Learnings from a successful cotton breeding program
Challenges, priorities and realities

Warwick Stiller | ICAC November 13 2019

Australia’s National Science Agency
Outline

• CSIRO Breeding Program overview
• Measures of success
• Stages of breeding programs
• Learnings
• Summary
Cotton breeding objectives

To develop Australian cotton cultivars with the package of:

– increased yield
– fibre quality preferred by international spinners
– resistance to all important diseases
– adaptation to all regions
– with GM traits of importance.

Achieved through the integration of traditional breeding and modern tools together with the understanding of market requirements.
CSIRO Cotton Research - A fully integrated continuum

Basic research
- Fibre biol/traits
  - MYB
  - PME
  - NAC
    - Designer fibre
    - Fibre mutants
- Markers
- Genomics
- Sequencing

Applied research
- Host Plant Resistance
- Abiotic stress
- Yield/quality
- Disease resistance
- Sodicity tolerance
- Herbicide resistance
- Breeding methods and practices
- Input of third party GM traits

Cultivar delivery
- Breeding
  - Yield
  - Disease resistance
  - Quality
  - Regional adaptation

Strategic ideas

Basic research → Applied research → Cultivar delivery

Input of third party GM traits
The CSIRO Cotton Breeding program is largely a phenotypic selection program based on measuring and selecting for:

- Yield
- Fibre quality
- Disease resistance
- etc.

- Large populations and collection of **accurate** multisite and multiyear data is critical
Past progress

Australian Irrigated yield

\[ y = 33.8x - 65708 \]

\[ R^2 = 0.88 \]
Global trends in cotton yields (kg lint/ha)

Source - ICAC
The interaction between breeding and crop management in improved cotton yield

S.M. Liu\textsuperscript{a,\*}, G.A. Constable\textsuperscript{a}, P.E. Reid\textsuperscript{a}, W.N. Stiller\textsuperscript{a}, B.R. Cullis\textsuperscript{b,c}
## Past progress

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<th>Year</th>
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<td>✔ ✔ ✔</td>
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- **Bacterial blight**: Presence is indicated by a check mark (✔), absence by a cross (x).
- **Verticillium Wilt**: Presence is indicated by a check mark (✔), absence by a cross (x).
- **Fusarium wilt**: Presence is indicated by a check mark (✔), absence by a cross (x).
- **Cotton Bunchy top**: Presence is indicated by a check mark (✔), absence by a cross (x).
- **Black Root rot**: Presence is indicated by a check mark (✔), absence by a cross (x).
Current focus

• Yield and quality improvement under high input, well managed farming systems
• Improved pest and disease resistance (relevant to Australia)
• Developing varieties with new GM traits (relevant to Australia)
Stages of a breeding program

• Primary
  • Addressing immediate industry issues (market failure)
  • Germplasm sourced from a wide range

• Secondary
  • Some major issues overcome – more focus on yield and fibre quality
  • More targeted germplasm introductions

• Tertiary
  • Primary focus on overall package – yield, fibre quality, disease resistance etc.
  • Intercross and reselection among proprietary germplasm
  • Generally results in more specific adaptation to the target region/environment
Learnings – breeding is a powerful tool, but...

• Critical to understand the industry and its requirements
  • What might be priorities for us may be very different to yours
• How technologically advanced is the industry?
• Understand the constraints to production
  • Prioritise the major issues – water, soil fertility, climate, pests, disease etc
  • Many of these need to be addressed by changes in soil and crop management rather than breeding – focus on fixing them first then use breeding to make further improvements
Consider the application
• Substantial interest in developing a cotton industry
• Very different climate and soils
• Continuing debate around planting window
• Uncertainty around some management practices ie. use of growth regulants
• Currently, cultivar is not the limiting factor
Learnings

• Breeding is expensive and long term
  • Return on investment is often better and quicker through changes in management

• Need an imperative for breeding with difficult traits
  • eg if pest or disease resistance has to be transferred from another species it is very long term research >15 years
  • Need long term view, consistent focus and funding
  • No value in starting something if you can’t finish it

• Must be realistic about what can be achieved through breeding
  • eg If yields are low due to lack of nutrition, cultivar is not the limiting factor and breeding will achieve little gain
Realities

• If you want to do breeding there are no shortcuts
  • Must commit to investing and doing the hard work

• Our breeding program requires significant return on investment, government does not provide funding.
Assistance

• Extensive germplasm is available from collections
Summary

• New cultivars can address production constraints and improve yield and quality
• However, this must be targeted for each production region – there are no shortcuts
• New cultivars will not solve some major production issues – these need to be addressed by changes in soil and crop management.
• New technology is powerful, but must be supported by research, stewardship, production protocols and quality assurance
Thank you

CSIRO Agriculture and Food
Dr Warwick Stiller

Warwick.Stiller@csiro.au