



Cotton Micronaire can be predicted from seed imbibition date, latitude, and in-crop temperatures.

Australia's National Science Agency

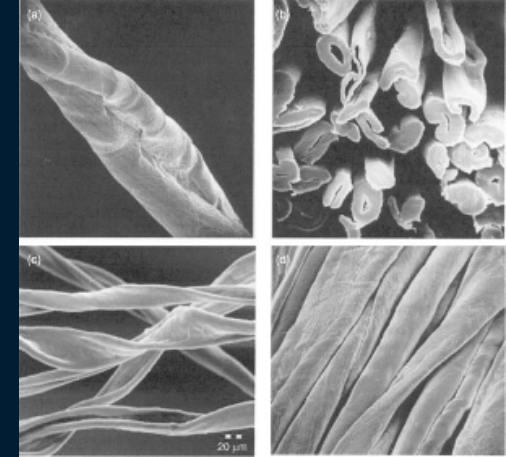


Image: <https://paperpulpingmachine.com/applications/cotton-pulp-making/>

Development of the Mic prediction Shiny app. for the Australian Cotton Industry

Tim Weaver¹, Brint Gardner², Lauren Stevens², Michael Bange³, Chris Teague³, Stuart Gordon⁴ | October 2024

¹formerly CSIRO Agriculture & Food, Australian Cotton Research Institute, Myall Vale, NSW. Currently The University of Sydney, I.A Watson Grains Research Centre, Narrabri, NSW. 2390

²CSIRO, 36 Gardiner Road, Clayton, Vic 3168.

³CSD, 'Shenstone'. 2952 Culgoora Road, Wee Waa, NSW 2388.

⁴CSIRO, 671 Sneydes Road, Werribee, Vic 3030.






I would like to begin by acknowledging the Minang/Menang Noongar people as the Traditional Owners of the land on which the Agronomy Conference is being held this week and pay my respect to their Elders past and present.





CSD Agronomy Tools

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Agronomy Tools ^


- Day Degree Calculator
- Got the green light for planting?
- Simulated Time to Estimated First Flower
- Variety Performance Comparison
- Variety Performance
- CottonTracka
- BARRY
- Dryland row configuration performance tool
- Replant Calculator

Feedback





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-  Extension resources include regular newsletters, videos and planting guides

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Overview

- Importance of cotton fibre quality
- CSD dataset
- Modelling the dataset – key predictors for Micronaire
- Development of a Shiny app for the cotton industry

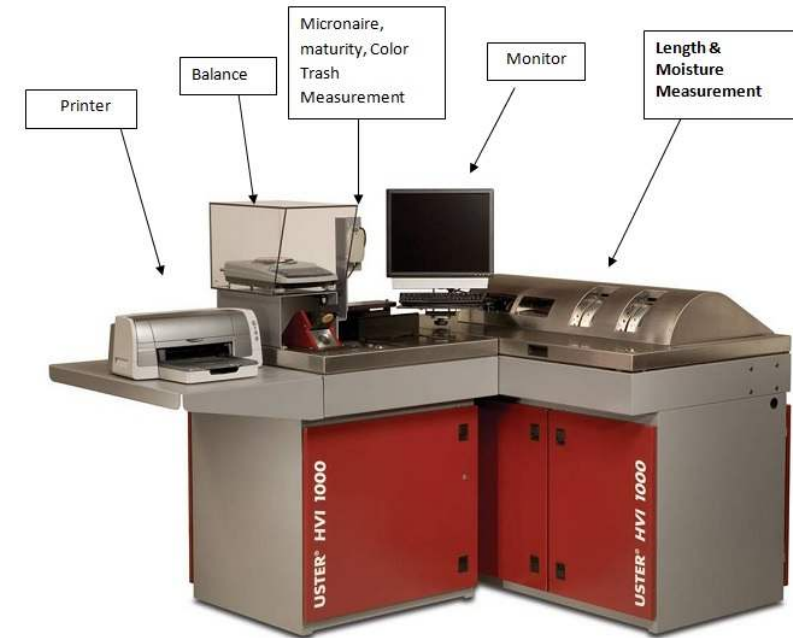


Image: <https://www.textileblog.com/uster-hvi-1000-features-measurements/>

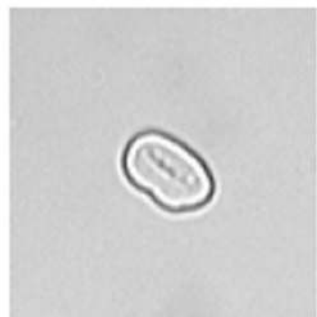




Importance of Micronaire

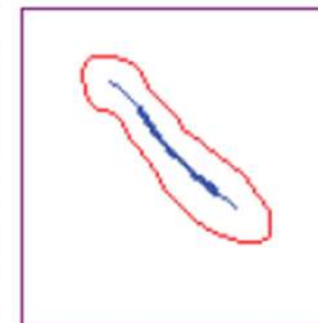


- Micronaire measures specific surface area (across a plug of fibres) and provides indications of fibre maturity (no units) and linear density (mg/km)
- Best fibres are mature and fine (ideal Mic. range is between 3.8 – 4.5)
- Outside this range there are price discounts (\$\$\$).
- Fibres <3.8 are deemed immature – breakages and poor dye uptake.
- Fibres >4.5 are too coarse for fine count yarns. The yarn will be weaker and more uneven.



