NACP Livestock Thermal Stress Learning Series

Thriving Through Change: Manage Livestock Thermal Stress Before It Costs You!

The Northern Australia Climate Program (NACP) would like to acknowledge the support of the University of Queensland and the SQNNSW Innovation Hub in co-delivering the Livestock Thermal Stress Learning Series.

Key Learnings and Take Away Messages from the Webinar series

Overview and Purpose

Livestock thermal stress is an increasing challenge for northern Australia's grazing systems. The four-part webinar series from the Northern Australia Climate Program brought together experts from the University of Southern Queensland, The University of Queensland, and FeedWorks Ltd. The series explored how livestock thermal stress (heat and chill) impacts productivity, welfare, and long-term resilience. Its purpose was to provide graziers and stakeholders with practical strategies and tools to manage risk and improve livestock outcomes in a changing climate.

Webinar 1 introduced the science behind thermal stress and gave producers a practical understanding to help manage the risks. It raised the importance of monitoring minimum temperatures due to its relevance to managing accumulated heat load.
https://youtu.be/ZbvyiXgRNd0?si=7cESKXfHC87HPsUA

Webinar 2 explored the physiology of thermoregulation, the importance of panting scores, and the critical role of lung health in livestock's ability to cope with thermal stress.
https://youtu.be/pVZ2GlQf7rY?si=jGOtBV4CffYib34A

Webinar 3 discussed how genetics, phenotypes, and epigenetics influence livestock resilience to thermal stress, and what current research reveals about production impacts and intergenerational effects.
https://youtu.be/t_VFOIaxJLE?si=rdhOQLKUSbBiK5HT

Webinar 4 was a wrap-up session featuring expert Q&A, long-term climate projections, and practical advice for managing livestock under increasing thermal stress.
https://youtu.be/PAjZ-ft6zHI?si=6MIVceJoVoLPJ1vB

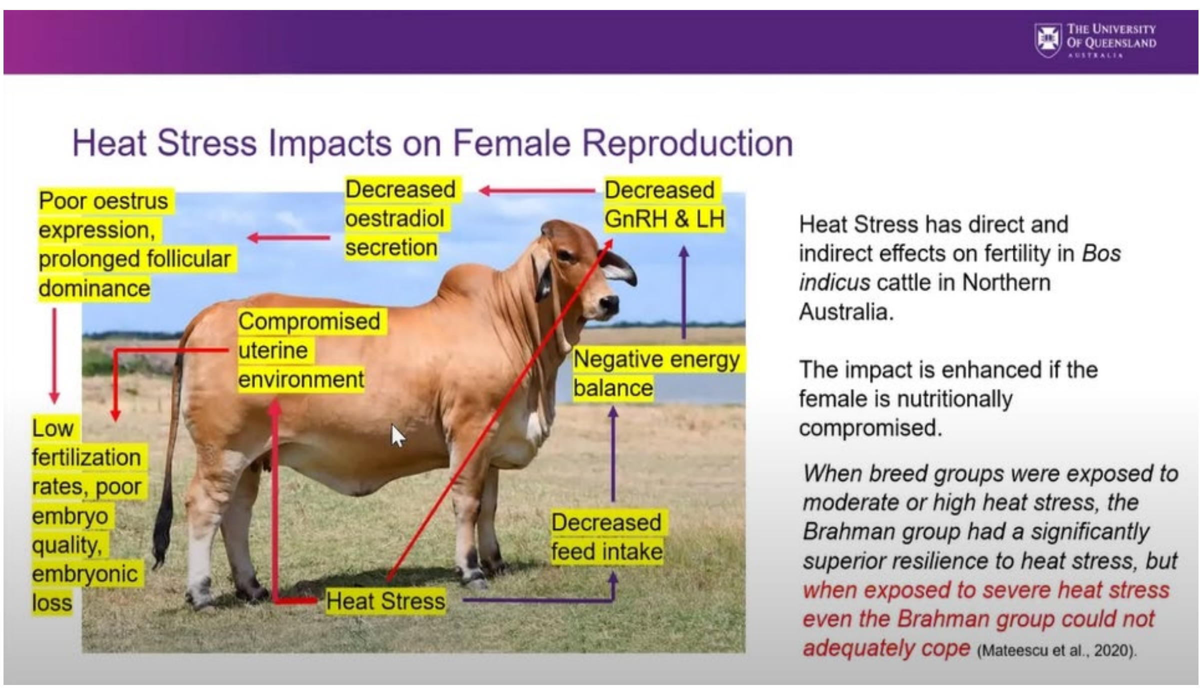
Webinar 1: Understanding Thermal Stress

Understanding Livestock Thermal Stress

- **Thermal stress** includes both **heat stress** and **chill (cold) stress**.
- There are two main types:
  - **Chronic**: Day-to-day exposure (e.g., normal summer/winter conditions). Chronic heat stress may be more impactful than acute events.
  - **Acute**: Sudden, short-term events with significant impacts on productivity and animal welfare (e.g., heatwaves or cold snaps).
- The challenges: climate variability (heat and rainfall), extreme events, nutritional limitations, parasites, breed type, poor reproductive performance.
- Multiple stressors: drought + floods + poor nutrition + weather/climate stress (heat and cold) + walking distance (water & feed)
- The challenges and stressors should not be considered in isolation.

