11º CONGRESSO BRASILEIRO DO ALGODÃO

Limitations of HVI in Cotton Fiber Quality Research

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Fiber and Biopolymer Research Institute

- The FBRI serves the cotton fiber research needs of cotton breeders, manufacturers, and public agencies.
- We use HVI, but cotton fiber quality research uses different protocols on HVI and additional instruments to have a better representation of fiber quality.
- My objective today is to share a few examples from our current research.

Fiber Quality in Research

- Advances in textile manufacturing have increased demands for cotton fibers that are long, uniform, mature, fine, strong, and with low contamination levels.

- The primary objective of cotton breeding is to improve fiber quality and yield simultaneously.

Sample Processability

Sample processability

- Cotton fiber quality is at its best within the mature unopened boll.
- Cotton fiber is subjected to a series of mechnical processes that each have the potential to break fibers, degrading fiber quality.
- Thus, the quality of the cotton fiber in the yarn is not the same as the quality of the fiber in the field.

Materials and Methods

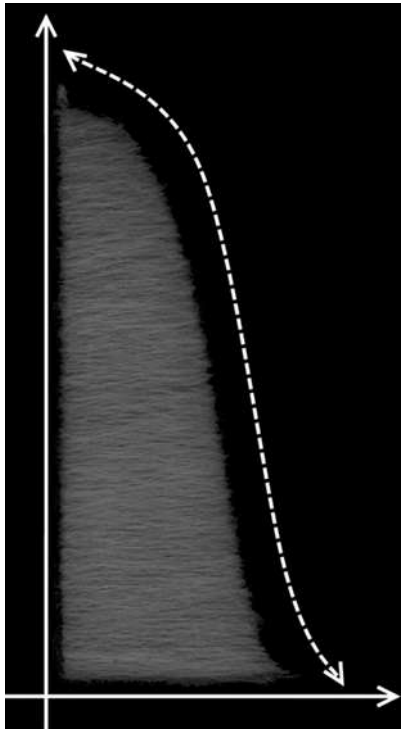
- A set of 129 breeder samples was selected to capture a wide range of variation in within sample fiber length
  - The within sample distribution of fiber length of each sample was evaluated with AFIS.
  - After AFIS testing, each sample was subjected to a laboratory scale mechnical process (MDTA3).
  - After processing, the within sample distribution of fiber length of each sample was evaluated with AFIS.
- The impact of processing was quantified by measuring the distance between the AFIS length distribution before and after processing.

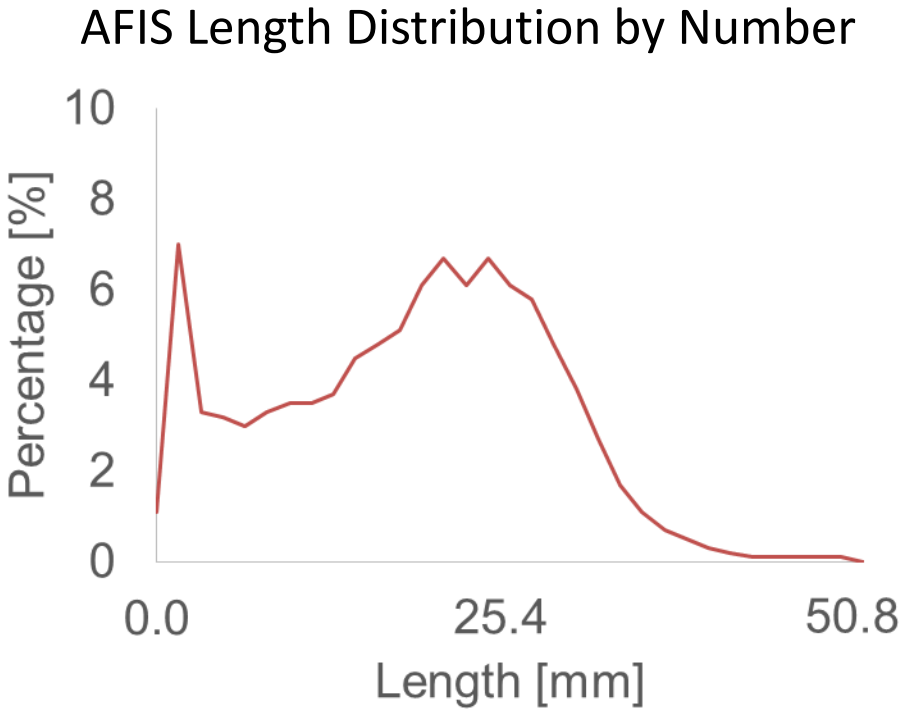
Advanced Fiber Information System

- AFIS is an individual fiber tester that provides the complete within sample distribution of length, maturity, and fineness.

