Communicating Climate Change
Module 16
An initiative of the National Agriculture and Climate Change Action Plan

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Farm-level adaptation options: North East Agricultural Region, Western 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 about 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 the North East Agricultural Region (NEAR) of Western Australia, as evaluated by researchers and local producers.

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 the NEAR to have increased by 0.6–2°C, and annual rainfall to have decreased by up to 20%, relative to 1980–99 conditions. As a result, the frequency and severity of droughts in the region is predicted to increase.
- Farm-based modelling studies in the NEAR suggest that, by 2030, with no changes in current management practices, wheat yields could decline by up to 11% (compared to average yields for 1998–2007), for a warming of 1.6°C and a decrease in annual rainfall of 6.5%.
- Greater yield variability is predicted for agricultural systems in the NEAR.
- Introducing or increasing a fallow component in crop rotations should reduce yield variability by increasing yield in lower rainfall years. This may offset projected yield losses and, in some instances, increase mean yields by up to 9.5%.
- Options such as changing to shorter-season wheat varieties or changing wheat to barley will have limited benefits.

A cooperative venture between
Managing Climate Variability R&D Program
MLA Meat & Livestock Australia
BCG shared solutions

Adaptation options for NEAR farming systems

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 crop varieties/species 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, fallowing), 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 – Yuna, Morawa and Mullewa 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 Yuna, Morawa and Mullewa:

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

CSIRO measured the effectiveness of these adaptation options in terms of yield (tonnes per hectare) compared to the baseline period of 1998–2007. This baseline period was chosen as it represents current production challenges more realistically than a longer historical period (average regional yield over the past 10 years was 1.8 tonnes per hectare compared to 2.4 tonnes per hectare for the past 50 years).

The climate change projections that CSIRO used included a projected warming of 1.6°C and annual rainfall declines of 6–8% relative to 1998–2007). These projected changes are likely to occur at 2030 in response to a global atmospheric carbon dioxide concentration of 440 parts per million (16% higher than current concentrations).

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

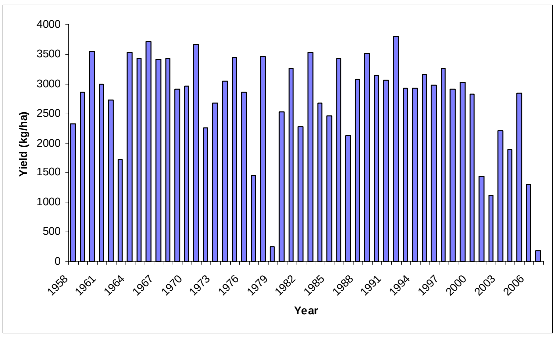
- If current management practices remain unchanged, crop yields may decline by 11% (within a possible range of 7–18%) for the three sites studied.
- Introducing a fallow into the rotation every third year was a useful adaptation option in response to the projected warming and decline in annual rainfall across all three sites. Mean yields increased by up to 9.5% (within a possible range of 4–13% between sites).
- Options such as choosing shorter-season varieties and different crops (e.g. barley) had limited effectiveness in mitigating projected yield declines.

How the model calculates attainable yield

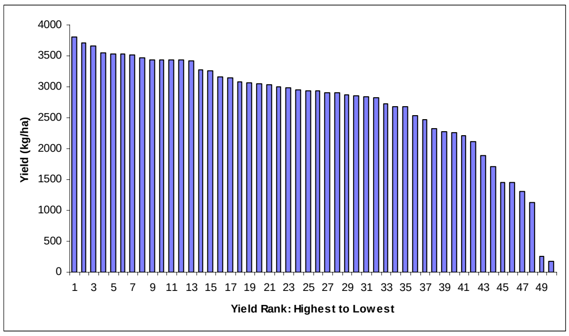
The model estimates attainable yield based on the interaction between soil moisture, nitrogen, rainfall, soil type, crop choice, cultivar, sowing date, temperature, radiation, rotation and on-farm management. The results do not account for disease, heat shock, herbicide damage, insects, wind damage or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



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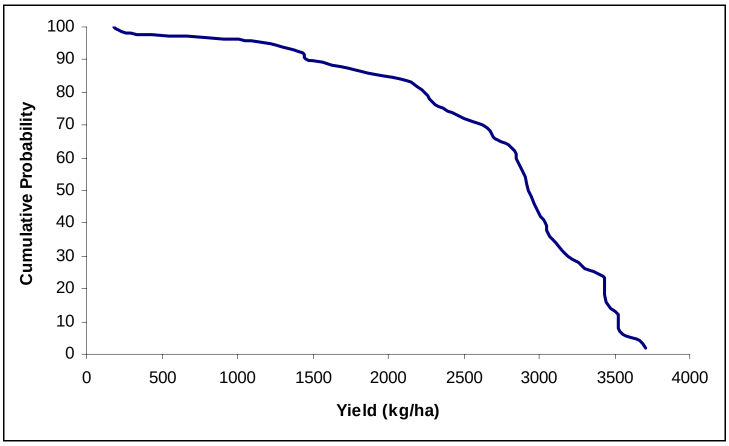

Figure 1: The APSIM process for calculating the probability of exceeding a given yield (kg/ha)

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 at Yuna, Morawa and Mullewa, simulated mean yields for 1998–2007 ('10 Year Baseline') are estimated at 1.6 tonnes per hectare, 2.1 tonnes per hectare and 1.7 tonnes per hectare respectively.

