Climate change and cropping: advantage through effective adaptation

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CLIMATE ADAPTATION
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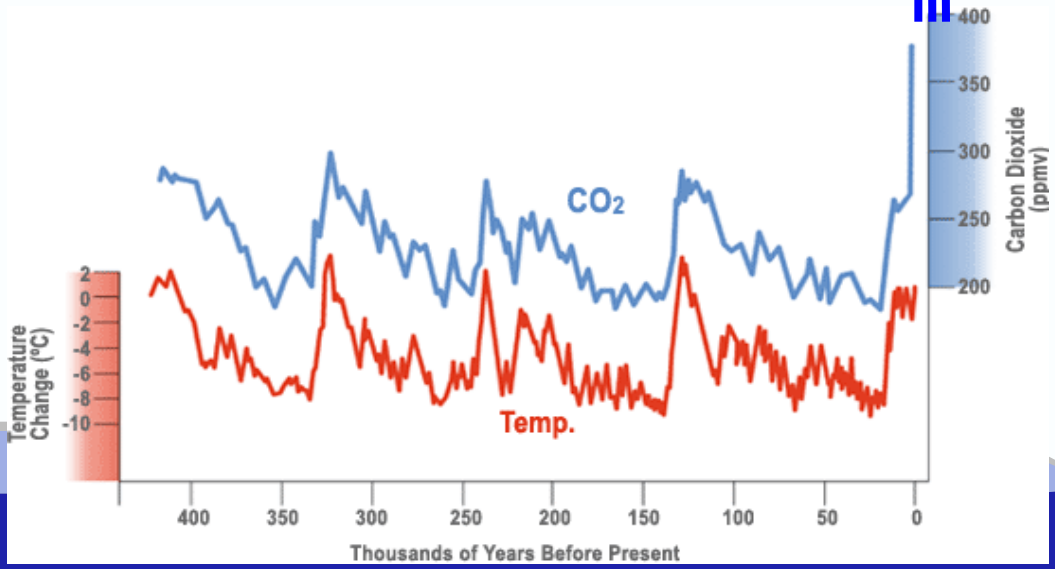
Outline

- Some of the changes in climate happening already and their impacts
- Briefly – what may the climate of southern Australia look like in the future ?
- Adaptation through crop management
- Adaptation through crop breeding

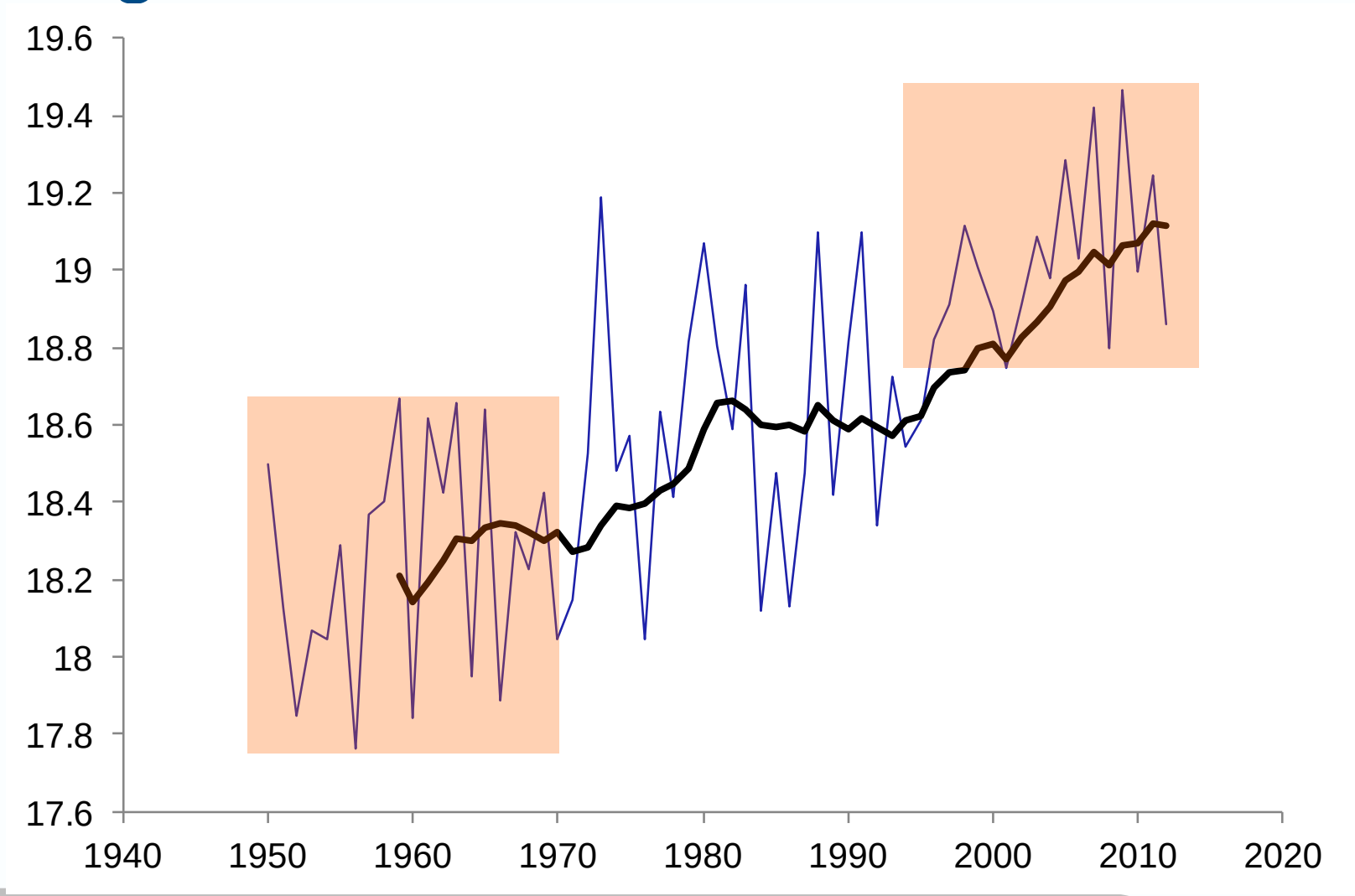
Carbon dioxide concentrations keep rising

