wantfa carbon farming

Farming with climate change in south-west Western Australia

We know that from year to year the climate conditions in south-west Western Australia are variable. Alongside this variability we are also observing conditions consistent with an increasingly warmer and drier climate.

VARIABILITY AND CHANGES IN THE CLIMATE are affecting the profitability of agriculture and the way it is managed, but there is still considerable uncertainty about the effect climate change will have at a farm level. Climate changes present, and will continue to present, both opportunities and challenges.

Opportunities for improved yield potential may arise from a reduction in frost incidence and waterlogging in some areas.

Challenges are likely to be most extreme in the marginal areas of Western Australia's wheatbelt. Warmer and drier conditions are projected to lead to declines in crop yields by 20 to 50 per cent in the low to medium rainfall areas of south-western Australia by 2050 to 2100.

How much warming have we experienced?

- Since 1910, Australia has experienced an increase in average sea surface temperature of 0.9°C (Figure 1). Increases in land surface temperatures have been slightly greater. Maximum daily temperatures have increased by 0.8°C and overnight minimums have increased by 1.1°C.
- Seven of the 10 warmest years on record in Australia have occurred since 1998.

With the warming trend we have experienced heatwaves of increased duration and intensity. Heatwaves are defined as three or more days of unusually high temperatures for the area. Increased duration and intensity of heatwaves has started to and is likely to cause more cases of heat stress in grain crops. Heat stress in wheat is most damaging during reproductive and grain-filling stages (Farooq *et al.*, 2011).

Warmer and drier conditions are presenting many challenges to farmers.

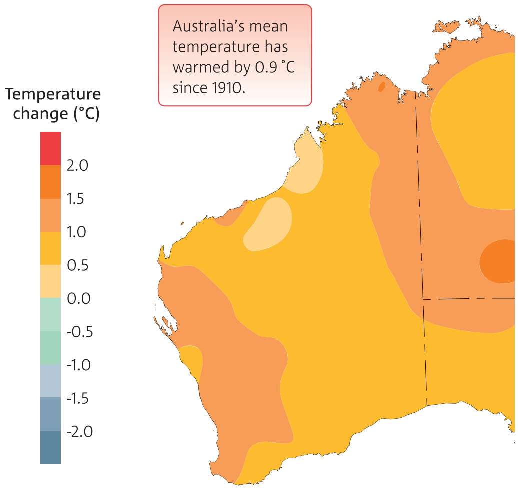

Figure 1: Annual mean temperature changes across Australia from 1910 to 2013 (Bureau of Meteorology and CSIRO, 2014).

When temperatures are elevated between anthesis and grain maturity, yields are lower because the plant has less time and capacity to capture resources for growth through photosynthesis (Farooq *et al.*, 2011). Above optimum temperatures during grain filling are reported to result in a 10–15 per cent yield loss in Australian grain crops (Wardlaw and Wrigley, 1994). Adaptation options for increasing occurrence of heat waves under climate change include earlier sowing, shorter season cultivar or more tolerant cultivar.

What is happening with rainfall?

Since the 1970s we have observed a 17 per cent decrease in average winter rainfall in the south-west of Australia. The most significant impact of this new average rainfall is in a dry year where rainfall is lower than the average. A low rainfall scenario, coupled with increasing temperatures, is likely to lead to much drier soils and greater production risks for farmers.

It is not all bad news. Rainfall is increasing in the north of the state. We might be able to expect slightly more

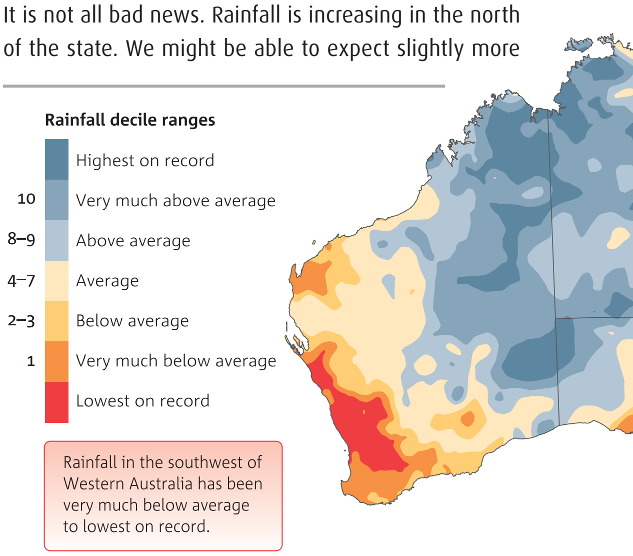

Figure 2: Rainfall deciles for April–November since 1996. The decile map shows the extent that rainfall is above average, average or below average for the period since 1996, compared with the entire rainfall record from 1900 (Bureau of Meteorology and CSIRO, 2014).

summer rainfall in the south-west and we expect to still see high (winter) rainfall years, however they tend to be occurring less often.

