



The CSIRO Cotton Breeding Program

Warwick Stiller

Australia's National Science Agency



Outline

- Introduction to the Program
- Resources
- Objectives, strategy and priorities
- Keys to success

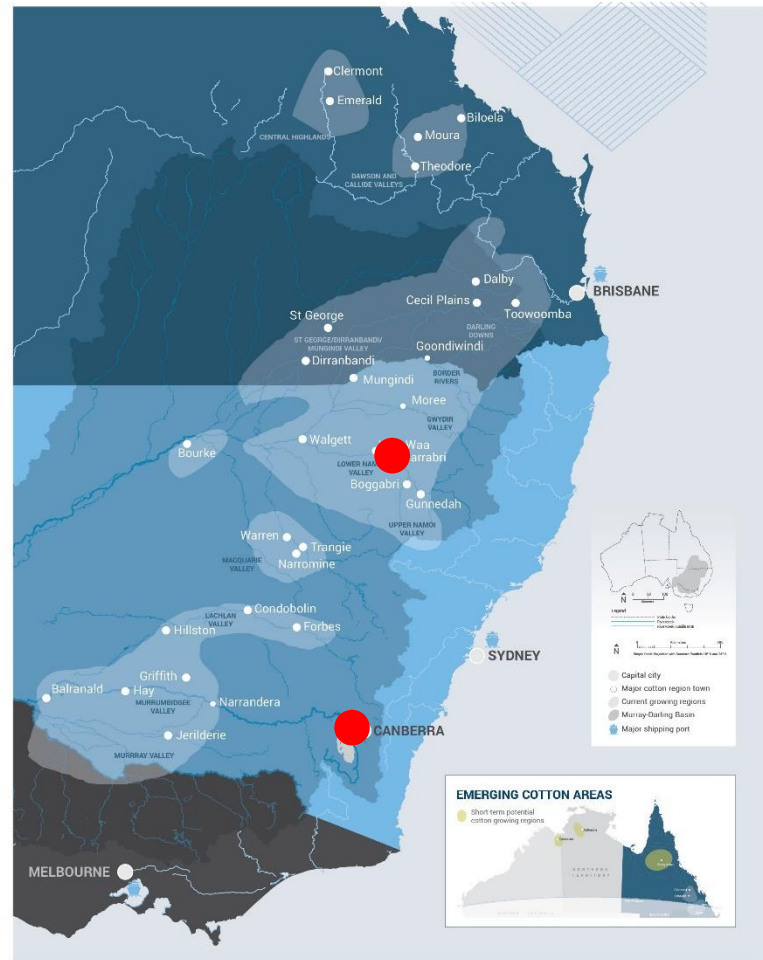


Who??

- The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is an Australian Federal Government agency responsible for scientific research.
- Established in 1926 under *The Science and Industry Research Act*.
- Charter is to 'turn science into solutions'
- CSIRO is governed by a board appointed by the Australian Government, with seven directors plus the CEO.
- ~5,500 employees

The Cotton Breeding Program

- Established in 1972
- Fully integrated program from discovery to delivery of varieties
- ~30 staff based at Narrabri NSW
- ~20 staff based at Canberra ACT



Span of Public and Private

- Unique situation
- We operate within a government entity but with commercial outcomes
- Funding for research projects through long term agreements with commercial partner Cotton Seed Distributors Ltd.
- Licencing in of 3rd party GM traits is critical
- Breeding Program is self-funded



The Cotton Breeding Program

- Dedicated facilities, fields and equipment
- Laboratories, greenhouses, ginning, delinting, fibre testing and packing facilities.
- Four plot harvesters – JD7760, JD9930, 2 x Case 2022
- Two plot planters
- Transport equipment
- Staff capabilities:
 - Molecular, genomic, quantitative genetics, statistics, applied breeding, agronomy, physiology, pathology, entomology, software development, computer vision, machine learning, A.I., electronics, field and machinery operation