Between 520 to 1000 ppmv by 2100



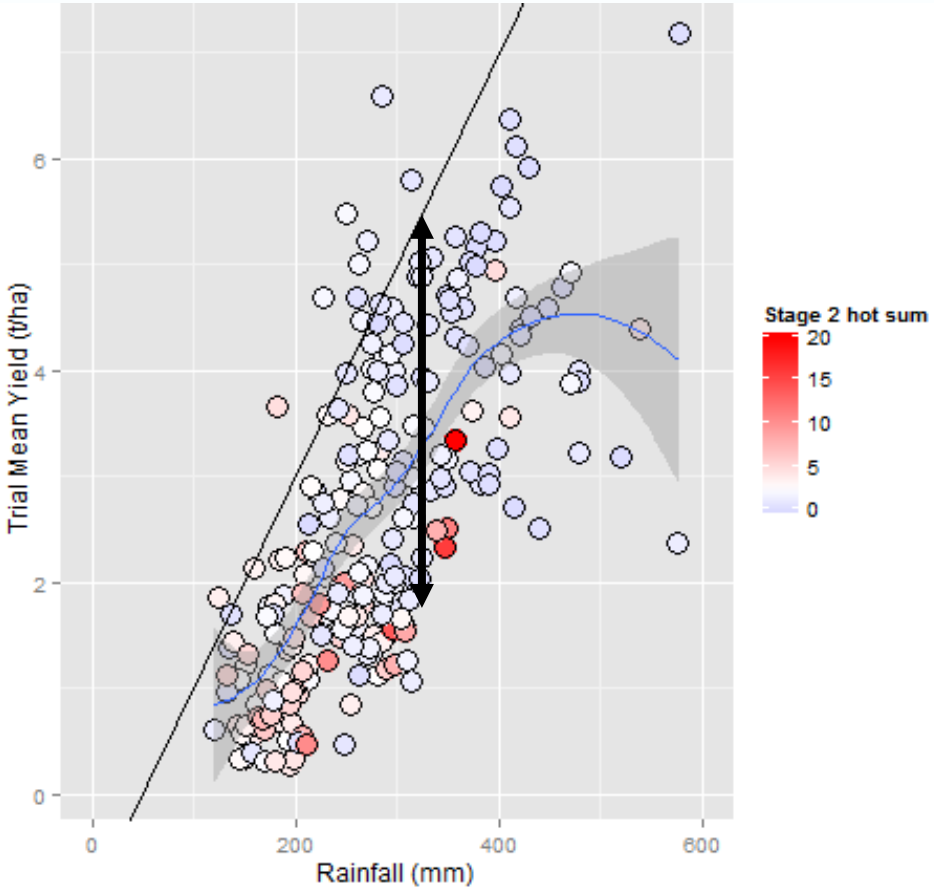
IPCC (2007)

Temperatures across southern Australia keep on rising



Data: Bureau of Meteorology (2013), Analysis: Howden (2013)

Results from National Variety Trials show heat already affects yield in SA/western Victoria



Trial mean yield (since 2005) is related to rainfall during season

High ‘hot_sum’ (> 30°C for more than 5 to 10h) around flowering reduced trial mean in at least 30 trials

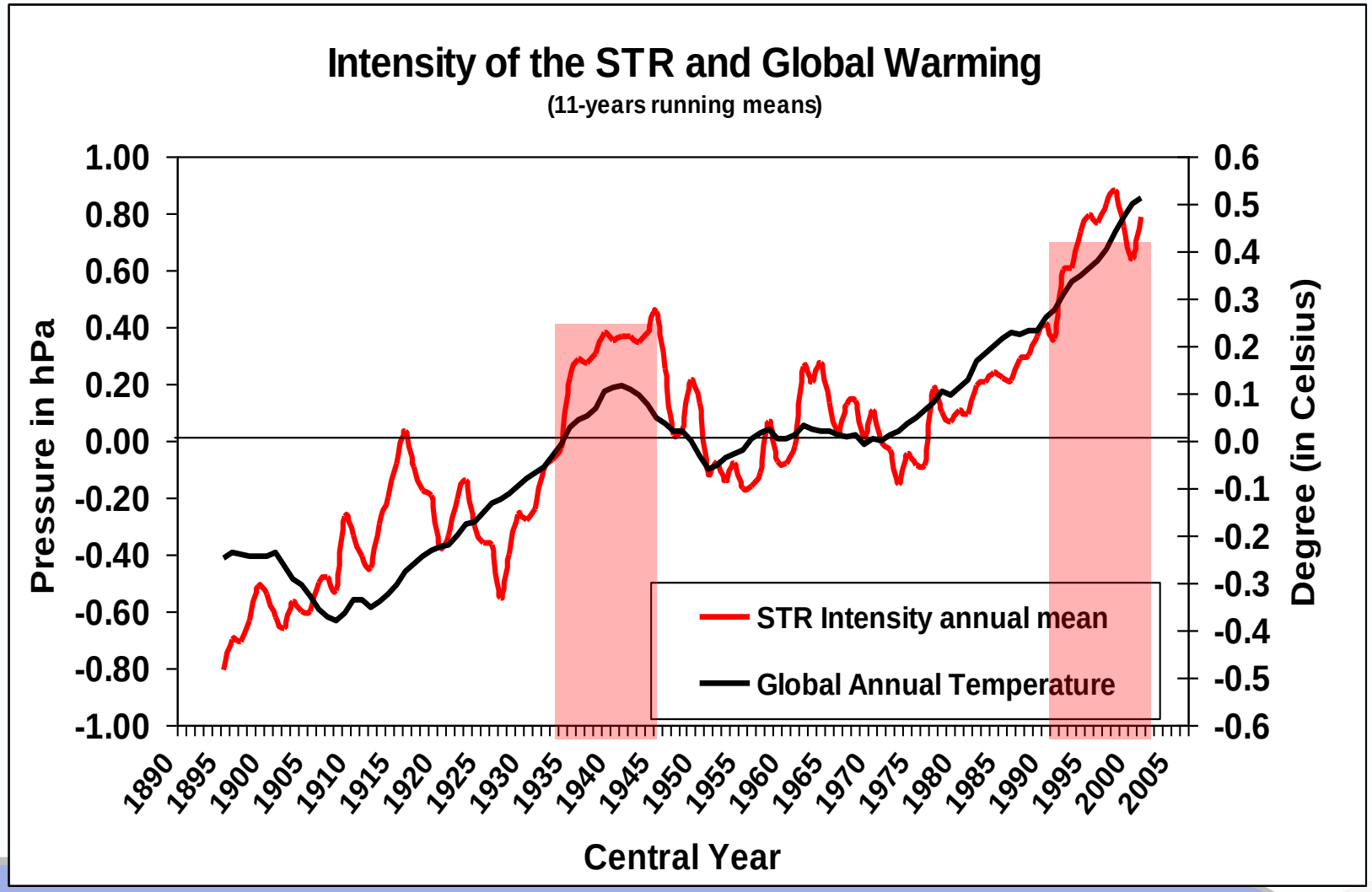
Differential effects with variety (not shown)

