


BY SNOW BARLOW AND JOANNE DALY
s.barlow@unimelb.edu.au, jo.daly@iinet.net.au

Adapting Australian agriculture to climate change

Wheat harvesting.

OUR CHANGING CLIMATE **Climatic trends are initiating substantial shifts in land use as farmers seek to manage the emerging climate risks and seize any opportunities that they present.**

Australian agriculture is currently enjoying the benefits of good seasons and strong Asian demand for food that is perceived to be safe and of high quality. The gross value of farm production in 2016-17 will reach a record $64 billion with export earnings of $47.7 billion. The 2016-17 winter grains crop was a record 58.9 million tonnes.

Despite this outstanding year Australian farmers remain vulnerable to climate. The majority of this farm production comes from southern Australia, which is already experiencing a drying and warming trend, which will continue to at least 2050 in the absence of significant reductions in global emissions.

The Murray–Darling basin, 'Australia's Food Bowl', and the majority of the wheat/sheep/cattle belt are projected to experience a further 1°C warming by 2030 and 2°C by 2050, with some overall drying and changes in the seasonality of rainfall.

Agricultural production environments are regional by nature and it is these regional shifts in temperature, rainfall and water availability that will impact most strongly on farmers. These climatic trends are already initiating substantial shifts in agricultural land use as farmers seek to manage the emerging climate risks and seize any opportunities that they present.

The most serious threat to agricultural production of changing climate is the increasing frequency of extreme weather events that can have devastating effects on production. Predominantly these are heatwave events (Figure 1) as the climate warms, but can also include intense rainfall events and flooding, increased bushfire frequency and intensity and severe frost.

Surprisingly, while warming decreases the overall frost frequency it does not necessarily decrease the frequency of the very damaging late spring frosts because of the interaction with increasing dryness and advanced development of crops.

KEY IMPACTS

Climate change over the past 25 years is already impacting on major agricultural production systems.

Pasture production and livestock productivity in southern Australia is being adversely affected by changing seasonality and diminished spring growth (Cullen and Eckard 2009).

Winegrape maturity is advancing by one day each year, leading to higher-alcohol wines and significant logistical challenges in

wineries (Webb *et al*, 2012).

The recent warming and changes in seasonal rainfall are already impacting on wheat, Australia's largest export crop. In an analysis of climate records and actual wheat yields of 50 locations across the entire wheatbelt since 1990, Hochman *et al* (2017) demonstrated that wheat yields had remained stable without the expected productivity gains expected from the application of new science and technologies. However, the potential wheat yields decreased by 27 per cent – from 4.4 to 3.2 tonnes per hectare (Figure 2).

In this 25-year period since 1990 the average wheat yields actually achieved by farmers have not declined, indicating that farmer adaptation through the adoption of new technologies and management techniques has managed to negate the negative changes in climate. These technology-driven productivity gains are essential to the continued international competitiveness of the Australian wheat industry. Clearly, there are limits to continuing technological advances to counter further drying and warming in the wheatbelt.

OPPORTUNITIES

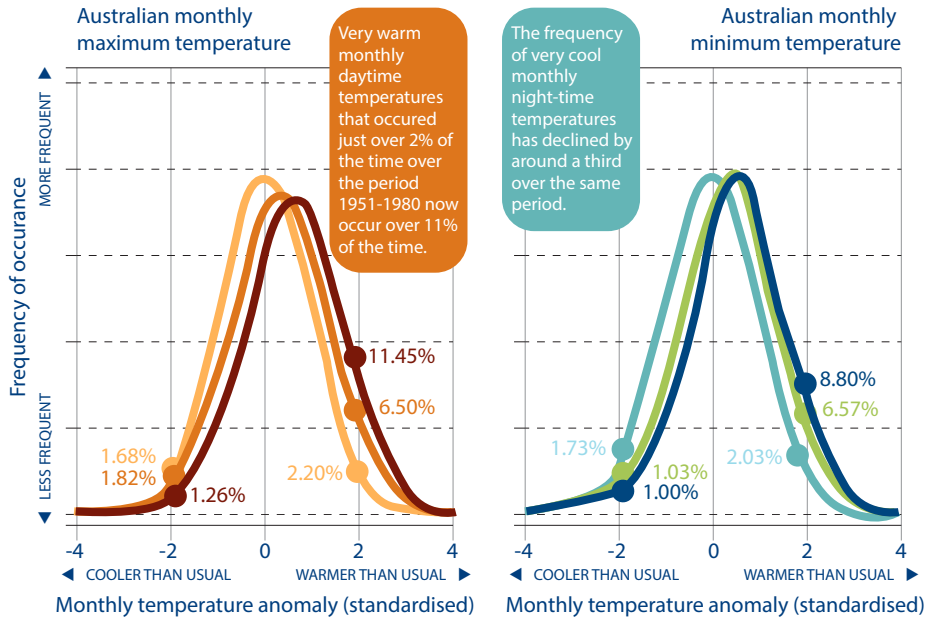
As regional climates change often threatening established industries, new opportunities can emerge for industries, previously limited by low temperatures, to expand into new regions provided the necessary national resources are available.

