Strategic feeding of sheep to alleviate heat stress and improve their production

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Background

- ❑ Extreme weather events such as heat waves, drought, and prolonged rainfall are increasing worldwide due to climate change (IPCC, 2023).
- ❑ The annual average surface temperature is increasing in Australia (Figure 1).
- ❑ The high environmental temperature (above 25°C) from November to March (Figure 2), may cause heat stress and reduce animal production.

Figure 1

Anomalies in temperature in Australia compared to the standard average temperature of 1961-1990 (BOM, 2022)

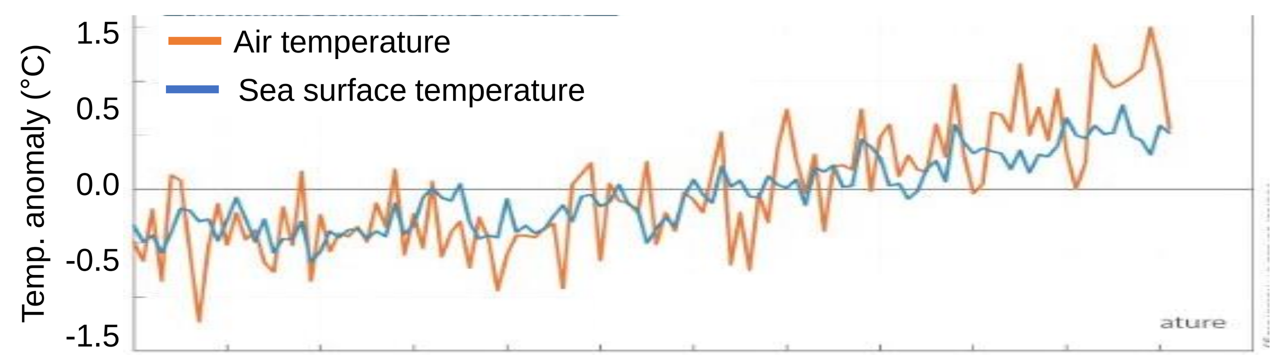
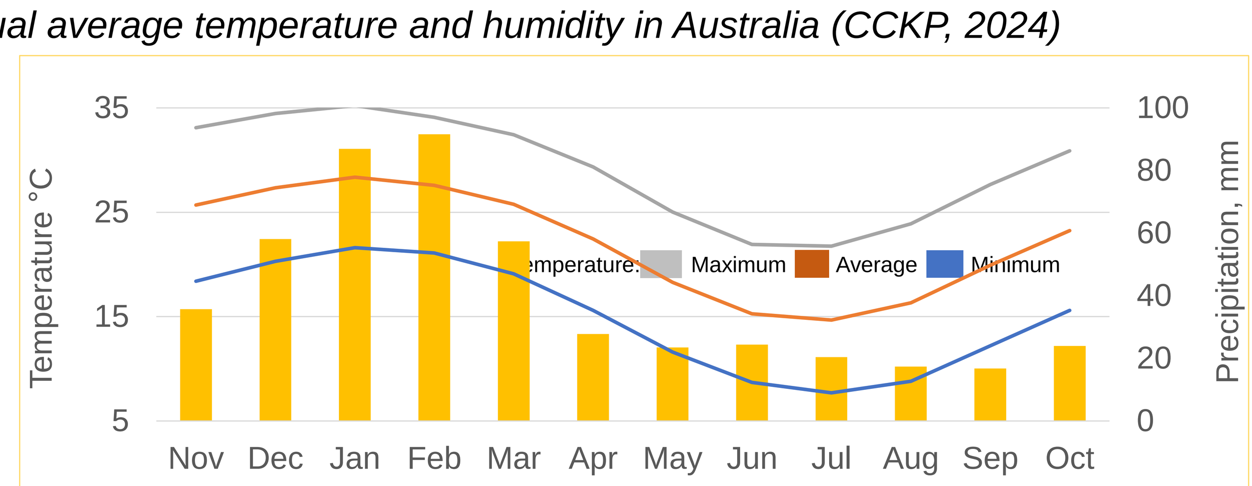


Figure 2

Annual average temperature and humidity in Australia (CCKP, 2024)



Heat stress impacts on animal production

- ❑ High ambient temperature (>25°C) may interfere with the thermoregulation of sheep, leading to heat stress (HS) (Figure 3)
- ❑ HS reduces feed intake and changes the normal physiological and metabolic activities, resulting in poor production and reproduction (Figure 4) (Gonzalez-Rivas et al 2020).
- ❑ The meat of heat-stressed lambs is dark firm and dry (DFD) which is of poor quality, and sold at a discount price, causing economic loss (Zhang et al., 2024; Ponnampalam, et al., 2017).

