Position paper: The National Agri-Climate Program

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Executive summary

The Northern Australia Climate Program (NACP) delivers innovative research, development, extension and adoption (RDE&A) outcomes to improve the capacity of the red meat industry to manage drought and climate risk across northern Australia.

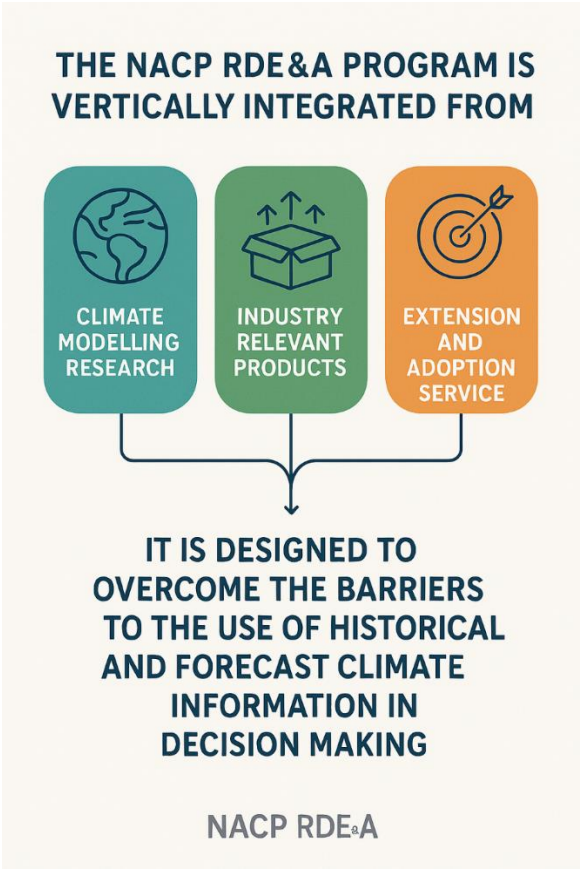
NACP research has delivered improvements in the Bureau of Meteorology's seasonal dynamical climate prediction system and provided new insights into historical weather and climate events. NACP development has produced and updated a suite of industry and policy driven tailored forecast products, and the NACP extension and adoption service has improved producer and value chain resilience to drought and weather-climate variability. These achievements have led to measurable economic, environmental, and social improvements at the farm scale.

Recent work has demonstrated the value of seasonal climate forecasts for Australian agriculture and a likely increase in future impacts of weather and climate on the industry. Hence, there exists an increasing need to leverage the successful RDE&A model introduced in NACP to enhance drought and climate resilience for Australia. Led by the University of Southern Queensland (UniSQ) and co-designed with industry partners, we propose an expansion of the NACP framework across regions and industries to deliver a 'bigger and bolder' program of work, including:

This work aligns with Meat and Livestock Australia (MLA) priorities for 2025-2030, investing in R&D and adoption programs to "*enhance productivity and resilience for producers and the supply chain*" (MLA Strategic Plan 2025). A future program will continue MLA's strong commitment to their Red Meat 2030 objective related to *Our Environment*.

Background

Since its inception in 2017, NACP has provided new and improved climate forecasts at multiple timescales, new and locally relevant decision and discussion support tools, and a trusted extension service to help northern red meat producers integrate climate prediction technologies into decision making.



NACP is delivered by the Centre for Applied Climate Sciences at the University of Southern Queensland (UniSQ), in collaboration with state governments, research agencies and NRM Groups.

The NACP Research, Development and Extension team, including program partners from MLA and DCAP, at the NACP annual meeting in Rockhampton (September 2024).

Research

NACP research has improved the basic science and delivered improvements in the Bureau's Australian Community Climate and Earth-System Simulator-Seasonal (ACCESS-S) operational general circulation model (GCM) through improved accuracy of multi-week to seasonal forecasts and a reduction in GCM biases and errors, of direct relevance to the northern Australia red meat industry.

Through case studies, the research component has also delivered new insights into historical weather and climate events that have directly impacted northern Australian livestock. Such studies have provided the motivation for developing many of the prototype forecast products for the northern red meat industry.