By 2030, with a warming of 1.6°C and a reduction in annual rainfall of 6.5%, median yields decline by approximately 11% (i.e. baseline yields of 1.6 tonnes per hectare, 2.1 tonnes per hectare and 1.9 tonnes per hectare respectively) (Figure 2).

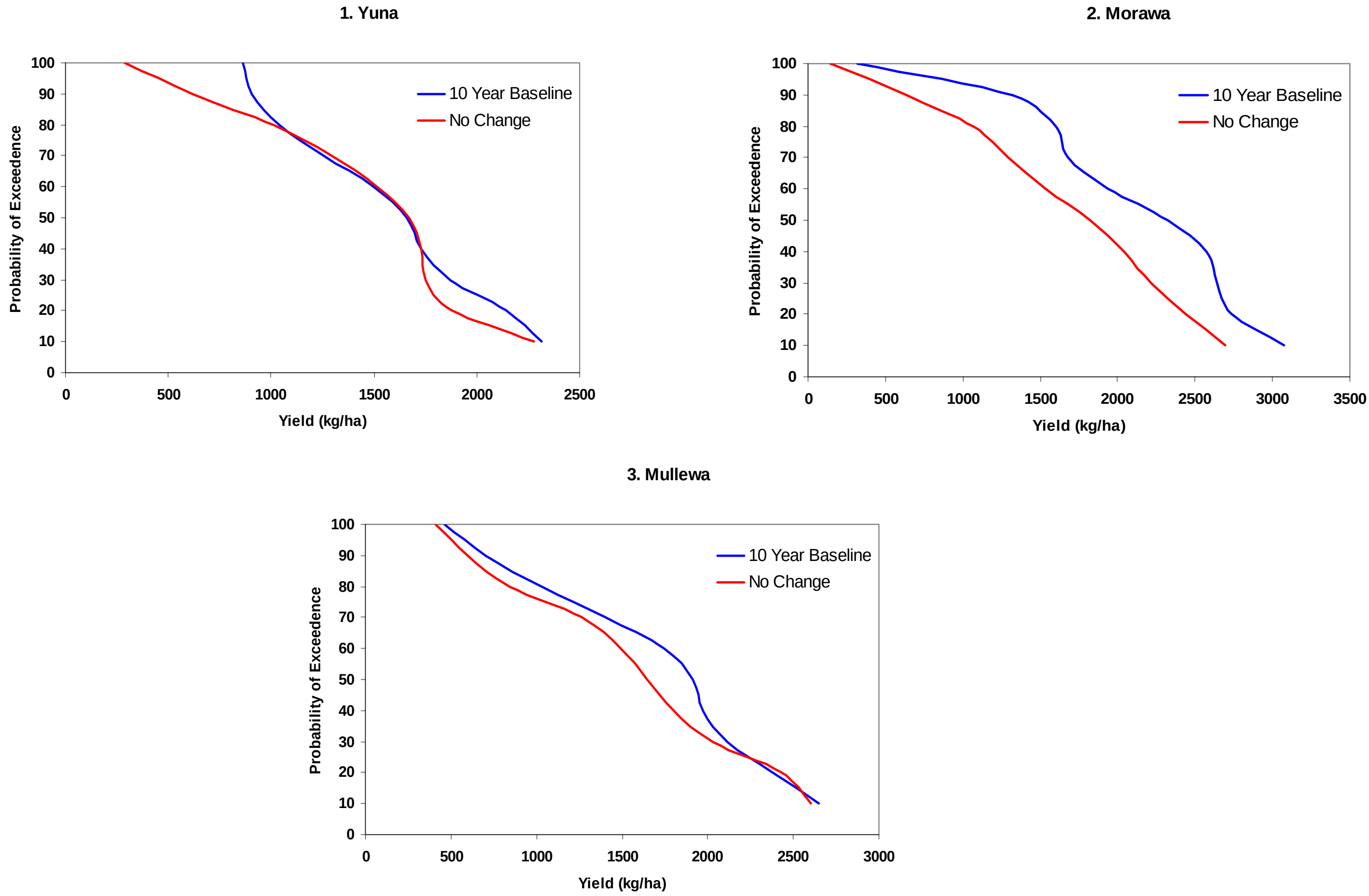

Figure 2: Wheat yields (kg/ha) for the period 1998–2007 ('10 Year Baseline'), compared with simulated yields for 2030 with no change to current management ('No Change')

Introducing a fallow

Introducing a fallow every three years improved yield considerably under warmer and drier conditions at all three sites (Figure 3).