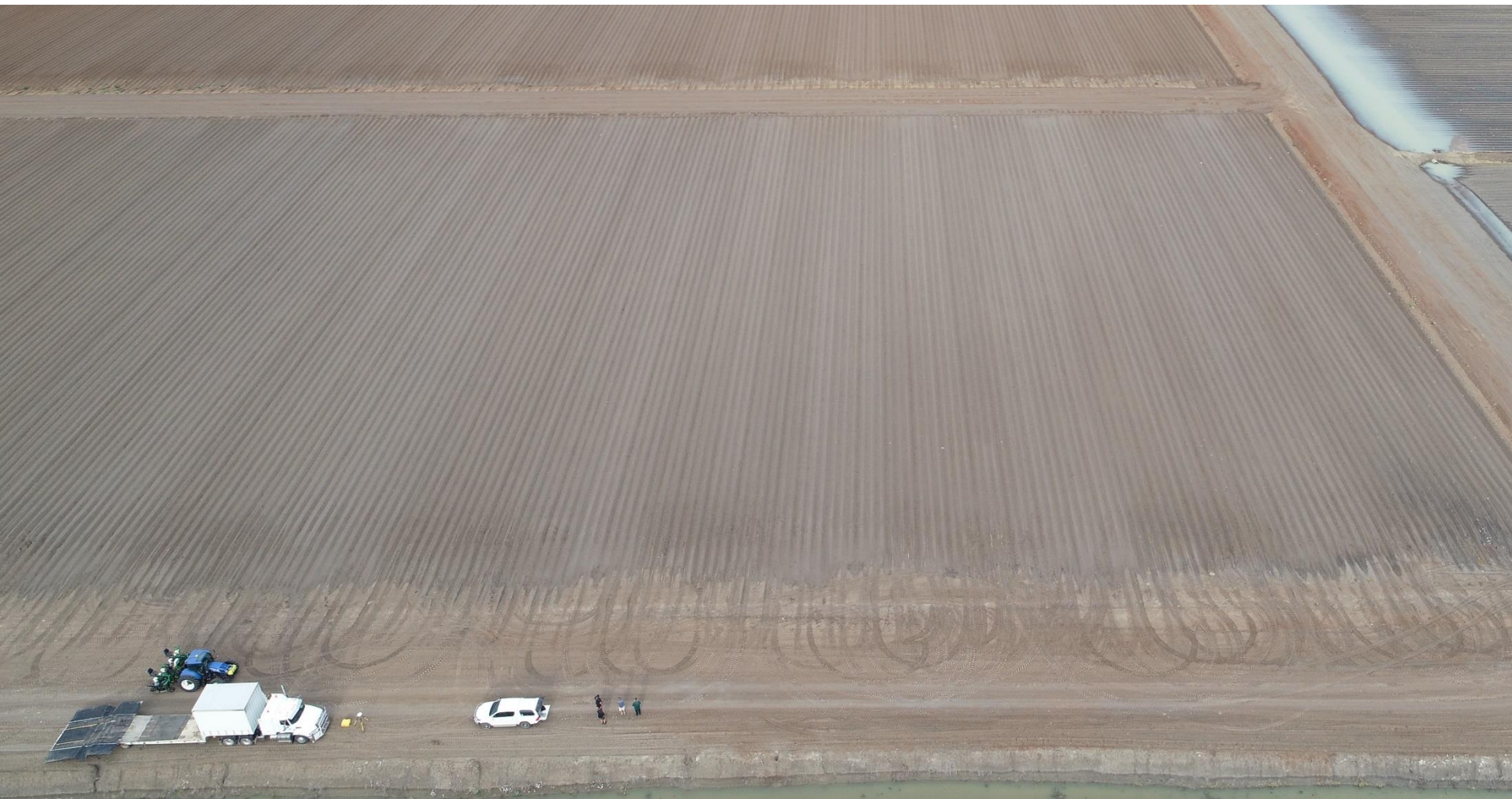










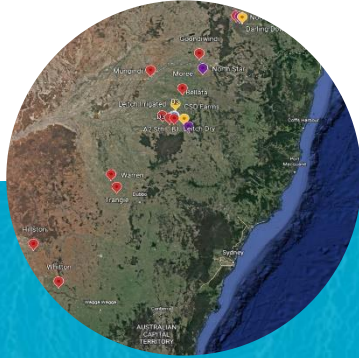




Logistics



200,000
packets
of seed



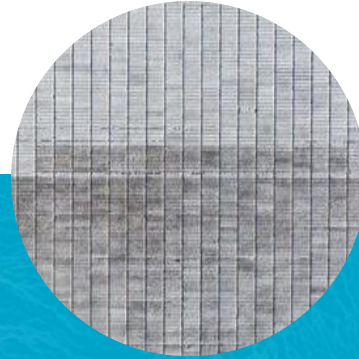
26 Sites,
5000 km