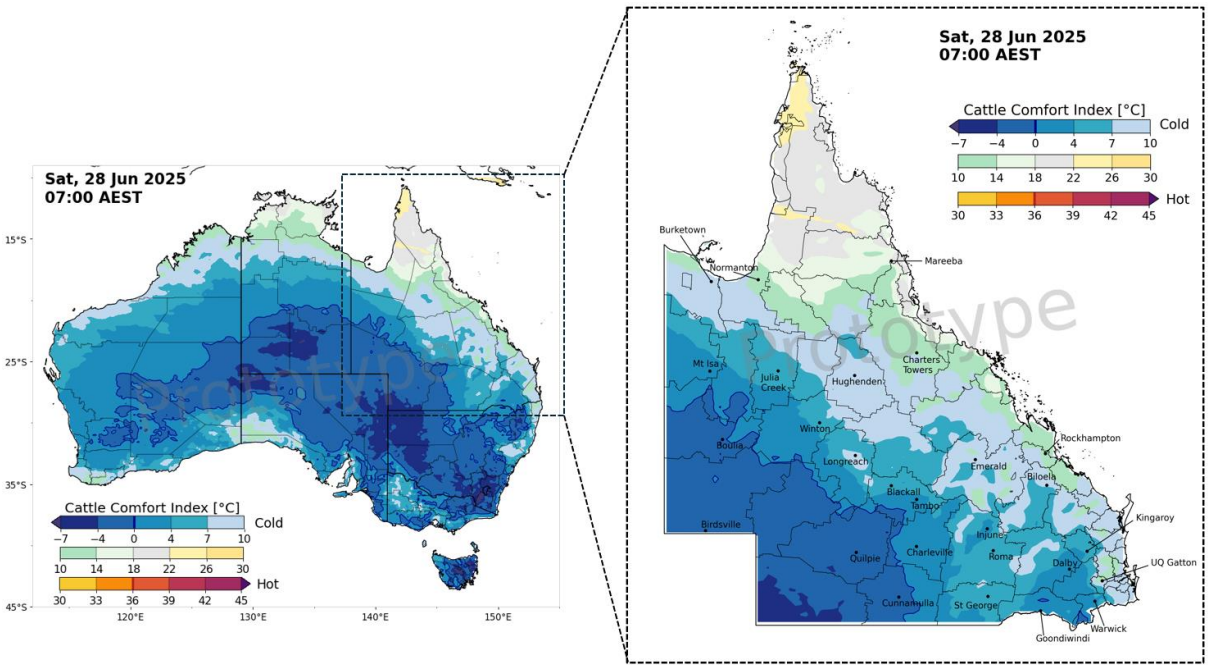
Development

NACP development has improved and maintained a suite of industry and policy driven tailored products, including forecasts of the Northern Rainfall Onset, 3-day rainfall chance, thermal stress in livestock, and national drought. The NACP development team have also been integral in creating climate monitoring products of conventional and flash drought, green date, and average condition maps associated with the Madden Julian Oscillation.

The Northern Rainfall Onset[1] and 3-day Rainfall Burst[2] products are operational on the Bureau's climate services webpage, as are the updated average rainfall and temperature condition maps[3] associated with the Madden Julian Oscillation. The cattle thermal stress indices and drought products are currently prototypes and under the ownership of UniSQ through NACP.

The program has advanced the design of forecast displays, allowing for a better understanding of forecast uncertainty and bridging the weather-climate divide. These innovative and targeted products have been developed and refined for use by producers and policymakers to make better informed decisions on drought and weather-to-climate variability.

[1] https://www.bom.gov.au/climate/rainfall-onset/
[2] https://www.bom.gov.au/climate/outlooks/#/rainfall/burst/15/weekly/0
[3] https://www.bom.gov.au/climate/mjo/#tabs=Averages



