Improving the productivity and climate resilience of the Australian Sheep Industry

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Locations
Kyancutta - Darren O'Brien & Jodie Reseigh-O'Brien
Kyancutta - Ty McKenna & family
Wudinna - Chris & Leanne Lymn
Rainfall
Kyancutta
Av Annual: 311 mm
2023 Total: 248.7 mm
Wudinna
Av Annual: 278 mm
2023 Total: 297.8 mm
Trial Design
Randomised block design
Livestock
Merino

Key messages

- **High ambient temperatures during mating and pregnancy can cause heat stress in sheep which impair reproductive outputs, costing the Australian sheep industry approximately $168 million each year.**
- **Alleviation strategies such as the antioxidants melatonin and vitamin ADE, have previously been linked to reducing the negative impact of heat stress in other species.**
- **Ewe supplementation just prior to joining with melatonin and/or ADE drench increased the number of potential lambs at pregnancy scanning.**
- **Two prototype calculators were developed; first, to predict the impact of Melatonin and Vitamin ADE on productivity and profitability of flocks, and the second, to use climate data for a particular location to predict the impact of heat events during joining on their lambing rates to then make decisions around adoption of heat alleviating management strategies.**

Why do the trial?

The aim of this trial was to determine the impacts of melatonin implants (Regulin®) and a vitamin ADE drench on the fertility and fecundity, and thermoregulation of sheep across South Australia. High ambient temperatures during mating and pregnancy impair health, reproduction and welfare of sheep. Each day in excess of 32°C during the week of mating reduces the number of lambs born per 100 ewes mated by 3.5%, with high temperatures during pregnancy retarding fetal growth and, thus, reducing lamb survival and weaning rates.

Strategies which increase the capacity of sheep to tolerate heat and mitigate the negative impacts on reproduction are essential to maintain flock productivity and sustainability. Both melatonin and vitamin ADE have potent antioxidant properties which can act by reducing free radicals within the body that are produced during heat stress. Determining their capability in reducing the negative effects of heat stress in sheep will also provide the sheep industry with the ability to predict the impact of heat events on flock productivity and make informed decisions around the adoption of amelioration strategies.

How was it done?

This trial work ran from the 20 November 2022 until July of 2023 at 21 producer sites, across South Australia. The producer sites were obtained through collaborations with multiple farming systems group including; South Australian Research and Development Institute (SARDI), MacKillop Farm Management Group (MFMG), Barossa Improved Grazing Group (BIGG), Upper North Farming Systems Group (UNFS), Northern and Yorke Landscape Board (NYLB), Mallee Sustainable Farming Systems Group (MSF), Murray Plains Farming Systems Group (MPF), and Agricultural Innovation and Research Eyre Peninsula (AIR EP).

The trial consisted of three treatments; control (no supplementation), melatonin and ADE; across 21 producer sites, each site acting as a replicate. Just prior to joining, ewes were randomly allocated into three treatments consisting of Melatonin, Vitamin ADE and Control. The melatonin ewes received an 18 mg melatonin capsule (Regulin®) via a subcutaneous injection behind the ear, the Vitamin ADE ewes received a 10 ml oral drench of Maxivit Vitamin A, D & E Oral (Compass Feeds), and the Control ewes did not receive any treatment.

Following administration of the treatment the ewes were returned as one mob through till pregnancy scanning and managed according to standard husbandry for that particular farming site. All ewes were individually identified using either visual or electronic ear tags, or the use of branding paint. Pregnancy status and the number of fetuses carried by each ewe were determined by an experienced commercial operator using ultrasound. These data were used to calculate the following outcomes for each flock and each treatment: percentage of ewes pregnant, and the percentage of ewes carrying 1, 2, 3 or 4 fetuses, which in turn was used to calculate potential lambing rate (expressed as fetuses as a percentage of ewes joined and fetuses as a percentage of pregnant ewes).