5000
emasculations

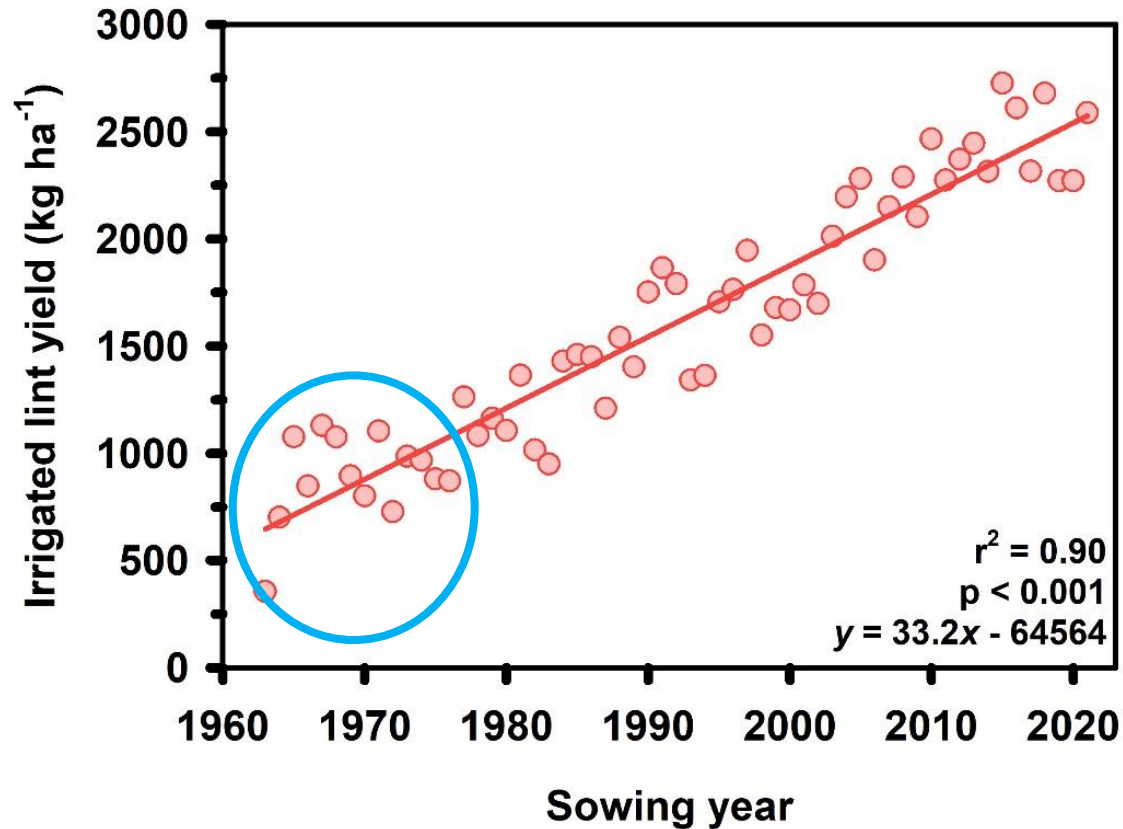


25,000
Single
Plant
Selections



50,000
field plots

A successful program



What does it take to run a successful program?