Since the 1990s winter rainfall across much of the south-west of Australia has been very much below the long-term average (from 1900).

We are also observing a gradual increase in the number of small rainfall events at the beginning of the growing season. Without stored moisture or similar sized rainfall events backing each other up (if the soil is dry), most of the water will evaporate and not be useful to the emerging crop.

How can we mitigate Ⓜ and adapt Ⓐ to climate changes?

Cropping options

Crop species and variety choices:

- Crops with a higher tolerance for dry conditions, heat stress and capacity to maximise water use efficiency. These traits may be delivered by plant breeding in the longer term.
- Grow something different where and when the current practices are too high risk or unprofitable. Ⓐ

Rotation choices:

- Summer cover crops to take advantage of summer rain (that is expected to increase) and reduce greenhouse gas emissions over summer (e.g. millet, sorghum, cowpeas, sunflowers, lablab). Ⓐ Ⓜ
- Legumes to provide mineral nitrogen to the subsequent cereal. Legumes as a source of nitrogen can reduce the reliance on fertiliser nitrogen. Ⓐ Ⓜ

Time of sowing:

- Early (dry) sowing can help to produce more biomass that returns more crop residue to the soil increasing the potential for carbon sequestration and can help to make the most of variable growing season rainfall events. Ⓐ Ⓜ
- Early sowing can help to minimise the exposure to and impact of heat stress toward the end of the season. Ⓐ

Farming practices:

- Controlled traffic. Ⓐ Ⓜ
- Variable rate technology. Ⓐ Ⓜ
- More efficient fertilisers. Ⓐ Ⓜ
- Consider strategic cropping—if there is no planting opportunity then don't plant—or ensure you have the flexibility to change your cropping program to suit the season as it unfolds.
- As seasonal forecasting improves, use of weather forecasting to match the cropping program to the predicted season.

Livestock options

Pastures options:

- Pastures to aid carbon sequestration, in particular, perennial pastures. Ⓜ
- Pastures and shrubs to reduce methane production from livestock. Much research is looking at the most appropriate species for Western Australia; we expect results within three years. Ⓜ
- Flexible feed base—maintain soil fertility for higher yielding pastures and fodder crops. Ⓐ
- Annual and perennial pasture mixes for feed supply all year. Ⓐ

Sheep management will play an important role in climate change mitigation and adaptation.

Chickpeas are a heat tolerant crop.

Think about genetics:

- Fast growth of lambs. Ⓐ Ⓜ
- Early weaning:
  - allows feed to be allocated to breeding ewes instead of lambs
  - reduces the time that animals are producing methane. Ⓐ Ⓜ
- High reproductive rate—breeding unit is more accountable for greenhouse gas emissions through high outputs. Ⓜ
- Resilience to hot, dry conditions and nutritional stress. Research into genetic traits is occurring at the moment; it will be a medium to longer-term adaptation option. Ⓐ

Infrastructure for flexibility:

- Improve water storage and distribution. Ⓐ
- Invest in livestock feeding equipment. Ⓐ

Farm management and active risk management

- Develop the capacity to make tactical changes to management based on the seasonal conditions. Ⓐ
- Develop the capacity of your business to evaluate the short, medium and long-term impacts of climate change on your farm and identify adaptation options. Ⓐ

References

Climate observations and projections are from: Bureaus of Meteorology and CSIRO 2014. *State of the Climate 2014* Canberra: Commonwealth of Australia.

Information on heat stress and heat tolerance in wheat and other cereals is from:

Farooq, M., Bramley, H., Palta, J. A. & Siddique, K. H. M. 2011. Heat stress in wheat during reproductive and grain-filling phases. *Critical Reviews in Plant Sciences*, 30, 491–507.

Wardlaw, I. F. & Wrigley, C. W. 1994. Heat Tolerance in Temperate Cereals: An Overview. *Australian Journal of Plant Physiology*, 21, 695–703.

Disclaimer

Acknowledgement

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Figures

You can download high res copies of the figures used here from the *State of the Climate 2014* Report online at http://www.bom.gov.au/state-of-the-climate/