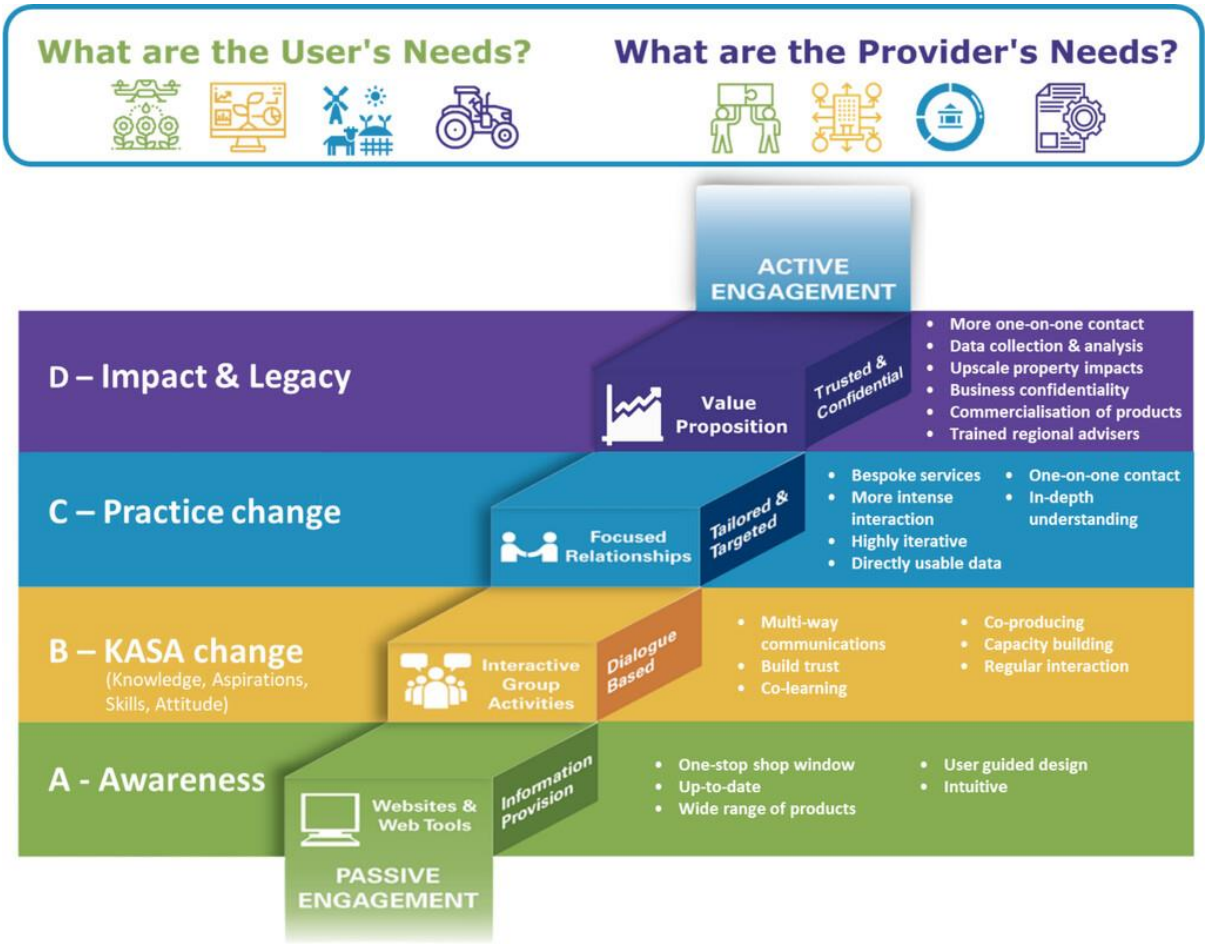
The Cattle Comfort Index forecast prototype, produced from the Bureau of Meteorology's 7-day weather forecast model, ACCESS-G. The prototype forecasts are freely available and updated every day at: https://nacp.org.au/cattle_thermal_stress_forecasts

Extension and Adoption

NACP Extension and Adoption (E&A) uses extension officers ('Climate Mates'), supported by UniSQ and Bureau researchers, to deliver a climate service to producers and those involved in the red meat supply chain. The E&A program has integrated and embedded climate forecast information into Northern Australia grazing industry networks to improve producer and value chain resilience to drought and weather-climate variability. This has improved weather and climate awareness, knowledge and skills, provided support and confidence to users in their decision making, and delivered practice change to reduce risks related climate variability and weather extremes.

Outreach - NACP Research Infrastructure & Engagement (2017–2025)				
15+ Researchers	14+ Climate Mates	>200 Producers Engaged	140+ Workshops & Roadshows	9+ Tools/Products Developed
4 Product Websites	76 Publications (Q1) & Reports	200+ Media Interviews/Comms	13 Case Studies	44 YouTube Videos

These improvements and outcomes are being tracked and recorded using the online Customer Relationship Management tool HubSpot, which is helping meet the long-term goal and the end-of-program objectives to meet Category A (awareness), B (knowledge and skills), and C (practice change) targets to address key performance measures in line with the 'staircase of engagement' framework[4] demonstrated below:



Schematic of four broad categories of engagement between users (e.g., primary producers) and funding providers (e.g., MLA, DCAP, UniSQ) of climate services. Adapted with permission from Hewitt et al. (2017).

A key output of NACP has been the development of the Profitable Grazing Systems (PGS) Supported Learning Package (SLP). *Climate for Decision Making*- includes:

- producer and deliverer manuals
- Presentation slide packs
- Knowledge, Attitude, Skills and Aspirations (KASA) assessment
- Monitoring and evaluation forms
- Train the Trainer resources

[4] https://doi.org/10.1038/nclimate3378, https://doi.org/10.1175/BAMS-D-21-0309.1

The PGS is under the ownership of MLA, and *Climate for Decision Making* is one of many PGS SLPs developed by MLA.

