

JULY 2024

Sheep reproduction RD&A alert

This sheep reproduction RD&A alert is an initiative of the Sheep Reproduction Strategic Partnership (SRSP).

Have you seen the [Sheep Sustainability Framework's](#) (SSF) Digital Data Dashboard? The dashboard showcases current and historical data across the four themes of the SSF:

- Caring for our sheep
- Enhancing the environment and climate
- Looking after our people, our customers and the community
- Ensuring a financially resilient industry

The data is presented in an easy-to-understand graphical format. You can access the dashboard from the [SSF website](#).

The SRSP aims to help sheep producers to profitability and sustainably increase lamb production through increasing lamb survival and weaning rates and will coordinate a national approach to improving sheep reproductive performance.

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Feature project update

Quantifying and improving reproductive performance of shedding sheep

Background

This project will quantify the reproductive performance of shedding sheep breeds, provide an understanding of the causes of reproductive wastage and determine on-farm management options that have the capacity to mitigate the wastage. The management systems developed will be applicable to a range of production systems across Australia.

Aim

To quantify the reproductive performance of shedding sheep, identify the causes of reproductive wastage and determine management strategies to mitigate these causes across the range of agro-ecological zones.

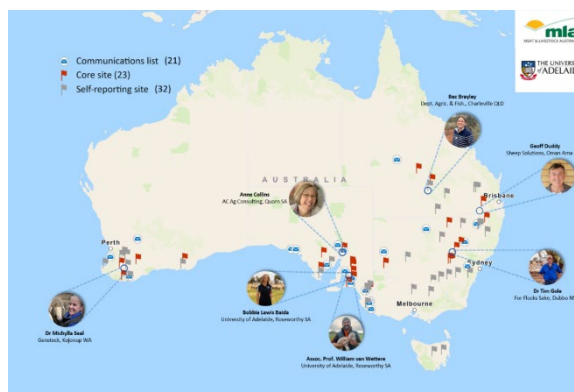
Project objectives

- Quantify the current reproductive performance of commercial shedding sheep flocks across Australia,
- Understand the causes of reproductive wastage in shedding sheep and the opportunities for improvement, and
- Support producers to optimise the reproductive performance of shedding sheep through demonstrating successful commercial scale management practices and identifying and developing resources to support industry service providers and producers.

Current progress

The project is progressing on schedule. Twenty-seven core and 30 self-reporting sites have been selected and enrolled in the project, with sites split across 6 states, representing the most common breeds, and covering 560,500 hectares and 137,326 breeding ewes. Data collection has begun at each of the sites.

For more information on the reproductive performance of shedding sheep project contact Assoc. Prof. Will van Wettere (william.vanwettere@adelaide.edu.au).



Review papers

Pain relief interventions in Australian livestock husbandry: A review of animal welfare and pain duration

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DOI <https://doi.org/10.3390/ani14131901>

Simple Summary

It is well established that animals feel pain akin to humans, although the expression of that pain is not as easy to perceive, especially considering that many species actively conceal or disguise pain, distress, or weakness. Current methods of husbandry practices used to improve welfare or production cause inherently painful tissue damage. Current interventions focus on immediate pain relief, but research indicates persistent pain behaviours post procedure, with pain experienced after routine husbandry procedures such as castration, tail docking, dehorning, and mulesing reported as lasting for days and sometimes weeks after the operation, affecting the animal's welfare and production performance. As livestock handlers, animal owners and veterinarians become better at recognising situations where pain and distress are experienced, efforts are increasing to improve pain mitigation methods. The challenges of avoiding multiple handling of livestock, or relying on owner compliance, may be found in developing long-acting pain relief solutions.

