

# The CSIRO Cotton Breeding Program

Warwick Stiller

# Outline

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

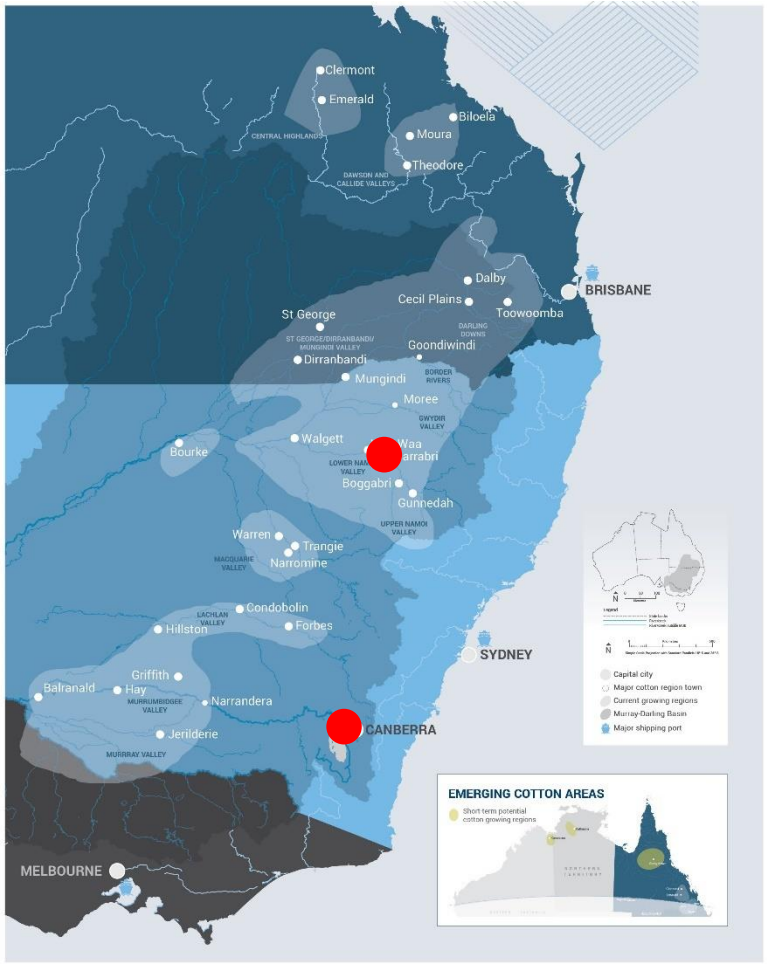
# Who??