In addition, on each producer site, at least one temperature device (tiny tag; Hastings Data Loggers) was placed in the paddock in which joining occurred, and was moved with the flock as required. The tiny tag was set to record ambient temperature and humidity at hourly intervals during the joining period. These data were used to understand the potential impact of climate on potential lambing rates, with each day over 32°C during the week of joining. The original objective was to use the climate data collected for each producer site to develop a prototype calculator for use by sheep producers to make informed decisions around implementation of heat alleviating strategies, which will hereon be referred to as the "Sheep_Heat_Economics_HotDays" calculator. However, due to the milder than normal climate experienced during summer of 2022/2023, it was decided to use historical climate data obtained from the Bureau of Meteorology (BoM) to develop this calculator. The additional benefit of using the BoM data is that it is a more robust data set, with data being available for the past 65 years, and is also available over a wider range of locations and is, thus, more relevant to a wider range of producers. The underlying premise for this calculator is that producers can insert their location, and receive outputs predicting the extent to which lambing rate is likely to be decreased by heat events (days > 32°C) in their location and for their chosen joining period, with each day > 32°C during joining (the average per week for the joining period) multiplied by 3.5 to give the expected reduction in lambing rate (fetuses per 100 ewes joined; as per Lindsay *et al*., 1975; Kleemann and Walker, 2005; van Wettere *et al*., 2021).

In addition, a second prototype calculator (the *"SheepHeat_Economics_Supplement"* calculator) was developed to provide sheep producers with the ability to determine the effect of using either melatonin or ADE on productivity and profitability of their flock. This calculator incorporates the cost of production values provided in the PIRSA Gross Margin Guide, and allows a range of scenarios to be modelled, whereby flock size, DSE rating, lambing rate, treatment type and efficacy (improvement in lambing rate), cost of production and lamb sale price can be altered to test the financial outcome.

Statistical analysis was conducted using SPSS (IBM). A general linear mixed model, with region, breed and age included in the model, was run to determine the impact of treatment on all parameters measured.

Table 1. Effect of treating ewes in flocks at three properties on Eyre Peninsula with Regulin® and Vitamin ADE at joining on pregnancy rate and fetal number at pregnancy scanning.

Treatment	Ewe No.	Lamb No.	% Preg	% Single	% Twin	% Triplets	Lambs, % ewes joined
Control	622	791	81a	34	46 a	<1	127.2 a
Vitamin ADE	798	1114	86 b	32	52 b	1	139.6 b
Regulin®	702	1134	97 c	32	64 c	<1	161.5 c

[ab] *Within column indicate differences between means; P < 0.05*

Table 2. Effect of treating ewes in flocks across South Australia with Regulin® and Vitamin ADE at joining on pregnancy rate and fetal number at pregnancy scanning.

Treatment	Ewe No.	Lamb No.	% Preg	% Single	% Twin	% Triplets	Lambs, % ewes joined
Control	4075	5013	84 a	46 a	36 a	1	123 a
Vitamin ADE	3005	4194	90 b	42 ab	47 b	1	140 b
Regulin®	3343	4653	87 b	37 b	48 b	2	139 b

[ab] *Within column indicate differences between means; P < 0.05*

What happened?

Across the three producer sites situated in the Eyre Peninsula the use of melatonin and ADE supplementation increased the ewe fertility and fecundity (Table 1). For every 100 ewes joined, melatonin increased pregnancy rates by 16 ewes, and ADE drench increased pregnancy rates by 5 ewes. Additionally, where potential lambing rate is based on the number of fetuses present at scanning, the supplementation of melatonin prior to joining increased this by 34.3 %, and ADE by 12.4 %. Similar results are observed when the data from all 21 producer sites across South Australia is combined with both melatonin and ADE increasing the number of pregnant ewes, and potential lambing rate by 16 % and 17 % respectively (Table 2).

