

Communicating Climate Change

Module 16

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Farm-level adaptation options: south-eastern South Australia

As Australia's producers continue to be challenged by increased climate variability and climate change, seeking out region-specific adaptation options is important to ensure regional productivity.

Understanding which adaptation options to pursue in response to climate change remains a challenge, due to uncertainty regarding the full extent of future climate change, the response of different crops, and future commodity prices and input costs. Combining expert farmer knowledge with both crop and climate science will help to identify a range of effective adaptation options to greatly reduce the negative impacts of climate change.

Here we look at the effectiveness of adaptation options for cropping systems in south-eastern South Australia, as evaluated by researchers and local producers at three farms at Lameroo, Paskeville and Tarlee.

Overall, results suggest that some crop management adaptations have a potentially significant role in maintaining or increasing yields under variable and changing climate conditions. Different adaptation options will be required at a range of spatial scales to deal with the different sets of physical and socioeconomic conditions (climate, soils, production systems etc).

Key facts

- By 2030, we can expect mean temperatures in south-eastern South Australia to increase by 0.6–2°C, and annual rainfall to decrease by up to 10%, compared with average climatic conditions for 1980–99. As a result, the frequency and severity of droughts in the region is predicted to increase.
- Modelling studies at three farms suggest that, by 2030, without any change in current management practices, median wheat yields could decline by up to 8% (compared with average yields for 1998–2007), for a warming of 1.2°C and a decrease in annual rainfall of 8%.
- Agricultural systems in the region are predicted to have greater yield variability.
- The modelling studies show that introducing or increasing a fallow or pasture component in crop rotations should reduce yield variability across years by increasing yield in lower rainfall years. This may offset projected median yield losses by an average of 7% (range of 5–8% across the farms studied).
- Changing to shorter- or longer-season wheat varieties, or changing from wheat to barley, will have limited benefits.

A cooperative venture between



Adaptation options for farming systems in South Australia

Many options for adapting farming systems to climate change are extensions of existing strategies that farmers use to manage climate variability. These options include:

- selecting varieties or species of plants that have more appropriate thermal time (degree days) and vernalisation (exposure to cold temperatures required for flowering) requirements, and/or increased resistance to heat shock and drought
- increasing the use of technologies to 'harvest' water, conserve soil moisture (e.g. retaining crop residue, letting land lie fallow), and transporting, storing and using water more effectively
- selecting appropriate soil types for cropping, in response to seasonal climate conditions
- changing the timing of cropping activities in response to seasonal changes in temperature and rainfall
- managing pests, diseases, and weeds more effectively
- using seasonal climate forecasts to moderate fertiliser and herbicide inputs
- using climate forecasts to reduce production risk

Adaptation options for cropping – Lameroo, Paskeville and Tarlee case studies

While a range of broadscale adaptation options have been identified, these options need to be formally evaluated for specific farming systems, soil types, and on-farm management.

CSIRO has evaluated the effectiveness of the following adaptation options for a number of simple, continuous wheat cropping systems at Lameroo, Paskeville and Tarlee:

- introducing fallows into a continuous cropping system
- choosing shorter- or longer-season wheat varieties
- changing crop type from wheat to barley

CSIRO measured the effectiveness of these adaptation options in terms of yield (kilograms per hectare) compared with the baseline period of 1998–2007. This baseline period represents current production challenges.

They used a 2030 climate change projection of 1.2°C warming in mean temperature and annual rainfall declines of 7.5–8.5%, relative to 1998–2007. These projected changes are likely to occur at 2030 in response atmospheric carbon dioxide concentration of 440 parts per million.

The impacts of climate change on yield were modelled using the Agricultural Production Systems sIMulator (APSIM) (Figure 1). The model indicates the following:

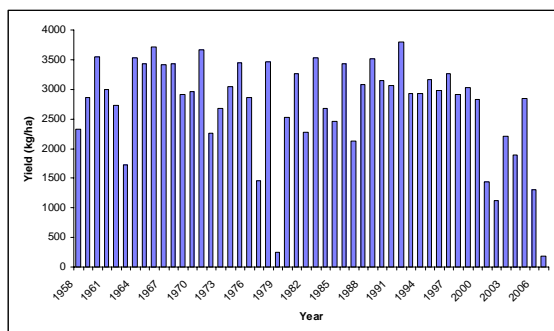
- If current management practices remain unchanged, under a 2030 climate change scenario median crop yields may decline by an average of 5% (within a possible range of 3–8%) for the three sites studied.
- Introducing a fallow into the rotation every third year was a useful adaptation option in response to the projected warming and decline in annual rainfall across all three sites. Median yields increased by an average of 7% (within a possible range of 5–8%) compared with the scenarios where management was unchanged.
- The benefits of changing to longer- or shorter-season varieties, or to different crops (e.g. barley), varied from site to site, but generally did not offset projected yield declines.

