

A close-up photograph of a field of green barley. The stalks are in sharp focus in the foreground, showing the developing grain heads. The background is a soft-focus expanse of the same field stretching to a distant horizon under a sky filled with large, white, fluffy clouds. The overall lighting is natural, suggesting a bright day with some cloud cover.

# **Are breeding programs delivering value for money for the Australian Barley Industry?**

David Moody, Senior Barley Breeder, InterGrain

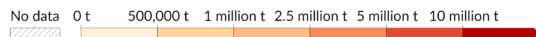
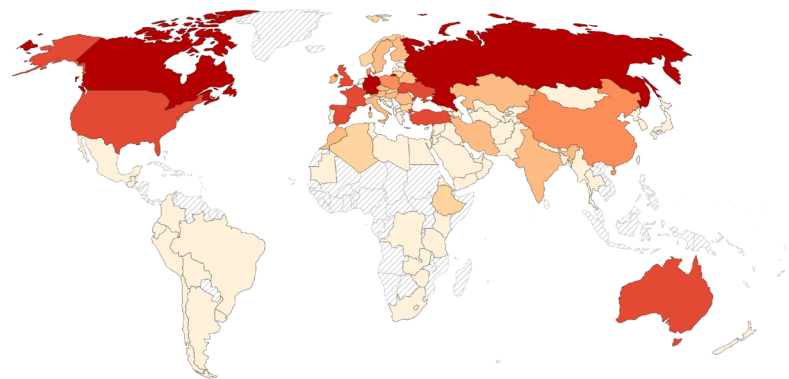
# Decline in EPR compliance

- In recent years, EPR compliance has fallen
- Current EPR losses during an average season are estimated to be \$11.5m pa for wheat and \$8.1m pa for barley
- In 2021-22 due to exceptional seasonal conditions the loss was \$15.8m and \$11.9m for wheat and barley respectively

| State   | 2021/22 EPR Compliance %<br>(wheat and barley) |
|---------|--|
| Qld     | 46%  |
| NSW     | 74%  |
| Vic/Tas | 80%  |
| SA      | 89%  |
| WA      | >95%   |

### Barley production, 1999

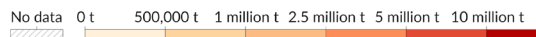
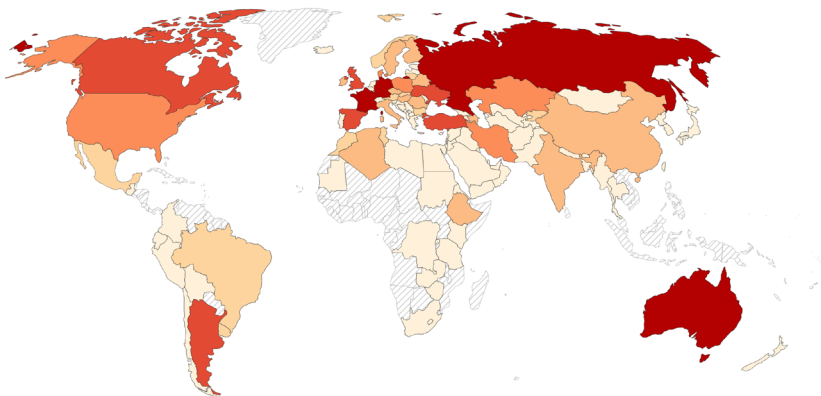
Barley production is measured in tonnes.



Data source: Food and Agriculture Organization of the United Nations (2023) | OurWorldInData.org/agricultural-production | CC BY

