Exploring unrealized Australian wheat yield potential

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AAGI Analytics for the Australian Grains Industry

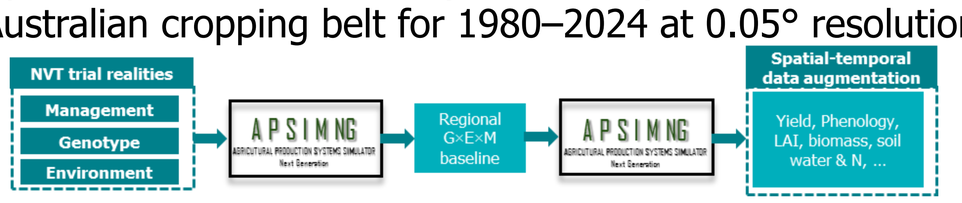
ABSTRACT

Wheat is a critical staple crop and a major source of dietary calories worldwide. Australia contributes around 11% of global wheat exports. Stable and sustained growth in Australian wheat production is therefore vital to global food security and socioeconomic wellbeing. However, Australian wheat growers currently achieve only about half of the water-limited yield potential. Quantifying this yield gap and identifying feasible agronomic strategies to close it are essential steps towards unlocking the unrealised productivity potential of Australian wheat systems.

Our results showed that Australia still has potential to increase wheat yield, especially in coastal regions. Agricultural investment and management should be region-specific to maximise yield gains. For example, in coastal regions, higher fertiliser rates, quick- to mid-maturing wheat genotypes, and later sowing may lead to higher yields. Our findings highlight the importance of matching management strategies to regional conditions in wheat cropping systems to realise further yield potential.

Method

- Upscale NVT wheat data (2015–2023) from trial sites to the Australian cropping belt for 1980–2024 at 0.05° resolution.



- Determine the G × E × M combinations associated with attainable yield (80th percentile) and potential yield (99th percentile), and quantify the yield gap for each grid cell.
- Identify the dominant factor among genotype, environment, and management for closing the yield gap.
- Quantify changes in genotype, fertiliser rate, and sowing time required to move from attainable to potential yield.

Yield and WUE Gaps

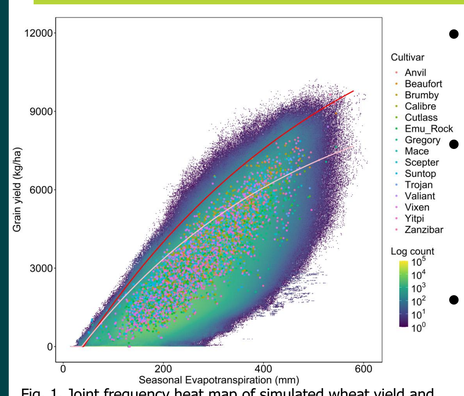


Fig. 1. Joint frequency heat map of simulated wheat yield and evapotranspiration across all GxExM scenarios. Red and pink lines represented the 99% and 80% quantile regression curves, respectively, based on the negative exponential function.

- Attainable and potential yield frontiers were 7.0 and 9.1 t ha^{-1}, respectively.
- Yield gaps ranged from 0.05 to 3.5 t ha^{-1}, with the largest gaps in south-eastern coastal Australia.
- WUE differences ranged from −1.5 to 8.5 kg ha^{-1} mm^{-1}, with the largest values in south-eastern coastal Australia.

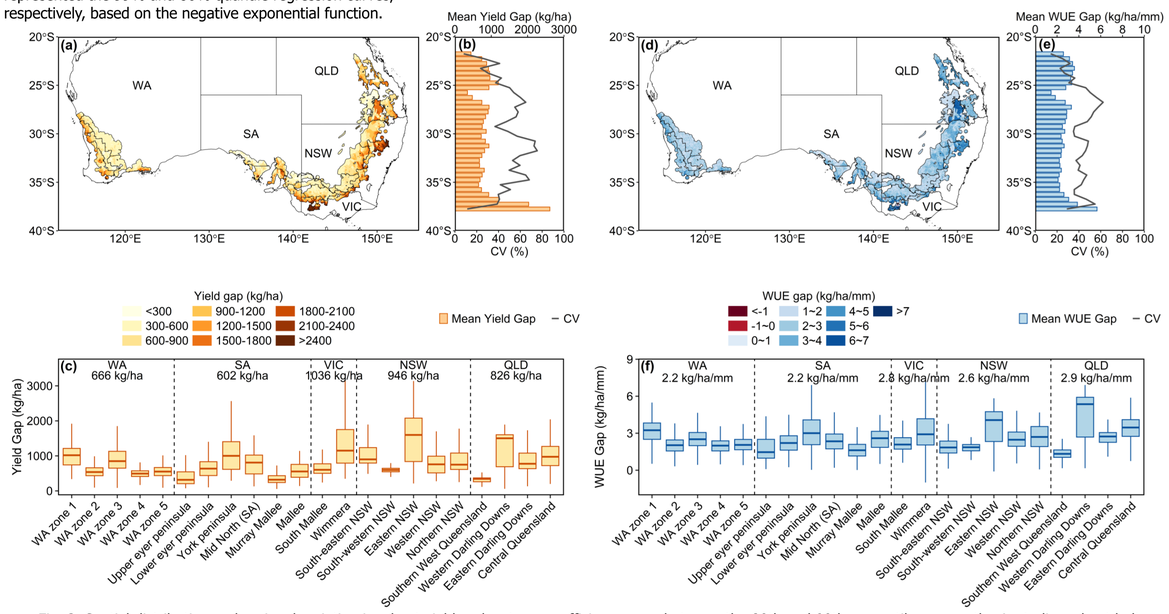


Fig. 2. Spatial distribution and regional variation in wheat yield and water-use efficiency gaps between the 80th and 99th percentiles across the Australian wheat belt.