- AFIS also provides many summary parameters of these distributions.
  - Average length by number
  - Short fiber content by number
  - Average fiber fineness
  - Average fiber maturity

Within sample variation in fiber length





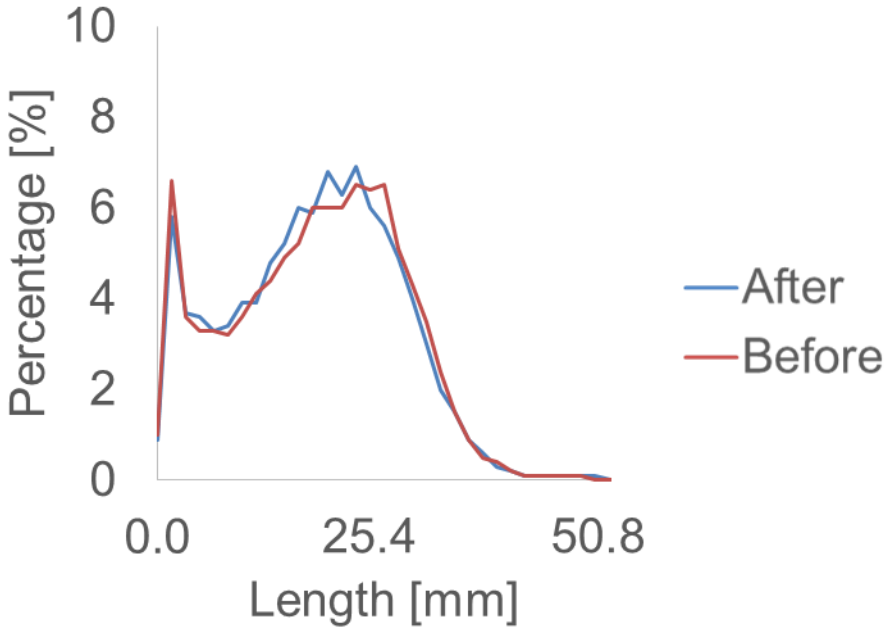
Laboratory scale processing

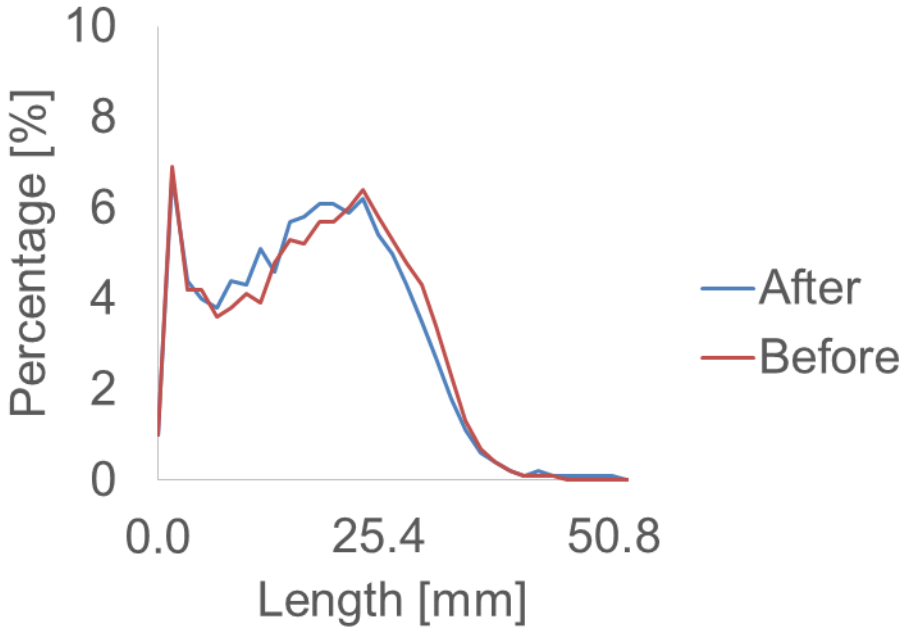
Before Processing
length distribution
by number

MDTA3
(Mechanical Processing)