Potential Impacts on Development and Lifetime Productivity

- Reproductive effects: Poor fertility, embryonic loss, reduced conception rates.
- Developmental effects: Lower birth weights, impaired immune systems, shorter gestation.
- Multigenerational impacts: DNA damage, long-term physiological and behavioural changes.
- Breed differences: Even heat-tolerant breeds like Brahmans can be affected.

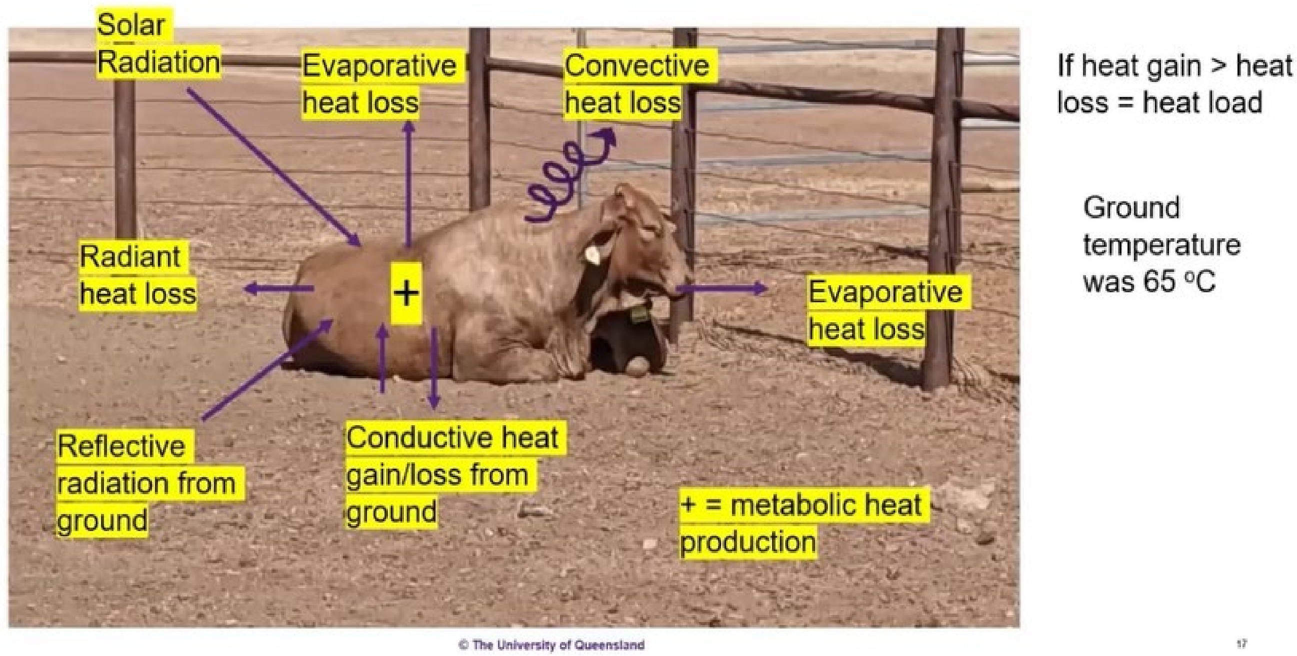


Climate Drivers of Thermal Stress

- Climate drivers, both long-term and short-term, influence the timing, intensity, and duration of thermal stress events across seasons.
    - El Niño–Southern Oscillation (ENSO): Influences rainfall and temperature patterns.
        - El Niño events may increase heat stress risk through drier, hotter conditions. Increased risk of dust storms in prolonged periods of dry, reducing lung health.
        - La Niña events may reduce daytime temperatures and lower the risk of heat stress. However, higher humidity can limit evaporative cooling (panting and sweating) and lead to risk of thermal stress. Chill stress risk may rise due to higher chances of prolonged wet and windy conditions, especially following tropical systems or monsoon activity.
    - Indian Ocean Dipole (IOD): Positive phases typically linked with reduced cloud cover and rainfall, increasing heat load in spring months; negative phases associated with cooler, wetter conditions and increase in humidity.
    - Madden–Julian Oscillation (MJO): Affects multi-week rainfall and cloud cover; an active phase of the MJO to the north of Australia can reduce heat stress by increasing cloudiness and rain. Tropical Cyclone development is more likely when the MJO is active during the northern wet season.
    - Southern Annular Mode (SAM): Influences wind and temperature.
        - Negative phases can bring hotter, drier conditions to southern Queensland and parts of New South Wales.
        - Positive phases can increase rainfall and humidity over central eastern Australia.
    - Australian Monsoon: Drives seasonal humidity and rainfall.
        - Delayed onset, weak monsoons, or extended periods between monsoon bursts increase heat stress risk, especially in northern regions.