Micronaire: 4.3
Linear density: 108 mtex
Theta: 0.86
Perimeter: 33 μm
Wall area: 73 μm^2

Good



Micronaire: 5.3
Linear density: 279 mtex
Theta: 0.45
Perimeter: 72 μm
Wall area: 187 μm^2

Poor



What drives difference in Micronaire

- Cotton fibre is primarily cellulose
 - The cotton plant's journey during growth affects fibre development:
 - Cultivars can be inherently different in their Micronaire, although most new, high yielding cultivars have similar 'Micronaire' traits
 - Environment and management have large effects on final Micronaire. Key effects are due to:
 - Temperature
 - Radiation
 - Leaf defoliation
 - Water deficits
 - Internal plant competition from bolls for carbohydrates
- (Bange et. al 2021)





CSD Data set

We now have a larger dataset including a diversity of Genetics (**G**), over multiple seasons (**E**) and varying managements (**M**).



Cotton boll



Cotton seed



Cotton linter

Image: <https://paperpulpmachine.com/applications/cotton-pulp-making/>

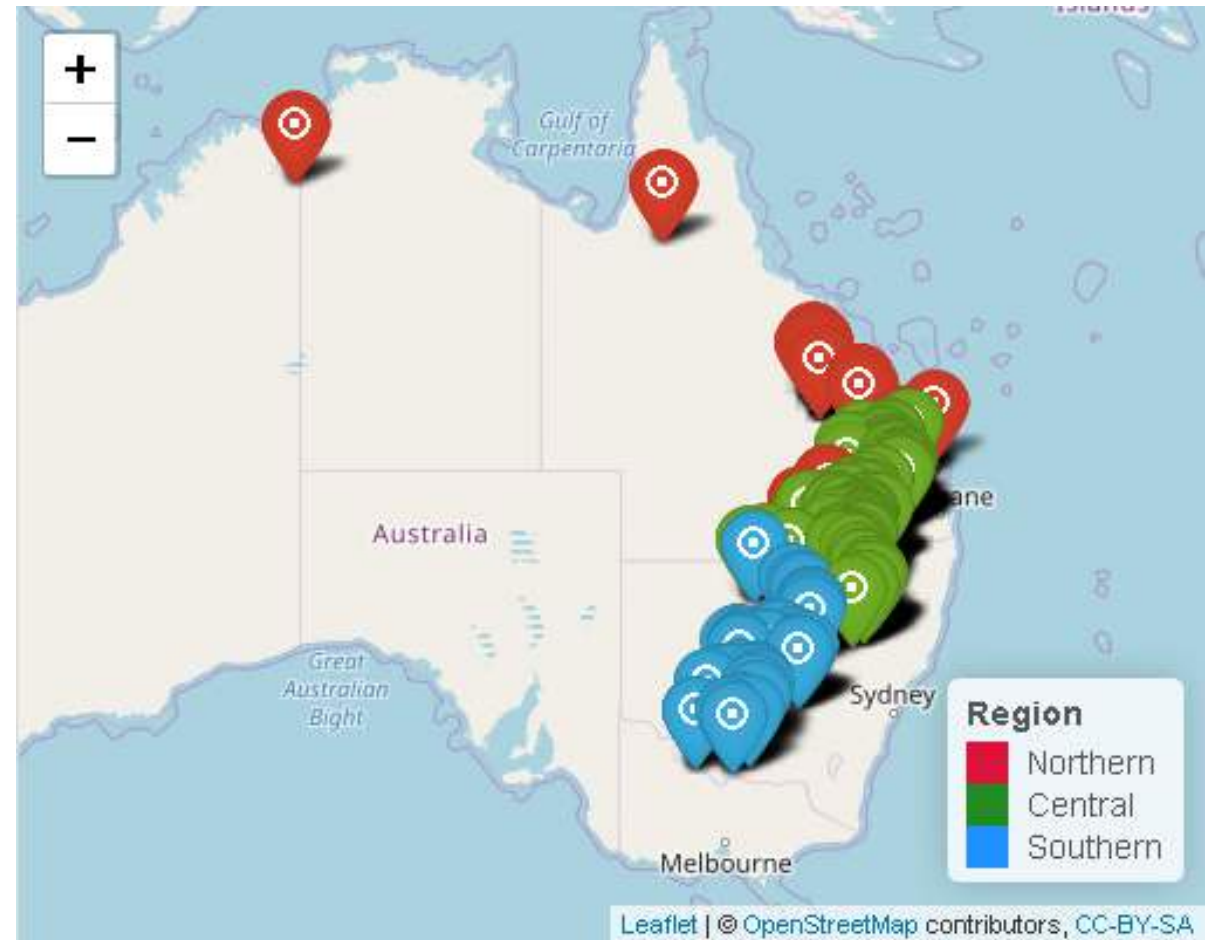




Dataset

- 273 variables/features
- 3+ Varieties
- 7+ Seasons
- 2+ Cultivation Types

To predict:
Micronaire





Modelling the data