- 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



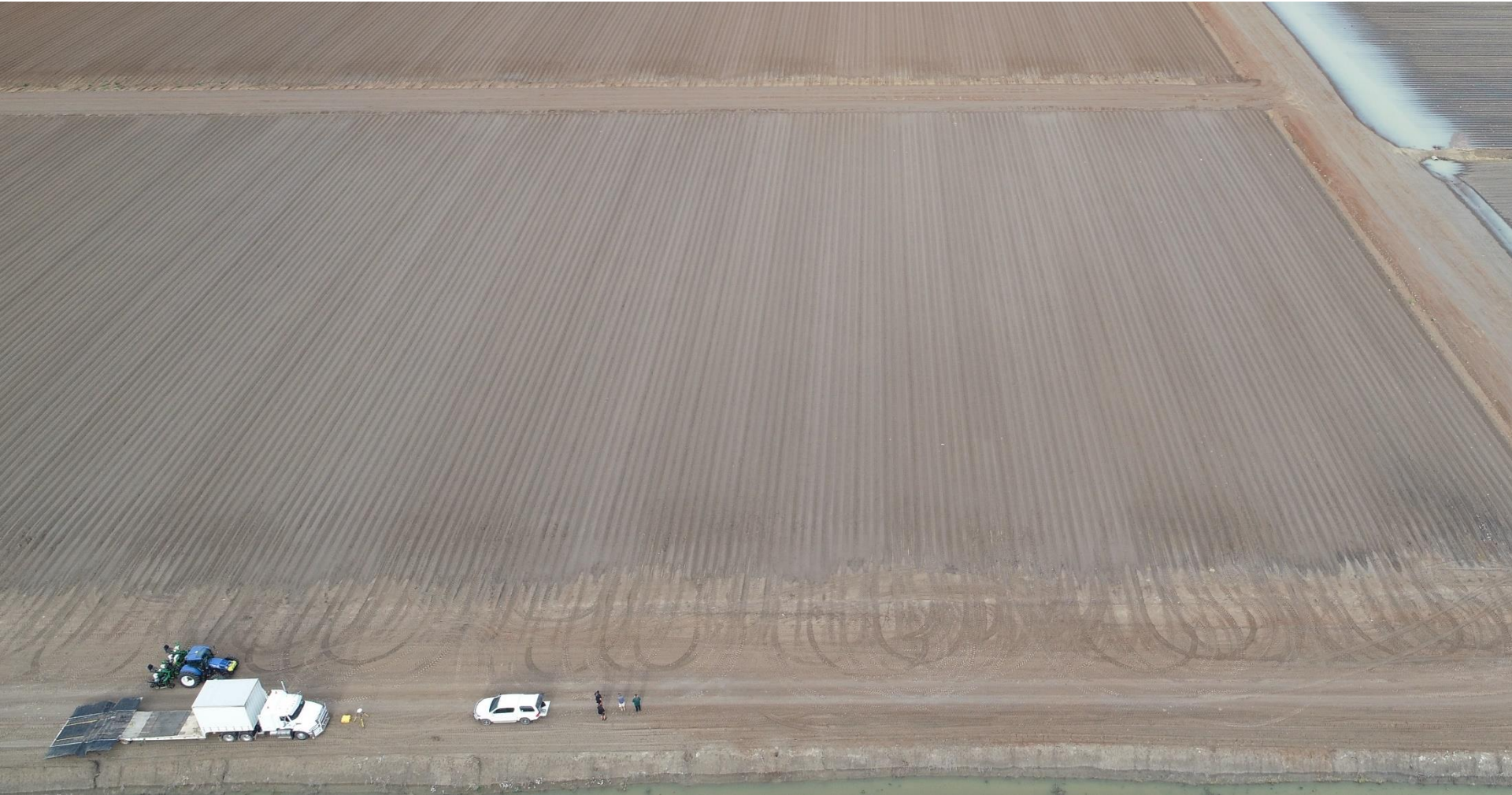
# Span of Public and Private

- 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

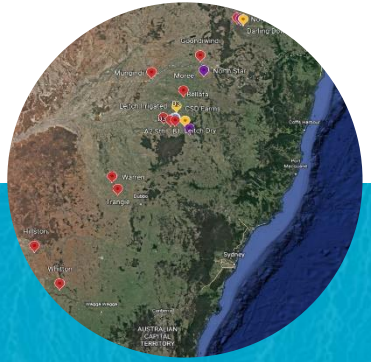
- Dedicated facilities, fields and equipment
- Laboratories, greenhouses, ginning, delinting, fibre testing and packing facilities.
- Four plot harvesters – JD7760, JD9930, 2 x Case 2022
- Two plot planters
- Transport equipment
- Staff capabilities:
  - Molecular, genomic, quantitative genetics, statistics,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