- Engagement with stakeholders (growers, industry, end users)
- Defined strategy
- Line of sight to impact
- Clear focus
- Efficient use of resources – infrastructure, equipment, staff capabilities

Cotton breeding objectives

To develop Australian cotton varieties 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

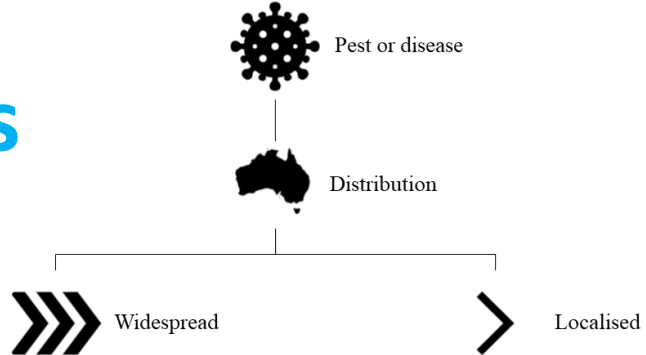
Achieved through the integration of traditional breeding and modern tools together with the understanding of market requirements



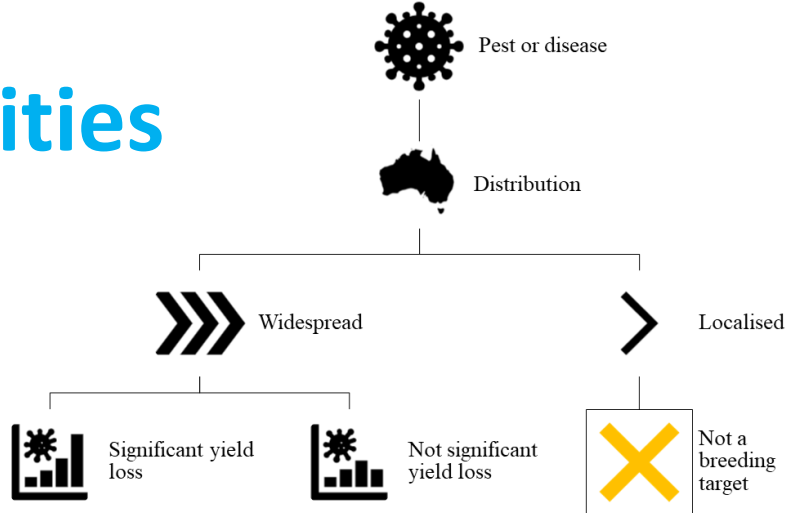
Strategic priorities

- A breeding program can have many competing priorities.
- Resources are always limited.
- Though engagement with stakeholders activities need to be prioritised.
- Requires a defined strategy.
- A simple example on pest resistance.....