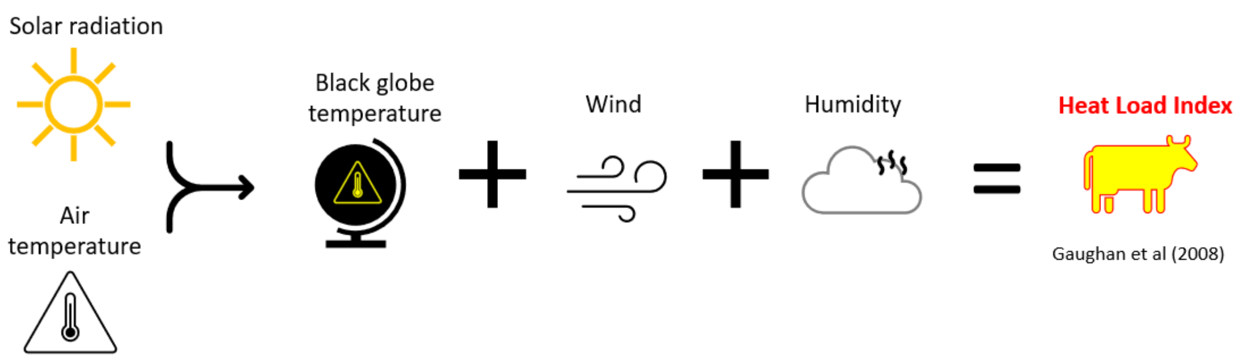
Environmental Factors

- Humidity plays a major role in reducing an animals ability to dissipate heat.
    - Evaporative cooling (sweating, respiration) is key with 80–85% of heat loss occurring through evaporative cooling.
    - High humidity reduces effectiveness of these cooling mechanisms.
- Wind speed: Can aid heat loss depending on temperature and skin wetness. Lack of airflow can hamper dissipation of heat.
- Solar radiation: Dark-coated animals tend to absorb more heat.
- Ground temperature: Shade and grass cover significantly reduce heat load.
- Nighttime cooling: Essential for recovery; lack of nocturnal cooling can lead to accumulated heat load.



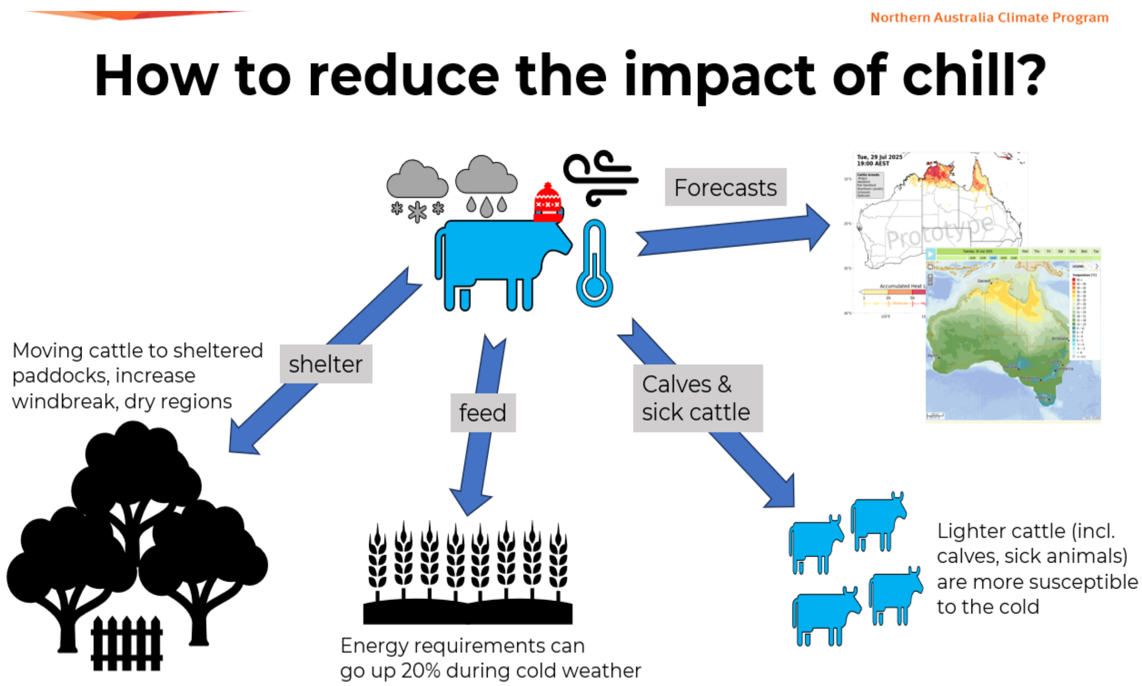
Heat Load Index (HLI) & Accumulated Heat Load

- Developed to measure thermal stress more accurately than temperature alone.
- Thresholds vary by breed, coat colour, acclimatisation, health, and shade/water access.
- Accumulated heat load is critical during multi-day heatwaves where there is insufficient nighttime relief.