Using previous research by Bange *et al.* 2010 & 2021

- Ave. temperature during boll filling (fibre development) from 430-870 day degrees (Base 12) (using long paddock data) was added to the dataset
- XGBoost analysis on the 274 variables (+1 ave. temp)
- Variables with <5% importance were removed leaving 14 in the model to predict micronaire (r^2 of 0.7)

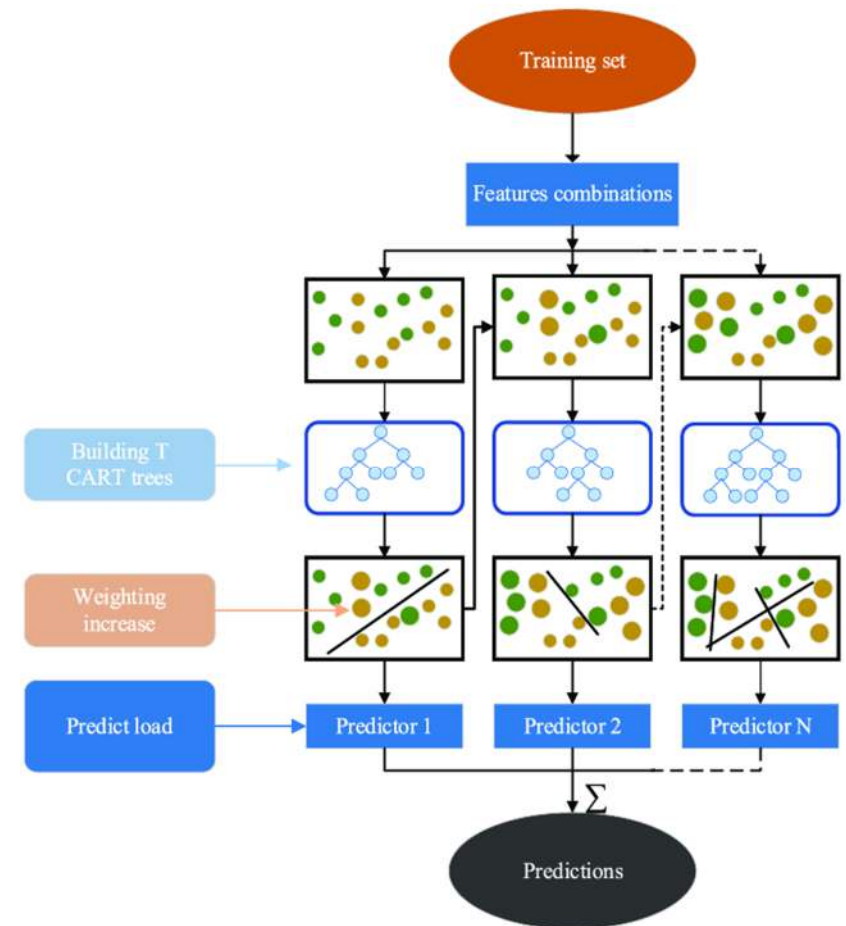


Image: https://www.researchgate.net/figure/Schematic-illustration-of-the-XGboost-model_fig2_362100649

$$\text{day degrees (Base 12)} = \frac{(T_{\max} - 12) + (T_{\min} - 12)}{2}$$





Top 14 variables in importance were:

1. Latitude
2. defoliation hot days $> 35^{\circ}\text{C}$ (ie. days above 35°C from seed imbibition to first defoliation date)
3. day degree at cut-out (ie. day degrees from seed imbibition to cut-out)
4. cut-out days after planting
5. average daily temperature during boll fill
6. first flower NAWF (nodes above first white flower)
7. mid-squaring nodes to the first fruiting branch
8. first flower days after planting
9. first flower day degrees Base 12
10. cut-out total bolls
11. day degrees at cut-out
12. first flower first position retention
13. region and
14. variety