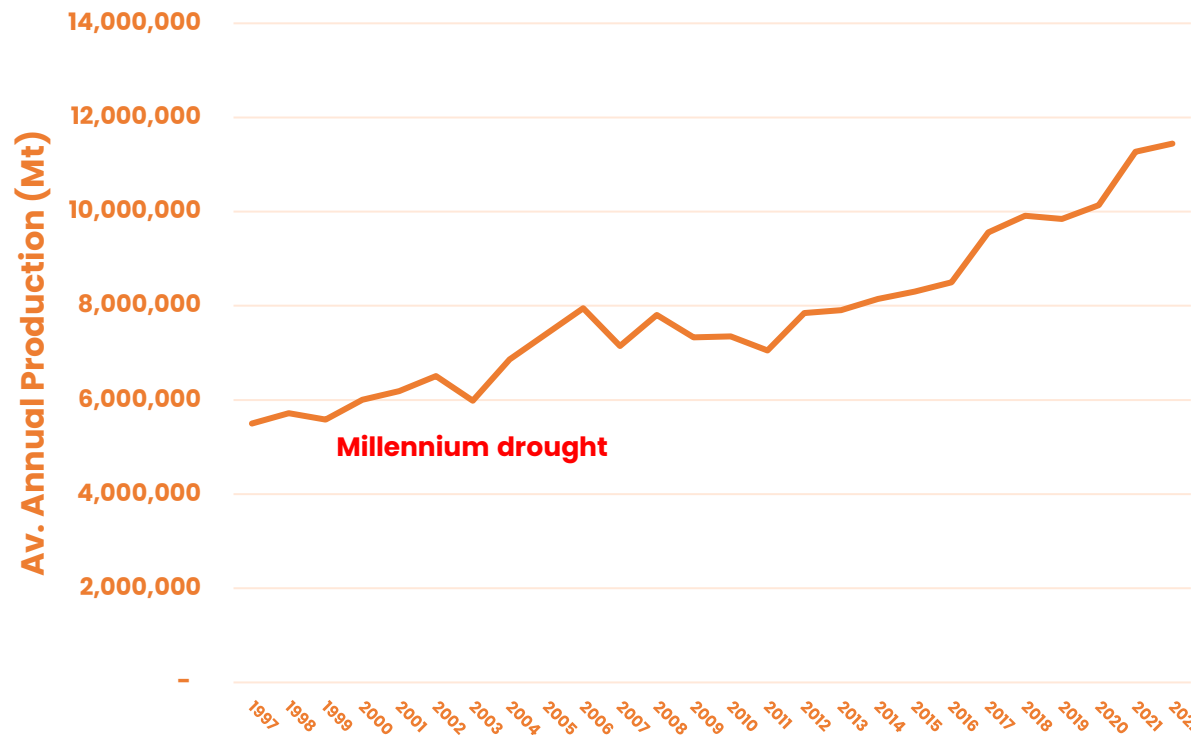
### Barley production, 2022

Barley production is measured in tonnes.



Data source: Food and Agriculture Organization of the United Nations (2023) | OurWorldInData.org/agricultural-production | CC BY

## Barley 5 year Avg Annual production



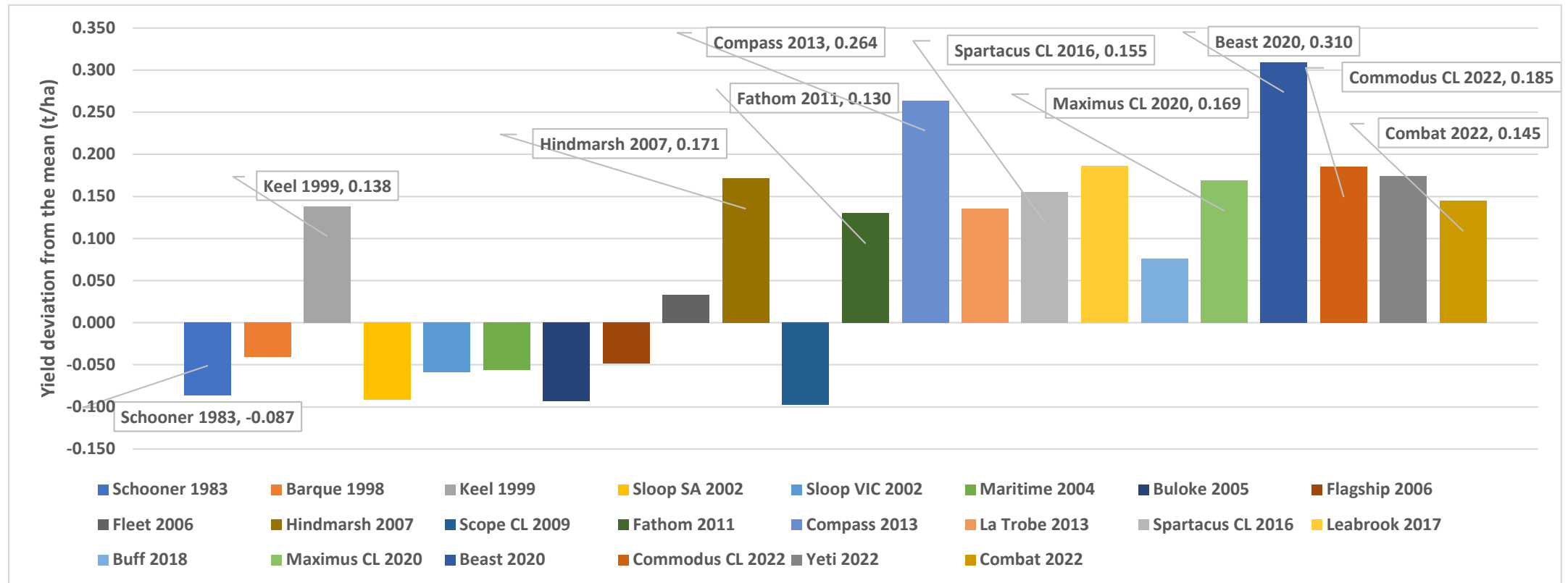
- **Australia's annual average barley production has grown from 5.5m Mt in 1997 to 11.5m MT in 2022**



# How have breeding programs performed since advent of EPRs?

- **Yield improvements**
- **Quality improvements/premiums/market access**
- **Disease resistance**
- **Other agronomic traits**