Livestock Hypothermia

- Loss of insulation and exposure to wind rapidly increases heat loss
    - Cold mud will result in major heat loss, especially from legs.
    - Made worse if animal is in poor condition or young (newborn and weaners).
- Often associated with extreme weather (e.g., monsoon systems, cyclones).
- Rapid shifts from hot/dry to cold/wet conditions can cause mass livestock losses.
- Example: February 2019 northwest QLD event led to over 500,000 cattle and sheep deaths.



Clear Messages

- Animals need adaptable stress response systems to stay healthy and productive in changing conditions.
- Thermal stress is a major driver of productivity and welfare losses.
- Monitoring and forecasting are essential for proactive management.
- Breed differences matter—heat-tolerant animals are not immune.

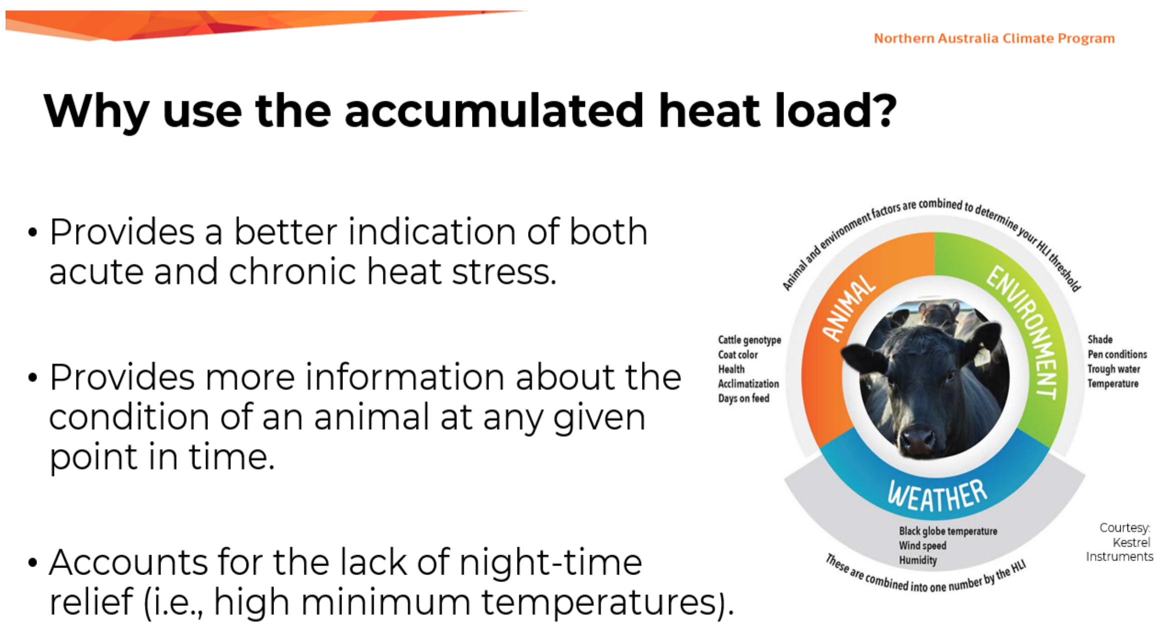
Practical Strategies

- Use thermal stress forecasts to guide mustering, transport, and weaning decisions.
- Ensure access to shade and clean water.
- Monitor night-time cooling and accumulated heat load during heatwaves.

Tools & Forecasting Resources

Practical use: Helps you plan activities like mustering, weaning, branding, transport, and assisted breeding programs.

- NACP Thermal Stress Forecasts: cattle comfort, heat load and accumulated heat load forecasts https://nacp.org.au/cattle_thermal_stress_forecasts
  - BoM's MetEye: 7-day forecasts with temperature, humidity, and wind speed. https://www.bom.gov.au/australia/meteye/