Abstract

In veterinary medicine and livestock production, ensuring good animal husbandry is vital for the physical and emotional wellbeing of animals under our care. Pain poses challenges for assessment and mitigation, especially in species unable to express pain overtly. This review examines current pain mitigation interventions in routine husbandry, focuses on the duration of pain after procedures and implications for animal welfare. Pain behaviours have been observed for days or weeks after regular husbandry procedures, and many studies have noted pain-related behaviour persisting until study finalisation, suggesting potential undocumented pain beyond study completion. Current products registered in Australia for pain mitigation in livestock primarily target immediate pain associated with procedures. The future of pain relief in livestock demands longer-acting solutions to address post-procedural pain adequately. Providing pain relief for at least 72 h post surgery is recommended, but current products require retreatment intervals to achieve this, posing practical challenges, especially in livestock. Methods of pain relief provision, such as voluntary consumption of medicated feed, transdermal medication delivery and long-acting formulations offer potential solutions for prolonged pain relief, with research ongoing in these areas. There is a need for further research and development of longer-acting pain relief to ensure optimal welfare of livestock.

Scientific papers

Genome-wide associations with longevity and reproductive traits in U.S. rangeland ewes

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Frontiers in Genetics Volume 15 May 2025 **OPEN ACCESS**

DOI <https://doi.org/10.3389/fgene.2024.1398123>

Abstract

Introduction: Improving ewe longevity is an important breeding and management goal, as death loss and early culling of mature ewes are economic burdens in the sheep industry. Ewe longevity can be improved by selecting for positive reproductive outcomes. However, the breeding approaches for accomplishing this come with the challenge of recording a lifetime trait. Characterizing genetic factors underpinning ewe longevity and related traits could result in the development of genomic selection strategies to improve the stayability of sheep through early, informed selection of replacement ewes.

Methods: Towards this aim, a genome-wide association study (GWAS) was performed to identify genetic markers associated with ewe longevity, reproductive, and production traits. Traits evaluated included longevity (i.e., length of time in the flock), parity and the lifetime number of lambs born, lambs born alive, lambs weaned, and weight of lambs weaned. Ewe records from previous studies were used. Specifically, Rambouillet (n = 480), Polypay (n = 404), Suffolk (n = 182), and Columbia (n = 64) breed ewes (N = 1,130) were analyzed against 503,617 SNPs in across-breed and within-breed GWAS conducted with the Bayesian-information and Linkage-disequilibrium Iteratively Nested Keyway (BLINK) model in R.

Results: The across-breed GWAS identified 25 significant SNPs and the within-breed GWAS for Rambouillet, Polypay, and Suffolk ewes identified an additional 19 significant SNPs. The most significant markers were rs411309094 (13:22,467,143) associated with longevity in across-breed GWAS (p-value = 8.3E-13) and rs429525276 (2:148,398,336) associated with both longevity (p-value = 6.4E-15) and parity (p-value = 4.8E-15) in Rambouillet GWAS. Significant SNPs were identified within or in proximity (± 50 kb) of genes with known or proposed roles in reproduction, dentition, and the immune system. These genes include ALPL, ANOS1, ARHGEF26, ASIC2, ASTN2, ATP8A2, CAMK2D, CEP89, DISC1, ITGB6, KCNH8, MBNL3, MINDY4, MTSS1, PLEKHA7, PRIM2, RNF43, ROBO2, SLCO1A2, TMEM266, TNFRSF21, and ZNF804B.

Discussion: This study proposes multiple SNPs as candidates for use in selection indices and suggests genes for further research towards improving understanding of the genetic factors contributing to longevity, reproductive, and production traits of ewes.

The impact of gastrointestinal parasitism on the behaviour and welfare of weaned housed lambs

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Applied Animal Behaviour Science, Volume 276, July 2024 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.applanim.2024.106323>

Highlights

- Lambs kept indoors were infected with *Teladorsagia circumcincta*.
- Gastrointestinal parasitism impacted lamb behaviour during early infection.
- Changes in standing behaviour may be a reaction to abdominal discomfort.
- Lambs infected experienced increased affective states related to fear and anxiety.
- Identifying behaviour change early and non-invasively could improve animal welfare.