How the model calculates attainable yield

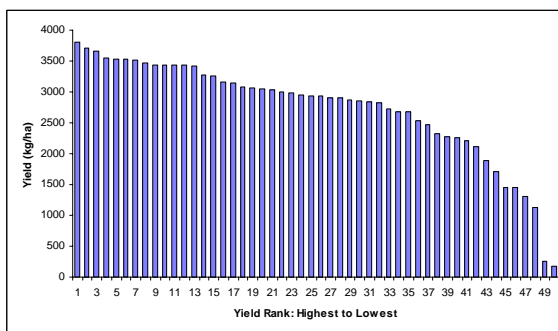
The model estimates attainable yield based on the interaction between soil moisture, nitrogen, rainfall, soil type, crop choice, cultivar, sowing date, temperature, radiation, rotation and on-farm management. The results do not account for disease, heat shock, herbicide damage, insects, wind damage or harvest loss.

The annual historical yields (Figure 1.1) are ranked (Figure 1.2) and used as a basis for developing a 'yield potential curve', also known as a 'probability of exceedance curve' (Figure 1.3), which shows the per cent chance of exceeding a given yield. The attributes (rainfall, nitrogen etc) can be changed to generate new yield potential curves, highlighting the impact of changing individual or combinations of attributes.

1.1



1.2



1.3

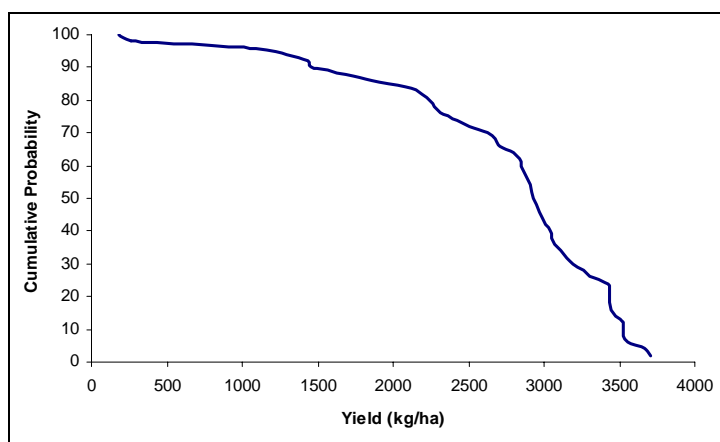


Figure 1: The APSIM process for calculating the probability of exceeding a given yield (kg/ha)

1.1 Simulated annual wheat yields (kg/ha) for a continuous wheat farming system, 1957–2007

1.2 Yields ranked from highest to lowest, 1957–2007

1.3 Yield potential curve (i.e. per cent chance of exceeding a given yield) based on the historical ranked yields

Impact of climate change with no change to current management practices

For the three sites, simulated mean yields for 1998–2007 ('10 Year Baseline') are estimated at 1.7 tonnes/hectare, 2.7 tonnes/hectare and 4.2 tonnes/hectare respectively (Figure 2).

By 2030, with a warming of 1.2°C and a reduction in annual rainfall of 8%, median yields are likely to decline by an average of 5% (i.e. to 1.6 tonnes/hectare, 2.6 tonnes/hectare and 4.0 tonnes/hectare respectively) if there is no change in current management ('No Change').