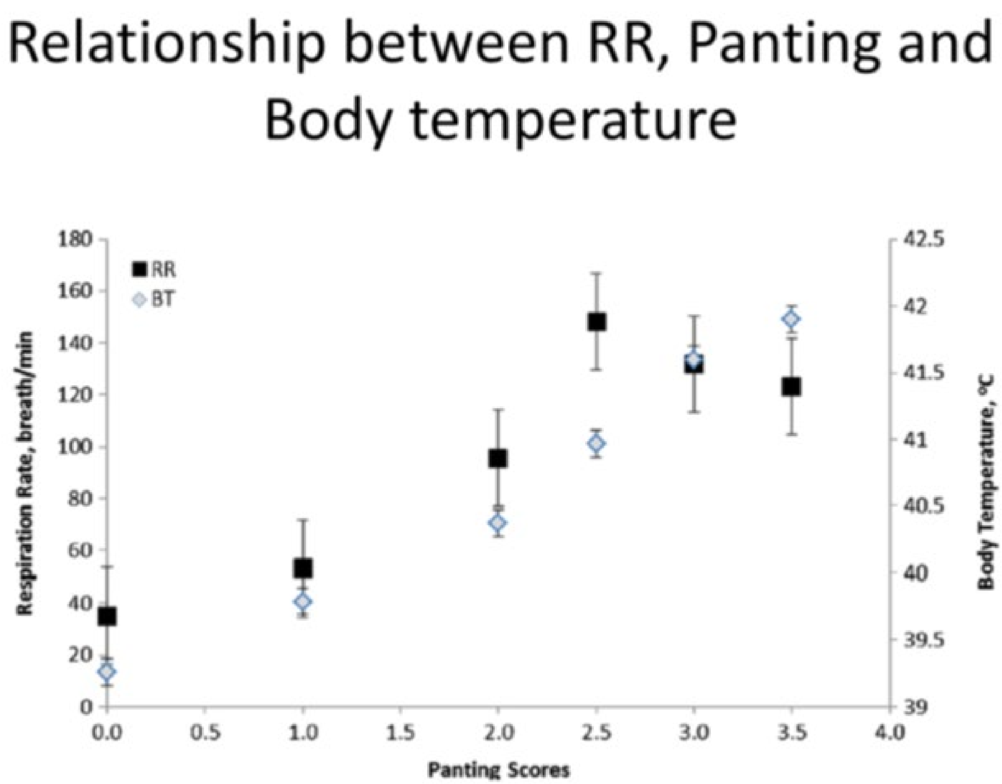
Webinar 2: How Livestock Thermoregulate & Why Lung Health Matters

Physiology of Thermoregulation

- Thermoregulation is complex: Animals prioritise cooling the brain over the body. Panting and sweating are key mechanisms of thermoregulation.
- Thermoneutral zone (TNZ): The range where animals don't need extra energy to stay warm or cool. Outside this zone, energy demands rise.
- Evaporative cooling (panting, sweating) is the most effective heat loss method, especially in high humidity.
- Movement increases body temperature: Even short walks can raise temperature by 1°C, pushing heat-stressed animals over the edge.
- Airflow and shade are vital environmental factors for managing heat load.

Panting Score as a Practical Tool

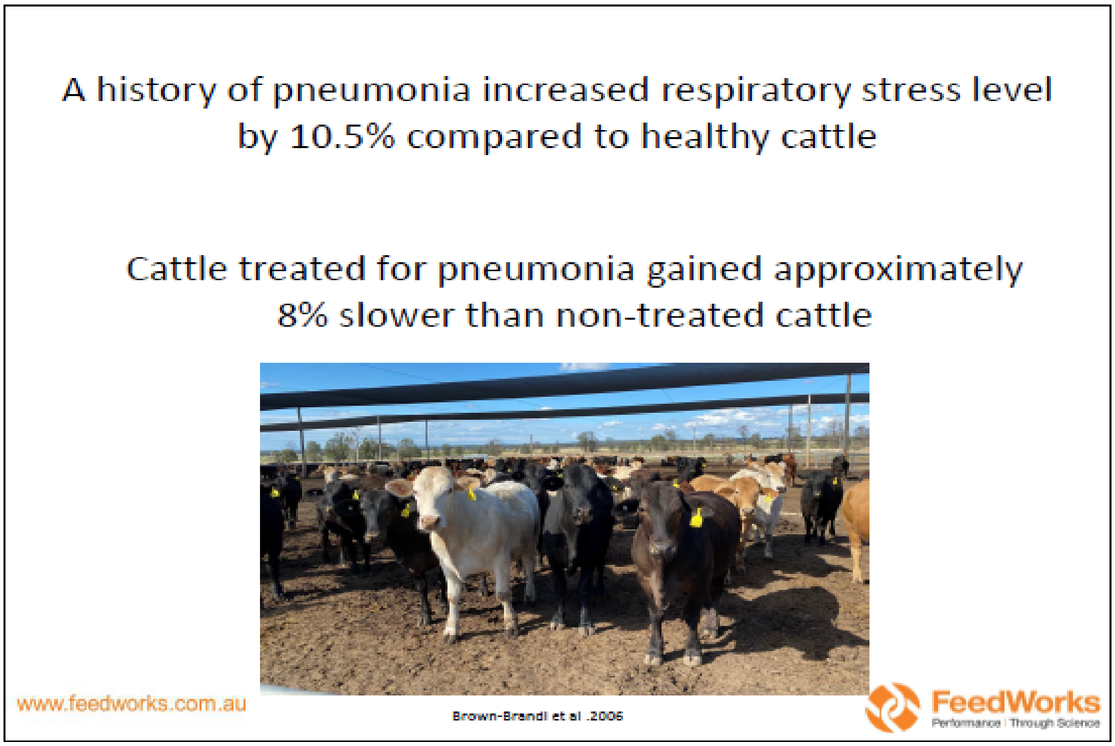
- A visual scale (0–4.5) helps assess thermal stress without needing to count respiration rates.
- Low-grade panting already indicates a compromised energy balance and reduced productivity.
- High-grade panting signals severe heat stress and immune system activation.



