Climate change and livestock in southern Australia

Southern Livestock Adaptation 2030

Background

With the majority of future climate scenarios suggesting that much of southern Australia could potentially experience higher temperatures and less rainfall, livestock production is likely to become more difficult in the future.

While no one can accurately forecast exactly what is going to happen, it makes strategic sense for an industry to “peer over the horizon” and examine the impacts of possible future climates.

The last decade was exceptionally dry, but what might happen to production and profit if, over the next two decades, temperatures increase by 1 or 2°C, and rainfall decreases by 10 to 15 per cent as is forecasted by some models?

Until now, these questions could not be tackled.

World first modelling of climate change and livestock production at a local (country town) level.


The project

Combining sophisticated modelling tools with Global Circulation Models (GCM’s), local weather data and producers’ own production and financial data, the Southern Livestock Adaptation 2030 (SLA2030) project brought researchers, extension experts and producers together to look at a range of future climate scenarios and the impact on farm profitability and productivity.

Given that farmers want to know what might happen in their own backyard, the project sought to refine the often broad-brush climate forecasts by examining the impacts at a local and farm enterprise level.

The project firstly modelled and validated what had been experienced in the past (1970-1999 and 2000-2009) and then looked ahead to consider the impacts in 2030 and beyond. Various adaptations were also modelled to see what worked and what didn’t.

Over 80 locations modelled, often utilising producers’ own production and financial data.
Modelling locations

Modelling directly involving producers was undertaken in 46 distinct locations (country towns) across southern Australia. A further 43 locations were modelled by University of Melbourne, CSIRO and the Tasmanian Institute of Agriculture (TIA).

Partners

This project was supported by funding from the Australian Government Department of Agriculture, Fisheries and Forestry as part of Australia’s Farming Future’s Climate Change Research Program, Meat & Livestock Australia (MLA), Dairy Australia and Australian Wool Innovation. Project partners include CSIRO, the University of Melbourne, NSW Department of Primary Industries (NSW DPI), Victorian Department of Primary Industries (VIC DPI), Department of Agriculture and Food West Australia (DAFWA), Tasmanian Institute of Agriculture (TIA) and hundreds of livestock producers across southern Australia.
University of Melbourne – Impacts of climate change on pasture production

Associate Professor Richard Eckard, University of Melbourne

“There is likely to be higher pasture growth rates in winter and early spring, but the spring growing season will contract, with an earlier onset of the dry summer period.”

Associate Professor Richard Eckard

The project

This sub-project of the SLA2030 program conducted and coordinated modelling to address a range of key industry questions on climate change impacts, adaptation and mitigation for the southern Australian grazing industries.

The project concluded that current pasture systems are reasonably resilient to changes in average temperatures forecasted to 2050; however, forecasted changes in seasonal rainfall distribution are likely to impact on the distribution of pasture growth.

The research in a nutshell - adaptation

Total annual pasture production in southern Australia is generally resilient to warming of +1°C and 10 per cent less rainfall, but further changes are likely to reduce annual pasture growth (Fig 1).

In regions where perennial ryegrass/sub-clover pasture grasses etc (C4) are not currently grown, substantial warming is still required before they will be more productive than the current kikuyu (C3) species. See figure 2.

Fig. 1. Contrasting surfaces of mean annual pasture production (years 1971–2000) under increasing temperature and change in rainfall at (a) Elliott and (b) Hamilton.
Analysis of historical climate at five sites across Victoria and Tasmania indicates a trend for a greater frequency of short spring growing seasons (example shown of Hamilton, Fig 3), but no clear trend of increasing variability in pasture production.

The forecast of warmer and drier future climates in southern Australia will most likely result in higher pasture growth rates in winter and early spring, but the spring growing season will contract, with an earlier onset of the dry summer period.

If the forecasts are right, warmer, drier climates will be experienced, rooting depth and heat tolerance traits in pasture plants will become increasingly important. Therefore adaptation needs to include breeding for higher temperature tolerance and deeper rooting in C3 grasses, higher metabolisable energy (ME) in C4 grasses, or alternatively including legumes or supplementation on C4 grasses pastures, to maintain animal production.

Shorter spring growing seasons will also require changes to grazing adaptation to maintain efficient utilisation of annual pasture growth.