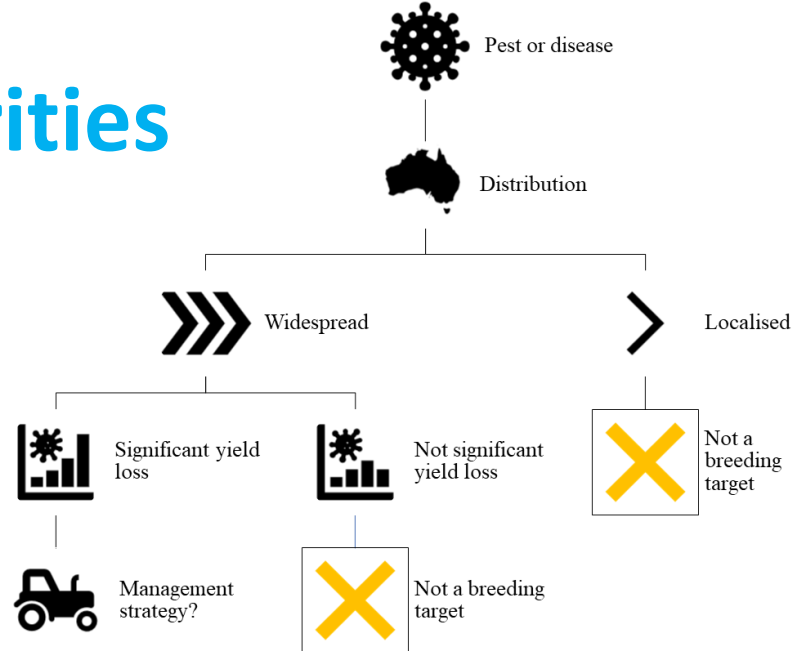
Strategic priorities



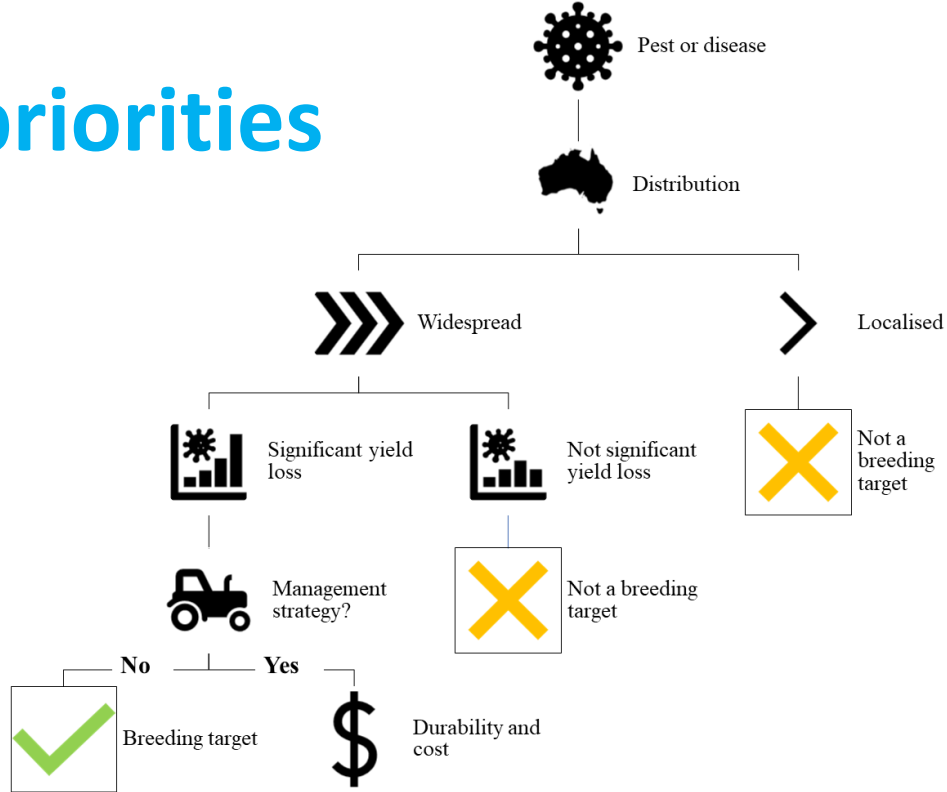
Strategic priorities



Strategic priorities



Strategic priorities



Strategic priorities



Keys to success

- Understand the landscape
 - What do stakeholders want/need
 - Limit academic studies to those that contribute to variety development ie. Line of sight to impact
- Long term view
 - Strategic planning – future focused
 - Fast-fail
 - Fast-follow
- Develop genuine partnerships/collaborations



Keys to success

- Collect and store accurate and reliable data
- Continually evaluate new tools/techniques/methods – but don't just chase the shiny objects
- Always look for efficiencies – smarter often beats bigger
- Build a team with diverse capabilities
- Success isn't based on what resources you have, it's about how you use them



Thank you

Dr Warwick Stiller

CSIRO Agriculture and Food



Case study - Fov

- *Fusarium oxysporum f. sp. vasinfectum* (Australian biotype)
- First identified in 1993 on the Darling Downs in Queensland
- New biotype, no race designation, VCG 01111 and 01112
- Similar reaction on cotton differentials as Race 1, however, genetic analysis indicates these biotypes are clearly distinct from other known races.
- Severe effects - plant death from germination to maturity; no association with nematodes.
- Without significant control of this disease, there would be no cotton industry in Australia