Dominant management practices

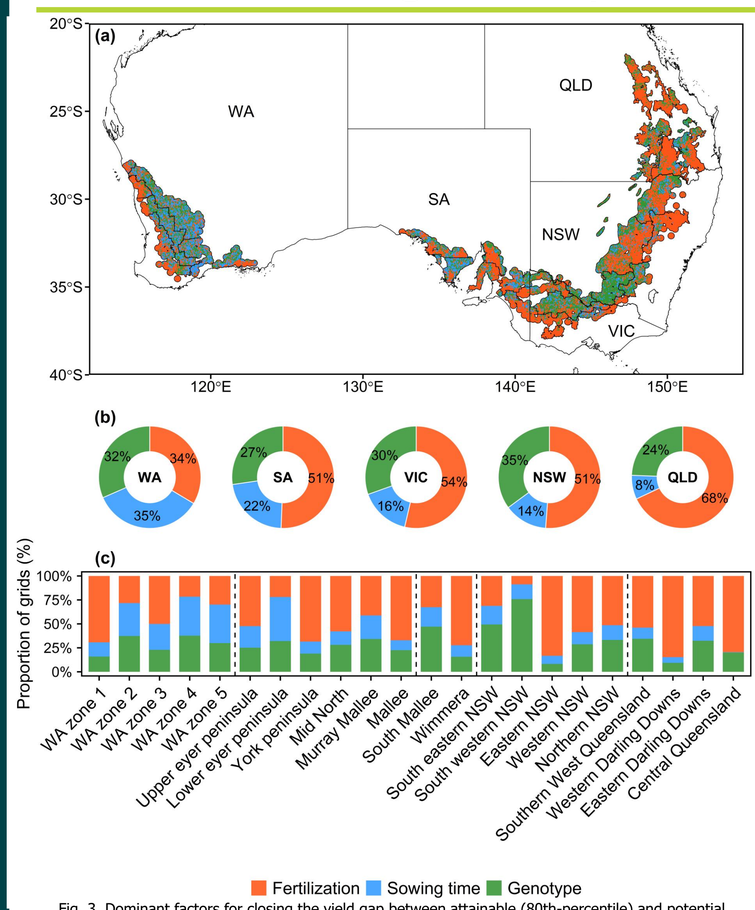


Fig. 3. Dominant factors for closing the yield gap between attainable (80th-percentile) and potential (99th-percentile) wheat yields at grid, subregional, and state scales across the Australian cropping belt.

Fertilisation, genotype, and sowing time contributed similarly to further yield gains across grid cells in the Western Australian cropping belt.

In eastern Australia, genotype and fertilisation were the dominant factors, with fertilisation particularly important in coastal grid cells.

Changes in management for closing yield gaps

- The proportion of grid cells planted with quick- to mid-maturing genotypes increased across all fertilisation and sowing-time categories when moving from attainable to potential yield.
- More than half of the Australian cropping belt could achieve further yield gains through increased fertilisation with earlier sowing.
- Increased fertilisation combined with later sowing generated the largest yield gains and applied to approximately one-third of the cropping belt.

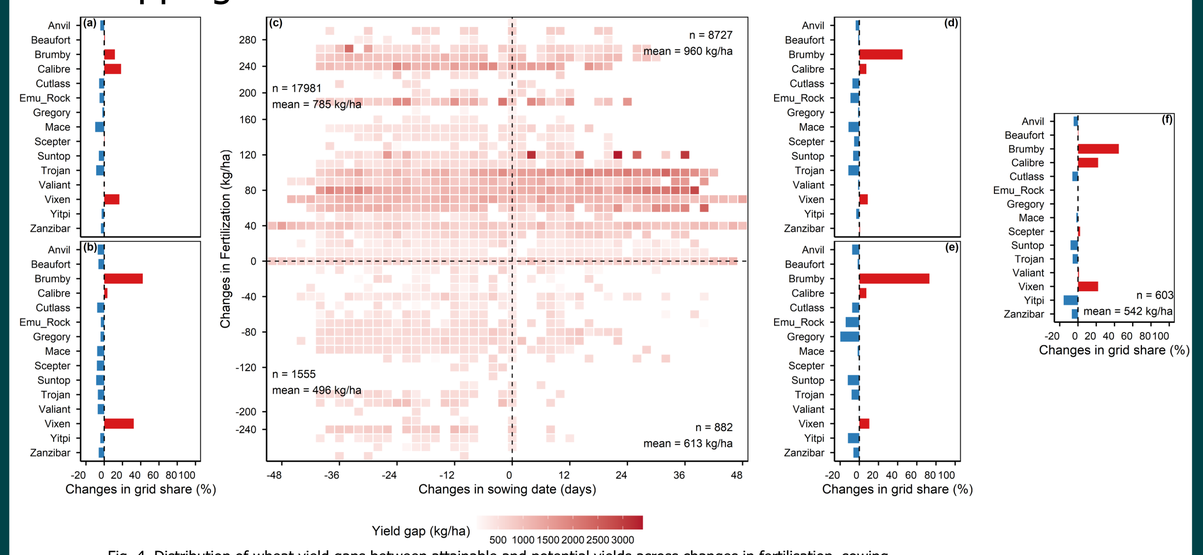


Fig. 4. Distribution of wheat yield gaps between attainable and potential yields across changes in fertilisation, sowing time, and genotype. "n" denotes the number of grid cells in each category, and "mean" indicates the average yield gap.

Conclusion

Australia still has potential to increase wheat yield, especially in coastal regions. Agricultural investment and management should be region-specific to maximise yield gains. For example, in coastal regions, higher fertiliser rates, quick- to mid-maturing wheat genotypes, and later sowing may lead to higher yields.

References

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