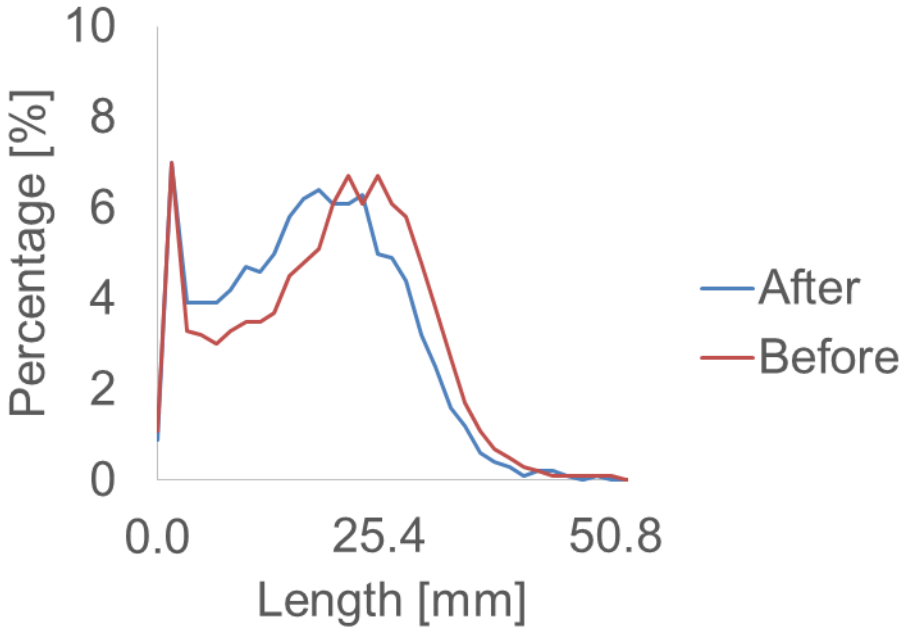
After Processing
length distribution
by number

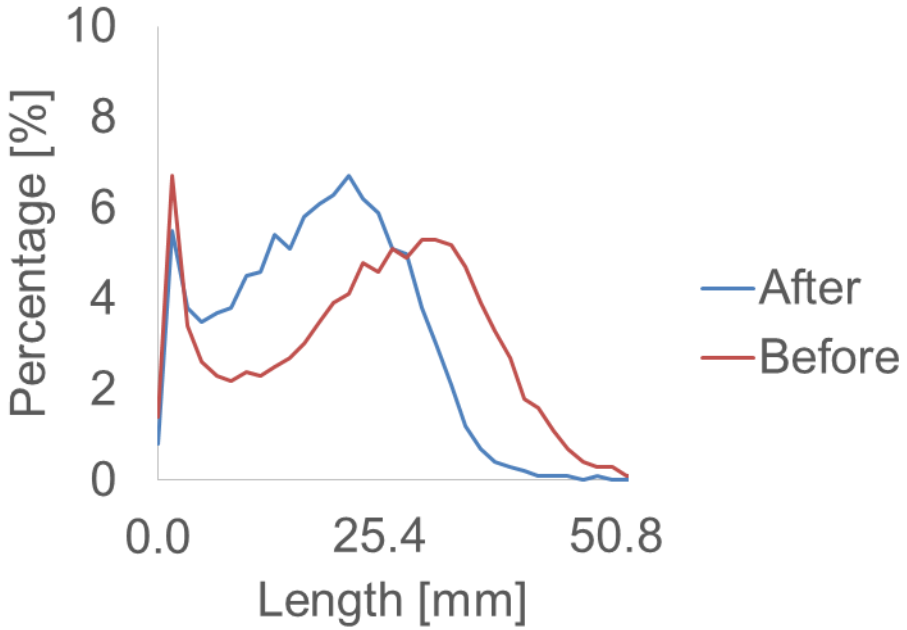
Samples exhibiting good processing performance





Samples exhibiting poor processing performance





Discussion

- Mechanical processing breaks fibers and degrades fiber quality.

- While mechanical processing has a large impact on some samples, the impact is minimal on others.
  - Immature fibers are weak and tend to break more frequently during processing.
  - Samples with more immature fibers will tend to exhibit a poor processing performance.

- Current HVI fiber testing protocols do not capture the samples potential processing performance.

The impact of cotton fiber maturity on estimates of the number of fibers per seed surface area (fiber density)

Measurement of Fibers per Seed

- Making selections based on yield components such as fibers per seed surface area, also known as fiber density (FD), might allow for the development of finer fibers along with better yield stability (Coyle and Smith, 1997 ; Clement et al., 2014).