CASE INTERNATIONAL



# Logistics

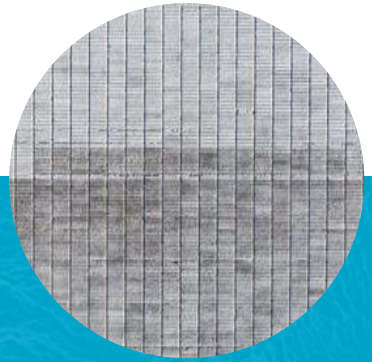
200,000 packets of seed



26 Sites, 5000 km

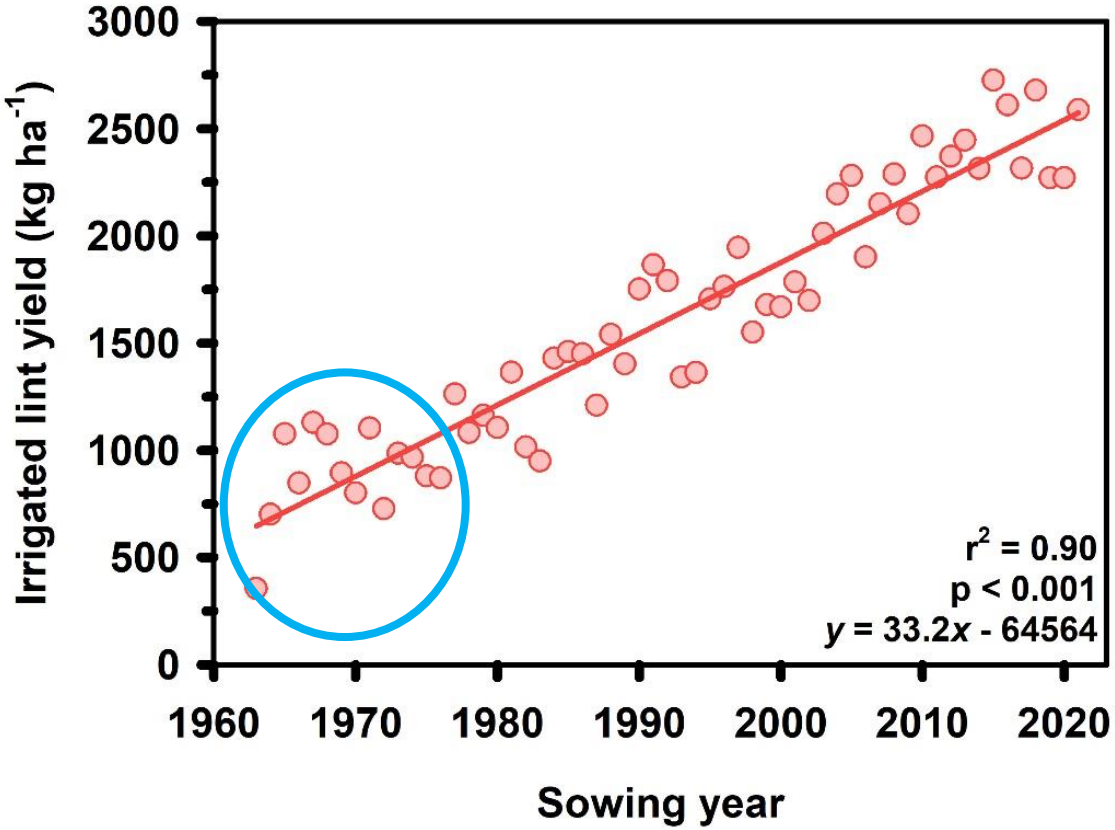
5000 emasculations

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

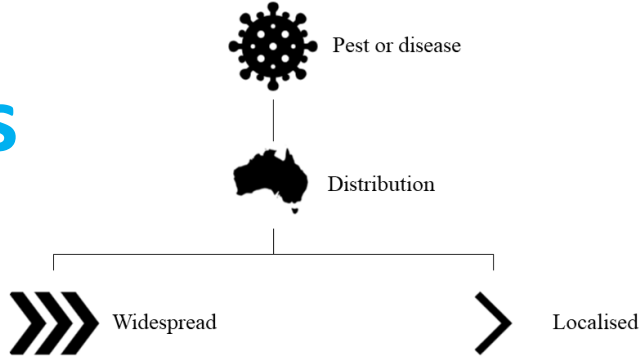
Achieved through the integration of traditional breeding and modern tools together with the understanding of market requirements