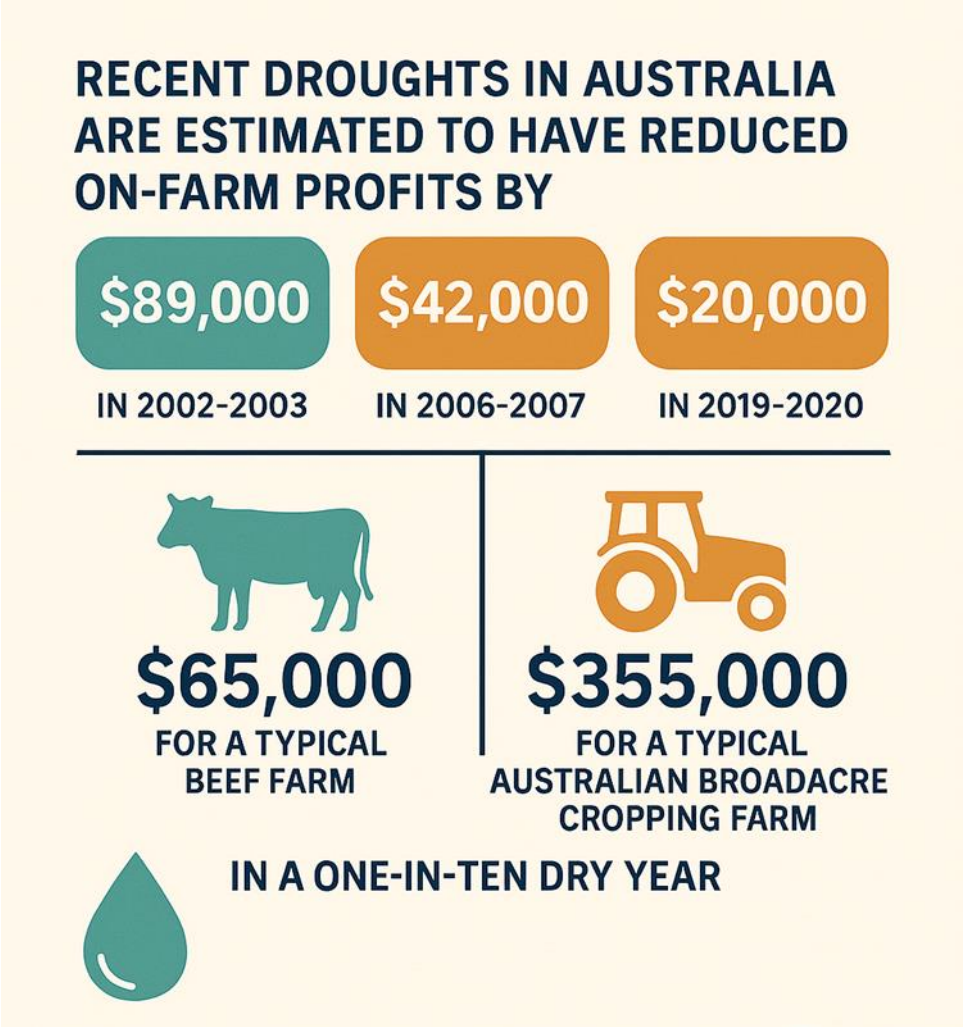
In addition to the RDE&A services, a key focus area in NACP's final stage to mid-2026 is to build a compilation of producer case studies that demonstrate the environmental benefits and increased productivity at the farm scale, that have positive economic and social outcomes, as demonstrated in case studies collected to date[5] .

Extension in action: Climate Mate Vicki Mayne presenting at GroWQ Ag Innovation Expo in Longreach (July 2024).

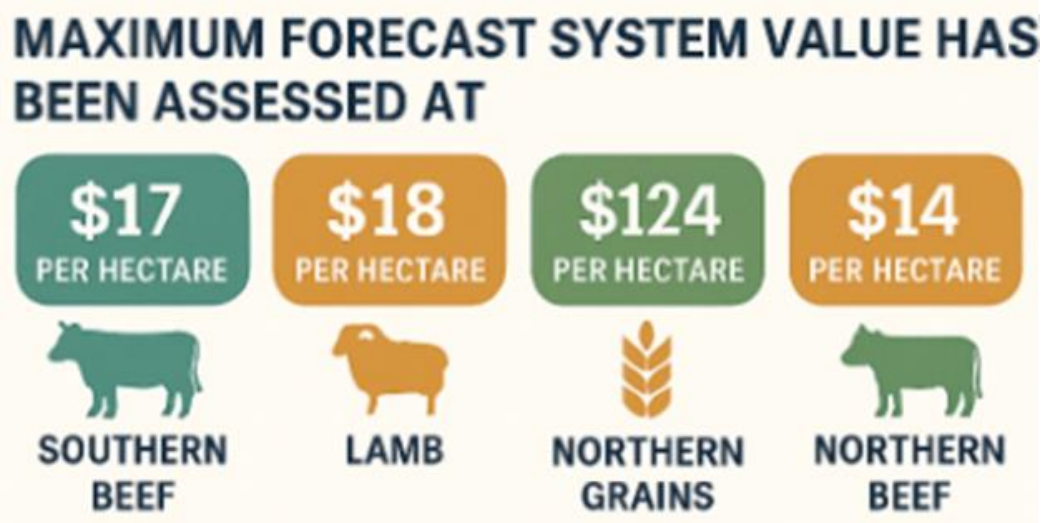
Motivation

Climate variability, extremes and change are major drivers of Australian agriculture and other sectors, and their impact is likely to increase into the future. The northwest Queensland flooding event of February 2019 was estimated to cost Australia's GDP $5.68 billion, while the recent prolonged drought in 2017-2019 was estimated to cost more than $10 billion[6], with future drought projections anticipating a loss of $28 billion to Australia's GDP between 2022 and 2050[7].