Abstract

Gastrointestinal (GI) parasitism is a health and production concern in sheep, yet its impact on animal welfare remains unclear. The impact of subclinical infections is especially ambiguous as GI parasitism often remains undiagnosed until clinical signs such as diarrhoea are evident. This study applied quantitative and qualitative methods to examine the effects of subclinical *Teladorsagia circumcincta* infection on the behaviour and welfare of 96 Suffolk-cross lambs (24 pens of 4 lambs) weaned at 10 weeks old. The hypothesis that parasitism causes negative affective states was tested. Lambs were divided into three groups at the pen level: ad-lib fed control (AC), restricted-fed control (RC), and ad-lib fed parasitised (AP). Parasitised lambs (AP) were dosed three times weekly with 7000 third stage *T. circumcincta* larvae (L3) from 16 weeks of age. Lambs in the RC group were pair fed to match AP feed intake to separate the effects of infection-induced anorexia from the potential direct impacts of infection. From 7 days pre-infection to 23 days post-infection, scan and behaviour samples were taken from video recordings to quantitatively monitor behaviour, and animal-based measures such as faecal soiling score (FSS) were recorded as welfare indicators. Lying, standing, eating, play and social behaviour were monitored. Qualitative behaviour assessment (QBA) was conducted weekly using the AWIN (2015) protocol to gain insight into the lambs' affective states over the onset of infection. Parasitised lambs were more likely to stand inactive than AC lambs as the infection progressed ($P=0.006$). They were also less likely to display eating behaviour in the third daily scan sample than RC lambs ($P<0.001$). Principal Component Analysis of the QBA data revealed that the first dimension (PC1) described arousal levels, the second (PC2) described the valence of the animals' affective states, and the third (PC3) described fearfulness and aggression levels. Parasitised lambs ($est=10.64, SE=0.33$) scored higher than RC lambs ($est=9.42, SE=0.33$) on PC3, the fearfulness dimension ($P=0.030$). There were no differences between fearfulness scores of AC and AP lambs or RC lambs and treatment group had no significant impact on the distribution of scores on PC1 or PC2. These findings demonstrate that subclinical GI parasitism negatively impacts lamb welfare not only in the health domain but in the behaviour and mental domains as well. This has implications for welfare assessments and early disease detection in lambs. Future research could explore remote monitoring of the indicators of parasitism identified in this study.

Growing up side by side: Social attachment between twin lambs and the role of the mother's presence

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Highlights

- The distance between twins gradually decreased during their development.
- The closeness between siblings was unaltered after temporary maternal separation.
- The social attachment between siblings gradually disappeared after abrupt weaning.

Abstract

Twin lambs establish a social attachment soon after birth, which implies that they prefer to interact with each other during the suckling period. However, the role of the mother's presence in maintaining the social attachment between twins has been scarcely studied. The aims of this study were to characterize the dynamics of the distance between twin lambs during lactation until three months after weaning, and to determine the impact of the mother in this regard. The study was performed with 11 East Friesian multiparous ewes, nine Finnish Landrace multiparous ewes, and their twin lambs under grazing conditions. The distances among all lambs of the flock were measured from aerial pictures taken with a drone in three

periods: before weaning (on 33, 49, 62 and 78 days of age); before and after a temporary maternal separation (on 79, 81, 82 and 83 days of age) and immediately before and after weaning [94, 95, 96, 98 (weaning day), 99, 110, 124, 145 and 186 days of age]. The mothers and their lambs were temporarily separated at 81, 82, and 83 days of age to determine if the distance between siblings differed when the mother was absent. Distances between siblings vs the mean distance from each twin to the other lambs of the flock, and the distance between siblings vs the distance from each twin lamb to its' mother, were compared separately during the aforementioned periods. The sibling lambs were closer to each other than the other lambs of the flock before and after weaning ($P < 0.0001$, for both). While the distance between siblings increased from 49 to 78 days of age ($P = 0.01$), the distance from each twin lamb to its' mother did not change. After the temporary maternal separation, the distance between siblings was shorter than the mean distance from each twin to the other lambs of the flock ($P < 0.0001$). The distance between siblings increased from 33 to 78 days of age ($P \leq 0.03$), while the mean distance from each twin to the other lambs of the flock did not change. The distance between siblings and the mean distance from each twin to the other lambs of the flock decreased from 94 to 96–98 days of age ($P < 0.0001$). From 98–110 days of age, the distance between siblings and the mean distance from each twin to the other lambs of the flock increased ($P < 0.0001$). In conclusion, twins had a preferential social attachment to each other, that was gradually weakened during their development. The social attachment between siblings was likely because of their mother's presence, as it gradually disappeared after abrupt weaning.