# 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



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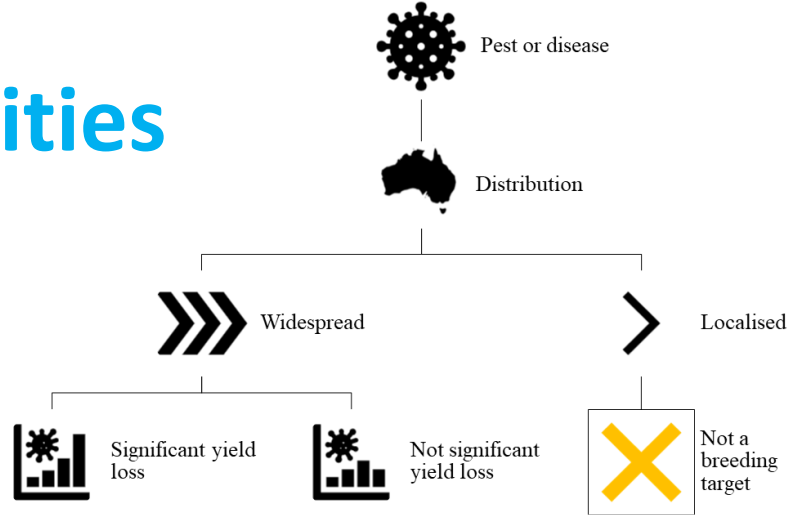

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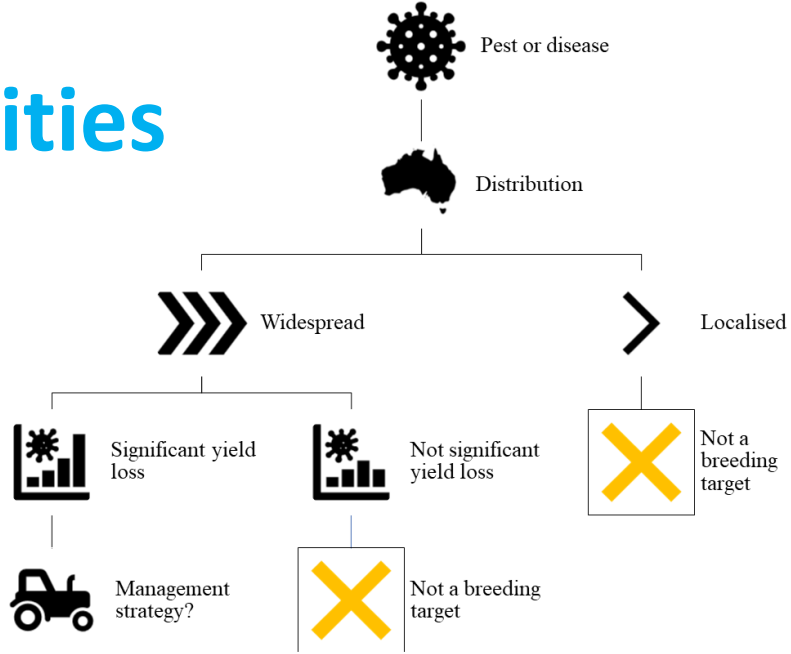

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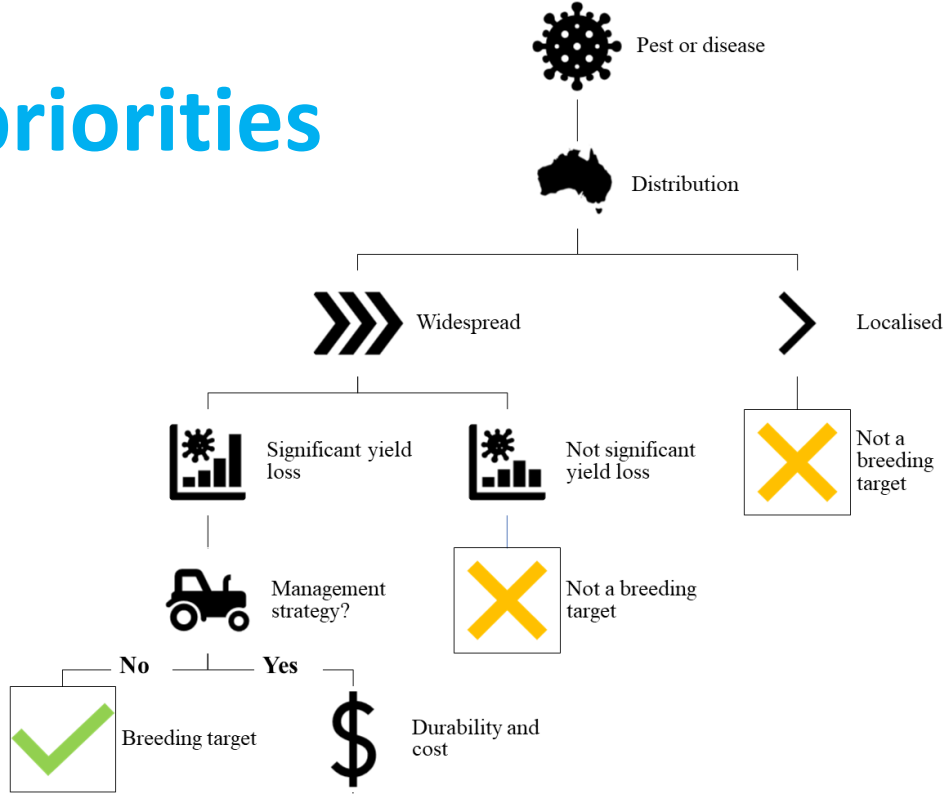