- Direct measurement of fibers per seed is cumbersome and impractical in a breeding program.

- Breeders that use fiber density as a selection criteria typically estimate fiber density using fiber quality measurements and samples weights.

Hypothesis

- Immature cotton fibers may easily break during mechanical processing and lead to an increase in short fibers, resulting in an overestimation of the number of fibers per seed surface area.

Objective

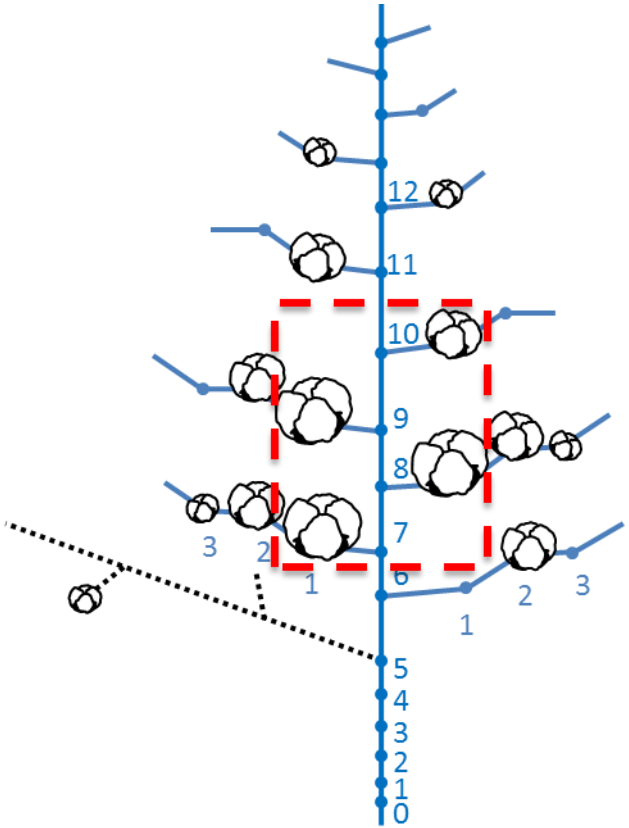
- To evaluate the impact of cotton fiber maturity on within-plant estimated number of fibers per seed surface area.

Materials

- Twelve modern commercial upland cotton varieties were grown in a randomized complete block design with three field replications in Lubbock, Texas during the 2012, 2013 and 2014 growing seasons.
  - Samples were harvested by position using a box picking method.
  - Seed surface area was measured by scanning after acid delinting.
  - The fiber quality of each sample was evaluated with the Advanced Fiber Information System (AFIS).
  - Estimates of fiber density were made using sample weights and fiber quality parameters provided by AFIS.

Box picking

- Bolls from each node and position were box picked at maturity.
- Only results from the first position bolls produced at nodes 7 through 10 are used in this presentation.
- Each sample was roller ginned.



Estimating the total number of fibers in a sample

AFIS fineness [mg/km]

Lint weight [mg]

AFIS mean length by number [mm]

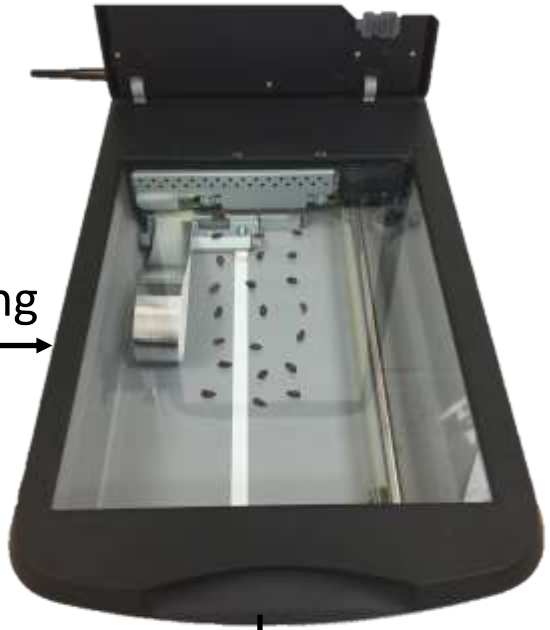
Total fiber length in sample [mm]