‘Climate change projections happening in front of our eyes’

‘Much of the rain has come in summer storm events and less in autumn, winter and spring. It is just like watching the CSIRO predictions come true before our eyes’

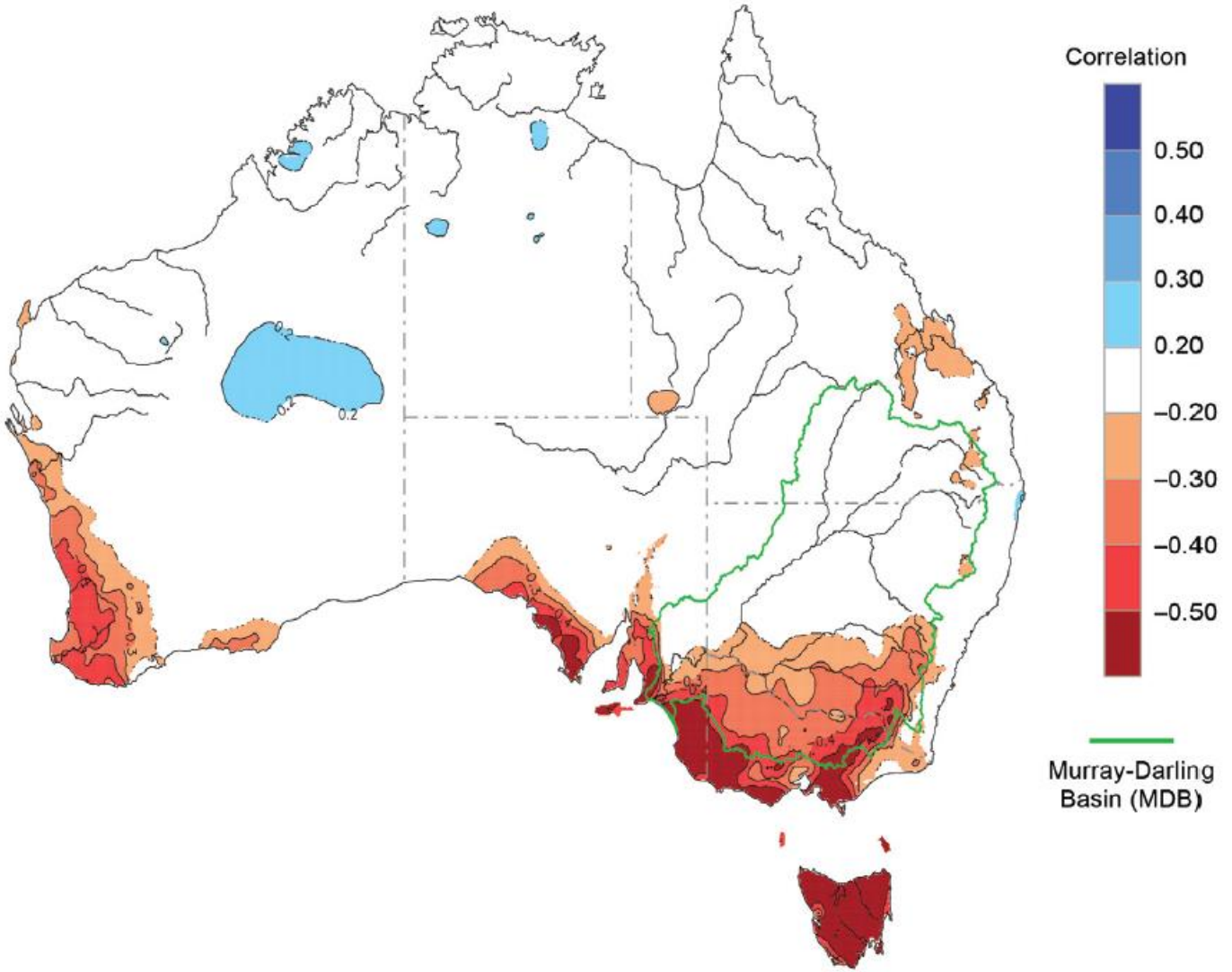
– *John Pettigrew, Farmer, Shepparton, Victoria*

Sub-tropical ridge strength and global temperature



(CSIRO 2010)

Subtropical ridge strength and rainfall are tightly linked in southern Australia



(Timbal 2011)

Managing in a variable *and changing* climate

‘Past performance is not a reliable indicator of future performance’
– *Aust Securities & Investment Commission*