The problem

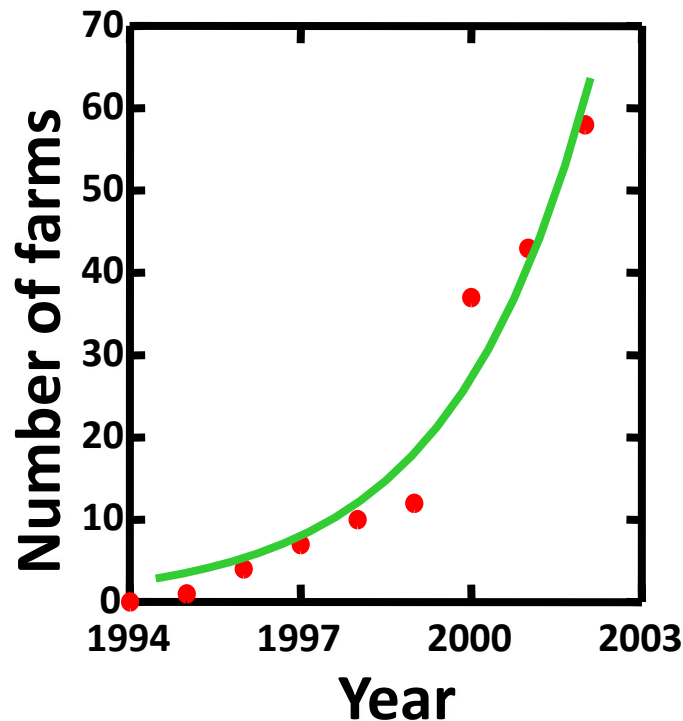


*Fusarium
oxysporum
vasinfectum
(Australian biotype)*



The problem

- In the worst affected fields, growing the most susceptible variety produced virtually zero yield.
- In the worst affected fields, growing the least susceptible variety available did not produce an economic yield.



Response

When a new disease is discovered in any crop, breeders usually:

1. Screen all commercial varieties
2. Screen other varieties available to them (germplasm collections)
3. Search for other disease resistant germplasm
4. Screen other related species

Increasing breeding difficulty



Response

- Understand the pathogen.
- Most commercially grown cotton cultivars in 1994 were highly susceptible.
- A large breeding program was initiated by CSIRO to identify and incorporate new sources of resistance.
- Identification of reliable long term field sites was critical.
- Coordination across the industry regarding management strategies



Methods

- Field nurseries
 - Assess survival from seedling to adult stages.
 - Assessment at maturity on absence of *Fov* symptoms.
 - Comparisons with a standard cultivar
- Developed a laboratory bioassay capable of identifying susceptible genotypes (but not reliable for distinguishing between medium and higher resistance).



Photo: Stephen Allen



Field nurseries



- Incidence levels
- Uniformity
- Rotations
- Seasonal effects

Gossypium sp. screened

<i>Gossypium</i> species	% lines with improved resistance
<i>Cultivated AD₁</i>	2
<i>AD₁ Landrace</i>	21
<i>AD₂</i>	15
<i>AD₃ AD₄ AD₅</i>	0
<i>A₁ A₂</i>	81

Landrace



Strategy

- Establish a true collaborative team with the required capabilities.
- Determine what pathogen you are dealing with and ensure you have a clear diagnostic test.
- Have a concerted, coordinated effort in searching for true resistant germplasm (field based).
- Incorporate the germplasm into breeding programs ensuring selection for resistance (field based).
- Determine an appropriate quantitative way of classifying cultivars for resistance (field based).
- Retrospectively develop molecular/genomic tools



Thank you

Dr Warwick Stiller

CSIRO Agriculture and Food



F.Rank system

- **Initial Plant Stand**
 - Count in a minimum plot length of 10m two weeks after emergence
- **Number of 'surviving' plants at Harvest**
 - number of plants in a plot that have no Vascular Browning when the stems of plants are cut at or near ground level at the end of the season.
- **Survival**
 - The survival is the number of plants that have no Vascular Browning at harvest as a percentage of the initial plant stand.
- **'F.rank'**
 - The calculation of the F.rank differs depending on whether the survival in the test variety (T) is lower or higher than the survival in the standard variety (S).
- The calculation is easily done in MS Excel using an 'IF' statement:
- $=IF(T < S, 100 * T / S, 100 + ((T - S) / (100 - S)) * 100)$