Project outputs
Numerous simulations were conducted, resulting in 15 peer reviewed papers, one book chapter and 15 conference papers from the team.

Fig. 2. The impact of rising temperature on the metabolisable energy yield of a perennial ryegrass / subclover pasture and a kikuyu / subclover pasture at a) Dookie, b) Ellinbank, c) Elliott and d) Hamilton.

Fig. 3. The decadal frequency of short and long spring growing seasons at Hamilton between 1901 to 2010.
CSIRO - Impacts of climate change on broadacre livestock production across southern Australia: 2030, 2050 and 2070

Dr Andrew Moore, CSIRO Climate Adaptation Flagship

The project

A consistent set of representative grazing systems at 25 locations across southern Australia with regionally-specific soils, pastures, livestock & management. At each location, five livestock enterprises were described: self-replacing Merino ewes, crossbred ewes for prime lamb production, fine-wool wethers, self-replacing beef cattle and steer finishing.

The CSIRO’s GRAZPLAN grazing systems models were utilised to simulate production of these grazing systems under historical climate and for climates forecasted at 2030, 2050 and 2070 by four global circulation models under the Special Report on Emissions Scenarios (SRES A2) scenario of future global change.

The findings

Changes in rainfall are the single most important driver of climate change impacts on broadacre livestock. The forecasts are uncertain, but the risk is that rainfall will decrease.

It was found that the impact will be greater in 2050 than 2030 and greater again in 2070. When producers fail to adapt it was noticed the biggest decline in the value of, and profit from, livestock production.

As far as where the biggest impact will be felt the data suggests that the drier farming zones will be hit hardest. Sustainable stocking rates are set to decline due to lower and more variable pasture growth and longer periods of pasture decay over summer.

The lower stocking rates are partly balanced by increases in production per head due to higher pasture legume content and lower lamb mortality.

As economic impacts are driven by ground cover risks, declines in income are broadly similar between different livestock enterprises.
The simple answer is yes.

The project explored the effect that implementing different management strategies might have in the face of changing climates for each of the 125 representative grazing systems.

Two main kinds of adaptations were considered:

(i) reducing the frequency of low ground cover by increasing soil fertility, removal of annual legumes to preserve ground cover, addition of lucerne and confinement feeding) and

(ii) making more efficient use of the smaller amount of forage through genetic improvement of livestock for a number of different objectives.

In all, over 5,000,000 site-years were modelled!

These adaptations are compared across locations, grazing enterprises and climates using “relative effectiveness”: the percentage of the impact on profitability that can be recovered by adopting each management change.

It was discovered that increasing soil fertility is the most effective and persistent adaptation option. Adding lucerne to the feedbase and confinement feeding are useful adaptations at some, but not all locations. Genetic improvement gains were found to increase out to 2050 but levelled off at 2070. Increasing the size of livestock is effective for crossbred ewes, but not for beef cattle.

Table 2. Relative effectiveness of a range of different potential adaptations in recovering the impact of climate change on the total profitability of livestock production across southern Australia (0% = no benefit; 100% = a return to the 1970-99 baseline value of production). Adaptations were only applied to those location by enterprise combinations where they increased profit at the sustainable optimum stocking rate. Values are averages over 4 GCMs.
So what does this mean for your bottom line?

Profitability of livestock production systems (under 15-year periods of historical climate dating back to 1898) was compared with outcomes under forecast future climates. Present-day genetics, management & prices were used throughout.

Average profit and its variability differ widely between 15-year periods in the historical record and different patterns emerge across Australia.

The climate between 1995-2010 was substantially worse than that of preceding decades as a driver of livestock systems at many, but not all locations.

Especially at 2050 and 2070, forecasted future climates are at, or beyond the range of historical medium-term variability.

Fig. 6. Box-plots of annual profits for Merino ewe enterprises at 3 locations over historical 15-year periods and projected climates
Input from producers was essential to ensure the enterprises investigated were relevant and the adaptations applied were economically and practically viable.

Input from hundreds of livestock producers at 46 locations across southern Australia to assess the impact of a changing climate on production and profit was essential to ensure the enterprises investigated were relevant, the modelling was accurate and the adaptations applied were economically and practically viable.