This is already occurring in southern Australia where the 1°C warming is already changing the suitability of regions for particular industries.

The Western Districts of Victoria, traditionally an almost exclusively grazing area because of cold wet winters, has seen the development of more than 250,000 hectares of grains cropping over the past 20 years.

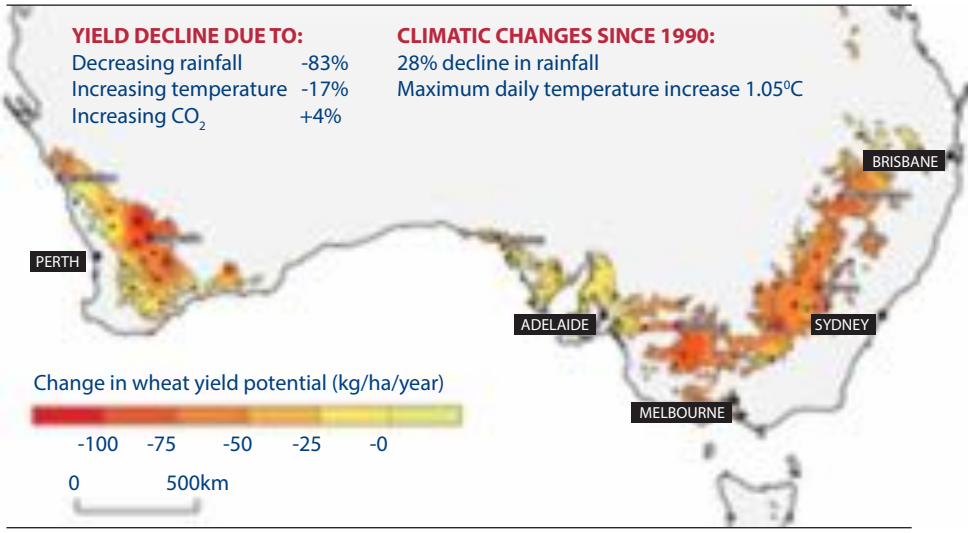
Similarly, the warming of irrigated cropping areas of southern NSW has initiated a significant expansion of the summer crop cotton from northern NSW into the Murrumbidgee Valley, the Riverina and now Victoria. Since 2000, cotton plantings in southern NSW have expanded five-fold to more than 50,000 hectares, while production has increased almost 10-fold with yields higher than the national average. In national terms southern NSW production has increased from less than four per cent of the national crop in

FIGURE 1 The increasing frequency of very warm (heatwave) temperatures occurring in the past decade resulting from a warming climate.



SOURCE: BOM

FIGURE 2 Wheat yield potential has declined from 4.4 to 3.2 tonnes per hectare since 1990, however actual yield has been constant due to farmer uptake of new technology.



SOURCE: HOCHMAN *ET AL*, 2017

Leading the world with research breakthroughs

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DIVE THE REEFS FROM YOUR DESKTOP

UQ is working to visually document life within reef systems across the globe. Images are made available for the world to explore on Google Street View and the Catlin Global Reef Record database.

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The world's first cervical cancer vaccine was developed by UQ's Professor Ian Frazer and the late Dr Jian Zhou. Over 187 million doses have been distributed in more than 130 countries since 2006.

USING MRI TO FIGHT CANCER

With the majority of the world's MRI scanners using technology engineered at UQ, the next step is to integrate radiation therapy with MRI scanners to target and treat cancer.

THE TREE OF SHELF-LIFE

UQ is working with Indigenous communities to unlock a lucrative industry using Kakadu plums to extend the storage life of food. This research has provided the scientific grounding for an emerging industry that has brought together funding, science, buyers and the Indigenous community.

HELPING OVER FOUR MILLION CHILDREN

Triple P – Positive Parenting Program is backed by more than 30 years of ongoing research at UQ. The program has helped more than four million children and their families in approximately 25 countries and has been translated from English into 19 other languages.

2001-02 to more than 25 per cent in 2015-16. This expansion has been made possible by warmer climates and the ability of cotton to compete for irrigation water.

CHALLENGES

The continued adaptation of Australia's agriculture industries in the face of a further 2°C warming will present significant scientific, technological and policy challenges if we are to maintain and perhaps increase the value of agricultural exports. While these challenges are varied and frequently industry-specific, there are major generic challenges.