Next steps

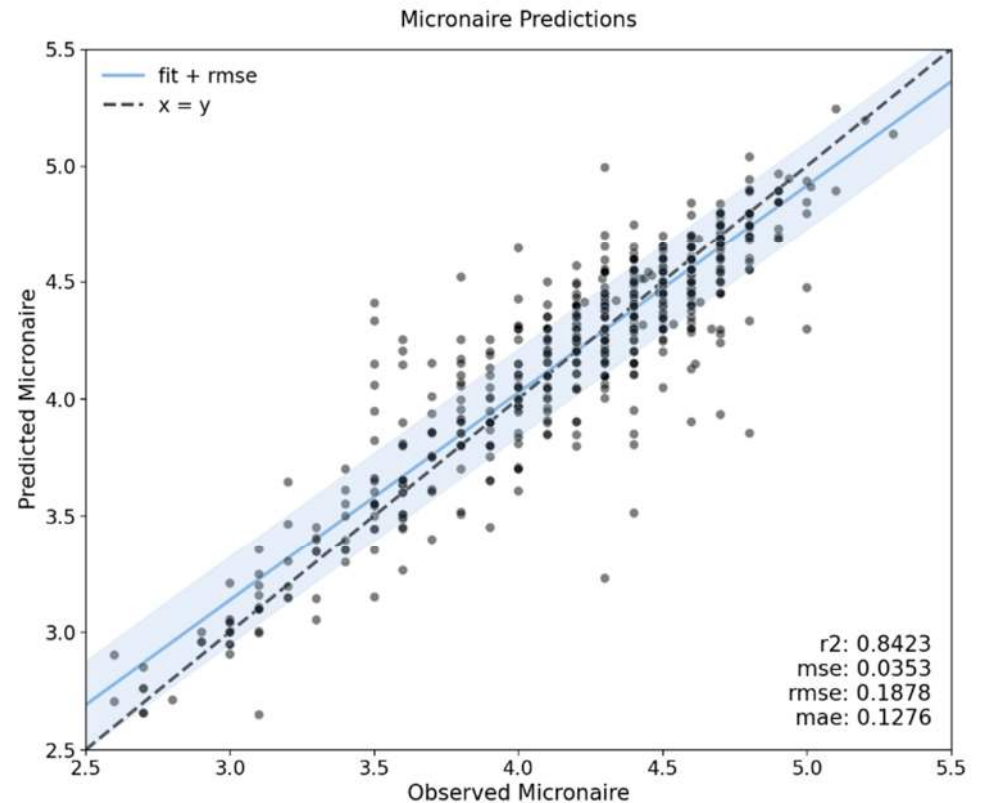
- Addition of another variable to investigate longer term climate variables
- Addition of average temperature from seed imbibition date to first defoliation date (thus addition of seed imbibition date that wasn't in the top 14)
- Multiple scenarios were run with the additional new variable + seed imbibition date (recursive feature elimination strategy)
- Each time the weakest feature was dropped out.
- Final model performance measure using LOO cross-validation.
- Best relationship was 4 variables with $r^2=0.842$ and $RMSE = 0.18$





Final Micronaire Prediction Model – Four Variables

- Average temperature (from seed imbibition date to the first defoliation) (52%)
- Latitude (24%)
- The number of days above 35°C (from seed imbibition date to the first defoliation date) (13%) and
- seed imbibition date (11%)



(Shading indicates RMSE)





R Shiny app developed for Industry

The screenshot shows the 'CSD Micronaire Predictive Model' interface. It features a sidebar with navigation options: Introduction, Predictive Model, and Summary. The main content area includes a title, a descriptive paragraph, and several interactive panels.

Model

Micronaire

Parameters

Latitude
-30

Seed Imbibation Day of Year
287

Hot days >35oC from seed imbibation to defoliation.
53

Average temperature from seed imbibation to defoliation.
25

Reset

MICRONAIRE ESTIMATE

4.3 ± 0.2

Snapshot

Name	Value
Latitude	-30
Seed Imbibation Day of Year	287
Hot days >35oC from seed imbibation to defoliation.	53
Average temperature from seed imbibation to defoliation.	25
Micronaire	4.3 ± 0.2

Download options: CSV, TXT





Acknowledgements

This research was funded by Cotton Seed Distributors. A large thank you is given to the CSD team of extension agronomists for the collection of the ambassador dataset.





Thank you

Formerly CSIRO A&F

Currently

The University of Sydney

Tim Weaver

Senior Lecturer in Farming
Systems Agronomy

+61 4 2725 5086

Timothy.weaver@sydney.edu.au

Australia's National Science Agency