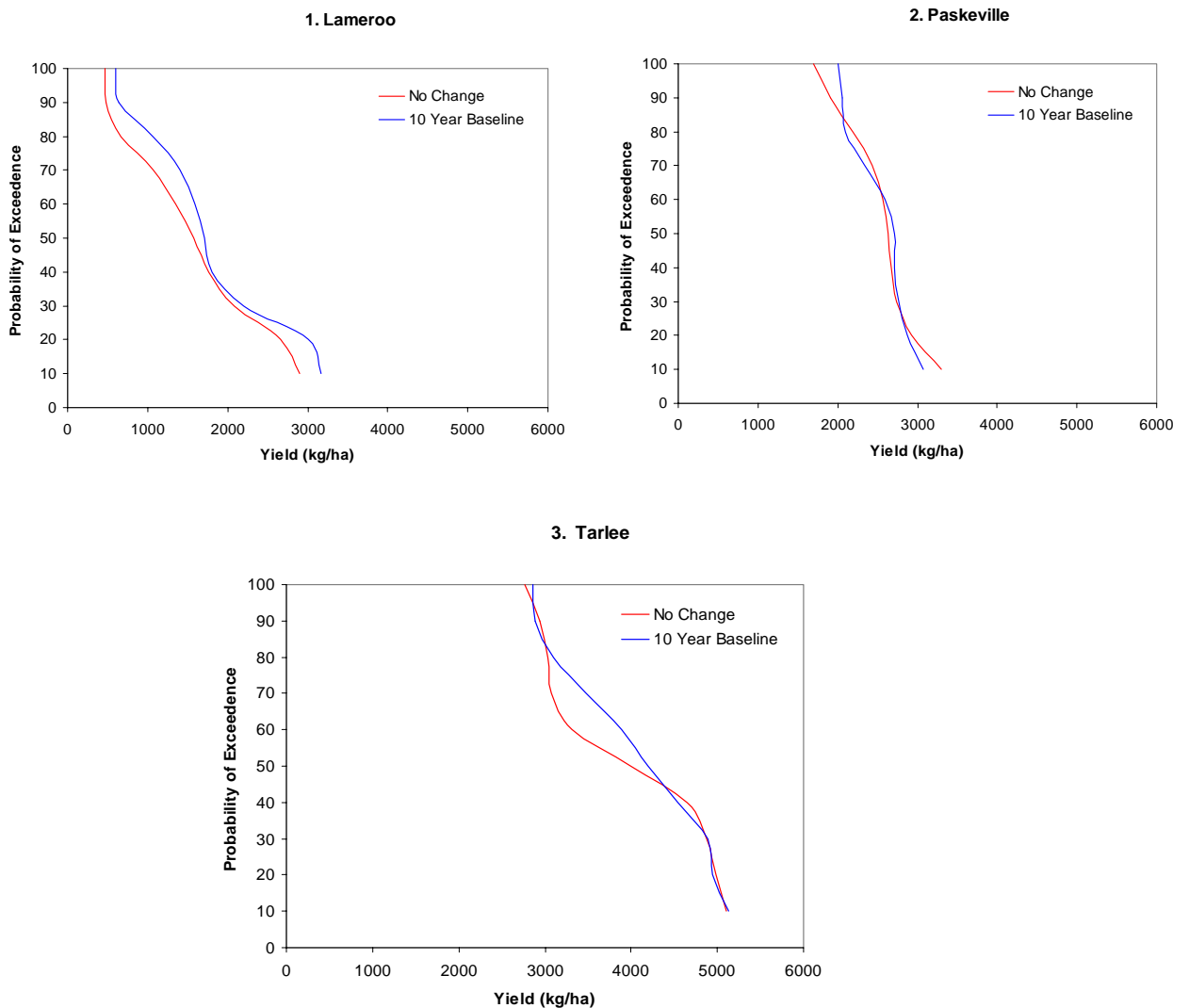


Figure 2: Wheat yields (kg/ha) for the period 1998–2007 ('10 Year Baseline'), compared with simulated yields for 2030 with no change to current management ('No Change')

Introducing a fallow

Introducing a fallow every three years improved yield considerably (Figure 3). At all three sites, under warmer and drier conditions, there was an average increase in median yield of 7% compared with the 'no change' scenario (yields ranged from 5–8% between sites).

At Paskeville, introducing the fallow component offset the yield losses that were caused by changing climate conditions. It also raised yields above those achieved in 1998–2007, due to improved soil moisture availability in years following the fallow.

In contrast, at Lameroo, introducing a fallow lifted yields above those achieved in 1998–2007 only in the highest yielding years (i.e. years with yields of 1.8–3 tonnes/hectare).

At Tarlee, introducing a fallow lifted yields above those achieved in 1998–2007 only in poor years (i.e. years where yields were less than the median of 4 tonnes/hectare).