# Yield Progress – Low Yield Environments

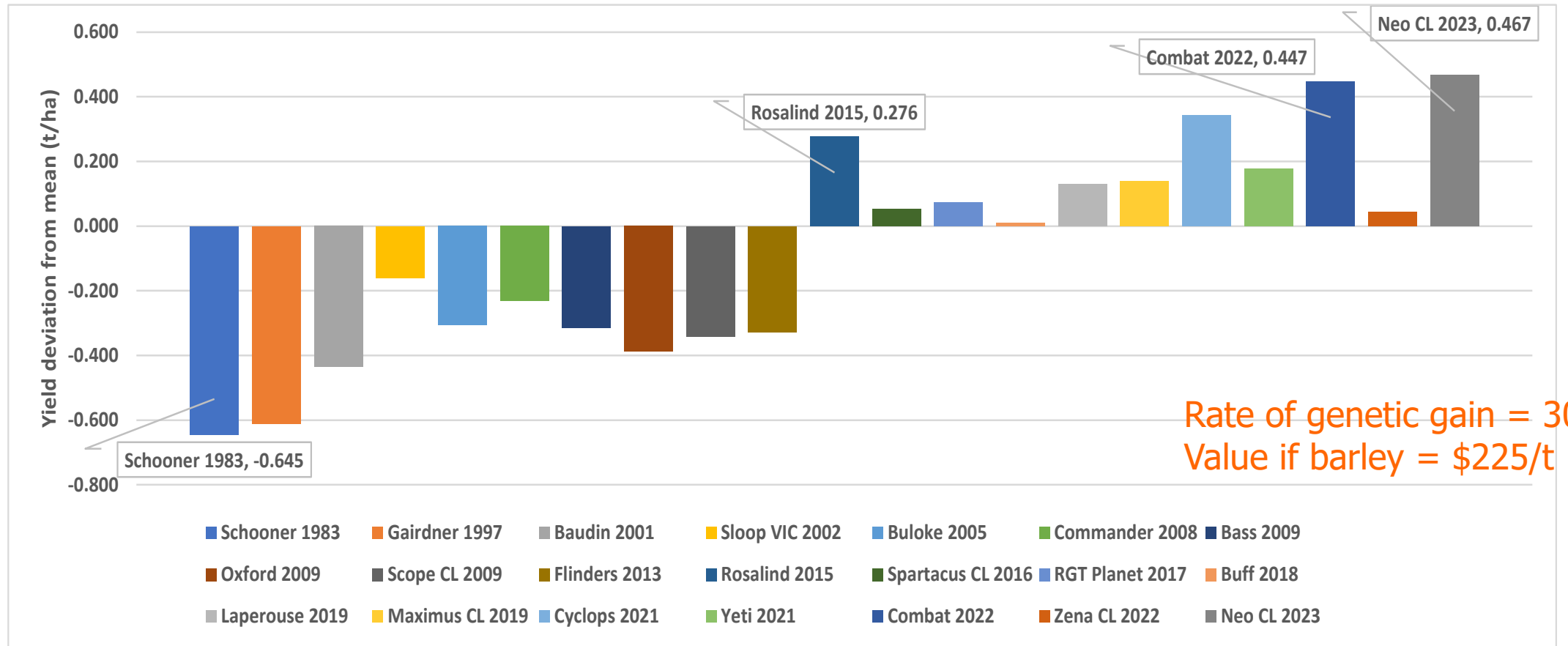


Mean yields of all (89) trials: 1.930 t/ha; genetic yield improvement 1983 – 2023 = 0.396 t/ha