[5] https://nacp.org.au/outreaches/case_studies
[6] https://www.smh.com.au/politics/federal/the-cost-of-drought-and-it-s-just-going-to-grow-20191102-p536rd.html
[7] https://aquanomics.ghd.com/en/australia.html#:~:text=Storms%20are%20expected%20to%20have,the%20battle%20against%20water%20risk



Recent work has demonstrated the value of seasonal climate forecasts on agriculture in Australia, which are helping farmers make informed decisions to minimise losses in poor years and maximise profits in good years.



At the farm scale, the maximum value of seasonal climate forecasts is $30,000 to northern beef and $11,900 to southern beef[8]. Through NACP, on-property economic improvements have been assessed at $22 per head of cattle, with improved confidence and trust in the Bureau of Meteorology and their forecasts, from the use of NACP products or advice from Climate Mates (with support from Bureau/UniSQ researchers)[9].

These examples demonstrate an increasing need to leverage, and expand on, the successful RDE&A framework introduced in NACP, to enhance drought and climate resilience of Australian landscapes for key farming commodities and resources, including livestock and pasture productivity, across time scales from weeks to seasons ahead.

Through NACP, the UniSQ-based project team has developed robust and trusted relationships with the Bureau of Meteorology, MLA, and the Drought and Climate Adaptation Program (DCAP) / DPI Queensland. An expansion of NACP beyond mid-2026 would continue to build on these close collaborative partnerships and could be readily extended to include new partnerships across regions and industries. As proposed below, this phase would extend out to December 2030 (see Appendix A for details) and focus on delivering measurable improvements in farm resilience with benefits across environmental, social and economic strategic objectives (see Appendix B for details).

[8] https://onlinelibrary.wiley.com/doi/10.1111/1467-8489.12389
[9] https://doi.org/10.1175/BAMS-D-21-0309.1

The environmental, social and economic strategic benefits of an extended National Agri-Climate Program.

Importantly, this will align with MLA's guiding principles for delivering and maximising impact, including:

- Delivering a program of work that is 'bigger and bolder' based on NACP3 success
- Strengthening the connection between R&D and industry insights, and establishing clear E&A pathways
- Contributing to the triple bottom line of social, environmental, and economic sustainability for the Australian red meat industry
- Continually improving the delivery of essential services through regular stakeholder consultation and feedback

The expanded program will also prioritise building local capacity through accredited training, internships, and research opportunities for PhD students and postdoctoral researchers in climate science, agri-tech, and extension services, helping to develop a climate-ready workforce across regional Australia. This phase will develop and maintain open-access digital platforms and interfaces to ensure transparency and broader accessibility. Our tools will enable producers, supply-chain workers, researchers, and agri-tech developers to easily access climate data, forecasts, and decision-support tools through a user-friendly interface.

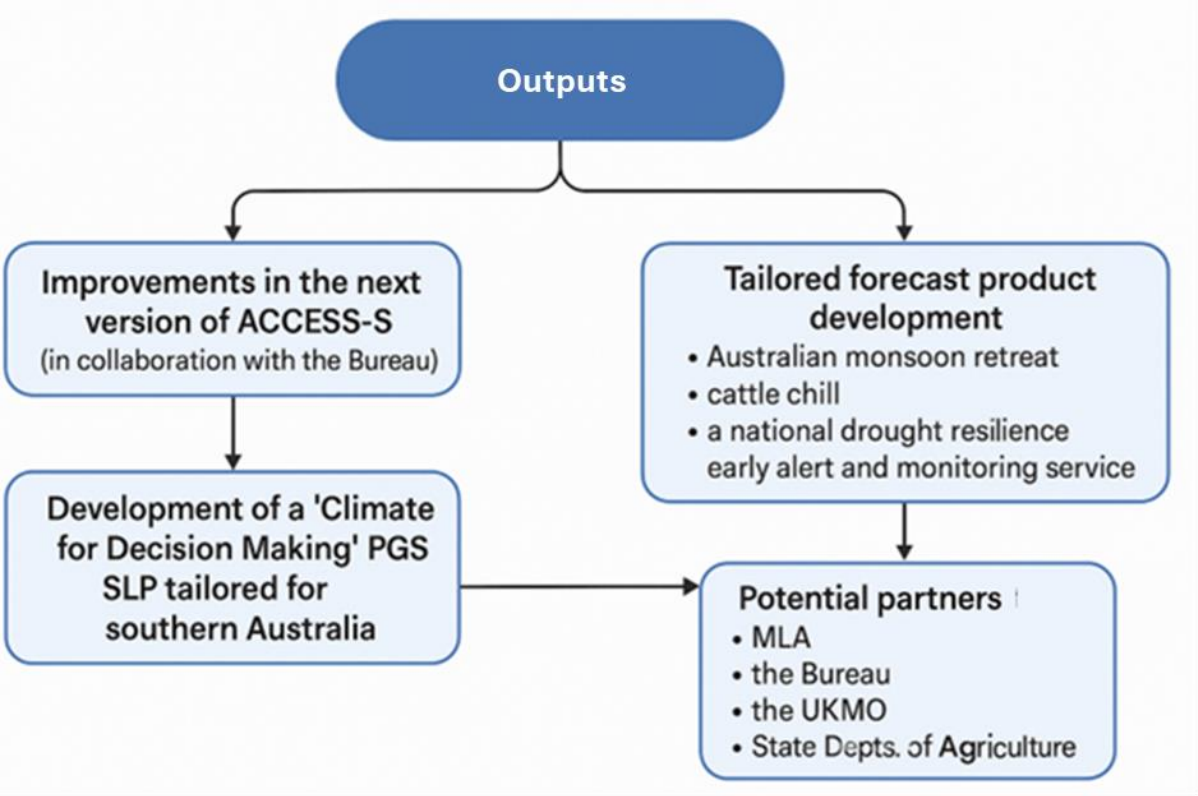
A NACP-like RDE&A program aligns with MLA's strong commitment to their Red Meat 2030 objective related to *Our Environment*, demonstrating "*leadership in sustainability, delivering on community expectations in the areas of land, water, biodiversity,* ***climate variability*** *and biosecurity*".

