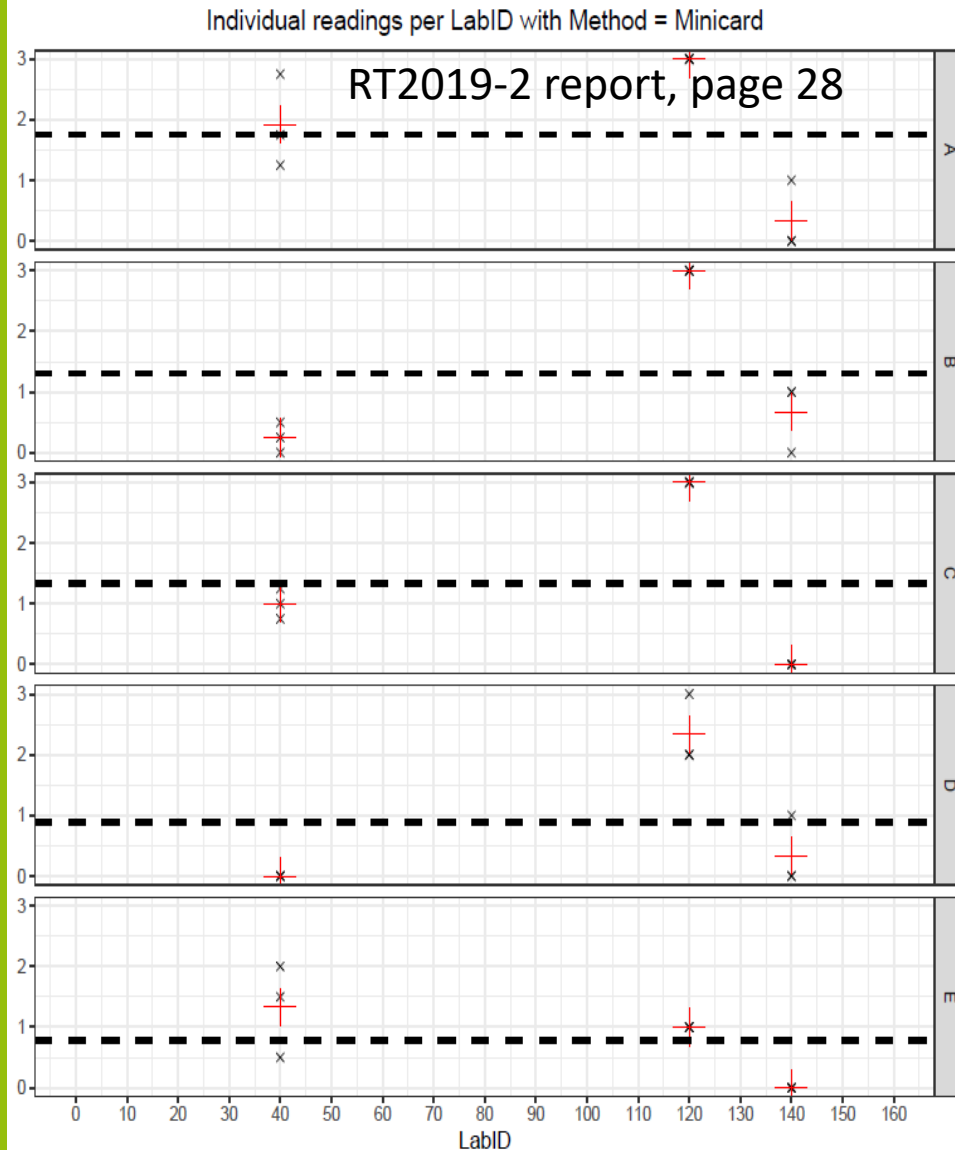
\*: Negative binomial distribution,  $k=9.43$ , 2 replications