Rate of genetic gain = 9.3 kg/ha/year. Value if barley = \$250/t = \$2.33/t/yr



# Yield Progress – Medium Yield Environments

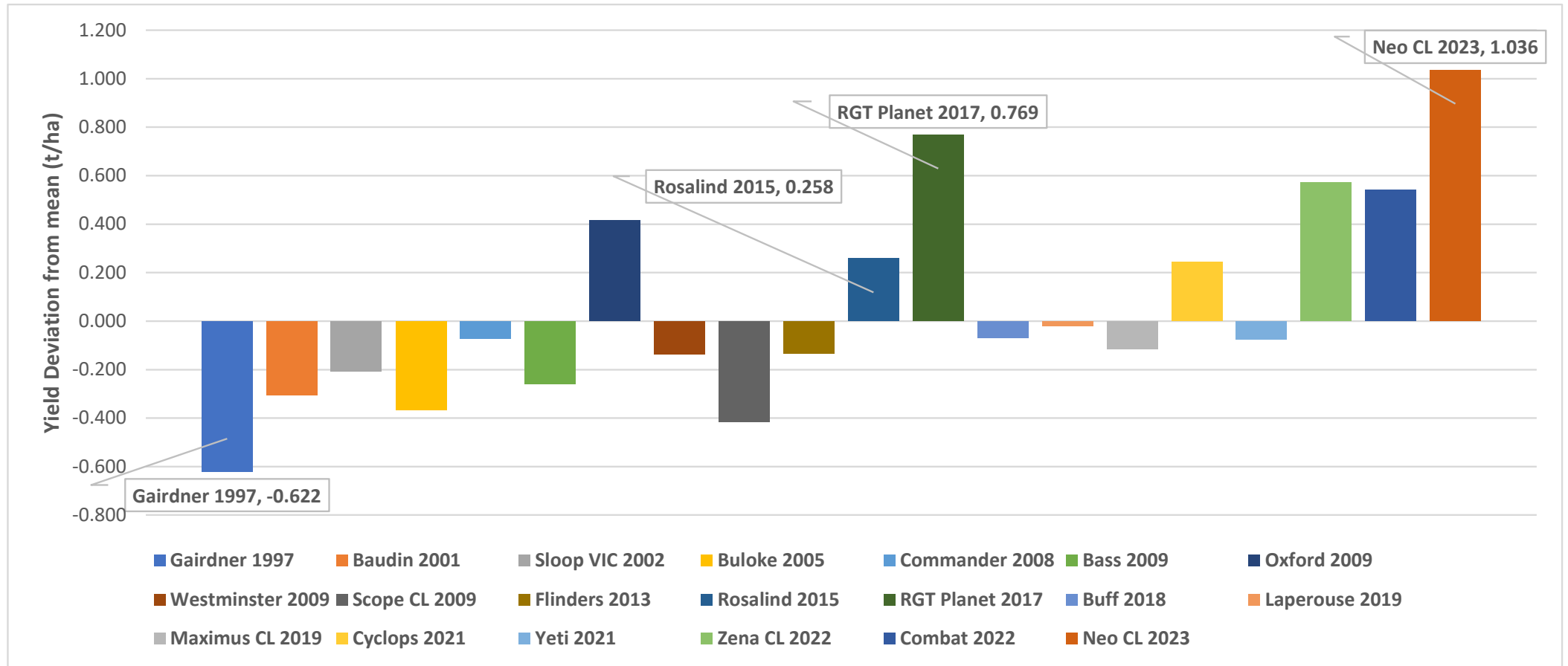


Mean yields of all (484) trials: 3.775 t/ha; genetic yield improvement 1983 – 2023 = 1.113 t/ha

Rate of genetic gain = 31 kg/ha/year. Value if barley = \$250/t = \$7.75/t/yr



# Yield Progress – High Yield Environments



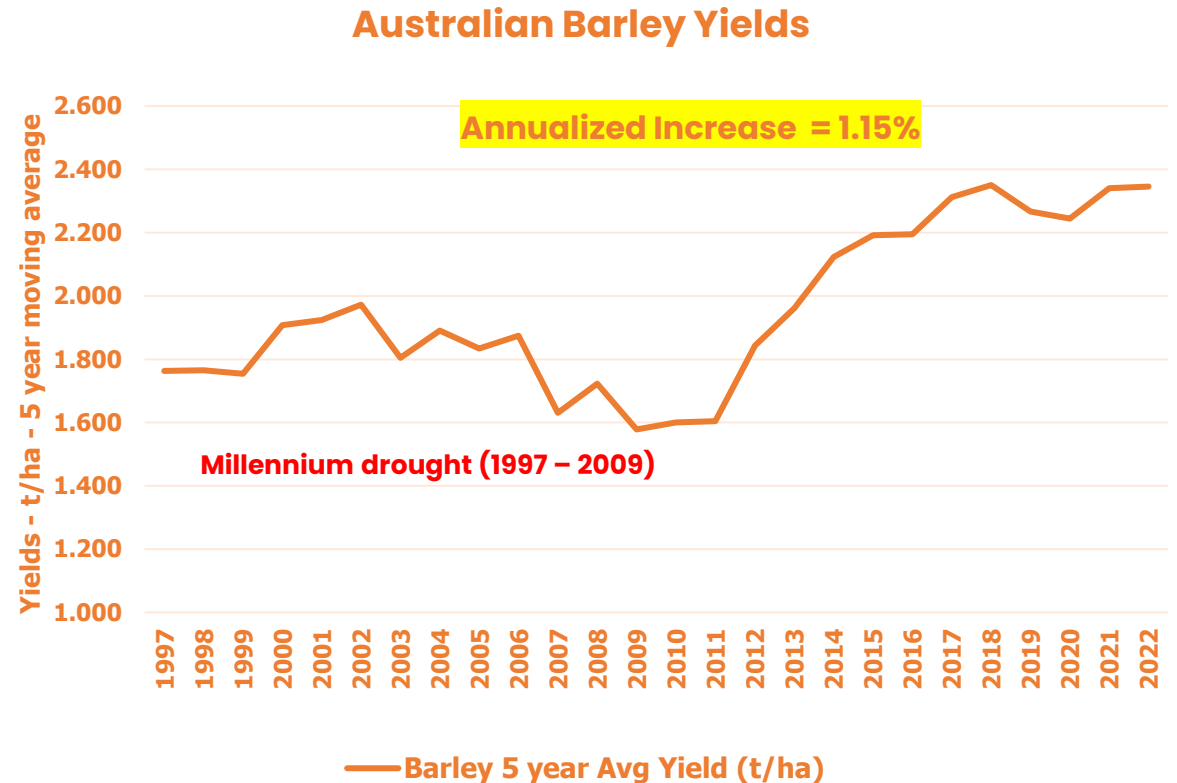
Mean yields of all trials: 5.009 t/ha; genetic yield improvement 1997 - 2023 = 1.657 t/ha