Figure 3

Impacts of high ambient temperature on the thermoregulation in sheep

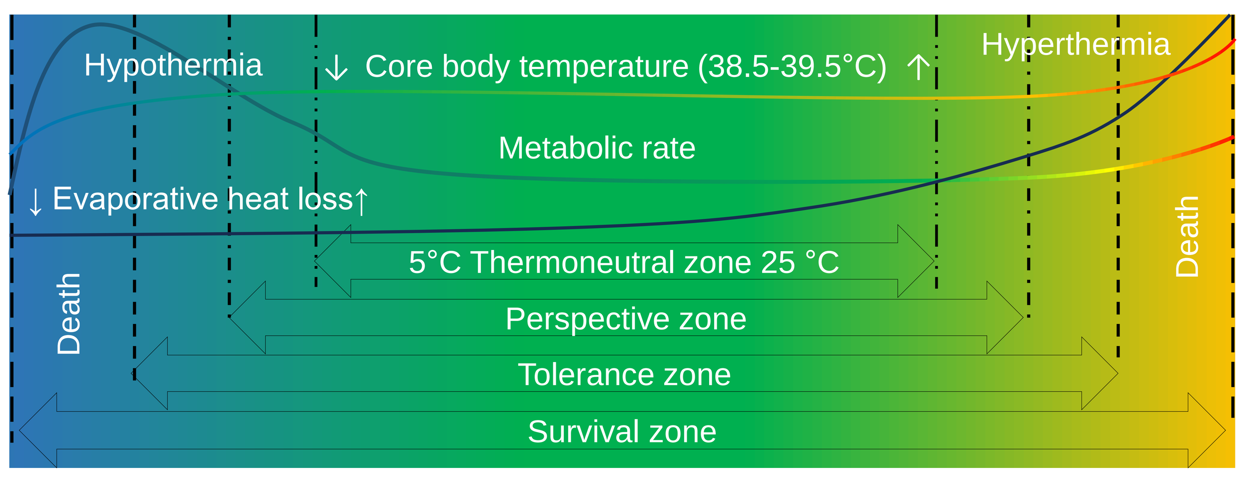
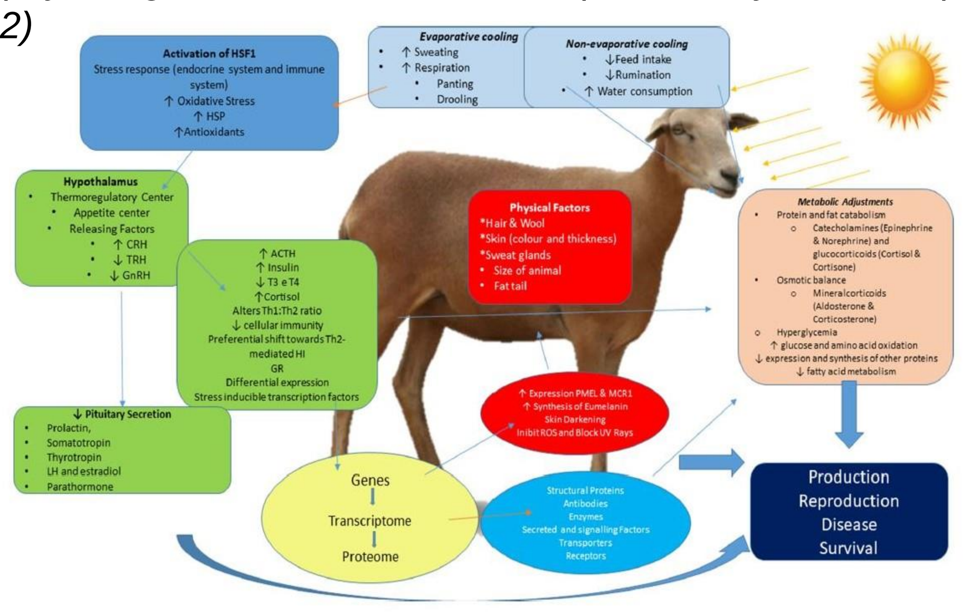


Figure 4

Heat stress alters physiological mechanisms and productivity in sheep (McManus et al., 2022)



Heat stress mitigation strategy

- ❑ Research suggests that supplementing slowly fermentable carbohydrates (SFC), rumen-protected fat (RPF), and increasing dietary protein may produce low heat-increment diets and mitigate HS symptoms (Garner et al., 2022; Kim et al., 2022; Gonzalez-Rivas et al., 2017; Knap and Grummer, 1991; Huber et al., 1994; Dixon et al., 1999).

Research gaps and hypothesis

Gaps	❑ The previous studies did not investigate nutrient utilization efficiency and profitability of feeding dietary supplementation. ❑ They did not study any benefits of supplementation (SFC & RPF) and feeding high-protein diet on preventing premortem tissue catabolism, post-mortem carcass composition, and meat quality of feedlot lambs.
Hypothesis	We hypothesize that supplementing SFC and RPF as energy sources and increasing dietary protein levels of feedlot lambs may increase nutrient intake and utilization efficiency, and improve production performances, meat quality, and profitability.