Total number of fibers in sample

Measuring Seed Surface Area

Delinting

Scanning

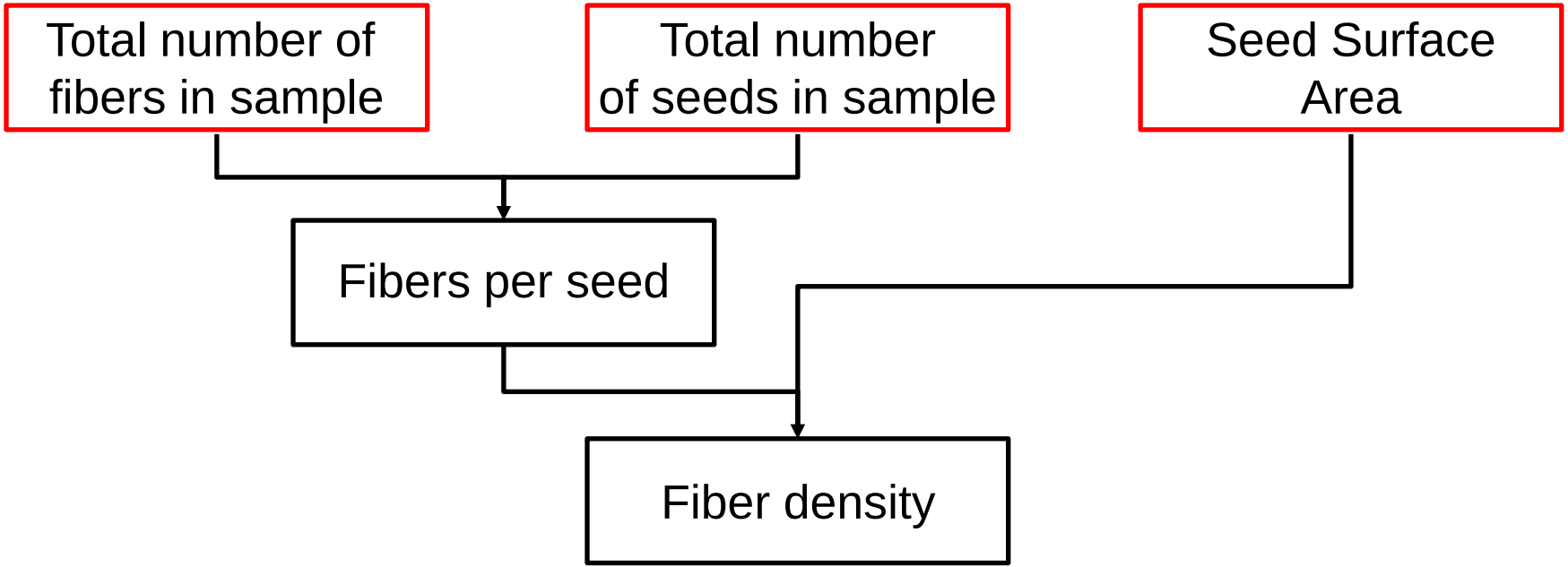


Total number of seeds in sample

Seed Surface Area

Estimating Fiber Density

The number of fibers per seed surface area

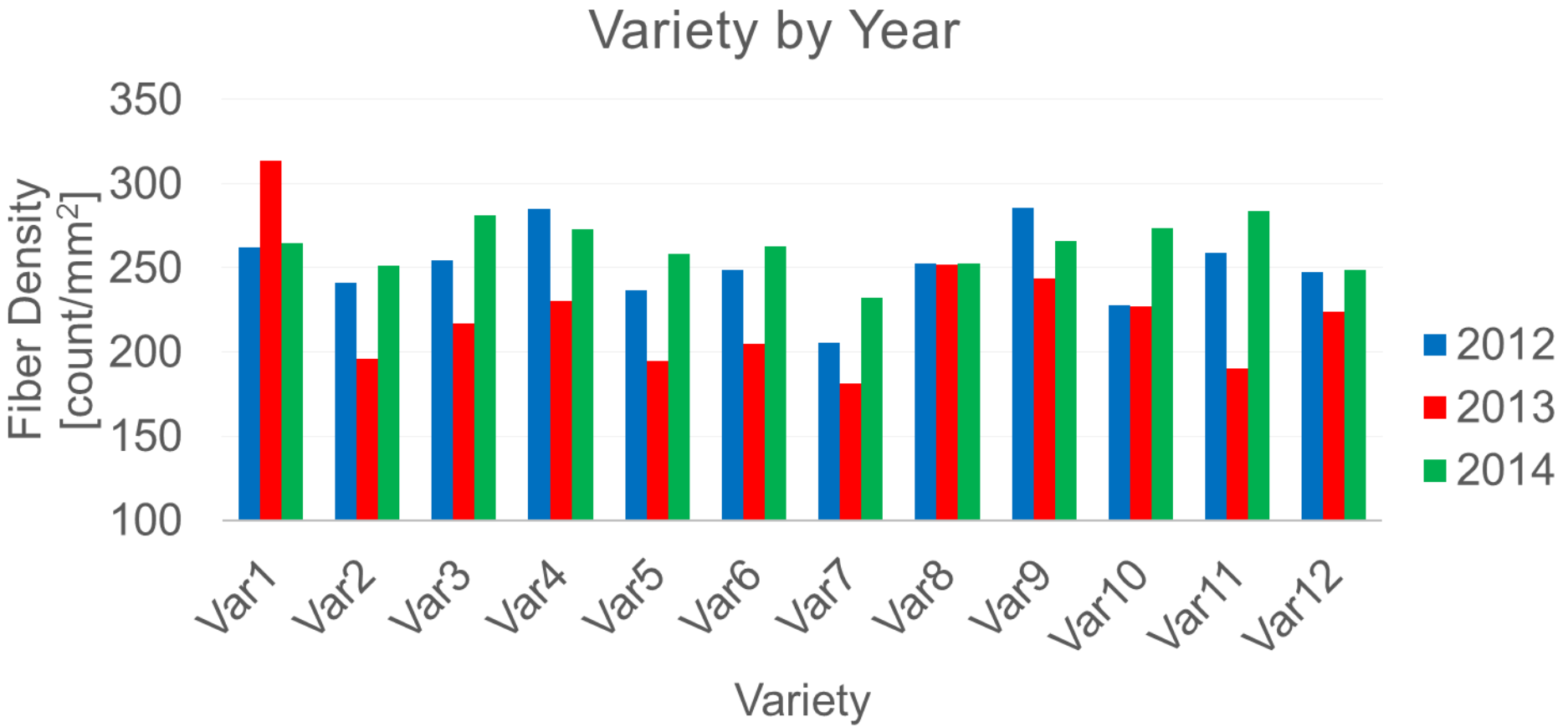


Results

Analysis of variance for fiber density

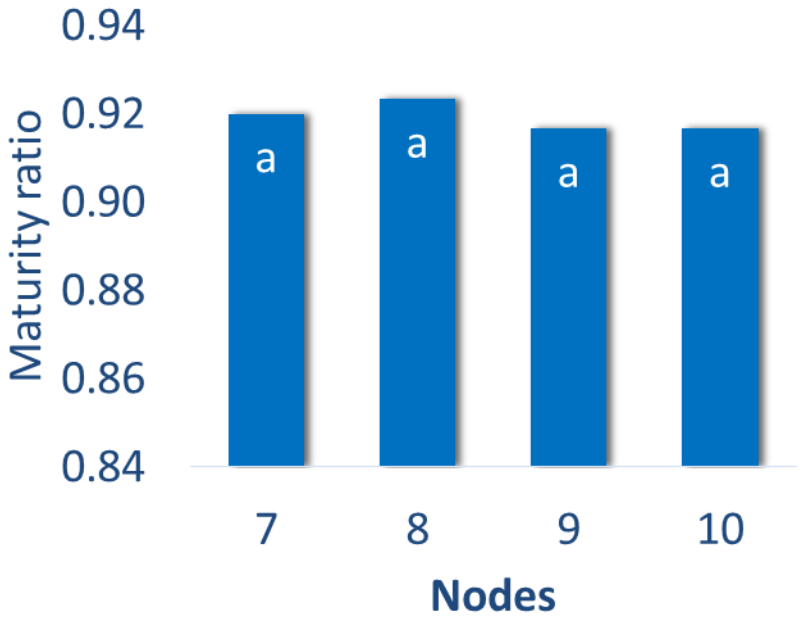
Sources of variation	Fiber density
Year	ns
Node	***
Variety	**
Variety x Year	**
Variety x Node	**
Variety x Node x Year	ns

* Significant at 0.05, ** Significant at 0.001, *** Significant at 0.0001 and ns = non-significant
Fiber Density = number of fibers per seed surface area (count)


Variety by Year
Fiber Density [count/mm²]
350
300
250
200
150
100
Var1
Var2
Var3
Var4
Var5
Var6
Var7
Var8
Var9
Var10
Var11
Var12
Variety
2012
2013
2014

