Communicating Climate Change
Module 16
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Farm-level adaptation options: Wimmera-Mallee

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 Wimmera-Mallee region in western Victoria, as evaluated by researchers and local producers.

Key facts

- By 2030, we can expect mean temperatures in the Wimmera-Mallee to have increased by 0.6–1.1°C, and annual rainfall to have decreased by up to 6%, relative to 1990 conditions. As a result, the frequency and severity of droughts in the region is predicted to increase.
- Farm-based modelling studies in the Wimmera-Mallee suggest that, by 2030, without any change in current management practices, wheat yields could decline by up to 18% (compared to average yields for 1980–99), for a warming of 1.1°C and a decrease in annual rainfall of 6%.
- Greater yield variability is predicted for agricultural systems in the Wimmera-Mallee.
- The modelling studies show that introducing or increasing a fallow or pasture component in crop rotations may offset potential yield losses by retaining more available soil moisture. In one continuous cropping system, introducing a fallow improved median yields by up to 30%.
- The modelling studies also show that retaining stubble or enhancing stubble retention is an effective way of offsetting potential yield losses in the region.
- Options such as reducing planting densities, increasing row spacing, and changing to shorter-season varieties were shown to provide few benefits for the farms examined in this region.

CSIRO
A cooperative venture between
Managing Climate Variability R&D Program
BCG shared solutions
mla Meat & Livestock Australia
Australian Government
Department of Agriculture, Fisheries and Forestry
Bureau of Meteorology

Adaptation options for farming systems

Many options for adapting to climate change in the Wimmera-Mallee region are extensions of existing strategies that farmers use to manage climate variability.

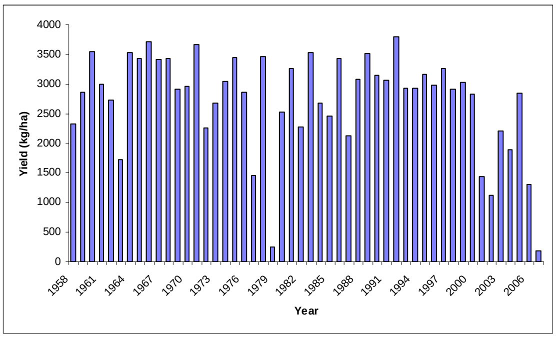
Adaptation options include:

- selecting varieties/species with appropriate thermal time (degree days) and vernalisation (exposure to cold temperatures required for flowering) requirements and/or with increased resistance to heat shock and drought
- using technologies to conserve soil moisture (e.g. retaining crop residue), and developing and using more efficient water transport and storage facilities to minimise transfer losses
- changing the timing of cropping activities in response to seasonal changes in temperature and rainfall
- managing pests, diseases and weeds more effectively
- using climate forecasts to reduce production risk

In a joint project between the Birchip Cropping Group and CSIRO, researchers and producers evaluated the effectiveness of a number of adaptation options for cropping, mixed cropping, and grazing farming systems in the Wimmera-Mallee region using the Agricultural Production Systems sIMulator (APSIM). This model estimates the annual ‘attainable yield’ (Figure 1.1) based on the interaction between soil moisture, nitrogen, rainfall, soil type, crop choice, cultivar, sowing date, temperature, radiation, rotation and on-farm management.

The annual historical yields 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



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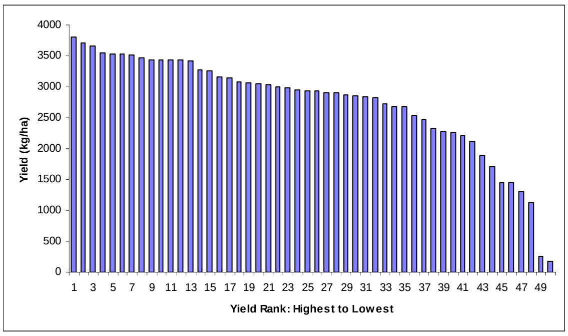