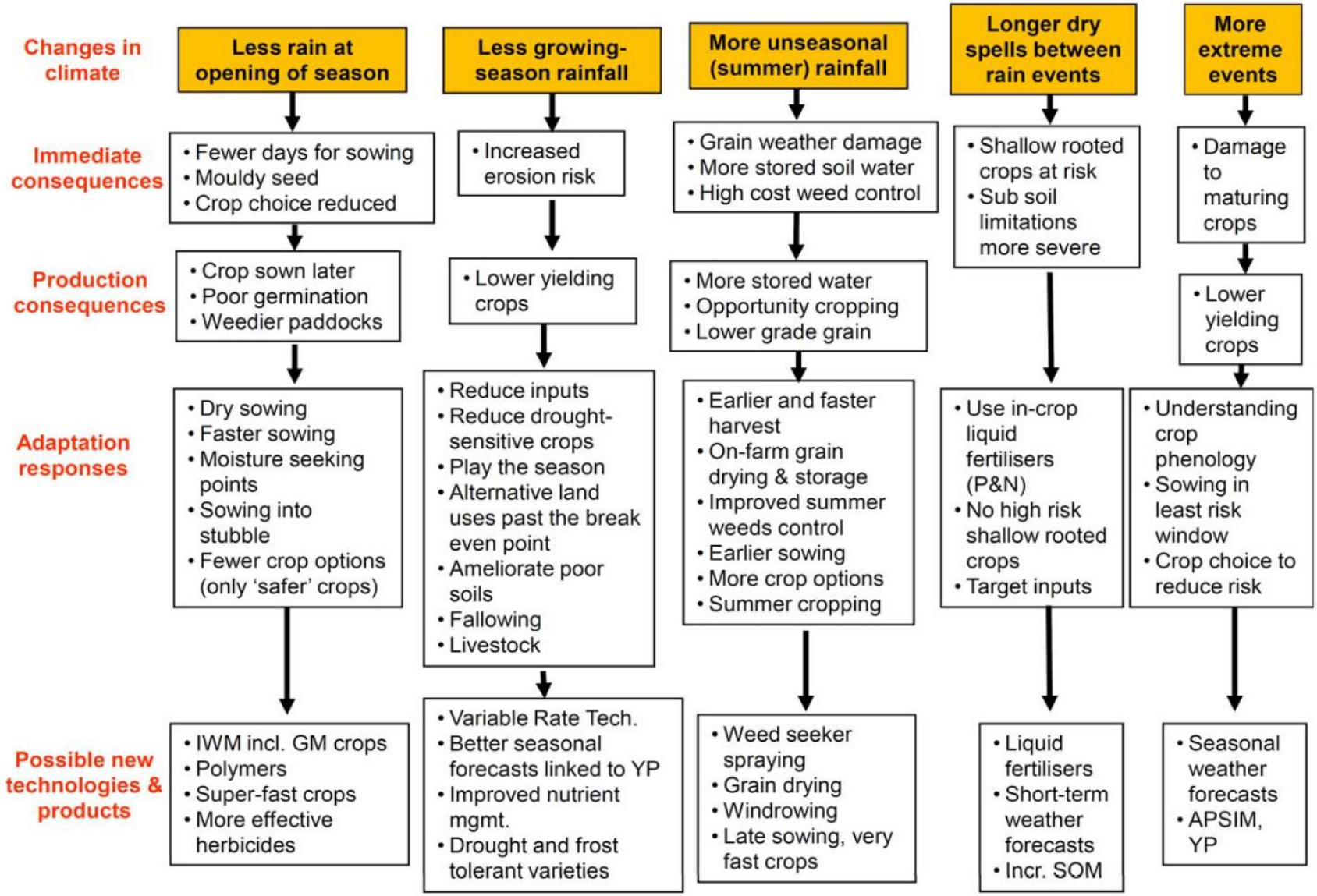
‘The past climate is no longer a reliable indicator of the future climate’

— *message from scientific community*

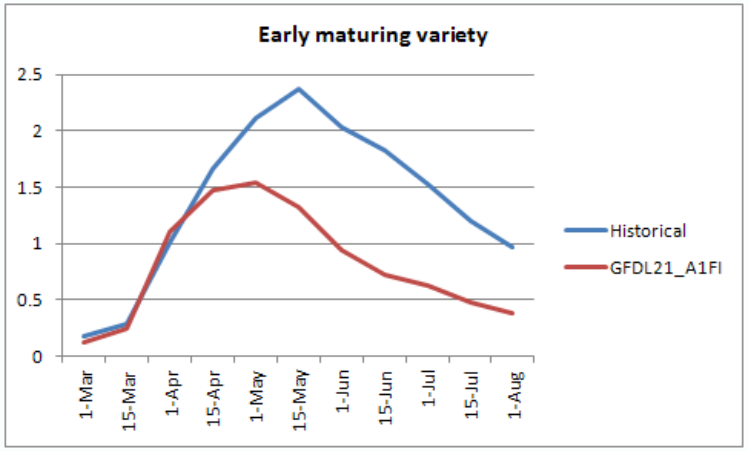
Australia's future climate ?

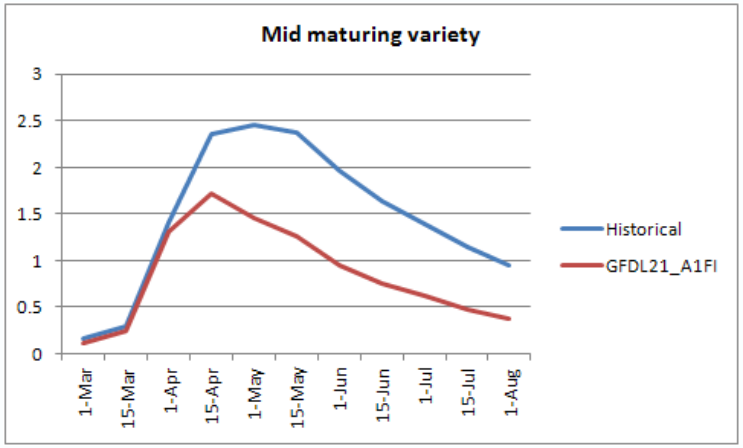
- Increased temperature
  - 0.4 to 2.0°C by 2030
  - 2 to 4°C by 2070
- More climate extremes
  - very hot days
  - more frosts
  - more storm activity
- Lower rainfall (on average), especially autumn, winter and spring but maybe higher variability
- Higher CO2 levels

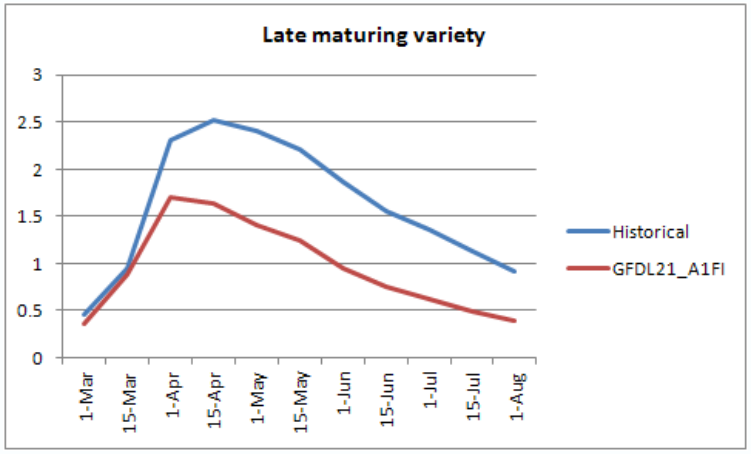
Crop management adaptations



Adaptation option evaluation – changes in sowing date (SA)