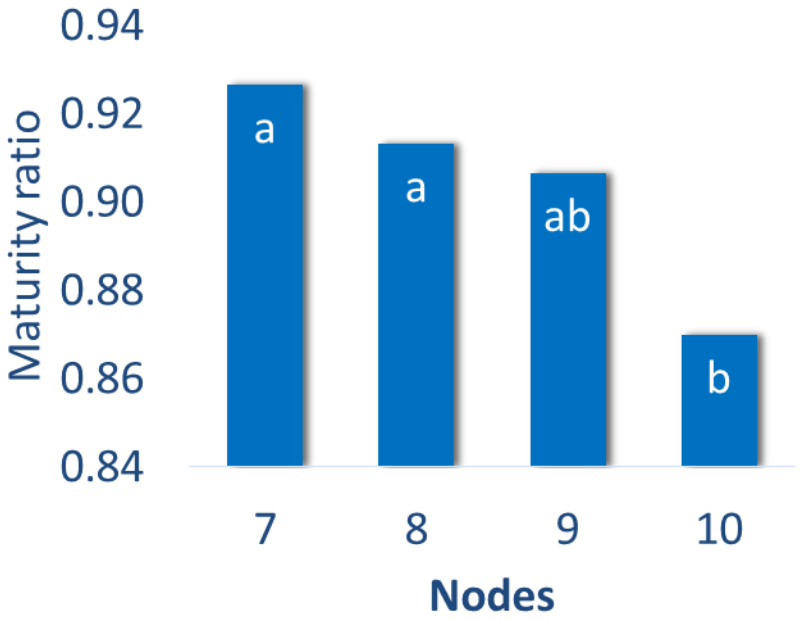
Variety A

More stable within-plant fiber maturity



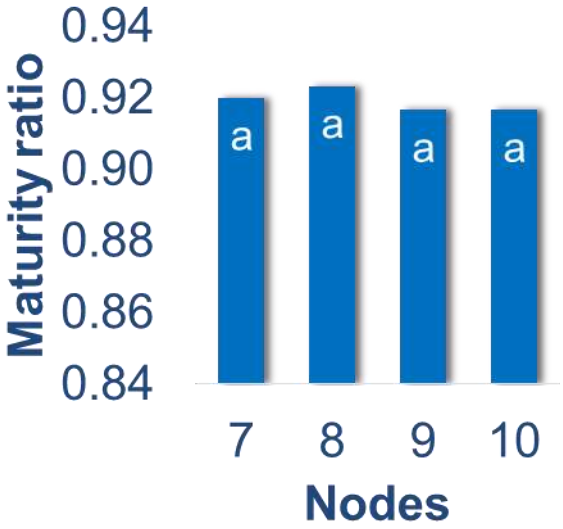
Variety B

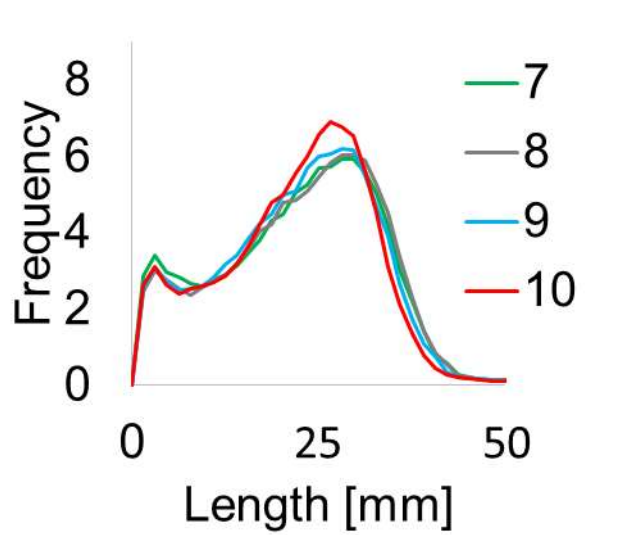
More variable within-plant fiber maturity

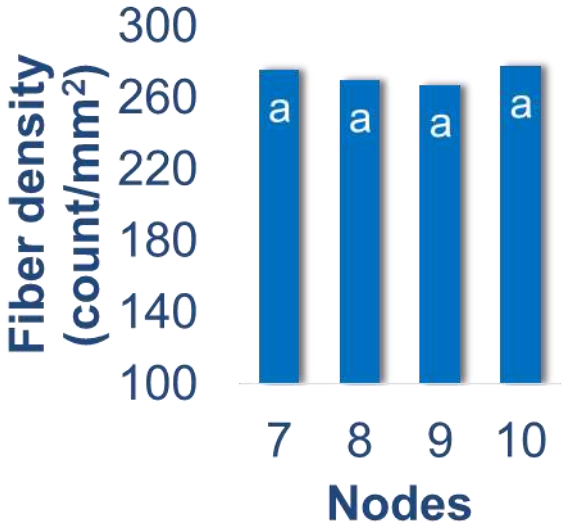


Variety A – More stable within-plant fiber maturity

Effect of fiber maturity on the fiber length distribution and the estimated number of fibers per seed surface area