Rate of genetic gain = 54 kg/ha/year. Value if barley = \$250/t = \$13.50/t/yr



# On-farm yield improvements in Australia

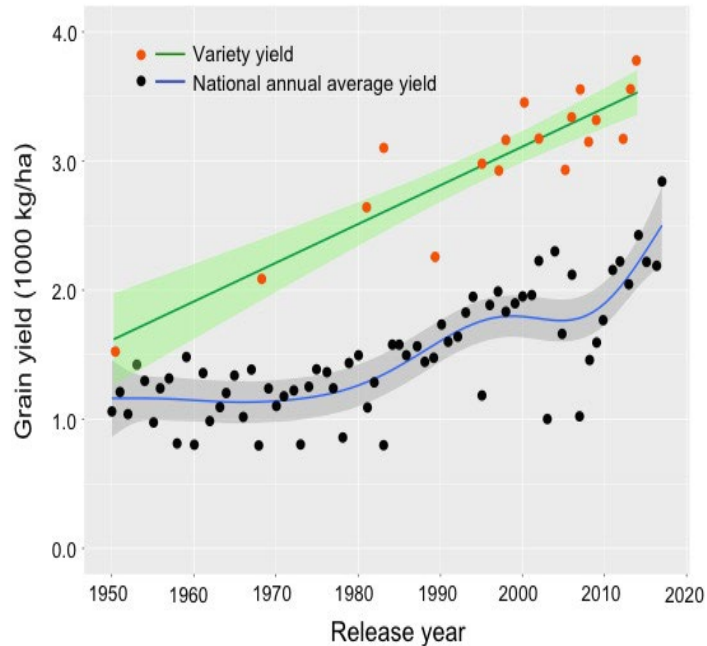
- Breeding programs are often criticized for claiming yield improvements that do not translate into on-farm gains
- Farm yields experience enormous seasonal variability, often masking genetic gains
- During the period of the Millennium Drought, average farm yields declined over an extended period
- Long-term analysis (over 25 years) reveals that on-farm yields have been increasing at approximately 1.15% per annum





# Genetic Contribution to on-farm yield improvement

## Barley yields observed in Australia



**Results indicate 72% of barley yield increase is due to genetic improvement**

- If 72% of the 1.15% per annum on-farm yield increase is due to genetic improvement, then the genetic improvement is contributing 0.83% per annum on-farm yield improvement
- At a farm gate price of \$250 per tonne, with average national yields of 2.35 t/ha, this yield improvement is worth \$4.86/tonne/yr

Western Crop Genetics Alliance



# Disease Resistance Breeding

- **CCN now completely under control in South Australia and Victoria with virtually all commercial barley varieties being CCN resistant.**
- **Foliar Diseases:**
  - **Usage of barley fungicides has increased in the last decade**
  - **Total market value has shown an 8-10% Compound Annual Growth Rate**
  - **The breadth of options for farmers has expanded, as have the average number of applications per crop**
  - **The average number of products used per crop has remained flat at 1.2, contributing to fungicide resistance development**
  - **Loss of fungicide efficacy is an emerging problem**

# Fungicide Usage

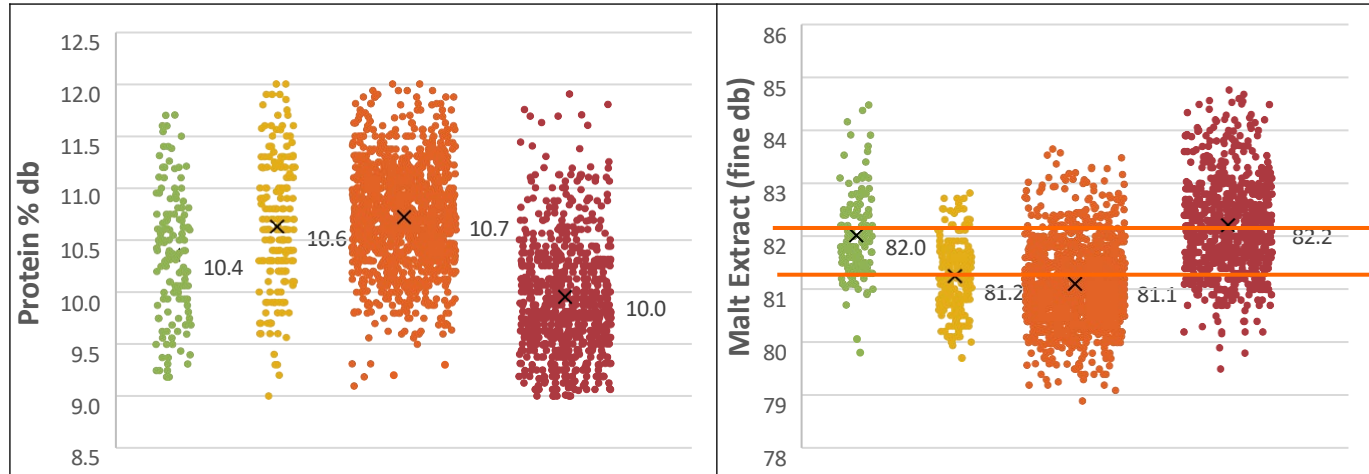
- **Good chemistry has become cheaper (eg azoxystrobin 250g/L was \$100–150/L 10 years ago, now closer to \$30/L, farm gate pricing).**
- **Basic chemistry has been widely adopted (eg tebuconazole is only \$2–3/ha)**
- **New chemistry continues to improve outcomes but currently a little expensive for barley (Aviator Xpro, Miravis Star)**
- **Premium seed treatments have been adopted (Vibrance, Evergol, launch and demise of Systiva, new products for CR and CCN)**
- **Fungicide usage increased significantly during the wetter seasons (20, 21, 22 and most of 23), contributing significantly to improved fungicide financial returns**