Source: The University of Queensland

Critical Role of Lung Health & Early Life Impacts

- Pneumonia in young stock can cause lifelong reductions in productivity and heat tolerance.
- Lung ultrasound is a valuable tool for early detection and management.
- Gut-lung axis: Stress events like weaning can trigger lung disease via microbiome shifts.



Production Impacts

- Reduced feed intake during heat events leads to long-term productivity losses.
- Feedlot studies show shaded cattle have:
    - Higher carcass weights
    - Better feed efficiency
    - Lower energy costs per kg of gain
- Cattle movement during heat events should be minimised to avoid further stress.

Grazing Insights

- GPS tracking shows cattle adjust resting patterns based on heat load.
- Behavioural changes (e.g., resting more during hot days) affect grazing time and productivity.
- Reproductive impacts include reduced fertility and calf survival due to heat stress.

Clear Messages

- If nights are hot – body temperature remains elevated, and livestock start the new day already compromised.
- **Cooling the brain is the priority!**
- Panting score is a simple, visual tool and practical way to assess heat stress severity
- Lung health is critical, and poor lung health in early life affects long-term heat tolerance and productivity.
- Airflow and shade are vital for managing heat load.
- Movement during heat events increases body temperature and risk.
- Feedlot and grazing studies show shade improves performance and welfare.

Practical Strategies

- Use panting scores to monitor animal stress levels.
- Minimise cattle movement during hot conditions.
- Reductions in Dry Matter Intake (DMI) is a method to reduce internal heat production.
- Shade is probably best management option
- Consider lung ultrasound for early detection of lung scarring in young stock.

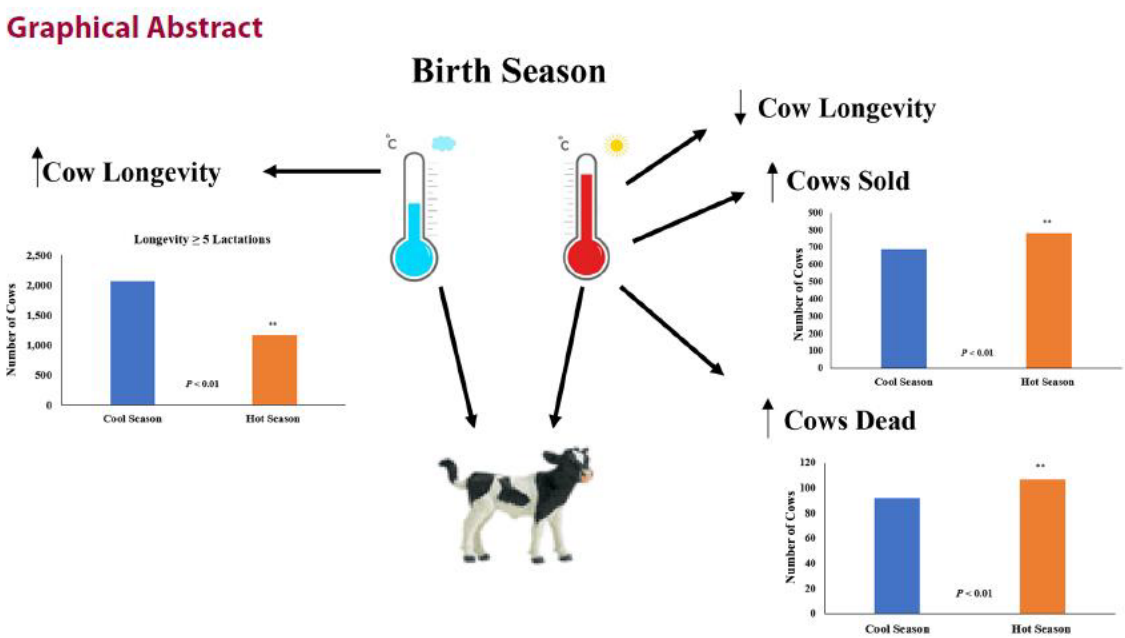
Tools & Resources

- Video on how to visually assess panting score in cattle: https://youtu.be/p_IY9VpwPwU?si=ON_48tgRZBbHQfyh

Webinar 3: Genetics, Epigenetics & Production Impacts

Genetics & Phenotype

- Livestock in northern Australia are regularly exposed to high heat loads.
- Heat stress affects feed intake, growth, reproduction, and calf survival.
- Bulls under heat stress show reduced semen quality and libido.
- Calves, regardless of breed, that are born in hot conditions face higher mortality, especially in the first week of their life.