# Strategic priorities

# 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

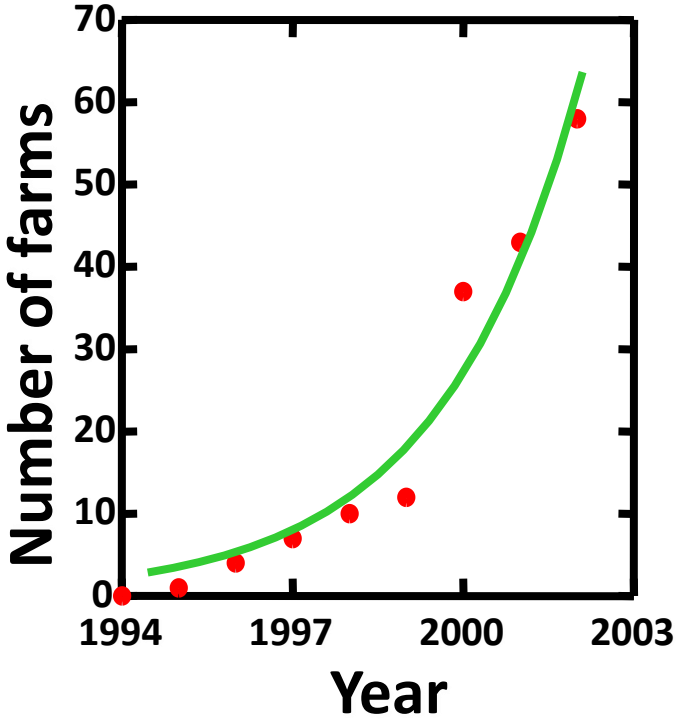
# The problem

***Fusarium oxysporum vasinfectum (Australian biotype)***

# The problem

- In the worst affected fields, growing the most susceptible variety produced virtually zero yield.

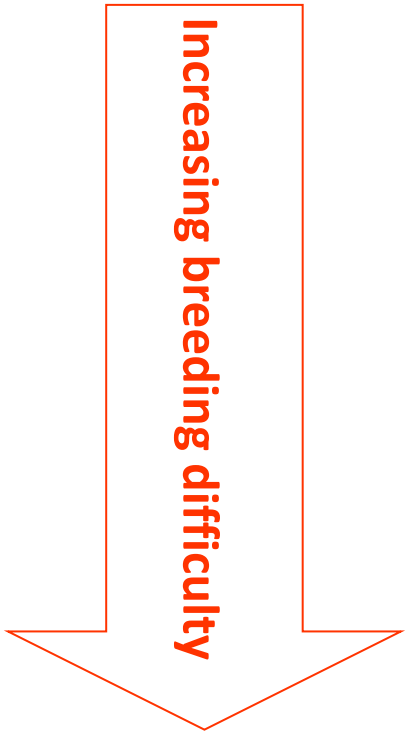
- In the worst affected fields, growing the least susceptible variety available did not produce an economic yield.



# 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



# 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*

| *Gossypium* species | % lines with improved resistance |
|---|---|
| *Cultivated $AD_1$* | 2 |
| *$AD_1$ Landrace* | 21 |
| *$AD_2$* | 15 |
| *$AD_3$ $AD_4$ $AD_5$* | 0 |
| *$A_1$ $A_2$* | 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

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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))