Effect of L-carnosine on frozen ram-semen quality evaluated by CASA and flow-cytometry

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DOI <https://doi.org/10.1071/AN24048>

Abstract

Context: Successful freezing of ram semen has not yet reached the desired levels. The main reason for this situation could be due to the fact that the spermatozoa of this species have a lipid composition different from that of other species.

Aims: The objective of the study was to evaluate the effect of different concentrations of L-carnosine added to the extender on ram semen after being frozen and thawed.

Methods: Semen was collected from six Akkaraman rams twice a week for a period of 3 weeks. Pooling was performed at each time. The semen were reconstituted with a pre-prepared tris + egg yolk solution and different amounts of L-carnosine to form experimental groups (Group 1: 1 mM, Group 2: 5 mM, Group 3: 10 mM, Group 4: 20 mM, Group 5: control) and were drawn into 0.25 mL mini straws. Subsequently, the samples were subjected to freezing by using an automated freezing device. Following the freezing process, the straws were placed in containers containing liquid nitrogen and thawed after 24 h.

Key results: After thawing, it was found that the samples containing 5 mM L-carnosine had superior results in all analyses. This concentration exhibited significantly higher percentages of progressive, total, and rapid sperm motility, live spermatozoa, high mitochondrial membrane potential rate, and higher GSH-Px concentrations. In addition, it was determined that 5 mM L-carnosine group protected the membrane integrity and significantly decreased the rate of abnormal spermatozoa, acrosomal damage rate, low mitochondrial membrane potential and apoptotic cell rate.

Conclusions: As a result, It was determined that adding 5 mM of L-carnosine to the semen extender during the freezing of ram samples would be beneficial for successful freezing.

Implications: The addition of 5 mM L-carnosine to ram-semen extenders ensures the freezability of the semen of this species; thus, this protocol could be used to perform artificial insemination with frozen ram semen.

Sheep producers report docking tails shorter than recommended, knowledge–practice gap, and inconsistent length descriptions: an Australian survey

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Animal Production Science, Volume 64, Issue 11, July 2024 **OPEN ACCESS**

DOI <https://doi.org/10.1071/AN24142>

Abstract

Context: In Australia, it is a common practice to dock sheep tails, to reduce breech soiling and flystrike. According to research, for docking to provide the optimal benefit, tails should be left at a length that covers the vulva in ewes and to an equivalent length in males. Docking tails shorter than recommended increases the risk of perineal cancers, arthritis and prolapse. Research indicates that some producers dock tails shorter than recommended, up to 57% in surveys and up to 86% in on-farm data.

Aims: This study aimed to ascertain the current tail docking length, practices, knowledge and attitudes of Australian sheep producers.

Methods: A national survey was conducted using online, hardcopy and computer-assisted telephone interview (CATI) modes of delivery (n = 547).

Key results: Fifty-seven percent (205/360) of online and hardcopy survey participants chose short tail images to represent their practice, where the vulva was exposed. Although 88% (135/154) of CATI participants described their sheep tail lengths to be covering the vulva, participants equated the length to leaving two tail joints (40%, 54/134) and/or 50 mm (29%, 39/134), both of which have been previously found to be too short to cover the vulva. There was a high awareness of the recommended length (75.7%, 408/539) and 60% (234/390) of participants described it accurately. Significant associations were identified between choosing the short tail image and (1) describing the recommended length to be shorter than it is ($P < 0.01$), (2) being a producer in South Australia ($P < 0.05$), and (3) practicing mulesing ($P < 0.01$). Tail docking is important for producers to reduce flystrike, but docking at their chosen length held more importance than following the recommendation. Participants tended to agree that shearers preferred short tails. Docking tails with a hot knife or rubber rings were the most common methods used.

Conclusions: These results indicated that short tail docking remains a sheep-welfare issue for Australian sheep, and that a knowledge–practice gap exists for some producers.

Implications: Future research in the space of tail length could address the identified knowledge–practice gap, attitudes, and individual barriers to benefit sheep welfare and the industry.