Source: Toledo et al. 2024

Behavioural Adaptations

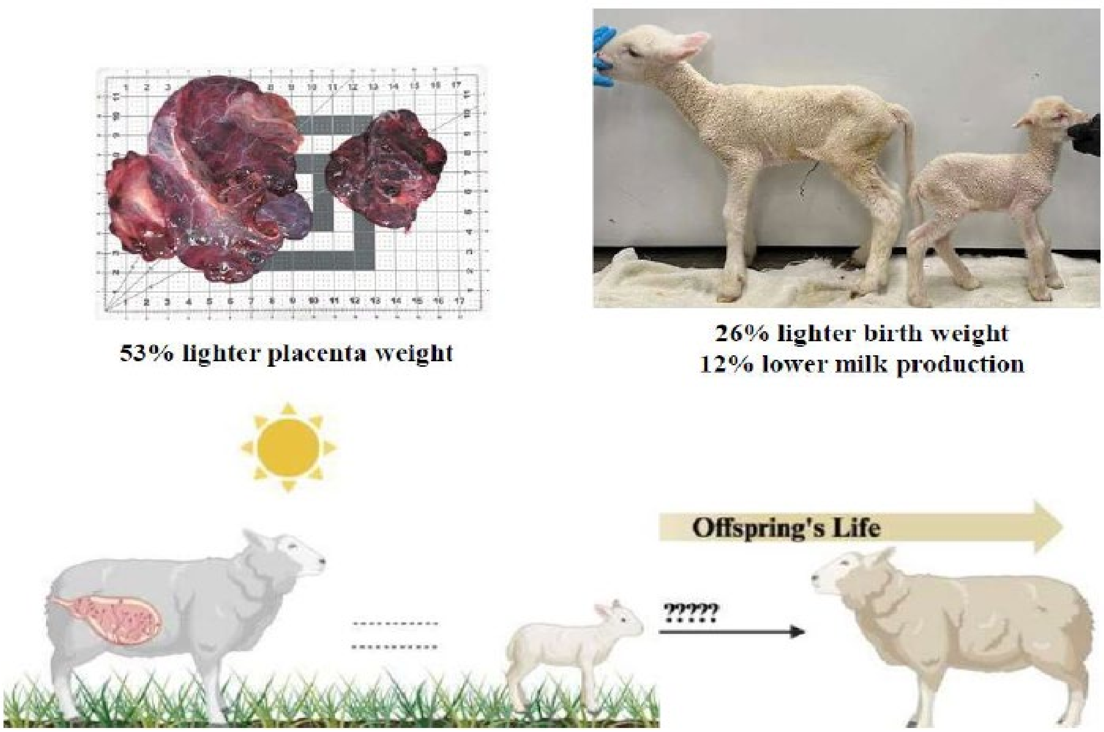
- Cows walk less and rest more during hot days.
- Grazing shifts to cooler nighttime hours.
- Shade access reduces time spent near water points and improves comfort.

Infrastructure Impacts

- Shade structures near water points showed a trend toward reduced calf loss (~6%), though not yet statistically significant.
- No major differences in pregnancy or weaning rates were observed in shaded vs. unshaded groups.

Epigenetics & Intergenerational Effects

- Heat stress during late gestation alters gene expression in calves.
- Calves born in hot seasons show:
  - Lower birth and weaning weights
  - Weaker immune systems
  - Reduced longevity and productivity
- These effects persist into the **second generation** (granddaughters), impacting herd performance long-term.



Fuentevilla et al. 2024

Genetic Selection Challenges

- Selecting for climate resilience requires:
  - Clear trait definitions
  - Long-term planning (25+ years)
  - Balancing productivity with survivability
- Genomic tools (e.g., EBVs with genomics) improve selection accuracy.
- Phenotypic data is still essential for reliable breeding decisions.

Multiple Stressors

- Nutritional, climatic, and physical stressors compound impacts.
- Livestock exposed to multiple stressors divert energy from growth and reproduction to survival.

Clear Messages

- Heat stress can have lasting impacts on herd performance.
- Heat and chill stress can reduce feed intake, fertility, and calf survival.
- Genetic and epigenetic factors influence resilience.
- Genetic selection for climate resilience is possible but complex.
- Epigenetic changes from gestational heat stress can affect multiple generations.
- Infrastructure and behaviors play key roles in adaptation.
- Behavioral adaptations (e.g., grazing at night) can help manage heat load.
- Infrastructure like shade near water points may reduce calf loss.

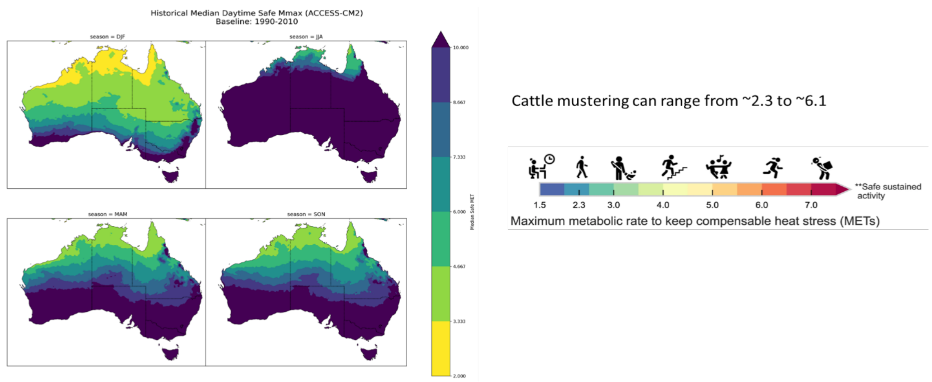
Practical Strategies

- Monitor calf survival and birth weights during hot seasons.
- Consider shade infrastructure near water points.
- Engage with genetic tools and data to inform breeding decisions.