1 Improved seasonal weather forecasts, including extreme weather events will be critical to allow farmers to manage their climate risks, particularly as the regional seasonable weather patterns are changing.

2 Improved genetics will be needed to allow adaptation to weather extremes, changes in season duration and changing pest and disease regimes.

3 Addressing decreasing plant protein due to increased CO_2 concentration will be essential to maintain or improve the nutritional value of crops and pasture for humans and animals.

4 Integration of sensor technologies and big data management on-farm to facilitate real-time information, thus assisting farmers to be more flexible and adaptive in managing climate and market risks. The availability of reliable internet services of acceptable bandwidth will be crucial to the implementation of these technologies.

Beyond addressing these scientific and technological challenges, Australian agriculture must continue to develop strategies that integrate new knowledge and technology into adapted farming systems that are more resilient to these emerging climate risks. A critical element in these strategies will be to acknowledge the needs of our Asian trading partners for high- quality food of trusted provenance.

The strategic confluence between the new climatic challenges and opportunities and needs of Asian markets must be integrated.

In general, Australian farmers are deeply engaged with managing climate risk, but their efforts must be strongly supported by the establishment of appropriate infrastructure and policy, as well as developing appropriate science and technology.

Infrastructure must include digital coverage to enable the emerging technologies of real-time data integration and robotics to be effectively deployed.

Water delivery infrastructure and controls systems are an integral part of this digital revolution as farmers seek to achieve more efficient and adaptable use of this critical resource.

As new regional climates emerge, it is critical that policies are in place to support the changes in land use and industries that will inevitably occur.

It is also critical that the nation take a proactive approach to ensuring its key export industries have the engagement capacity, technologies and policy settings to successfully adapt to a further 2°C warming by 2050 because it is inevitable. ⊙

FURTHER READING

1. BOM (2017) *State of the Climate 2016*, www.bom.gov.au/state-of-the-climate
2. CSIRO – Climate Change in Australia, https://www.climatechangeinaustralia.gov.au/en/
3. Webb, L.B., Whetton, P.H., Bhend, J., Darbyshire, R., Brigg, P.R and Barlow, E.W.R (2012) Earlier wine-grape ripening driven by climatic warming and drying and management practices. *Nature Climate Change*, Feb 26, 2012
4. Hochman, Z.,Gibbeted, D., L and H.Horan (2017) Climate trends account for stalled wheat yields in Australia. *Global Change Biology*, 23, 2071–81, doi: 10.1111/gcb.13604
5. Cullen B. R., Johnson I. R., Eckard R. J., Lodge G. M., Walker R. G.,Rawnsley R. P., and M. R. McCaskill (2009) Climate change effects on pasture systems in south-eastern Australia. *Crop & Pasture Science*, 60, 933–42

Professor Snow Barlow FTSE is an Emeritus Professor at the University of Melbourne. Previously he was Director of the Climate Change Research Strategy for Primary Industries (CCRSPI), coordinator of the Primary Industries Adaptation Research Network of the National Climate Change Adaptation Research Facility (NCCARF) and chaired the Expert Assessment Panel of the Commonwealth Governments Carbon Farming Futures Program. He has been Board member of two Rural Industry Research and Development Corporations, two cooperative research centres and the Prime Minister's Science, Engineering and Innovation Council (PMSEIC). He was awarded the Australian Medal for Agricultural Science in 2009.

Dr Joanne Daly FTSE is an honorary CSIRO Fellow and a former Group Executive of Agribusiness and Chief of Division. She worked in CSIRO for more than 30 years, originally as a researcher in entomology. She chaired the Expert Working Group on Security Australia's Agricultural Future for the Australian Council of Learned Academies. She is a Director of Plant Health Australia and was a Commissioner of The Australian Centre for International Agricultural Research (ACIAR). She has held a number of senior roles including Chair of The Global Biodiversity Information Facility (GBIF) and member of the Biosecurity Advisory Council and the Australian e-Research Infrastructure Council.

Read about the challenges for Australian agriculture on page 36

ATSE BACKING NEW FOOD AND AGRICULTURE AWARD

Two young Australians who have made outstanding contributions to the field of food and agriculture will be awarded the ICM Agrifood Award this year.

The Award – sponsored by ICM Agribusiness, one of Australia's major agribusiness groups, and administered by ATSE – consists of two annual awards to the value of $5000 each, to be awarded to one female and one male awardee.

It will recognise recipients who:

- demonstrate excellence, innovation and impact in a field related to Australian food and agriculture;
- are 40 years or under on the first day of the year in which the ICM Award is made (with allowance made for career breaks due to family or carer responsibilities);
- are acknowledged by peers for outstanding contributions to the food and agriculture sector in the past five years; and
- have advanced the standing of the broad profession of agriculture and food.

Nominations open 15 June and close 4 September.

Watch the ATSE website for details.