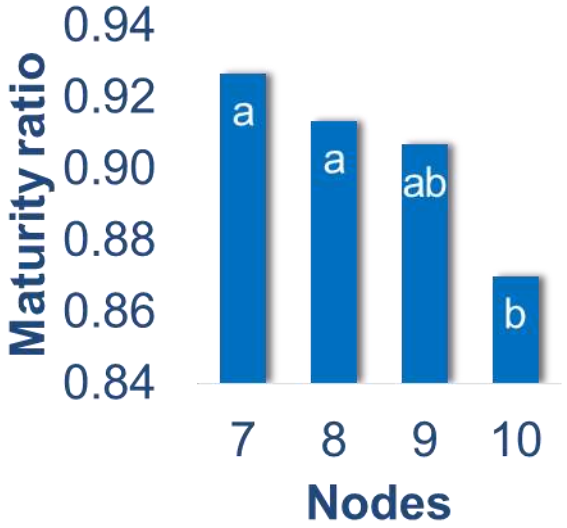


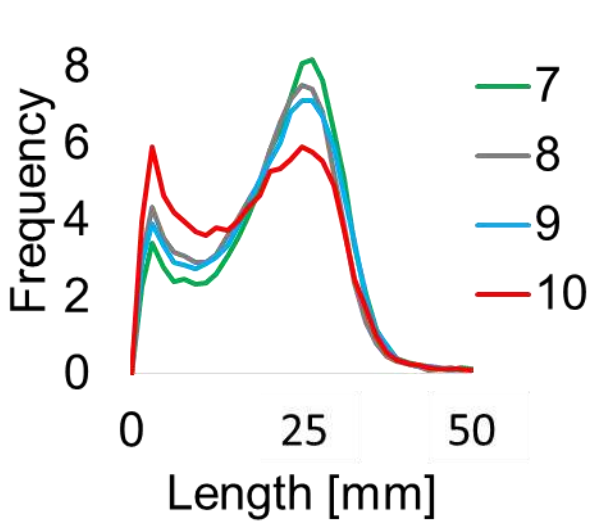


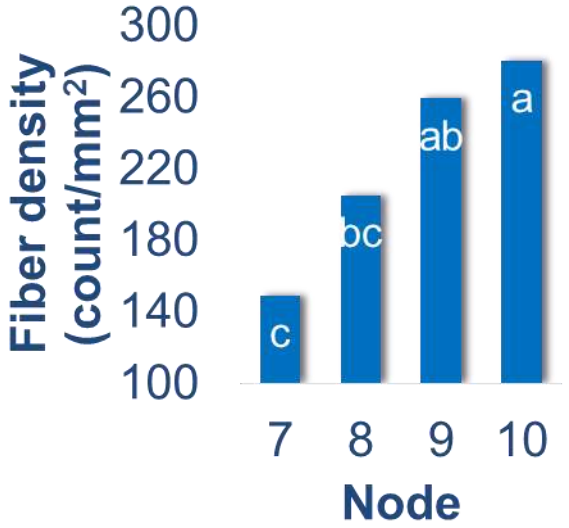


Variety B - More variable within-plant fiber maturity

Effect of fiber maturity on the fiber length distribution and the estimated number of fibers per seed surface area







Discussion

- Mature fibers break less frequently during processing, leading to fewer broken fibers and a lower short fiber content.

- In contrast, immature fibers may break more easily during processing leading to a reduced average fiber length by number, and an overestimation of the number of fibers per seed surface area.

- AFIS provides the information needed to estimate fiber density, but the fiber must be mature in order to use these estimates.

Conclusions

- Researchers need tools that help develop varieties that produce fiber with a quality that is competitive on demanding international markets.

- HVI testing cannot provide:
  - The within sample distribution of fiber length
  - Fiber maturity
  - Fiber fineness
  - Sample processability

- More informaton about fiber quality is needed than is provided by High Volume Instrument testing.

Acknowledgements
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Thank You