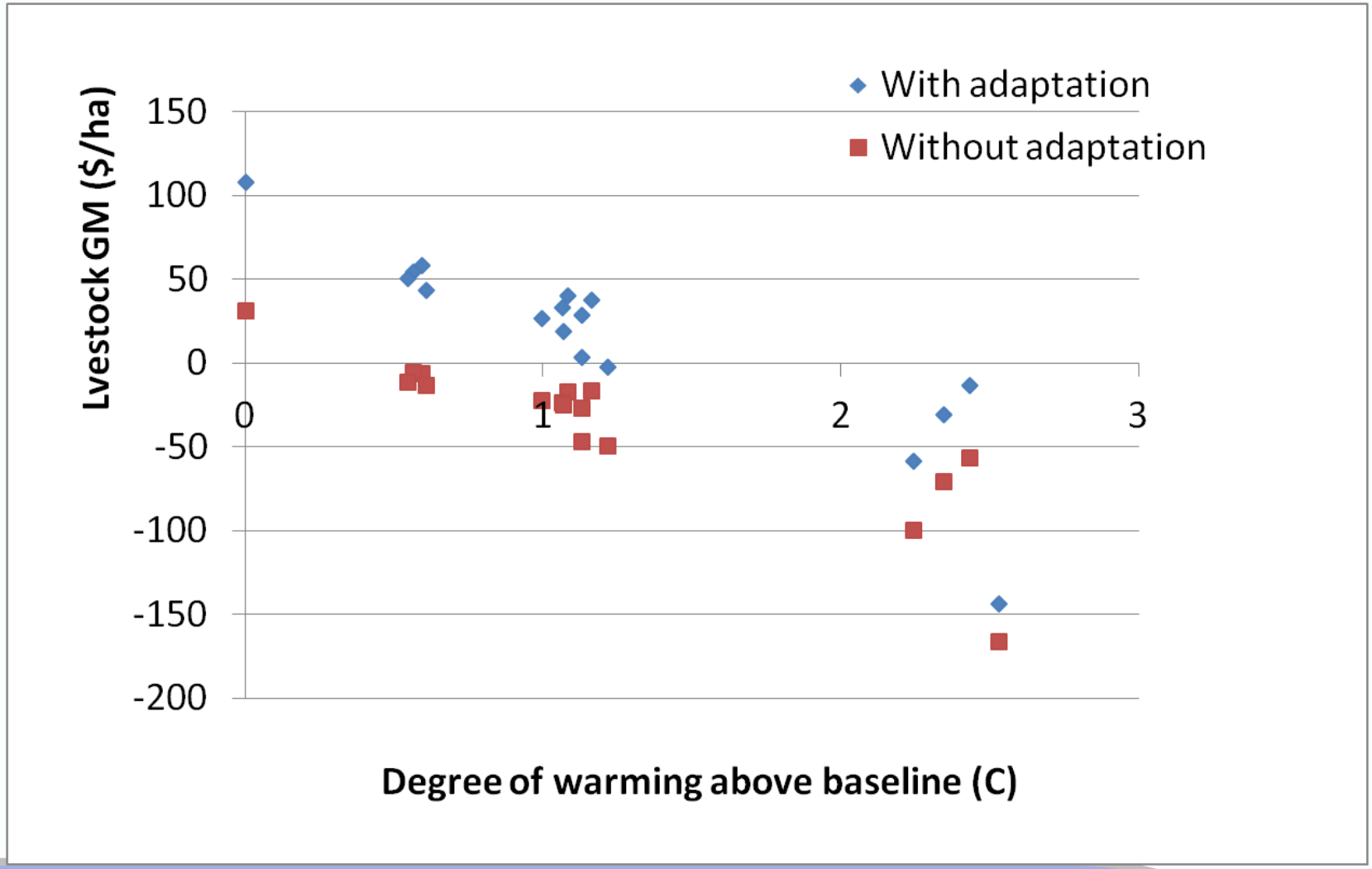






- Similar results found in WA, although consistent losses simulated due to water stress

Adaptation option evaluation – WA cropping grazing mix



Crop management adaptations

TABLE 6 - NEW SOUTH WALES (As in table 2)

ADAPTATION OPTION	MODEST CLIMATE CHANGE	MODERATE CLIMATE CHANGE	SIGNIFICANT CLIMATE CHANGE
Changing enterprise mix: Examine the most resilient enterprise mix in response to climate change.			
Adopt water-use efficient practices: Examine the value of sowing dry under projected warmer and drier conditions.			
Change varieties: Both longer and shorter season varieties in combination with changes in sowing window.			
Change rotations: Introduction and sequencing of fallows.			

TABLE 5 - TASMANIA (As in table 2)