# Application: testing, litigation risk, classification, trading





# Observations on variations in round-tests

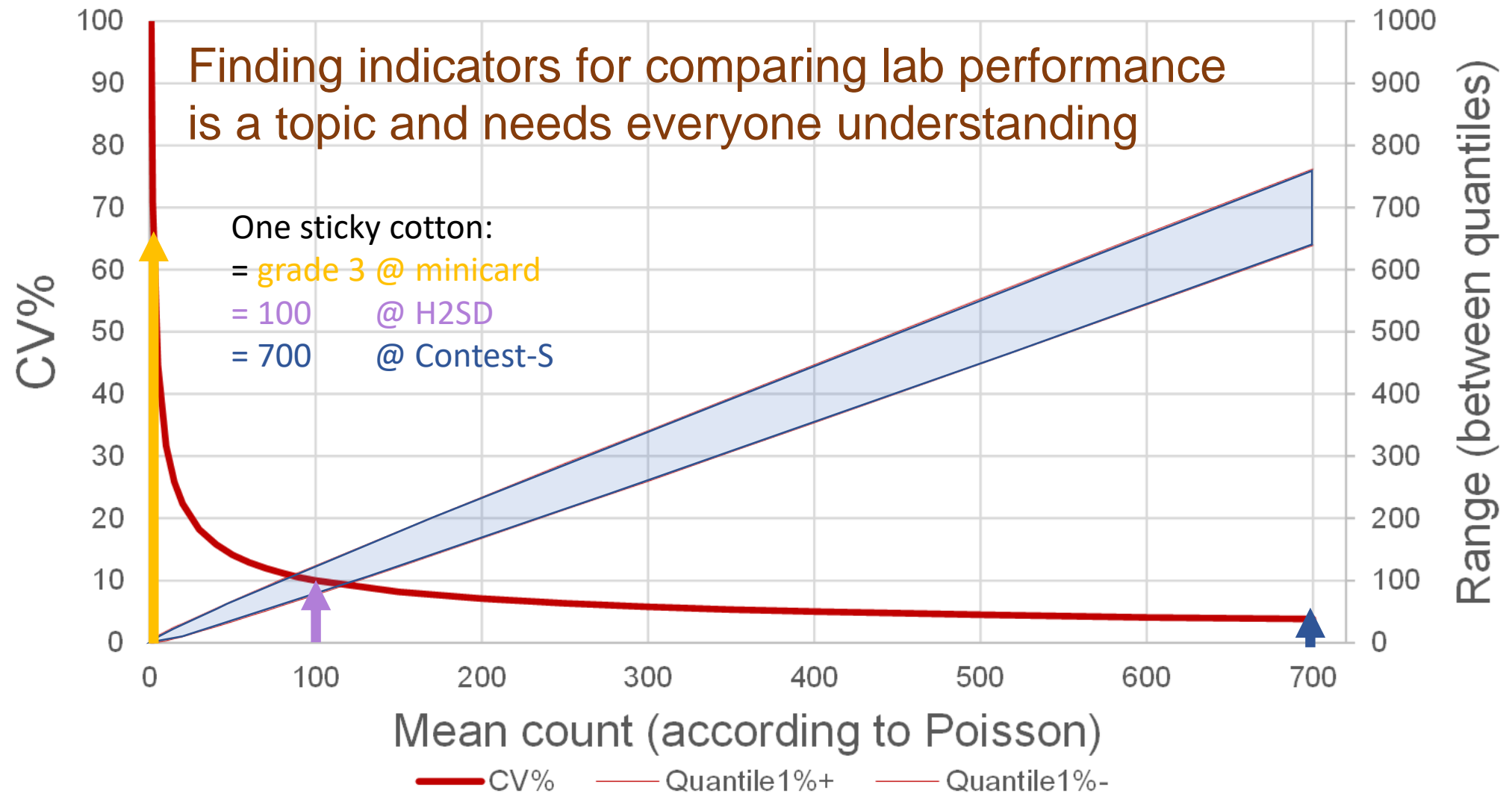


Easy to compare instrument variations within each method

- within lab.
  - between labs.
- Labs improve

→ Difficult to compare methods  
→ Need indicators

# Statistics and indicators of harmonization progress



# When the seed breaks, when the fibre sticks...

## Some contaminants of cotton

- Some words about CIRAD
- Main contaminants of cotton
- Seed-coat fragments
- Stickiness
- **Conclusion**

# Conclusion

## Seed-coat fragments

- Histocytological examination of the seeds:
  - ↳ Makes it possible to visualise the origin of the seed-coat breakage
  - ↳ Can explain the differences in SCF content between varieties
  - ↳ Is not an appropriate breeding tool



# Conclusion

## Seed-coat fragments

- Image analysis (Trashcam tool):
  - ↳ Gives a count in fibre or yarn well correlated with SC neps in yarn
  - ↳ Is an appropriate breeding tool

# Conclusion

## Seed-coat fragments

- Trashcam count:
  - ↳ Has a low but significant heritability
  - ↳ Makes it possible to breed cotton lines with low SCF
  - ↳ Allows a genetic gain of up to -50% SCF
  - ↳ Is significantly linked with GOT, fibre length, uniformity, tenacity, and reflectance

# Conclusion

## Stickiness

Work in progress!

1. Keep the link to spinning observations (predictive measurement)
2. Take care of the huge variability of stickiness and its measurement results and develop the best indicators to measure stickiness and performance
3. Harmonize methods able to predict spinning behavior as a priority (mechanical & thermo-mechanical methods with SCT, H2SD and Contest-S, Minicard as reference)

# Conclusion

## Stickiness

4. Continuation of RT as is (**welcome laboratories and sticky fibers**) with all method (please contact [jean-paul.gourlot@cirad.fr](mailto:jean-paul.gourlot@cirad.fr) or [drieling@faserinstitut.de](mailto:drieling@faserinstitut.de) at any time)  
**Total confidentiality assured**
5. Adoption of best practices guide to laboratories with support of Manufacturers including the development of a common categorization for all methods (for trade purposes), and suitably include stickiness testing in trade rules





**Thank you for your attention**  
**Any questions?**

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