Using the data obtained from the tiny tags on each of the producer sites, the number of days ≥ 32°C was calculated for the period of joining, this was then divided by the duration of joining to calculate the mean number of days ≥ 32°C during each week of joining. Using the equations developed by Lindsay *et al*. (1975) and Kleemann and Walker (2005), the number of days per week ≥ 32°C were multiplied by 3.5 to generate the impact on potential lambing rates (Table 3).

Using historical BoM data (1957 to 2023), and five sites across South Australia chosen as representative of climate, the incidence of days ≥ 32°C during typical joining periods (late December through to end of January) was calculated, and used to calculate the loss of potential lambs. This was done for an average joining period, as well as the hottest joining period since 1957. These data are presented in Figure 1, and in Figure 2 the financial impost of these losses are presented, based on a flock of 100 ewes.

What does this mean?

This project has demonstrated two easy to implement, highly adoptable and effective strategies to improve the fertility and, thus, productivity of sheep flocks which mate their ewes during late spring to early autumn. These strategies, Melatonin implants (Regulin® and Vitamin ADE oral drench), when given just prior to joining increased potential lambing rates and the percentage of ewes pregnant. Considering their mode of action, which relates to improved thermoregulation, as well as improved development and survival of embryos (eg Bouroutzika *et al*., 2020 and 2022; Contreras-Correa *et al*., 2023; Viola *et al*., 2023), adoption of these supplements is likely to improve the climate resilience of the South Australian sheep flock, and help to ensure its sustainability and productivity in the face of climate change.

Overall, Regulin® and Vitamin ADE treatment of ewes to increase lambing rate appears a robust, profitable management practice. Treatment efficacy and lamb sale price will impact the return on investment of Regulin® and Vitamin ADE treatments and should be considered when deciding to implement these practices. Further confirmation of the true heat-mitigating effects of these treatments on sheep flock fertility will then allow complex predictions of financial return across different production environments.

Table 3. Days per week of joining ≥ 32 °C and potential decrease in lambing rate for an average joining week on a subset of producer sites.

Trial Site	Region	Days per week of joining ≥ 32 °C	Potential decrease in lambing rates for an average joining week (%)
7	Barossa	3	10.5
19	Eyre Peninsula	4.6	16.1
5	Eyre Peninsula	3	10.5
17	Mallee	2.4	8.4
6	Upper North	3.8	13.3
16	Upper North	5.4	18.9
2	Upper North	4.2	14.7
3	Upper North	3.6	12.6
9	Murray Plains	1.4	4.9
10	Murray Plains	1.6	5.6
12	South East	2.4	8.4
1	South East	1.4	4.9
4	South East	0.6	2.1