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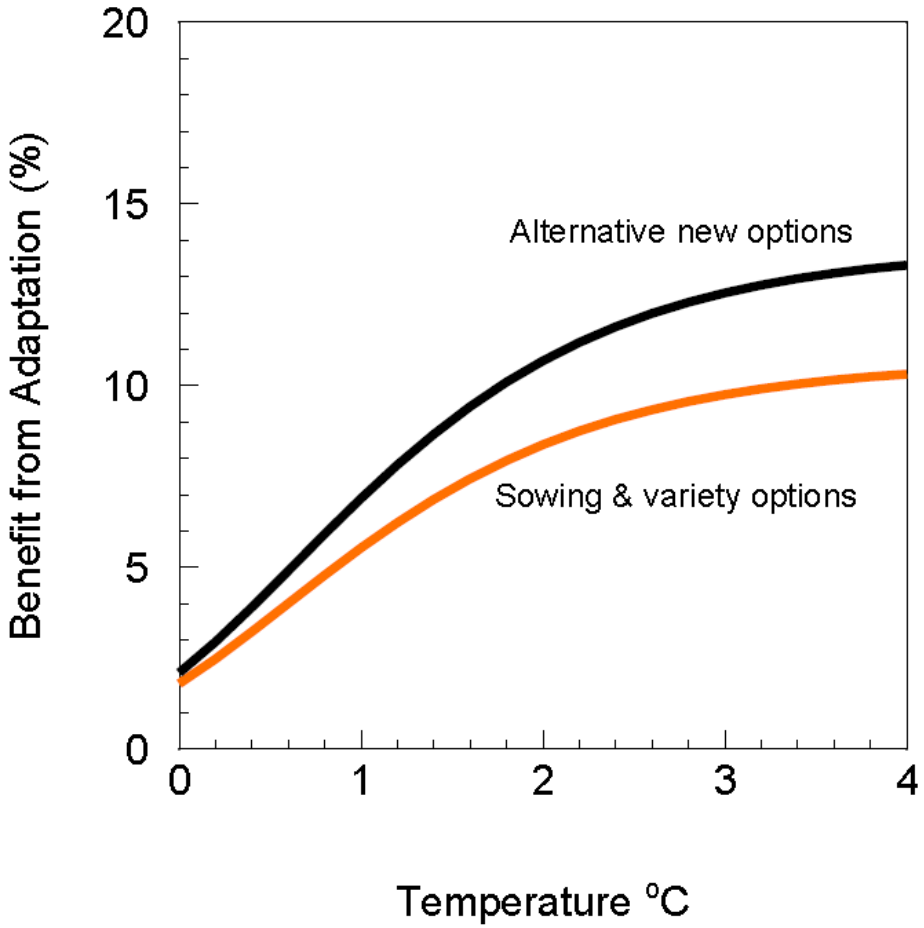
Climate adaptation: a journey from agronomic thinking to business management

2007	2009	2011	2012
• no cultivation, no-till and stubble retention • guidance systems • press wheels for water harvesting • inter-row sowing • opportunity cropping • less canola and pulses • hay • soil testing for N and water • sowing by the calendar not on moisture (dry sowing)	• containment areas for livestock • low P rates and N only just in time • postpone machinery purchases • no burning of stubbles • shorter season and heat tolerant varieties • variable sowing rate • improve sheep production	• canola only on soil moisture • bought and leased more light (sandy) country • concentrate on marketing (futures and foreign exchange rates) • decrease debt • off-farm income • reduce costs • improve harvest efficiency	• simplify all operations • larger paddocks – easier management • improve labour efficiency • improve financial management • requirement for more information and knowledge

Crimp *et al.* (2012)

Scaling results - nationally

- Beyond 2.5°C increase productivity declines irrespective of the options considered
- If rainfall declines, this point is reached at lower temperature increases (1.5°C and 2°C)
- Adaptation options are most effective under temperature increases of 1 to 2.5°C, with benefits levelling out after that
- The benefit from being well adapted is likely to be worth between $100 million to $500 million per annum to the wheat industry alone



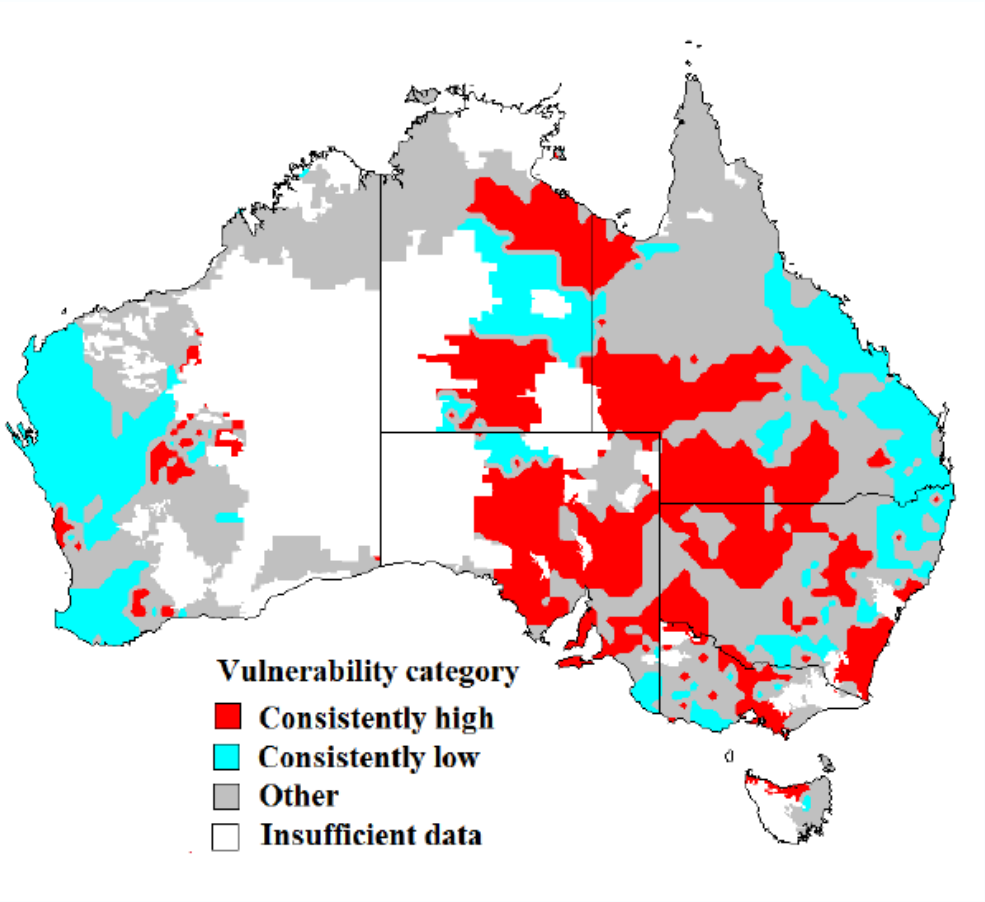
Broadacre vulnerability by 2030

Factors that reduce vulnerability:

- willingness to adapt new technologies;
- good farmer networks and sense of rural community;
- sufficient off-farm income and enterprise diversification.

