



Final Report

Off Farm Series | Cotton Research & Development Corporation

Part 1 - Summary Details

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: CMSE1310

Project Title: Scoping study of the influence of fibre length properties on the HVI fibre strength measurement.

Project Commencement Date: 1/7/12 **Project Completion Date:** 30/9/13

CRDC Program: Program 1: Value Chain

Part 2 – Contact Details

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Part 2 – Final Report Executive Summary

Provide a one page Summary of your research that is not commercial in confidence, and that can be published on the World Wide Web. Explain the main outcomes of the research and provide contact details for more information. It is important that the Executive Summary highlights concisely the key outputs from the project and, when they are adopted, what this will mean to the cotton industry.

The cotton industry relies on HVI™ measurements of cotton fibre quality for commercial trading. The current scoping study has confirmed the influence of cotton fibre length on the HVI Strength measurement i.e. cottons with longer fibre length characteristics appear to be artificially stronger in the HVI test than similar shorter cottons.

The methodology for this study utilised one cotton parent cut to produce a range of samples with different fibre length characteristics. Detailed single fibre testing confirmed that fibre strength and elongation values for the samples prepared at different lengths were the same i.e. the sample preparation technique of cutting the cotton sliver did not introduce any other unexpected damage of the cotton. The HVI measured strength values did vary between samples exhibiting a clear dependence on fibre length. Combining these two observations, it was concluded that the observed variation in the HVI strength values must be an artefact of the instrument test method.

The source of this error has been identified. The natural variation in the individual lengths of fibres with a cotton samples is such that in the HVI test some of the fibres will not fully span the distance between the two sets of breaking jaws. Thus the instrument will always have a tendency to slightly underestimate the breaking strength of the beard. Existing protocols to account of this through the current general calibration processes has been shown to be inadequate as the effect is dependent on the specific fibre length properties of individual cottons.

A first principle approach for correcting for this error was developed based on a detailed examination of both the internal operation of the HVI Strength Module and knowledge of the shape of the fibre length distribution. This resulted in the identification of a simple correction factor. Application of this correction factor removed the effect of fibre length on the corrected strength values.

This study also identified that the HVI Fibre Elongation values also contain a significant bias due to fibre length.

Adoption of the outcomes of this work will allow a more accurate determination of fibre strength and elongation which are important fibre quality parameters.

Part 3 – Final Report Guide

(The points below are to be used as a guideline when completing your final report.)

Background

Fibre strength and fibre length are recognised as two important fibre quality parameters, which are currently routinely measured commercially using the HVI system. Recent on-going CRDC funded work on spinning prediction and performance (the 'Cottonspec' project) has confirmed the importance of both fibre strength and fibre length to the spinner.

There are commercial premiums and discounts associated with both fibre length and strength.

A small study by J-P Gourlot from CIRAD reported at the US Beltwide meeting in 2002 that in cotton fibres cut to different lengths exhibited a significant effect on HVI strength. As the same cotton is being remeasured, *a priori* one would expect the strength value to be independent of the cutting process. The presence of a relationship is indicative of a measurement artefact.

Objectives

The primary objective of this scoping study is to verify the hypothesis that the observed bias in the HVI strength measurement is indeed real and to confirm through preliminary analysis and modelling the influence of the fibre length distribution on the HVI strength measurement.

Methods

This scoping study deliberately followed a similar initial methodology as used in the earlier work of Gourlot to reproduce his initial findings. A cotton sliver was cut at different length and then the resulting samples were evaluated using the standard HVI measurement techniques.

Using the same sample set, further experiments were conducted at the USDA Cotton Structure and Quality Research Laboratory in New Orleans

- a. using their FAVIMAT instrument to undertake single fibre tensile measurement to evaluate the single fibre strength and elongation values of the samples prepared at different lengths,
- b. using their HVI system to independently confirm the original data and experiments undertaken in Australia, and
- c. using their HVI system in a non-standard mode, to give access to critical internal aspects of the operation of the instrument to further characterise and

understand the operation of the instrument and to test and validate the ideas generated by the project.