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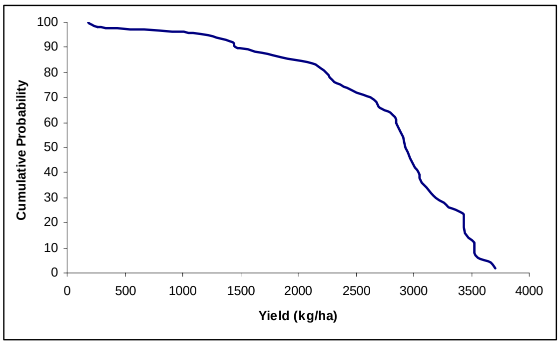

Figure 1:

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

1.2 Ranked baseline yields, 1957–2007

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

A range of adaptation options, including introducing or enhancing fallow management, introducing or enhancing crop residue retention, reducing planting densities, and planting shorter-season crop varieties, were considered under climate change conditions of:

- a mean temperature increase of 1.1°C and a reduction in annual rainfall of 6%, compared to conditions for the period 1980–99
- a global atmospheric carbon dioxide concentration of 465 parts per million (20% higher than current concentrations)

The researchers used historical climate data to model baseline yield potential curves for each case study farm in the Wimmera-Mallee region. Each curve is unique to the farm on which the model was run, reflecting the effectiveness of current management to climate variability.

Yield potential curves were also generated using the same current management practices but replacing the historical climate with future climate conditions. The results suggest that if current farm management practices remain unchanged, median crop yields could decrease by an average of 18% (with a possible range of 13–24%) across the farms examined.

Yield potential curves using future climate conditions and adaptive management strategies were also generated. The adaptation options most effective for three different farming systems in the region are outlined below.

Increasing the pasture component of a wheat-pasture farming system

For a wheat-pasture farming system, the ‘baseline’ yield potential curve (solid blue line) shows that, in any year, the farm had a 50% chance of exceeding 3.2 tonnes per hectare (Figure 2).

Modifying the climate data to reflect future expected conditions, but retaining current management practices (solid red line), resulted in a reduction in overall yield potential, with the farm having a 50% chance of exceeding 2.4 tonnes per hectare.

Increasing the pasture phase of the rotation under warmer and drier (future) climate conditions improved yields (black dashed line), with the farm having a 50% chance of exceeding 2.9 tonnes per hectare.

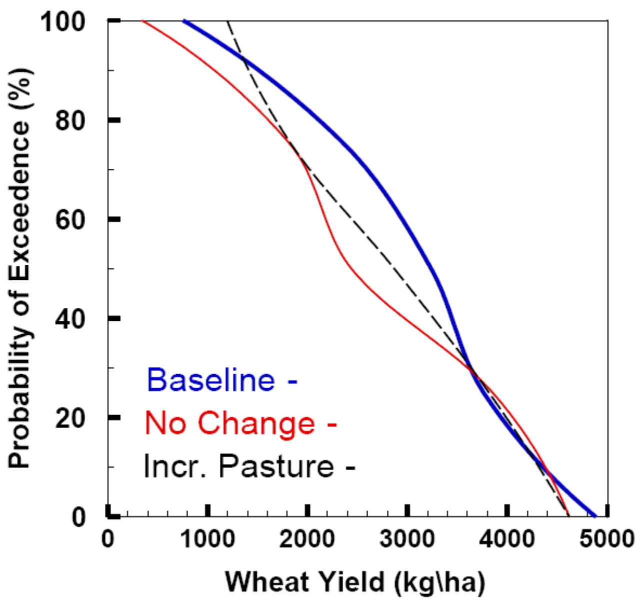

Figure 2: Simulated wheat yields for a wheat-pasture farming system under current climate conditions (‘Baseline’; blue solid line), compared to simulated yields in warmer and drier conditions with no change to current management (‘No Change’; red solid line), and to increased frequency of pasture in the rotation (‘Incr. Pasture’; black dotted line)

Retaining stubble in a mixed cropping-grazing system

For a mixed cropping-grazing system, retaining stubble residues increased simulated yield performance in poor-yielding years by about 30%. That is, retaining more residue resulted in improved yield performance for yields less than 2 tonnes per hectare but also resulted in a yield penalty for yields greater than 3 tonnes per hectare (Figure 3).