Factors that enhance vulnerability:

- poor succession planning;
- restrictive farm business size;
- poor equity to debt ratios; and
- increasing cost of production and labour costs.



Breeding for 2030

CO_2 *may* increase yield, depending on water supply etc

Warm temperatures accelerate development (reduce yield)

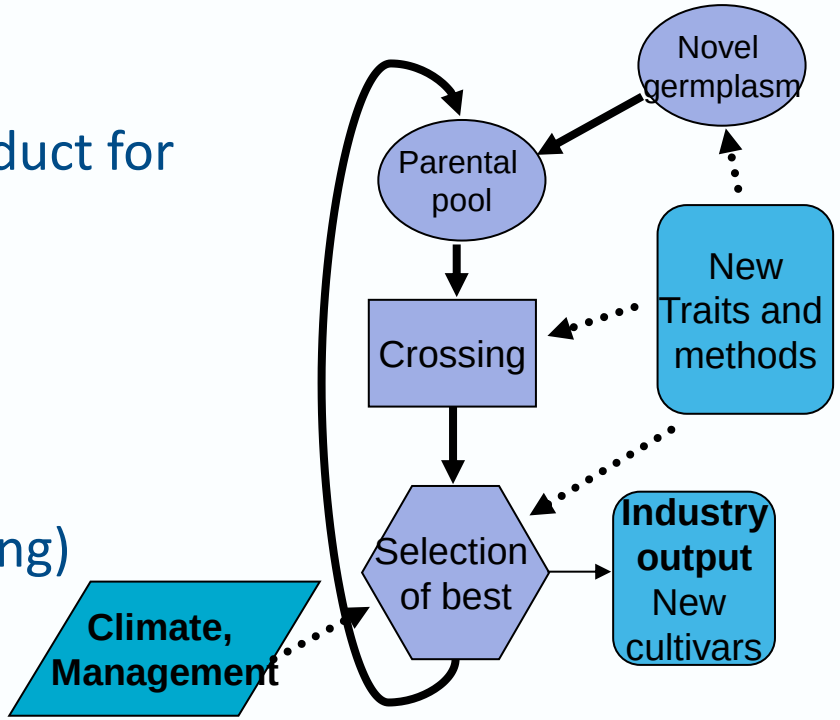
High temperatures damage crops

Plant breeding takes time

- 5 to 15 years from the first cross to product for farmers

Novel traits require

- New sources of variation
- New methods of evaluation (phenotyping)
- New methods of genetic integration



Chapman et al. (2012)

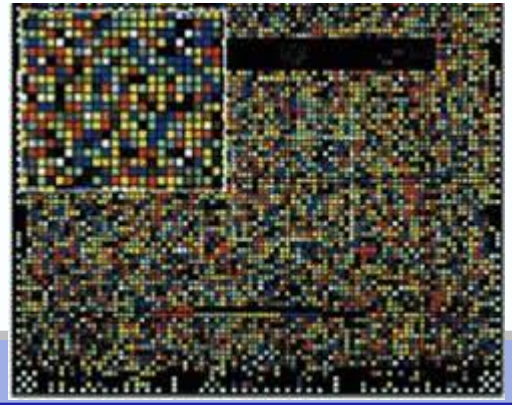
Technologies to breed for climate change

