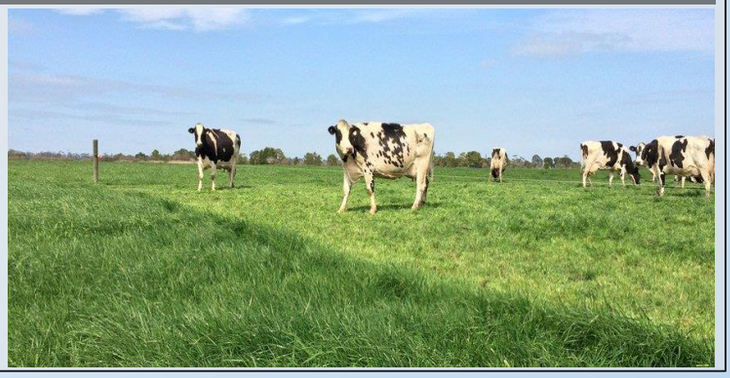
Climate resilient pastures: The PACE2 project

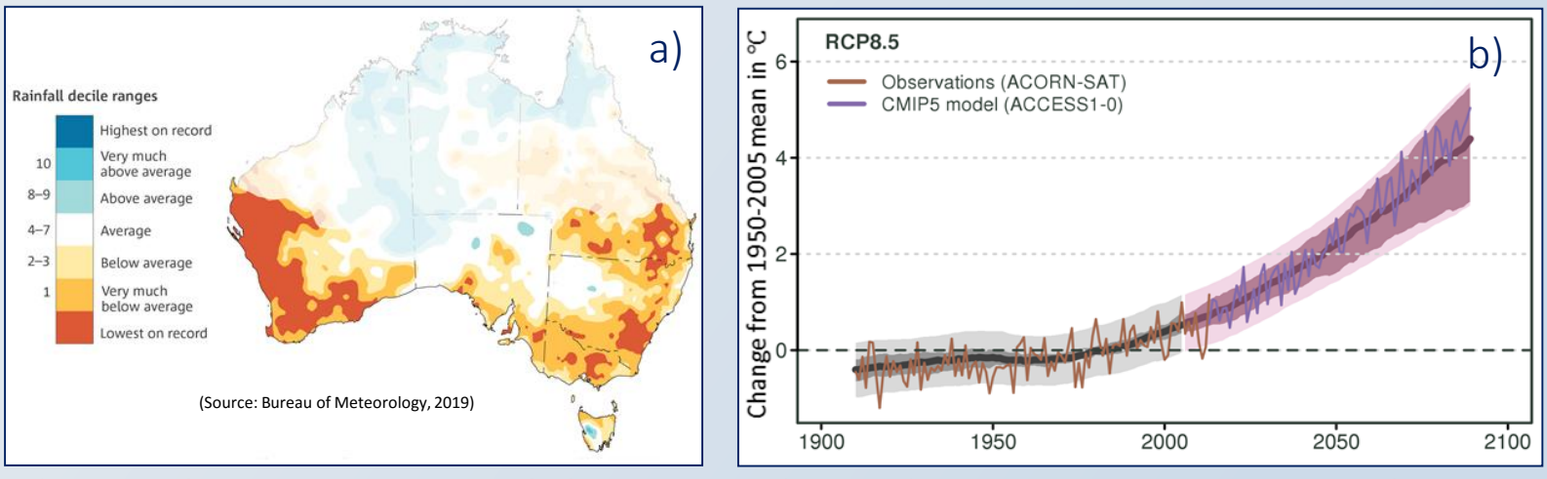
Australia's pastures and rangelands

Nearly 40% of Australia's land area is grassland and rangeland, supporting grazing and livestock production. This contributes $18.4 billion to our GDP and helps sustain ~0.5 million livelihoods. However, pasture-based livestock production is at risk from the direct (animal welfare) and indirect (pasture-driven) effects of climate change, including climate extremes such as severe droughts, floods and heatwaves.