Webinar 4: Forecasting & Practical Strategies

Climate Projections & Heat Load Trends

- Two warming scenarios were explored: global warming stabilised at 2.7°C and exceeding 4°C (above pre-industrial) by 2100.
- Heat Load Index (HLI) thresholds for Angus and Brahman cattle to accumulate heat load will be exceeded more frequently, extending further south.
- Human thermal stress also increases, affecting safe working conditions for producers.



Forecasting Tools

- My Climate View portal helps producers assess possible future climate impacts by region and commodity.
- NACP Thermal Stress Forecasts offer 7–10 day predictions for heat load and cattle comfort.
- Bureau of Meteorology seasonal outlooks show increased likelihood of unusually warm conditions across northern Australia (in recent years).

Practical Management Strategies

- Shelter and shade are critical (natural or artificial) but must allow airflow to avoid humidity buildup.
- Water access: Ensure cool, clean water with sufficient space to reduce crowding and trampling.
- Yard design: Avoid placing shade directly over troughs to prevent congregation.
- Dust suppression and lung health are vital, especially for young stock.
- Timing of procedures (e.g. spaying, scanning) should consider heat stress risk.

Genetics & Resilience

- Genetic selection for heat resilience is complex and still emerging.
- Epigenetics and foetal programming during gestation influence long-term productivity.
- Resilience must be viewed holistically not just heat, but nutrition, movement, and environmental stressors.

Clear Messages

- Use climate tools to guide decisions around livestock movements and management practices including mustering, transport, branding and weaning.
- Prioritise lung health, airflow, and shade access, especially for young and vulnerable stock.
- Consider long-term impacts of heat stress on herd genetics and productivity.
- There is no silver bullet. Small, cumulative changes make a big difference!

Practical Strategies

- Trial small changes and monitor outcomes.
- Utilising NACP forecasts regularly.
- Provide shelter (natural or artificial) that has sufficient airflow, and nearby cool water access.
- For longer-term strategy and climate projections use My Climate View for future planning.

Final Reflections

- Chronic heat stress may be more impactful than acute events.
- Every property is different—trial small changes and monitor outcomes.
- The series highlighted the importance of integrating climate science with practical livestock management.
- Climate projections show increasing heat load events across northern Australia.
- Forecasting tools support planning and risk reduction.
- Shelter, water access, and yard design are key management strategies.
- Genetics and resilience must be considered holistically.

There is NO silver bullet. Small, cumulative changes make a big difference!

Useful Forecast Tools

- NACP Thermal Stress Forecasts: https://nacp.org.au/cattle_thermal_stress_forecasts
- Bureau Long-Range Forecasts: http://www.bom.gov.au/climate/outlooks/#/overview/summary
- Bureau 7-day Forecasts: https://www.bom.gov.au/australia/meteye/
- My Climate View: https://myclimateview.com.au/

Links to Research Journal Articles

From Webinar 1

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From Webinar 3

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Northern Australia Climate Program

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

The research, development and extension is vertically integrated from world leading climate modelling research, development of industry-relevant products; and delivery of a targeted extension, adoption and commercialisation service.

The University of Southern Queensland (UniSQ) leads the program in collaboration with the Bureau of Meteorology (BoM), the UK Met Office, State Departments of Agriculture in Queensland (DAF), Northern Territory (DITT), and Western Australia (DPIRD) and four Natural Resource Management groups.

Research delivers improvements in the Australian ACCESS-S operational general circulation model (GCM) through improved accuracy of multi-week to seasonal forecasts and a reduction in GCM biases and errors.

Development delivers products requested by industry (and policy) including Northern Rainfall Onset, Drought Monitor, Rainfall Burst, Madden Julian Oscillation, Green Date, Heat Load Index, Chill Index and Flash Drought. This website contains the Drought Monitor, real-time Flash Drought monitoring, 1- and 3-month Drought outlooks, 3-hourly cattle thermal stress forecasts out to 9 days , a climate training course, case studies, regional climate guides, videos and the Climate Outlook (issued monthly).

Extension, adoption and commercialisation uses Climate Mates, supported by UniSQ and BoM researchers, to deliver a climate service to the red meat supply chain. This is focused on building awareness, knowledge and skills, and providing the support and confidence for clients to use weather and climate information in decision making.

Financial, environmental and social impacts are demonstrated through the collection and analysis of property data. The delivery of a commercial climate course with accredited trainers provides an avenue for adoption and impact beyond the life of the program.

NACP Funding: The Northern Australia Climate Program is funded by the Queensland Government's Drought and Climate Adaptation Program, the University of Southern Queensland, Meat and Livestock Australia.