Genotype

SNP Chips

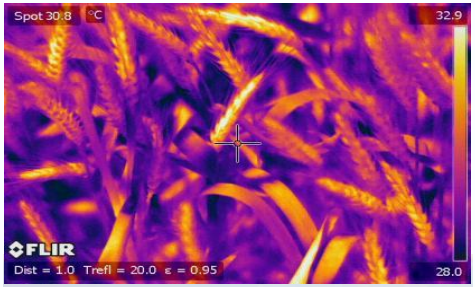
- ‘genome’ on a chip
- 90 000 genes

Data shows
which genes are ‘working’ in
a variety

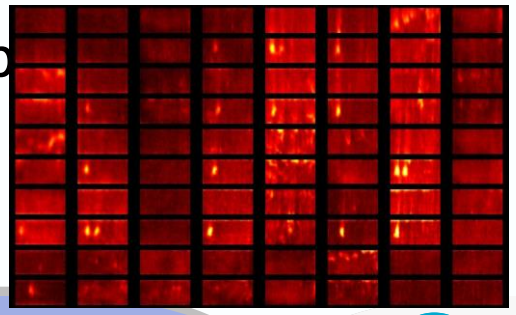


Phenotype

Thermal
cameras



Sensor
networks

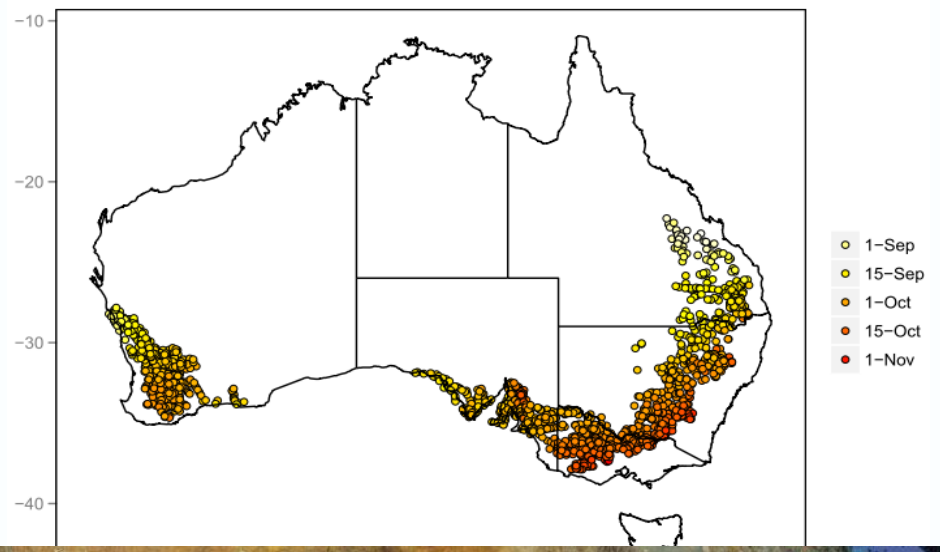


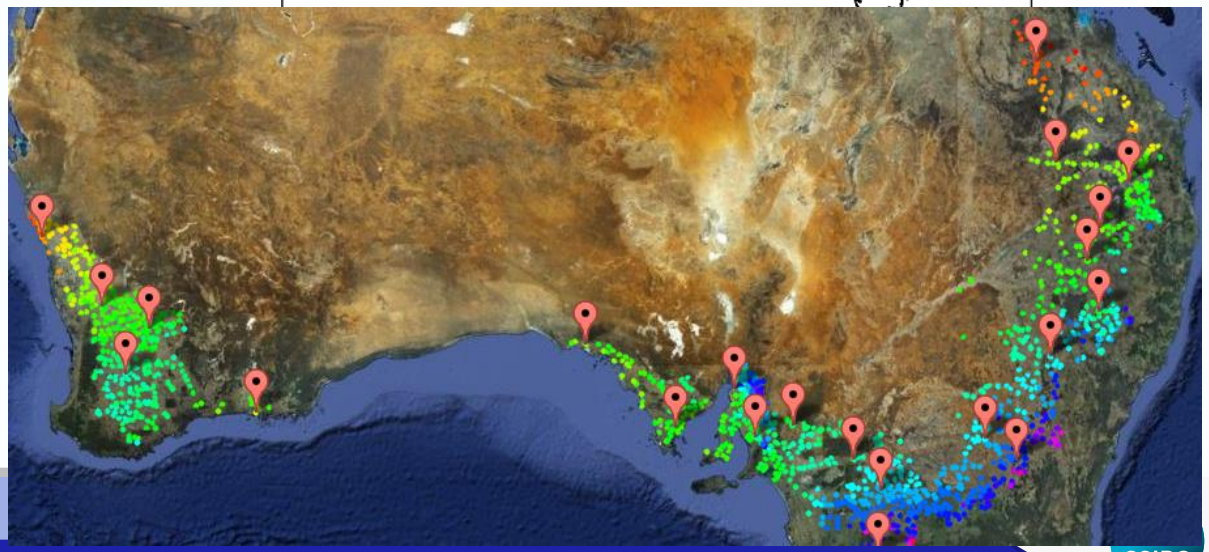
We can predict median heading times across Australian wheatbelt (e.g. for 1st June sowing)

Example for cultivar Janz (based on Vrn1, Ppd-D1 and EPS 'earliness per se' genes)

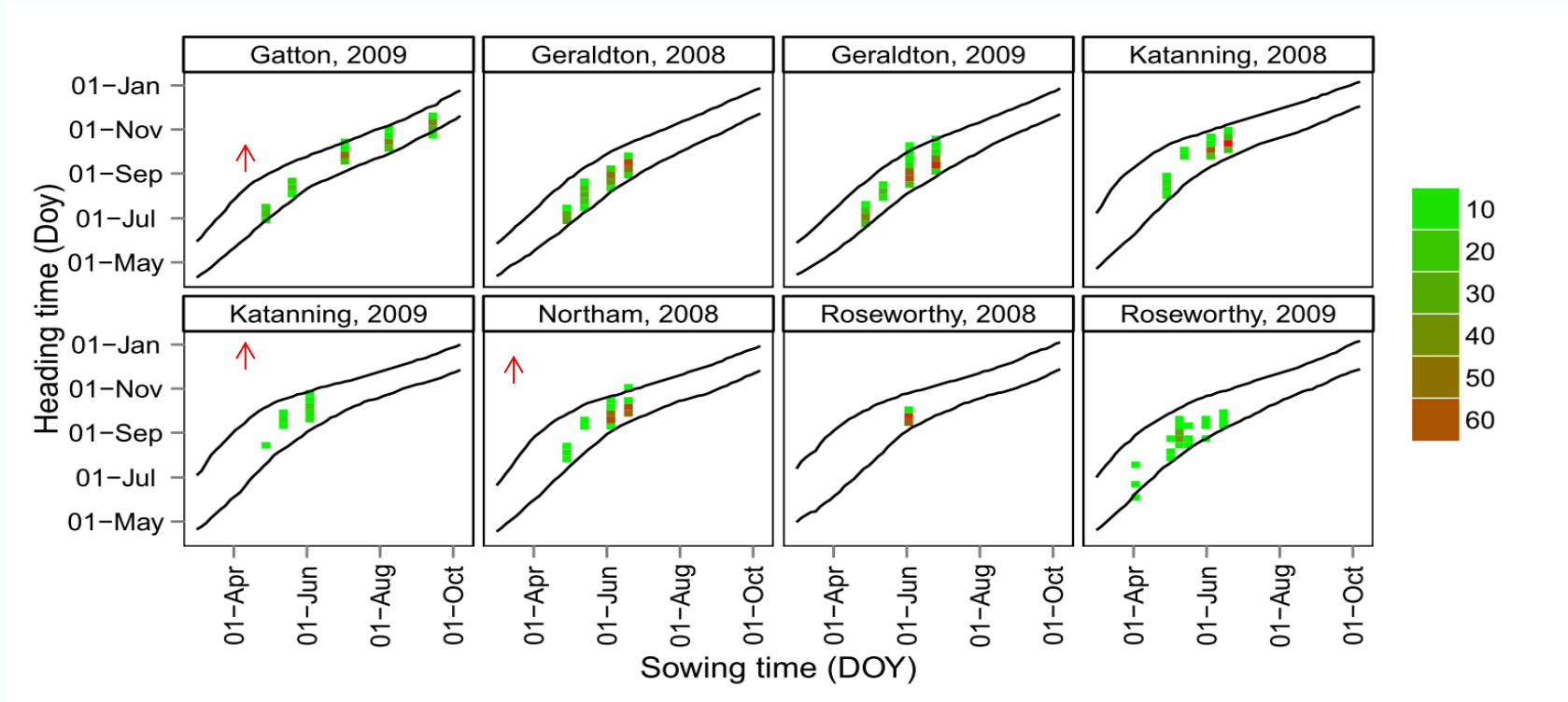
Gradually later from north to south and from inland to coast

Can do this for any genotype and future climates..





For early sowing, current genotypes *do not* explore full range of potential heading dates



Colours = number of genotypes heading on a certain date

Lines represent ‘genetic potential’ for flowering date

Thank you

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