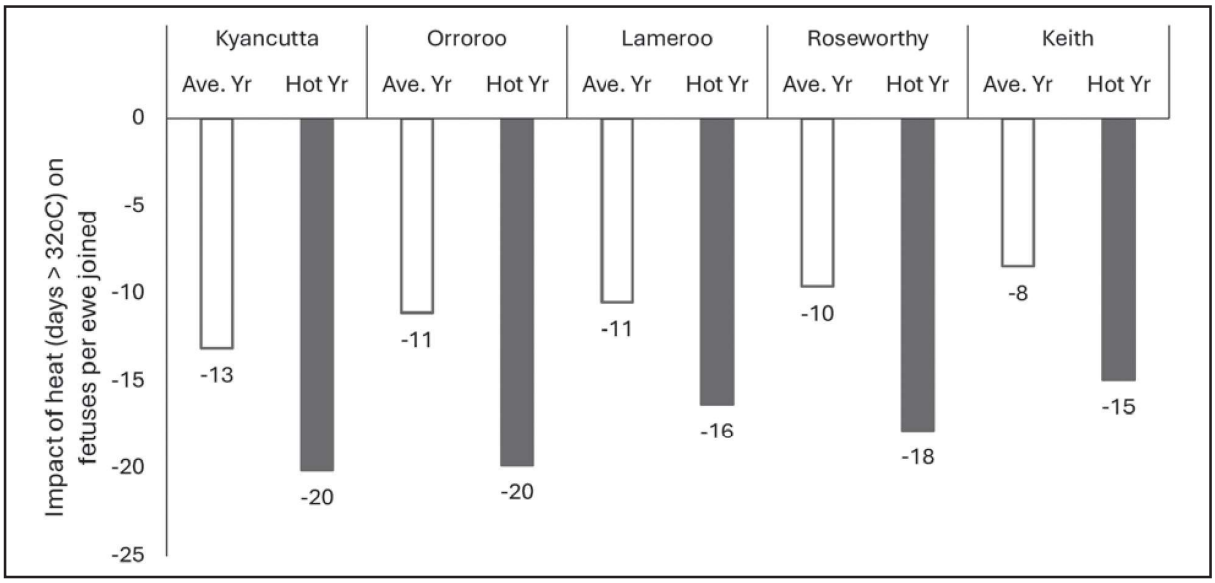

Figure 1. Impact of days ≥ 32°C during joining on potential lambing rate (fetuses per ewe joined) in an average summer joining period and the hottest summer period since 1957.

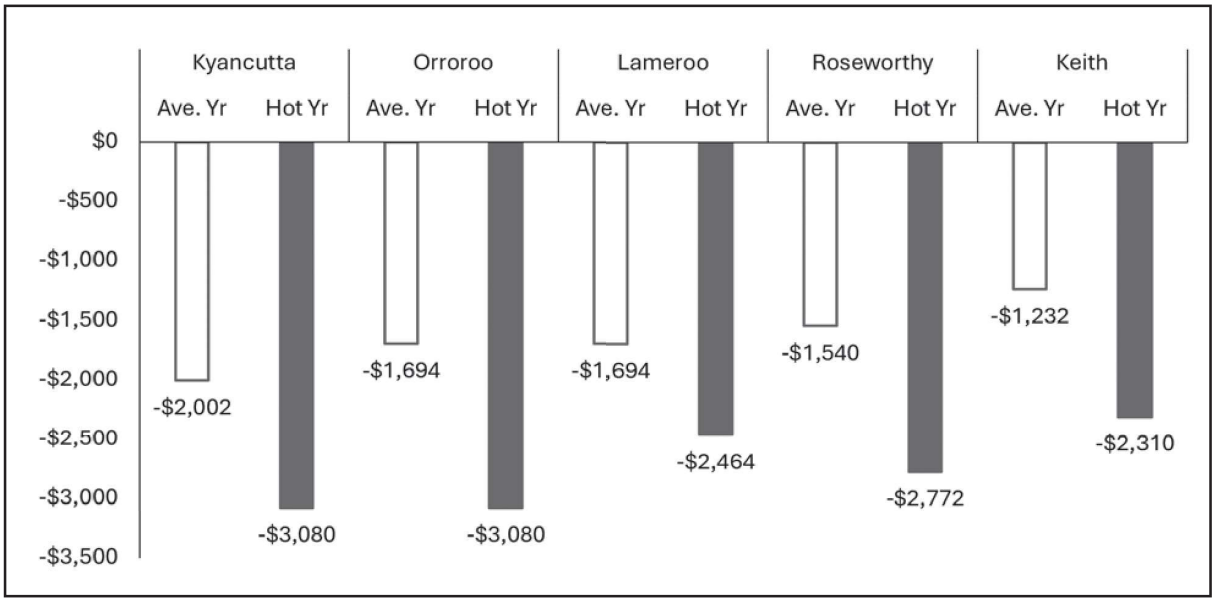

Figure 2. Financial loss due to the reduction in lambing rates that occur when 100 ewes are exposed to days ≥ 32°C during the week of joining. Calculated for an average summer joining period and the hottest summer joining period since 1957. Assumptions: lamb price of $130 / head minus $21 COP / head and a base line lambing rate of 140 %.

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