Proposed Research

The proposed project will conduct four feeding trials:

Study 1 & 2	Supplementation of SFC or RPF to alleviate heat stress of feedlot lambs
Study 3	Increasing dietary protein density to ameliorate heat stress of summer lambs
Objectives	❑ To mitigate heat stress of feedlot lambs during summer. ❑ To protect premortem tissue catabolism, improve productivity, carcass composition, and meat quality of feedlot lambs.

Materials and methods

Design of the experiments

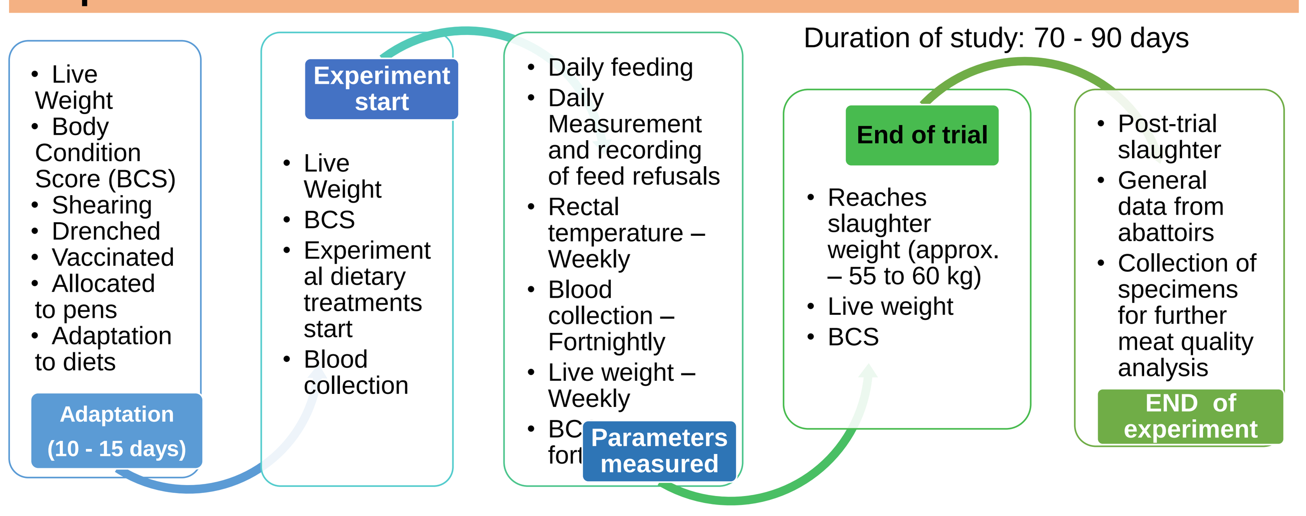
Study 1 & 2 (Animals: Merino/Composit lambs; 3-4 months)

Conventional diet	SFC/RPF diet	Conventional diet	SFC/RPF diet
Replication: 5 pens (3 lambs/pen)	Replication: 5 pens (3 lambs/pen)	Replication: 5 (3 lambs/pen)	Replication = 5 (3 lambs/pen)
Feeding: 3.5% LW	Feeding: 3.5% LW	Feeding: Ad libitum	Feeding: Ad libitum

Study 3 (Animals: Merino/Composit lambs; 3-4 months old)

Conventional diet	10% high CP diet	15% high CP diet
Replication: 6 pens (3 lambs/pen).	Replication: 6 pens (3 lambs/pen).	Replication = 6 pens (3 lambs/pen).
Feeding: ad libitum	Feeding: Ad libitum	Feeding: Ad libitum

Sequence of events



Parameters to be studied

Items	Parameters
Weather data	Temperature, RH, wind speed, solar radiation
Heat stress biomarkers	Respiratory rate, Rectal temperature, Rumen temperature
Production parameters	Live weight gain, Feed conversion ratio, Cost of production
Blood biomarkers, representing tissue catabolism	BUN, Total protein, Free amino acids (AA) Glucose, Lactate, NEFA, Beta-hydroxybutyrate (BHA), Oxidative stress index
Body composition and carcass characteristics	Hot carcass weight, Dressing percentage, Chilled carcass weight Carcass composition (fat, lean muscle, and bone)
Meat Quality	pHu, Glycogen and Lactate; Shear force, Colour

Conclusions

- ❑ The results of studies will help farmers formulate a diet that will minimize nutrient deficiency and mitigate the heat stress of lambs during summer
- ❑ The productivity of summer lambs and meat quality will be improved.
- ❑ The profitability of the meat industry may be increased.

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