National expansion into Southern Australia

The NACP RDE&A model can be expanded nationally to improve weather and climate awareness, knowledge and skills, and provide support and confidence to use this in decision making, across Australia. This could include key red meat and dairy regions in New South Wales, Victoria, South Australia, Tasmania, the Australian Capital Territory, and the southern half of Western Australia.

Complementing NACP, such a program would represent the next instalment of UniSQ-led climate initiatives to manage drought and climate risk. It would aim to deliver positive financial, environmental and social outcomes for the red meat industry across the nation.

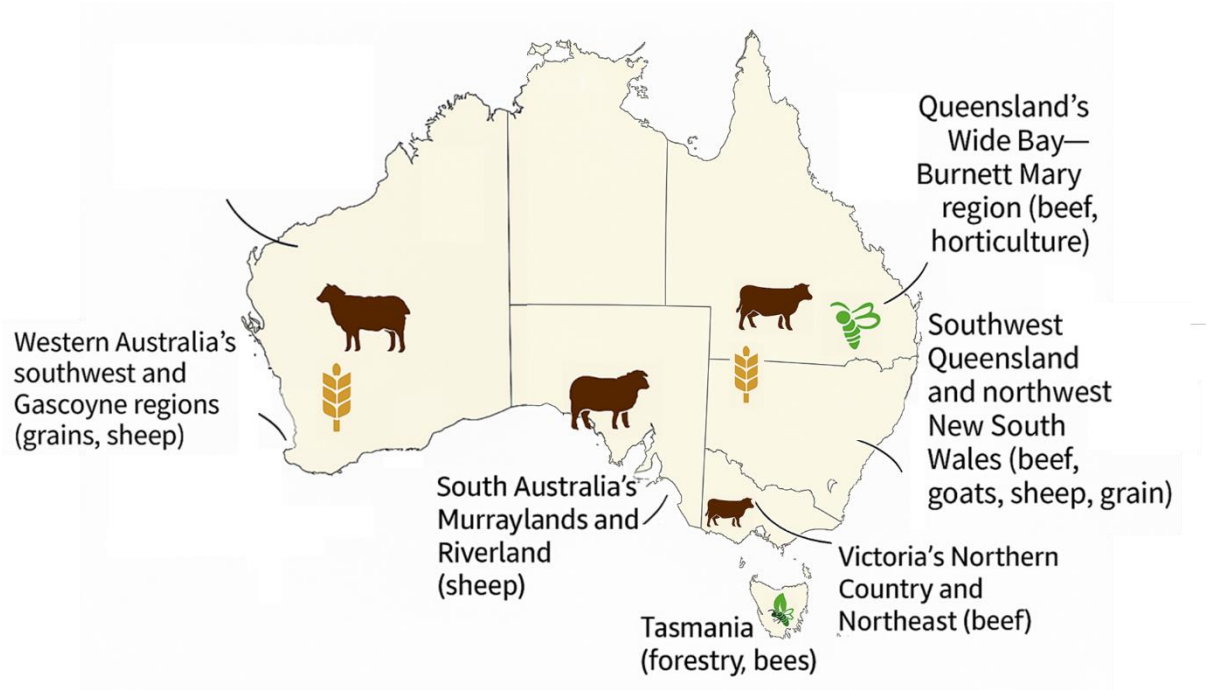
RDE&A outputs would include:



Industry expansion:

The NACP team recently gained support from industry stakeholders for a collaborative project on developing Australia's first drought early alert and monitoring service, leveraging the NACP E&A model (submitted to the Future Drought Fund Resilient Landscapes Program in November 2024). As such, we have secured new and existing links with the following groups:

Through this process, we have established connections with key Australian agricultural industries in:



A 'bigger and bolder' project that draws on the success of NACP and expands to these industries (and beyond) will build drought and climate resilience for a broader range of farming communities and commodities in livestock, horticulture, grains and forestry, leading to expansive improvements in farm resilience across large areas of Australia.