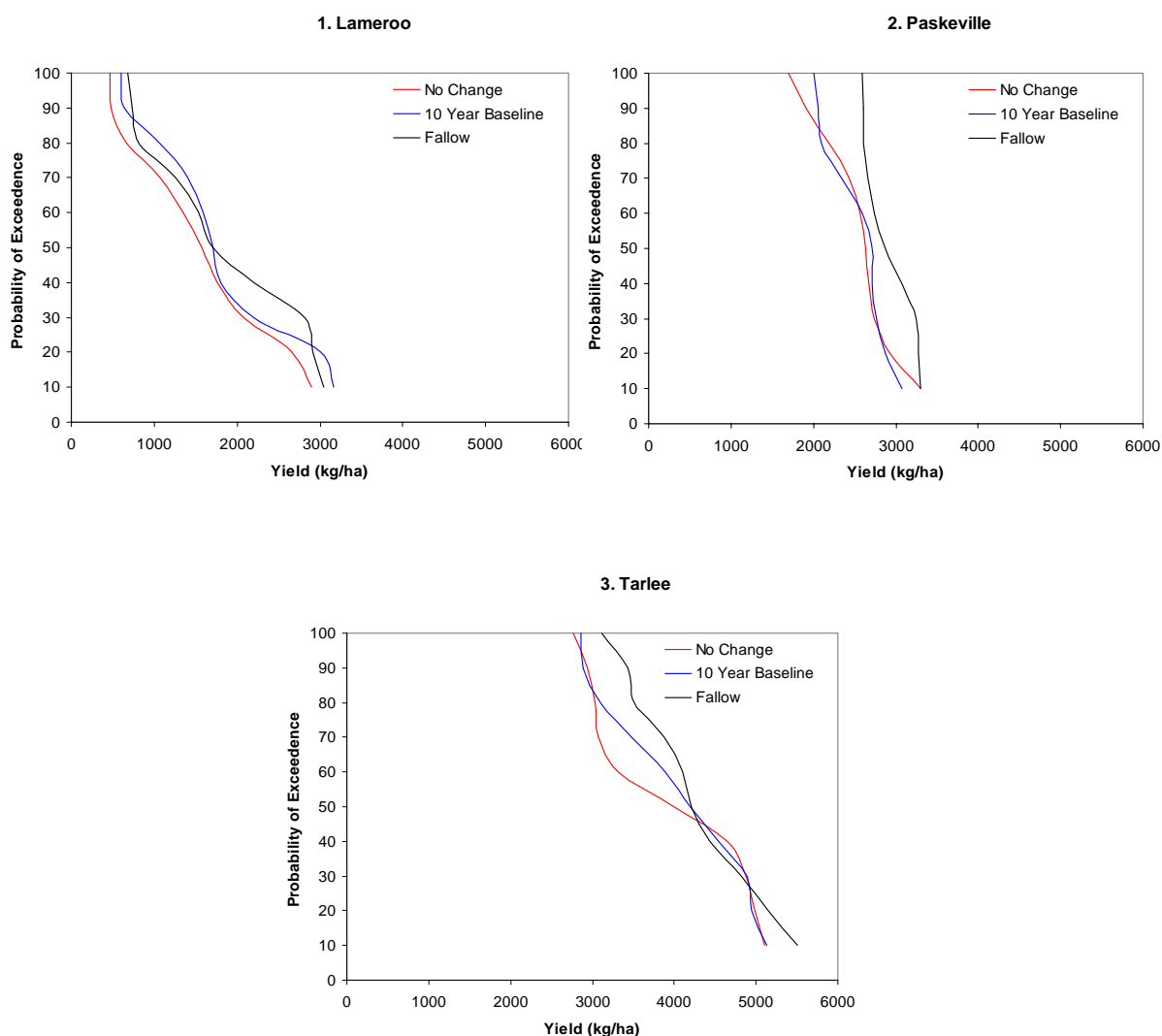


Figure 3: Wheat yields (kg/ha) for the period 1998–2007 ('10 Year Baseline') compared with simulated yields for 2030 with no change to current management ('No Change'), and including a fallow every three years ('Fallow')

Changing wheat variety/cultivar

Introducing a longer-season wheat variety (Camm) resulted in consistently lower yields at both Paskeville and Tarlee, with only slight improvements in better yielding years at Lameroo.

Other adaptation options, such as changing to a shorter-season wheat cultivar (Wyalkatchem) had mixed results across the three sites. At Tarlee, yield improvements were simulated across all years but only in the higher yielding years at Paskeville and in the lower yielding years at Tarlee.

Changing from wheat to barley

Replacing Yitpi wheat with a schooner barley produced mixed results across the three sites.

At Lameroo, barley produced greater average yields than wheat in all but the highest yielding years.

At Paskeville, barley yields were greater than wheat yields in both poor and high yielding years.

At Tarlee, barley yields were only higher in the lower yielding years.

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Further information

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