# Quality Improvements



## Malt Quality Comparison of Maximus CL to Benchmark Varieties from 2022 & 2023

■ Maximus CL (n=135) ■ Compass (n=200) ■ Spartacus CL (n=1167) ■ RGT Planet (n=700)



- **Malt Extract Improvement in Maximus CL versus Compass and Spartacus CL**

**Maximus CL now the dominant variety in Australia – quality improvement realized at scale**

Published on 1<sup>st</sup> July 2024

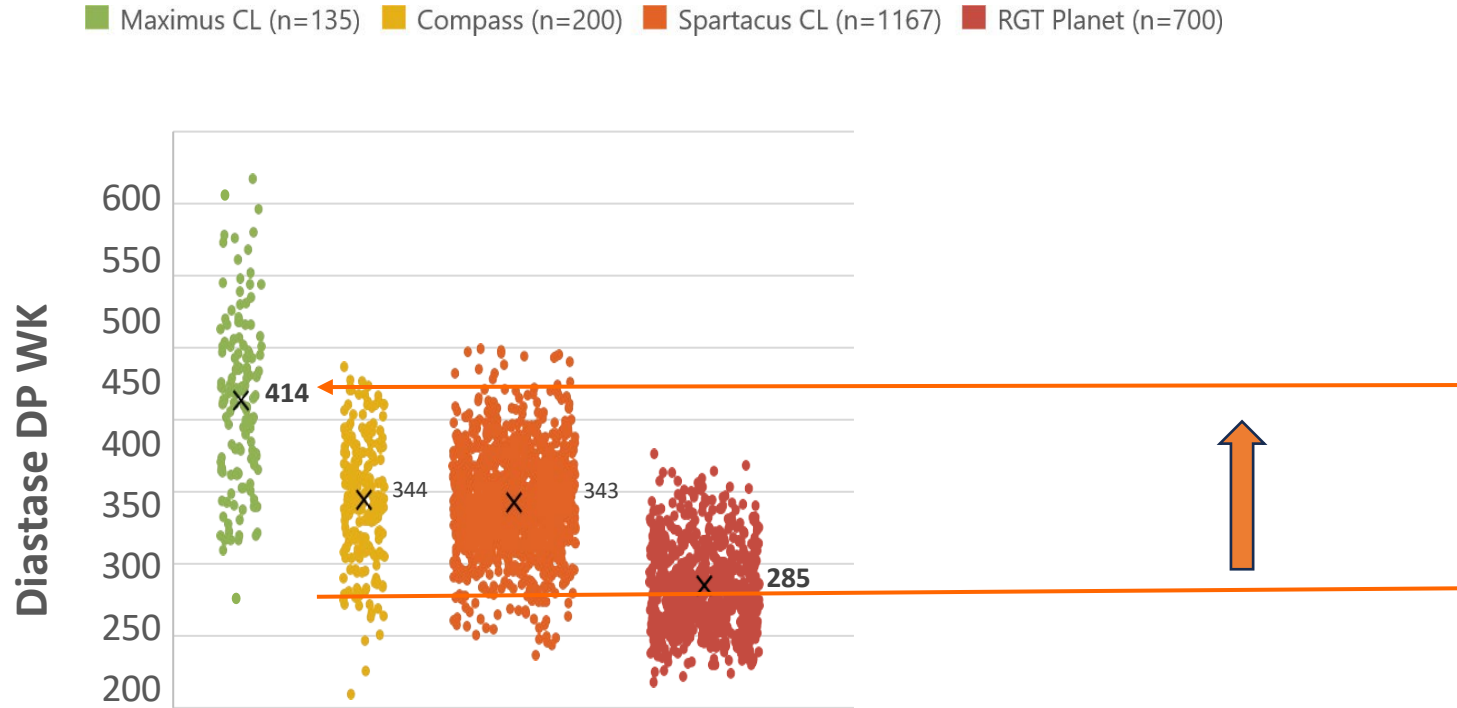
[www.grainsaustralia.com.au](http://www.grainsaustralia.com.au)



# Quality Improvements



## Malt Quality Comparison of Maximus CL to Benchmark Varieties from 2022 & 2023



- Substantial increase in Diastatic Power in Maximus CL versus Compass, Spartacus CL and RGT Planet
- Substantial reduction in saccharification rates during mashing