Use of two different methods for glucose determination in sheep under normoglycemic, hypoglycemic, and hyperglycemic conditions: an evaluation of practical diagnostic methods in ovines

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Animal Production Science, Volume 64, Issue 11, July 2024

DOI <https://doi.org/10.1071/AN24165>

Abstract

Context: Animals can present abnormal blood glucose concentrations because of various diseases or pathological conditions, stress, or hunger. Early diagnosis prevents complications, economic losses, and

death. The use of a portable glucometer (PGM) has been shown to be a good, simple, and practical alternative method with good precision and accuracy for assessing blood glucose in humans and companion animals.

Aims: The objective of this work was to evaluate the accuracy and reliability of a portable glucometer (PGM) for assessing glycemia in normoglycemic, hypoglycemic, and hyperglycemic sheep.

Methods: Blood glucose was evaluated in 60 normoglycemic, 15 hypoglycemic, and 15 hyperglycemic sheep. Blood samples were collected and analysed within 2 h by using PGM and the enzymatic method (EM). Each test was evaluated for sensitivity, specificity, and the area under the receiver operating characteristic (ROC) curve for two cutoff points, namely, one for hypoglycemia and the other for hyperglycemia.

Key results: The results of the Kolmogorov–Smirnov test ($P < 0.05$) for all groups evaluated did not show a normal distribution for the values evaluated by PGM and EM. Despite the significant difference found between the medians of the methods and the low homogeneity according to the coefficient of variation (CV), there was a homogeneous and linear dispersion of the results. The Bland–Altman test showed that the mean difference between the two methods was close to zero, denoting good agreement, precision, and accuracy of PGM when compared to EM.

Conclusions: PGM presents high accuracy and precision for assessing glycemia in sheep, providing satisfactory and reliable results when compared with EM.

Implications: The use of PGM facilitates the veterinarian's routine, promoting early diagnosis, field examinations, and monitoring of metabolic diseases.

The potential significance of antioxidants in livestock reproduction: Sperm viability and cryopreservation

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Animal Reproduction Science Volume 267, August 2024

DOI <https://doi.org/10.1016/j.anireprosci.2024.107512>

Highlights

- Semen preservation enables the successful future use of sperm through AI.
- The quality of preserved sperm can be reduced.
- ROS cause oxidative stress thus extremely detrimental to spermatozoa.
- Antioxidants can neutralise, disposes and inhibit the formation of ROS.

Abstract

Male reproductive efficiency is primarily defined by the generation of high-quality and viable sperm cells in farm animals. However, the literature shows that male fertility has declined in recent years due various factors including heat stress, which causes the development of free radicals and reactive oxygen species (ROS) which damages sperm cells. This review aimed to examine the potential significance of antioxidants in increasing and preserving sperm quality and viability. Data used to produce this review paper came from recently published articles in peer reviewed journals. Google Scholar, Science Direct, Research Gate, Web of Science, and the Directory of Open Access Journals were used to access the data. Various studies have shown that antioxidants play a critical role in preserving the sperm quality and viability by protecting sperm cells from the potential damage from oxidative stress induced by the development of oxygen species imbalances. However, there is less information on the use of natural or synthetic antioxidants to preserve semen quality through in vivo procedures, despite its growing popularity and promising results. Hence, there is a need for researchers to explore more on this topic, especially in other livestock species than poultry.

Autophagy is involved in granulosa cell death and follicular atresia in ewe ovaries

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Theriogenology, Volume 215 September 2024

DOI <https://doi.org/10.1016/j.theriogenology.2024.06.024>

Highlights

- Ovine granulosa cells undergo autophagy during follicular atresia at antral stage
- The autophagic marker level is higher in atretic than in healthy granulosa cells
- Granulosa cells of atretic follicles undergo apoptosis as well
- Autophagy and apoptosis could regulate granulosa cell death
- Both autophagy and apoptosis could be involved in antral follicle atresia in sheep