At Yuna, introducing the fallow offset the yield losses caused by the warmer and drier climate conditions. It also raised yields above those achieved in 1998–2007 (Figure 3.1).

Similarly, at both Morawa and Mullewa, yields were lifted above those achieved in 1998–2007 (Figure 3.2 and 3.3).

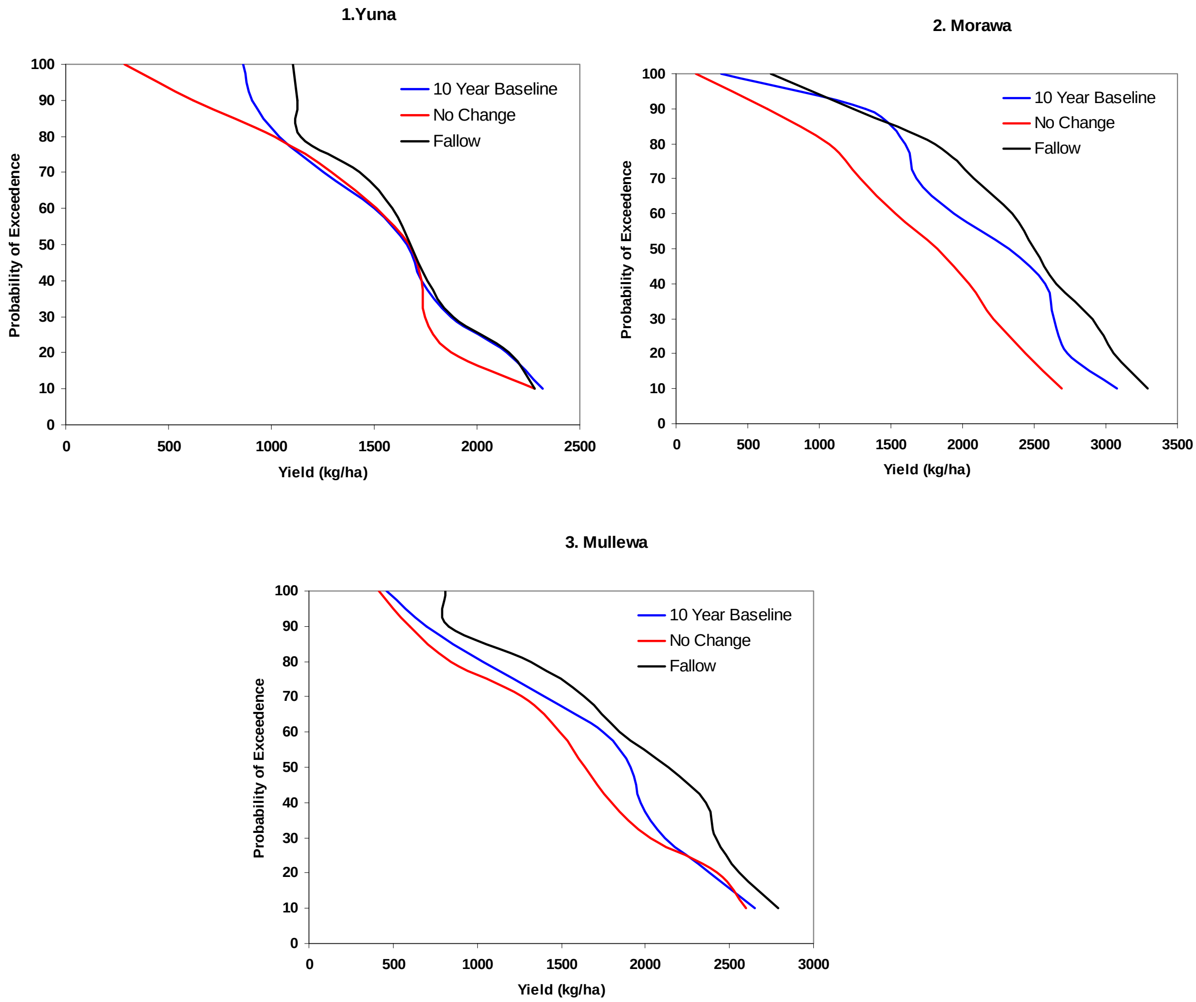

Figure 3: Wheat yields (kg/ha) for the period 1998–2007 ('10 Year Baseline') compared with simulated yields for 2030 with no change to current management ('No Change'), and including a fallow every three years ('Fallow')

Changing wheat variety/cultivar or changing from wheat to barley

Options such as changing to shorter-season wheat varieties or changing wheat to barley provided few positive benefits at each of the three sites studied.

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Further information

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