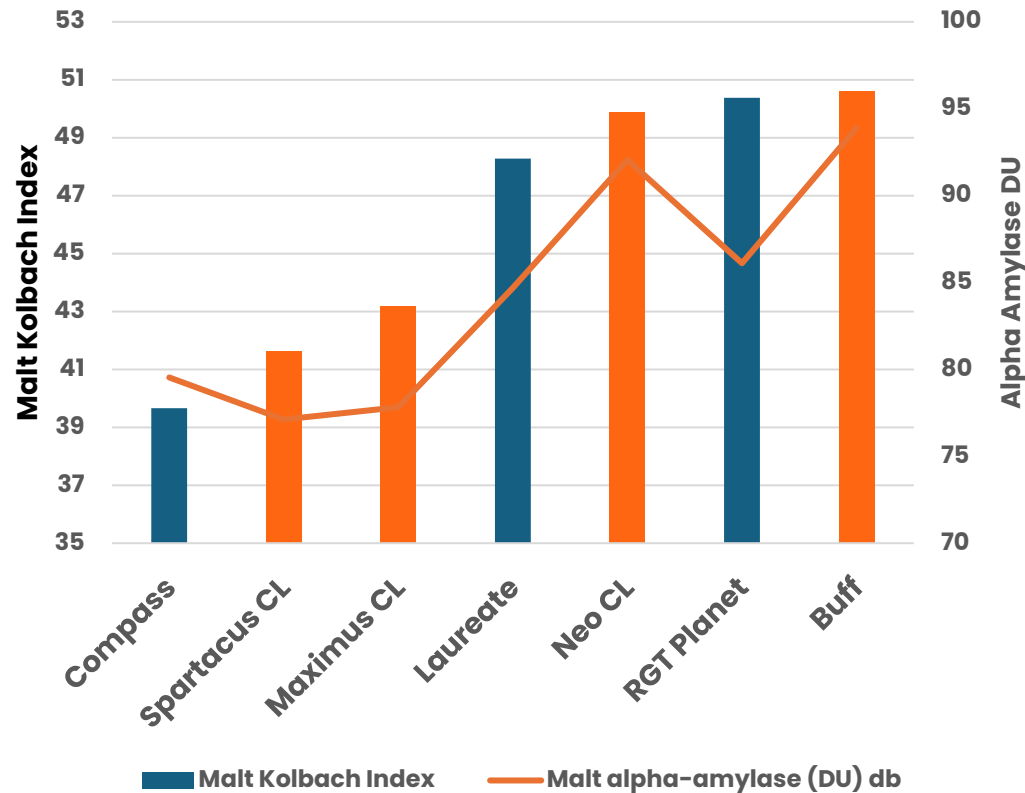
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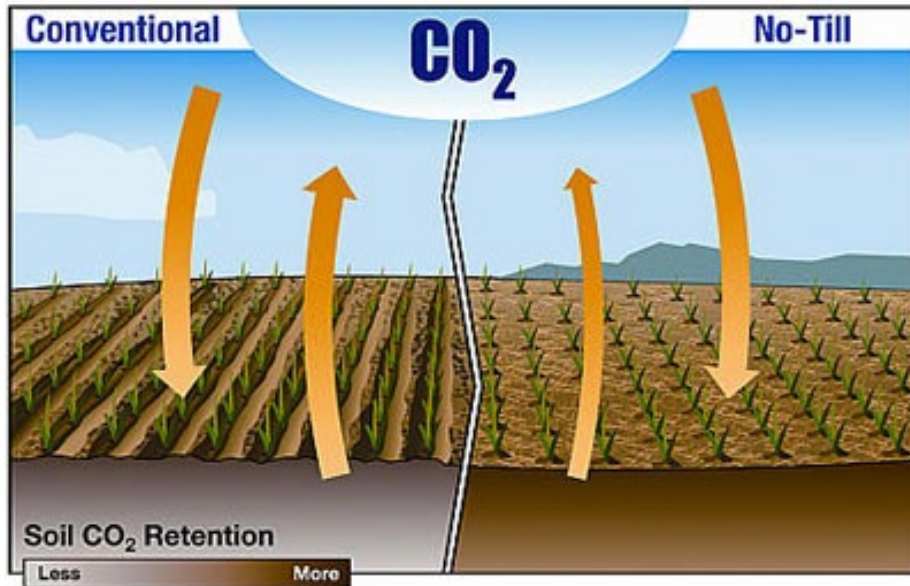


# Quality Improvements



- **Energy savings are now a principal component of end-user quality**
- **Faster modification**
  - **will reduce malt processing time**
  - **is an indicator of reduced GA requirement**
  - **Is associated with higher levels of alpha amylase**
- **Newer InterGrain varieties, Neo CL and Buff, have**
  - **more rapid modification and higher alpha amylase than older varieties Maximus CL and Spartacus CL**

# Agronomic traits



- **Effective weed management is critical in no-till farming systems = sustainability**
- **The Introduction of herbicide (imidazolinone) tolerance has been critical for the management of brome grass in no-till farming systems**
- **In the space of 14 years, Australian growers have moved from 0% to over 60% imidazolinone tolerant varieties**
- **The rate of adoption is an indicator of the benefit of this technology**