Topic expansion: Drought

Drought describes below-normal rainfall over months to years, leading to dry soils, reduced inflows, groundwater depletion and degraded landscapes. Understanding drivers of drought, forecasting the timing of its onset and duration, and implementing early warnings are critical to effective drought mitigation planning. While the Bureau issues useful monthly drought statements, it does not forecast drought or provide a tailored E&A service of drought-related tools for on-farm application. A UniSQ-led project that fills this gap builds on NACP to provide timely regionally specific drought information on weekly to seasonal time scales to improve decision-making before, during and after drought. This will enhance the drought and climate resilience of Australian landscapes for livestock, grains, and other industries.

Topic expansion: Extreme chill and heat stress

Extreme weather events like chill and heat stress can acutely affect livestock, increasing the risk of disease (or exacerbate morbidity due to disease) and ongoing fertility and weight gain issues. A future project could also expand on recent NACP work that explores two historic chill events in northern Australia and their prediction in the Bureau's operational prediction system ACCESS-S2. This work documents the model's limitations in representing and predicting such rapid changes in weather conditions and highlights the need for further research and targeted product development in this area to improve the decision-making capacity of livestock producers in the lead-up to these unseasonal events. This would build on the prototype cattle thermal stress forecasts recently developed under NACP. In collaboration with the Bureau, an extension project will provide thermal stress forecasts at a 1.5 km resolution through the Bureau's ACCESS-City models and present more targeted location-point forecasts.

Topic expansion: Climate change

The likely impact of a warmer and more extreme future climate on livestock conditions such as chill and heat stress is not yet understood. Future work could expand on the NACP framework to explore industry-led research questions relating to long-term changes in climate using the downscaled Coordinated Regional Climate Downscaling Experiment (CORDEX)-regional climate model projections, specifically on metrics that relate to livestock and agriculture more generally. This will inform future local policy decisions related to management and adaptation to changes in cattle comfort and help drive new research areas related to cattle physiology and adaptation techniques of interest to MLA and large cattle feedlot companies. In collaboration with the University of Queensland, this work could also include development of regionally specific climate projection tools around cattle comfort and a climate change learning module for understanding how to best manage the future risk and what the future changes might mean for viability of beef production for different regions of Australia.