Four GCM's from a possible 23 were chosen because of the performance in forecasting previous climate patterns across southern Australia. They also covered the range of temperature and rainfall changes forecast for the future.

The size of the impact increases substantially and the ability to manage that impact reduces at the hotter, drier end of the models.

There will most likely be as much variation in impacts from a changing climate within states as between states. This will be most pronounced in states which have large differences in rainfall and altitude.

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**State agencies**

– Vic DPI, SARDI, NSW DPI, TIA and DAFWA

**Farm level modelling, impacts and adaptations**

Phil Graham, NSW DPI

Fig. 7. For most of Southern Australia, warmer and drier future climates predicts changes in the seasonal pattern of pasture production, with higher growth rates in winter and early spring but a contraction of the spring growing season. This shows the results for Lismore, Victoria.
New South Wales

Growing seasons in NSW are expected to get shorter to 2030, leading to reduced stocking rates to manage ground cover over summer/autumn. This is likely to result in reduced profits across much of the state.

However tableland locations above 900 m with high rainfall don’t seem to be as affected due to the fact that higher winter temperatures remove the current low winter pasture production.

There is no single adaptation which recovers the forecasted reductions in profit. It requires a combination of factors but the most promising are those management strategies that producers already know about, including summer feed lots and continual genetic gain.

As rainfall decreases, the size of the impact appears to get greater, but sheep enterprises appear to be able to handle the increased climate pressure better than cattle.

<table>
<thead>
<tr>
<th>TIMEFRAME &amp; ADAPTATION</th>
<th>% OF GROSS MARGIN</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base - 1970 to 2000</td>
<td>100%</td>
<td>The base figure was $236/ha</td>
</tr>
<tr>
<td>2030 - Self replacing flock</td>
<td>60%</td>
<td>Business as usual - no adaptation</td>
</tr>
<tr>
<td>2030 - Summer feedlot</td>
<td>66%</td>
<td>The cost of labour is not accounted for. The feedlot would only be used in tough years.</td>
</tr>
<tr>
<td>2030 – Genetics</td>
<td>88%</td>
<td>No risk adaptation - 1% increase in fleece weight and 0.25% reduction in fibre diameter per annum.</td>
</tr>
<tr>
<td>2030 - Feedlot + Genetics</td>
<td>99%</td>
<td>Use of a combination of strategies is possible and provides greater benefit</td>
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Table 3: The response in profit/ha, expressed as a percentage of the base period (1970 to 2000), to adaptations within the 18um merino self replacing flock at Goulburn, NSW.

Victoria

Pasture growth across much of Victoria in 2030 will be characterised by increased winter production and a shorter spring. Models forecast annual pasture yield changes of +5 per cent to -26 per cent in the low rainfall zone and +6 per cent to -20 per cent in the high rainfall zone.

Lucerne as a pasture base in the low rainfall mixed livestock/cropping zone offers producers the ability to generate increased profits under future climate scenarios.

Earlier lambing may become more profitable for winter/spring lambing enterprises in the south west, but no trend was found for central/north east regions.

Changing from autumn to spring calving in both moderate and high rainfall zones offers little improvement in gross margins. Spring calving does not appear to gain anything from calving one or two months earlier.

Optimising soil fertility, pasture production and utilisation (via increased stocking rate) offers major gains to livestock profitability, both now and in the future.
South Australia

Modelling in most locations indicated a shorter growing season with decreased pasture quality. There is also likely to be increased variability in pasture growth. Combined, these factors are forecast to result in increased variability in farm gross margin.

In many cases, later lambing or calving compared to district practice would be more profitable, although this may mean that producers will have to supplementary feed their stock.

There are practical strategies that producers can implement to adapt to a changing climate. These include, increasing flexibility by varying sale times, confinement feeding, more animal trading (core breeding), self replacing systems and agistment.

Pastures based on an annual perennial mix are able to sustain a higher stocking rate due to more pasture being available over summer. Using such grazing management systems as controlled, cell, rotational, confinement, or techno grazing will ensure improved pasture utilisation. Ensuring adequate fertiliser applications will assist in maintaining high levels of pasture growth.

Tasmania

Pasture production is broadly indicated to increase to 2030 in key production areas, with increased temperatures, reduced frost frequency and similar or improved rainfall.