# Estimation of Future Gains: Driven by Investment

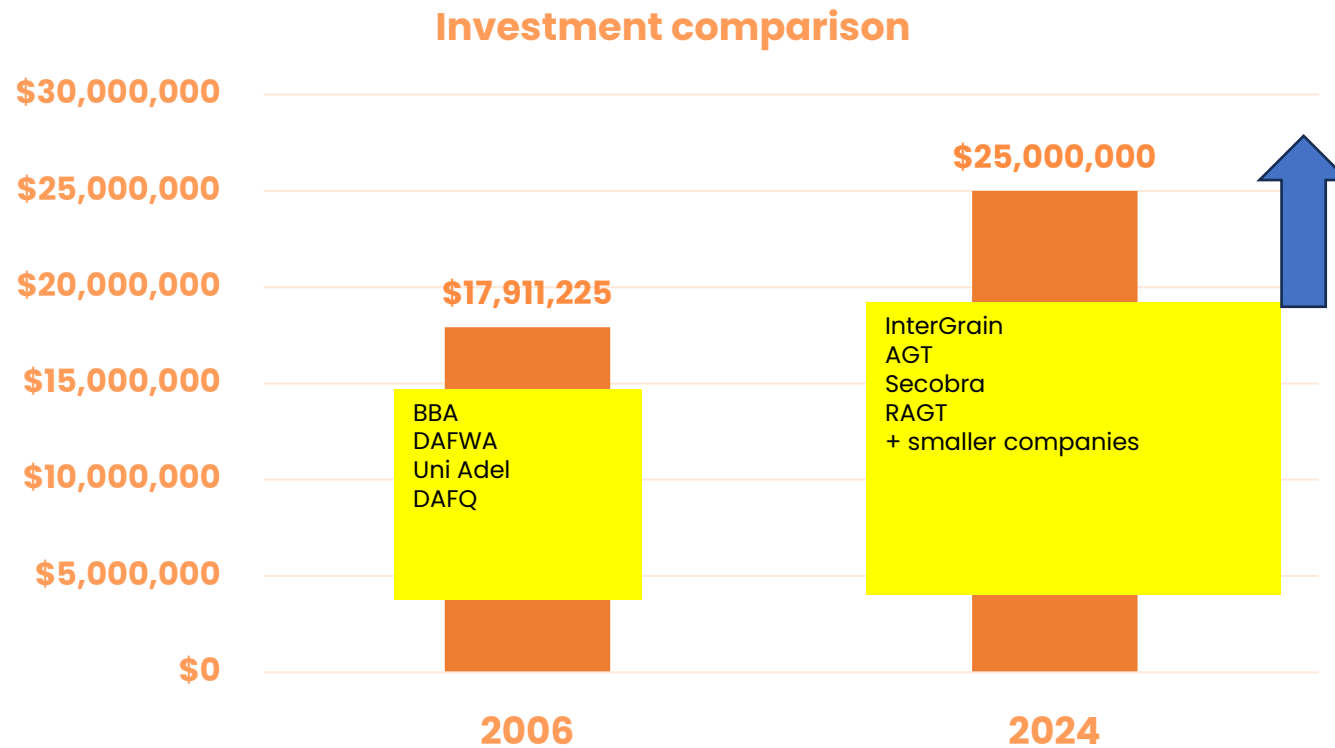
**2006**

## GRDC Investments: Barley Breeding Australia 20026-2011

| Project code       | Title   | Duration               | GRDC Investment-<br>Total Funds -<br>2006\$ | GRDC Investment-<br>Total Funds -<br>2006\$ | Assuming 60% co-<br>investment by State<br>Agencies and<br>Universities | Average<br>Annual Total<br>Investment |
|--------------------|---|------------------------|---|---|---|---------------------------------------|
| DAN00101           | BBA-NSWDPI  | 1/7/2006 to 30/06/2011 | \$858,624                                   |   |   |                                       |
| DAQ00110           | BBA-Northern Node                                     | 1/7/2006 to 30/06/2011 | \$5,225,719                                 |   |   |                                       |
| DAV00079           | National Barley<br>Enhancement Program<br>coordinator | 1/7/2006 to 30/06/2008 | \$92,541                                    |   |   |                                       |
| DAV00080           | Barley cultivar<br>development DPI<br>Horsham         | 1/7/2006 to 30/06/2009 | \$889,406                                   |   |   |                                       |
| UA00032            | Barley Improvement and<br>Industry Development        | 1/7/2006 to 30/06/2011 | \$8,807,456                                 |   |   |                                       |
| DAW00151           | BBA-Western Region                                    | 1/7/2006 to 30/06/2011 | \$7,024,108                                 |   |   |                                       |
| <b>Grand total</b> |   |                        | <b>\$22,897,854</b>                         | <b>\$35,822,450</b>                         | <b>\$89,556,125</b>   | <b>\$17,911,225</b>                   |



# Estimating Future Gains: Driven by Investment



- Investment in barley breeding has increased significantly since the privatization of breeding
- In addition to increased investment, Australian growers have had increased access to overseas germplasm

Investment in 2024 \$ value

# Summary

- **Substantial genetic gains in yield**
- **On farm yield improvements have lagged behind genetic improvements**
  - **In ability to accurately forecast the optimum variety**
  - **Growers selecting the incorrect variety**
  - **Varieties are packages of traits, and often the highest yielding variety is not the optimum package**
- **Quality improvements have been significant and are now being commercially realised**
- **Foliar disease resistance improvement have managed to keep pace with pathogen evolution but are yet to reach a stage of reducing fungicide costs**
- **Agronomic improvements, especially herbicide tolerance, have been substantial**
- **Increased investments indicate an enhanced rate of future improvements**



## CEREAL BREEDING FOR AUSTRALIA



# Thank you

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