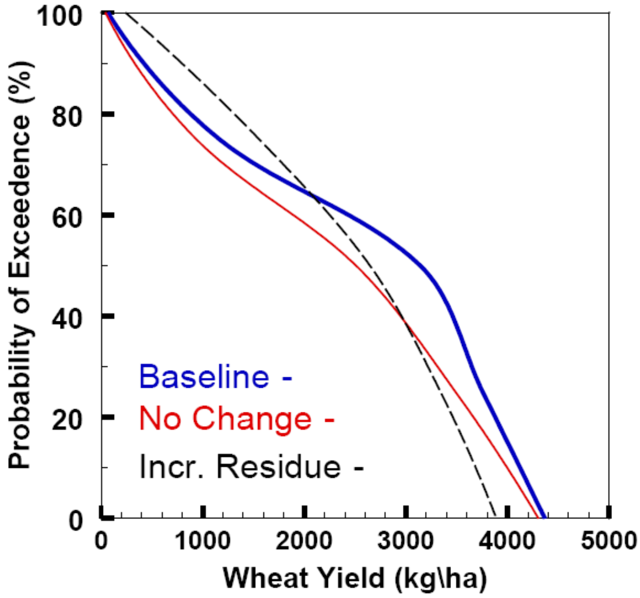

Figure 3: Simulated wheat yields for a mixed cropping-grazing farming system under current climate conditions (‘Baseline’; blue solid line), compared to simulated yields in warmer and drier conditions with no change to current management (‘No Change’; red solid line), and to increased residue retained (‘Incr. Residue’; black dotted line)

Fallowing in a mixed cropping system

For a continuous mixed cropping system, introducing a fallow into the rotation increased average wheat yield potentials by about 30% above yields predicted for current climate conditions, and 38% above yields predicted in a scenario where no adaptation options are implemented (Figure 4).

Yields in lower yielding years were consistently higher than under current climate conditions, suggesting that increasing fallows in this rotation would provide some yield benefits. (The effect of fallow on gross margins was not examined in these analyses).

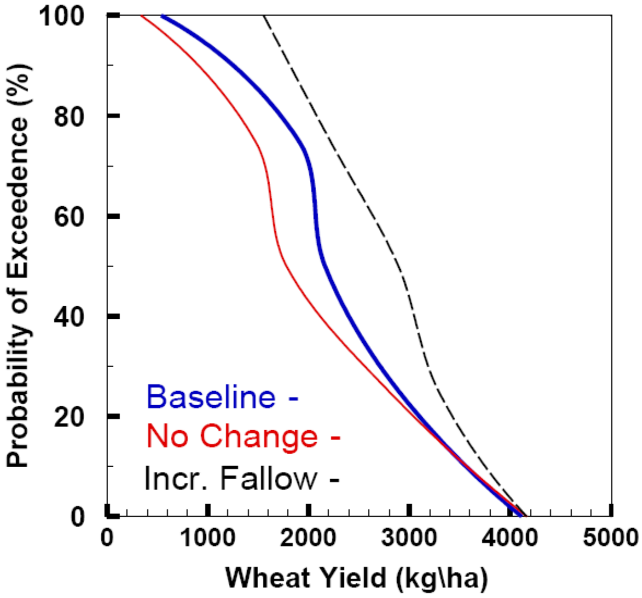

Figure 4: Simulated wheat yields for a mixed cropping farming system under current climate conditions (‘Baseline’; blue solid line), compared to simulated yields in warmer and drier conditions with no change to current management (‘No Change’; red solid line), and to introducing a fallow into the rotation (‘Incr. Fallow’; black dotted line)

Further information

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