Key challenges for the livestock industry

With temperatures predicted to rise by up to 4°C by the end of the century (IPCC, 2022), prolonged heatwaves are likely to become an increasingly common feature of our climate. Furthermore, with rising temperatures come expectations that many parts of SE Australia will experience increasingly dry winter and spring seasons, accompanied by both long periods of low rainfall and deluge rain events, making for highly variable future rainfall regimes. While variability has always been an integral feature of our climate, predicted shifts in temperature and rainfall driven by rising greenhouse gas concentrations are pushing us into uncharted climate territory. As a result, many traditionally-used pasture species will become less productive or unviable in their current range, driving the need to consider alternative species choices, including the expanded use of sub-tropical grasses and legumes in temperate locations.



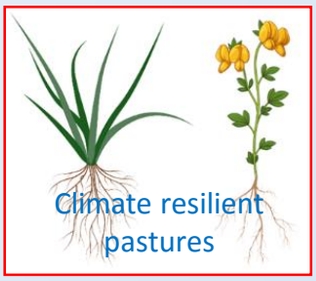
a) Anomalies of April to October Australian rainfall for the last 20 years (1999–2018) with respect to 1961 to 1990 averages and b) observed & predicted Australian average annual temperatures.

The PACE2 project is investigating how future climates will affect the productivity, persistence and nutritional characteristics of temperate and tropical pasture legumes, herbs and grasses, targeting species with the potential to reduce ruminant-associated methane emissions.

Future climate change scenarios

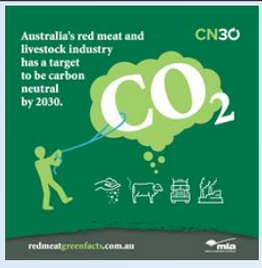
Altered rainfall regimes, more intense & frequent droughts

Atmospheric warming



Reduced greenhouse gas emissions

Productive & persistent pastures



- Climate-test promising temperate and tropical pasture species
- Evaluate management practices that enhance pasture persistence and soil carbon storage

The pastures and climate extremes (PACE) research facility (http://bit.ly/2gMbXuQ)

The pastures and climate extremes facility was established in 2017 to research pasture species' responses to predicted changes in the southern Australian climate, including winter & spring drought and atmospheric warming (+3^{o}C). The first phase of the PACE study focused on understanding the climate sensitivity of monoculture and mixed species combinations of pasture legumes & grasses. We found substantial reductions in pasture production and changes in nutritional quality in response to drought and warming for both tropical & temperate species. Of particular note was a lack of beneficial effects of warming over winter, and persistent effects of winter/spring drought through summer and autumn for some species. This research revealed that plant root plasticity & water use strategies can help explain species differences in climate sensitivity, while root carbon stores were associated with drought recovery.

The Pastures and Climate Extremes (PACE) field facility comprising (a) six replicate polytunnel shelters with the capacity to elevate temperature and control rainfall at the plot level; (b) individual species plots receiving contrasting climate treatments within a shelter.

The Pastures and Climate Extremes (PACE2) project

The new phase of PACE research, starting in 2022, aims to climate-test a new suite of pasture legumes, herbs and grasses and evaluate their performance (productivity, persistence, nutritional characteristics) and potential anti-methanogenic properties under contrasting temperature and rainfall regimes. Deep-rooted, perennial legumes and herbs appear promising for their climate-resilience and soil carbon storage potential. In addition, the foliar chemistry (e.g. secondary metabolites like tannin, flavonoids and saponins) of some species offers a potential mechanism for lowering ruminant methane emissions, while legume intercropping with grasses has also been shown to reduce nitrous oxide emissions at the ecosystem scale. The unique PACE experimental facility will be used to test major knowledge gaps on how the productivity, forage quality and methane abatement properties of these species and associated mixtures will be affected by projected increases in exposure to climate extremes.

The new PACE experiments

Experiment 1 *Compares the performance (productivity, persistence, foliar chemistry) of novel (for southern Australia) legume & herb species (Desmanthus, Sainfoin, Chicory) with more traditionally-used legumes (e.g. Lucerne & Biserrula) under future climate scenarios* ***(cool-season drought (60% reduction in winter/spring rainfall) and +3^{o}C year-round warming)***

Experiment 2 *Compares the performance of temperate and tropical pasture species mixtures under* ***contrasting rainfall regimes****.*

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