Abstract

In mammalian ovaries, most follicles do not ovulate and are eliminated by atresia, which primarily depends on granulosa cell (GC) apoptosis. Autophagy is an alternative mechanism involved in follicle depletion in mammals through independent or tandem action with apoptosis. However, follicular autophagy has not yet been investigated in sheep; therefore, the present study aimed to investigate the involvement of autophagy in atresia among a pool of growing antral follicles in ewe ovaries. The abundance of the autophagic marker LC3B-II was determined using western blotting in GCs collected from ewe antral follicles. The antral follicles were classified as healthy or atretic based on morphological criteria and steroid measurements in follicular fluid (FF). Immunofluorescence and confocal microscopy analyses were performed on GCs to evaluate the presence of autophagic proteins and their subcellular localisation. Caspase-3 and DNA fragmentation were assessed using western blotting and TUNEL assays, respectively, in the same GC population to investigate the simultaneous apoptosis. The novel results of this study demonstrated enhanced LC3B-II protein expression in GCs of atretic follicles compared to that of healthy ones (1.3-fold increase; $P = 0.0001$, ANOVA), indicating a correlation between autophagy enhancement in GCs and antral follicular atresia. Autophagy, either functioning independently or in tandem with apoptosis, may be involved in the atresia of growing antral follicles in ewe ovaries because atretic GCs also showed high levels of apoptotic markers. The findings of this study might have important implication on scientific understanding of ovarian follicle dynamics.

In vitro production of meiotically competent oocytes from early antral follicles in sheep

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Theriogenology, Volume 215 September 2024 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.theriogenology.2024.06.030>

Highlights

- LIVC protocol promotes efficient oocyte growth from sheep EAFs in the breeding season.
- LIVC supports chromatin transition, reduces transcriptional activity, and enhances meiotic competence.
- Cultured COCs showed higher viability, morphological integrity, and open gap junctions during the breeding season.

Abstract

The potential of using long in vitro culture (LIVC) of cumulus-oocyte complexes (COCs) from early antral follicles (EAFs) as an assisted reproductive technology in cattle has shown promising results. This study explored the feasibility of applying this technology to sheep as seasonal breeding animals. Ovaries from

sheep were collected during both the breeding and non-breeding seasons. COCs were isolated from EAFs (350–450 μm) and cultured in TCM199 medium supplemented with 0.15 $\mu\text{g}/\text{mL}$ Zn sulfate, 10–4IU/mL FSH, 10 ng/mL estradiol, 50 ng/mL testosterone, 50 ng/mL progesterone, and 5 μM Cilostamide. After five days of LIVC, the COCs were submitted to an in vitro maturation procedure. The results indicate successful in vitro development of COCs, evidenced by a significant increase in oocyte diameter ($p < 0.000$) and the preservation of gap junction communication between oocyte and cumulus cells. The gradual uncoupling was accompanied by a progressive chromatin transition from the non-surrounded nucleolus (NSN) to the surrounded nucleolus (SN) ($p < 0.000$), coupled with a gradual decrease in global transcriptional activity and an increase in oocyte meiotic competence ($p < 0.000$). Maintenance of oocyte-cumulus investment architecture, viability, and metaphase II capability was significantly higher in COCs collected during the breeding season ($p < 0.000$), suggesting higher quality than those obtained during the non-breeding season. In conclusion, our study confirms LIVC feasibility in sheep, emphasizing increased effectiveness during the breeding season in isolating higher-quality COCs from EAFs. These findings can influence improving the LIVC system in mammals with seasonal reproduction.

Upcoming events

Date	Event	Location
7 Aug 2024	Sheep confinement feeding roadshow Central West Local Lands Services	Forbes, NSW
7 Aug 2024	Growing more feed this spring Agriculture Victoria	Colac, Vic
7 Aug 2024	Common spring animal health issues Agriculture Victoria	Webinar
13 Aug 2024	BredWell FedWell Meat & Livestock Australia	Gibson, WA
13 Aug 2024	BredWell FedWell Meat & Livestock Australia	Edenhope, Vic
21 Aug 2024	Livestock 2024 Conference SALRC	Albury, NSW
23 Aug 2024	BredWell FedWell Meat & Livestock Australia	Boree Creek, NSW
29 Aug 2024	BredWell FedWell Meat & Livestock Australia	Kangaroo Island, SA