Results

Complete technical details of results and outcomes of this scoping study are described in two scientific papers published in *The Textile Research Journal*, copies of which are attached to the end of this report.

The primary results are:

- (a) It was confirmed that the HVI measurement of fibre strength is biased by fibre length i.e. cottons with longer fibre length characteristics appear to be artificially stronger in the HVI test than similar shorter cottons.

Single fibre testing using the FAVIMAT instrument confirmed no significant differences in the measured single fibre strength and elongation values for the samples prepared at different lengths i.e. the sample preparation technique of cutting the cotton sliver did not introduce any other unexpected damage of the cotton. The HVI measured strength values did vary between samples exhibiting a clear dependence on fibre length. From this it was concluded that the observed variation in the HVI strength values must be an artefact of the instrument test method.

- (b) The cause of this error in the HVI Strength measurement was identified.

It was identified that due to the natural wide variation in fibre lengths always present in ginned cotton samples, there will always be some cotton fibres in the tapered beard (the form of the cotton bundle in the HVI test) that do not span the full distance between the two sets of jaws in the HVI Strength module. Thus these 'non-spanning' fibres will not contribute to the measured breaking force resulting in an underestimate of the fibre bundle strength. A detailed examination of the shape of the tapered beard identified that this effect will be dependent on the fibre length characteristics and is the most likely source of this error/bias.

- (c) A model for correcting for this error was developed leading to a simple correction factor. It was demonstrated that application of this correction factor removed the bias in the 'corrected strength' values.

The concept that that 'non-spanning' fibre are the source of the error/bias was expanded and based detailed quantitative examination of the shape of the length distribution, the formula for a correction factor was developed from first principles. Application of the correction formula to the current data set satisfactorily removed the bias.

- (d) Two key assumptions underpinning the development of the successful correction factor approach were tested and demonstrated to be valid.

Experimentally the internal operation of the HVI Strength module was examined in detail to understand exactly where along the beard the strength measurement was undertaken, which related to key assumptions in the development of the above 'correction factor'

- (e) The HVI Elongation values were also demonstrated to exhibit a bias due to fibre length.

This was an interesting and important additional observation. The explanation of this bias was not examined in the current limited scoping study.

Outcomes

This small scoping study has been extremely successful, exceeding the planned project outcomes and objectives. As noted above an undesirable bias in the HVI measurement of strength has been confirmed, its source identified, and a correction developed and tested. Further the study has also identified that the HVI Elongation values also exhibit a similar unfortunate bias.

The outcomes of this project are being fully published in the scientific literature. There is thus no new Intellectual Property resulting from study that needs to be registered.

Conclusion

This project has identified an important bias or error in the current HVI measurement of both Strength and Elongation. In the short term it is unlikely that the manufacturer of the HVI instrument will modify the HVI instrument given that commercially they effectively hold an monopoly position in this market.

However the cotton industry can directly benefit from this work by noted that an improvement in fibre length will lead to the HVI system reporting improvements in fibre strength and fibre elongation as well as fibre length. Given that all three are important fibre quality parameters, this perhaps adds additional weigh/value to strategies and R&D designed to minimise fibre breakage and/or improve fibre length.

Extension Opportunities

There are currently no further extension endeavours planned as a direct follow on from this project.

Publications

Naylor G.R.S. Impact of Fiber Length on HVI Strength. Proc. Beltwide Cotton Conferences, 792-797, 2013.

Naylor G.R.S. Evidence and Potential Explanation of the Influence of Fiber Length on the HVI Measurement of Cotton Fiber Strength. Textile Res J (in press). DOI: 10.1177/0040517513483860 (published online 10 May 2013)

Naylor G.R.S., Delhom C., Cui X., Gourolot JP, and Rodgers J.E., Understanding the influence of fiber length on the HVI measurement of cotton fiber strength. Textile Res J (in press).

Copies of Publications

-  Length Strength Draft TRJ Paper2 v7. Online May 2013.pdf
-  Naylor TRJ Paper 1
-  Naylor Beltwide 2013.pdf