Optimising pasture utilisation through increased stocking rates and managing feed supply and demand are key adaptations for producers in Tasmania.

Increased soil fertility, legume content and selling stock earlier and at a lower target weight offered some projected gross margin benefits both now and in 2030.

In drier areas, negative profit change was forecast. While cocksfoot reduced variance and increased sustainability, it failed to arrest the decline in profit.

Where positive change was indicated, increasing stocking rate tended to carry less risk of gross margin variance in 2030, making this adaptation more accessible to producers.

Western Australia

Western Australia joined the SLA2030 project later than other states, so a more limited amount of modelling has been completed. The modelling results are quite varied at two locations - Kojonup and Ravensthorpe.

On balance, for both locations, there is expected to be increased rainfall variability and increased temperature. This will result in faster winter pasture growth rate but shorter growing seasons.

Increased CO$_2$ and temperature will result in an increase in legume content. While this will be positive for animal production, the rate of decline of dry pasture residues over summer may increase, resulting in wind erosion and groundcover limits being reached in a shorter period.

As a result, confinement feeding is likely to be an essential component of a sustainable grazing system for producers in these areas.
Some general observations

Pasture and livestock production models are reasonably accurate. While there seems to be some confidence about changes to temperature and CO2 in future (rainfall, average, timing and intensity) is more problematic.

There are a range of futures that may eventuate. This project is not about trying to forecast one future, rather increasing farmers awareness of the tool and people that are available to assist.

For the first time ever, this project allowed for the quantifying of impacts a changing climate may have at a local and farm enterprise level. Relativities and trends are more important than absolute values.

It is not expected that producers will rush out and adapt immediately as a result of this research. It is hoped that they will use the information generated from the models to better deal with what the future holds. Most importantly, the research shows that some adaptations, while beneficial in the future, are actually worth pursuing today.

“While climate scenarios show that grazing systems will still be viable in southern Australia in 2030, there is strong evidence that shows with some adaptation these systems can maintain or even increase profitability.”

Dr Robert Banks

Some key findings

Climate change predictions and the impact on production and profit vary across southern Australian locations.

The research indicates increased temperatures and decreased rainfall across many locations in southern Australia. That points to shorter growing seasons and reduced stocking rates in order to maintain ground cover.

For some areas e.g. parts of Tasmania and mainland higher rainfall / colder regions, the outcomes could be positive.

Relatively small temperature and rainfall changes can have big impacts on farm profitability, especially if farms don’t adapt to the changes.

While climate scenarios show that grazing systems will still be viable in southern Australia in 2030, there is strong evidence that shows with some adaptation these systems can maintain or even increase profitability.

Having said that there is no silver bullet, and the most advantageous adaptation strategies vary between regions. Importantly though, the best strategies or practices are already known to many producers and are as applicable today as they will be in the future.

While sheep may provide a buffer in bad years, there is no indication from any of the models that changing entire enterprises is going to be a fundamentally sensible thing to do in the future.

Modelling suggests that, with some adaptive breeding, current forage species will still be the most suitable into 2050, and there would be no production advantage moving to more tropical species within this timeframe.
“Relatively small temperature and rainfall changes can have big impacts on farm profitability, especially if farms don’t adapt to the changes.”

Dr Robert Banks, Manager R&D Strategy & Evaluation, MLA

Where to from here?
Further implications / questions

While the physical impacts of a changing climate pose a range of challenges for grazing systems, they also pose challenges to industry, government and how they may respond to it.

These may include:

How best can an individual producer adapt to changes which, on average will be gradual, but the incidence of extreme events may increase?

Does the industry have the right tools to understand the impact of extreme events?

When is the right time to change farming practice, and how will individuals know when to start?

As science continues to provide more answers, especially in relation to climate change predictions, will the findings found so far change dramatically?

Global food demand is increasing, there is more pressure on producers to mitigate changes in climate, and yet a changing climate could negatively affect production. What policy approaches should Government and industry seek to best align these competing interests?

Are there implications for service industries to agriculture and local governments that may need to be considered to provide producers with greater flexibility in the future?

The new information from the SLA2030 program is not only useful for farmers, but important for plant breeders, industry and government in considering policies and strategies to assist graziers to plan and adapt to a changing climate.

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Russell Pattinson
National Coordinator SLA2030