Topic expansion: Machine learning for prediction

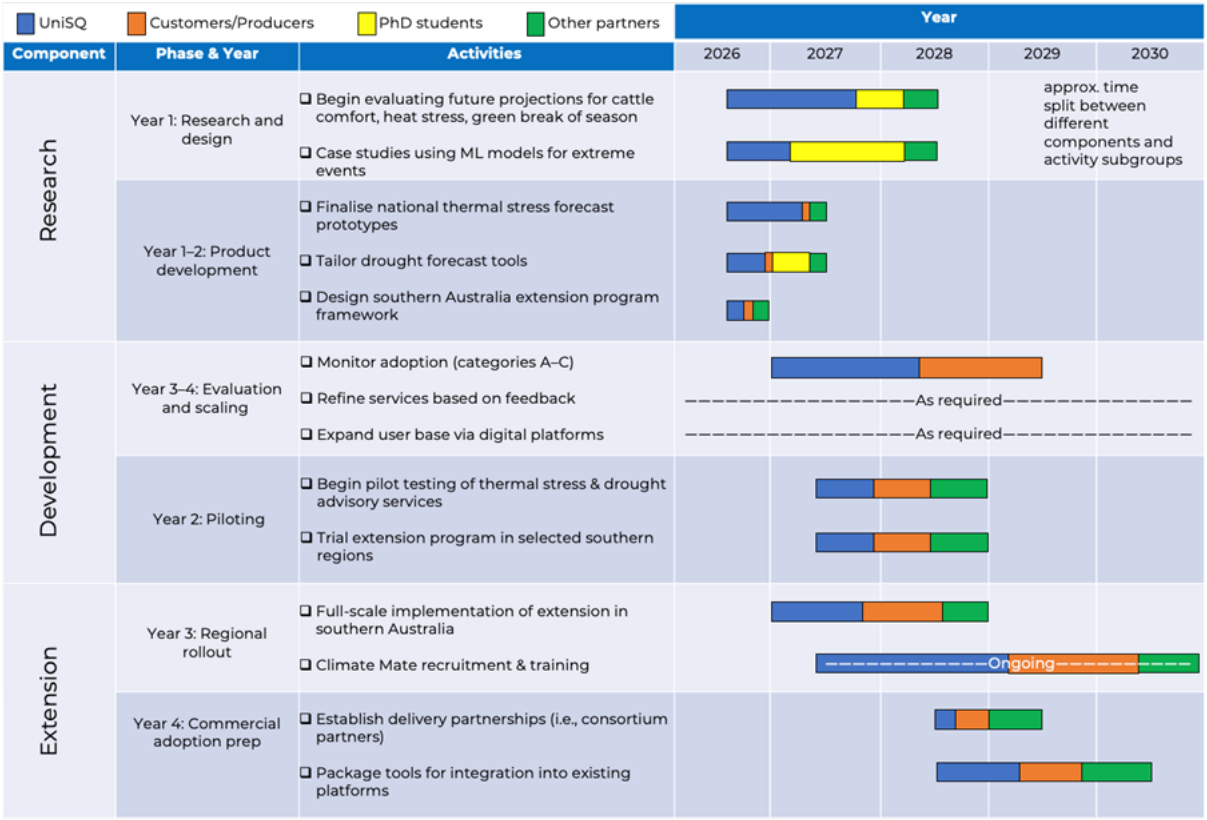
The field of data-driven weather and climate forecasting is advancing rapidly. Several international operational climate centres are now developing, evaluating and operationalising machine learning (ML) models and exploring their strengths and weaknesses compared to traditional physics-based (dynamical) models. The Bureau has begun assessing the performance of ML models alongside dynamical prediction systems for weather, subseasonal and seasonal timescales. Despite not being designed for subseasonal and seasonal prediction, they demonstrate surprisingly good performance at longer lead times and in capturing key drivers of climate variability, such as the Madden Julian Oscillation. With emerging plans to move towards ML global model prediction, a future project could include case studies and short-term weather forecasts using these ML models in collaboration with the Bureau and UK Met Office.

Conclusion

Building on the proven success of the Northern Australia Climate Program, there is a clear and pressing opportunity to expand this RDE&A model nationally and across sectors. The proposed next phase – "bigger, bolder, and broader" in scope – will leverage established partnerships, trusted networks, and demonstrated outcomes to strengthen the resilience of Australian agriculture to climate variability and long-term change. This will be achieved by extending the program's reach to southern regions, partnering with new industries, and exploring adaptation strategies for emerging climate risks – while incorporating new seasonal and subseasonal forecasting techniques based on machine learning models. A dedicated communications strategy will be implemented to raise awareness, share success stories, and engage stakeholders through media, podcasts, webinars, social media, and industry events. This will help ensure the continued visibility of our products and services, while also fostering broader stakeholder buy-in. Our initiative will continue to deliver economic, environmental, and social benefits aligned with MLA's strategic objectives and Red Meat 2030 targets related to Our Environment. With UniSQ's leadership and strong stakeholder support, the expanded program aims to provide a powerful pathway to future-proof Australia's farming resilience, landscapes, and communities.

Appendix A: Proposed Timeline

Below is a Gantt chart showing timeline of activity commencement and approximate duration. The timeline does not factor in the recruitment of staff, PhDs or extension officers. Here, the proposed project start date is July 2026, extending out to December 2030.



Appendix B: Benefit

Below is a detailed summary of Economic, Environmental and Social benefits for the proposal.

Activity (Research, Development or Extension)	Main economic benefit	Main environmental benefit	Main Social benefit
Operationalisation and upgrade of thermal stress forecasts for livestock (Development)	Increased productivity due to fewer cattle losses and healthier cattle	Reductions in cattle mortality and morbidity (i.e., overall improved cattle welfare)	Improvements in mental health of producers and regional communities if losses are reduced
Climate change risk assessment of cattle welfare (Research)	Decisions by graziers during climate extremes made with greater certainty if adaptation plan properly implemented	Improved land management for next generation of producers, particularly in terms of biosecurity and pasture risks (disease)	Greater wellbeing and improved optimism in the face of climate change
Machine learning prediction of weather and climate (Research)	Potential for improved prediction to minimise losses and maximize profits of farming enterprises	Improved prediction will lead to better animal and land/environmental outcomes through better-informed decision making	Greater trust in the forecasts, science and scientific institutions like the Bureau of Meteorology
Southern Australia Climate program (Extension)	Gains in productivity and profitability gains passed through the supply chains and in the local community due to increased awareness	Improved land management through greater awareness of climate variability and forecasting.	Increased scientific and extension capability and capacity
Drought Advisory service (Development/Extension)	Gains in productivity and profitability gains passed	Improved land and herd management through greater awareness of current drought conditions	Increased community resilience and spillover to local communities

	through the supply chains and in the local community due to increased drought awareness	and potential for drought	