

MARCH 2025

# Sheep reproduction RD&A alert

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

MLA's [Industry projections 2025 for Australian sheep](#) were released in March. The Market Intelligence team have forecasted a 7% decline in the sheep flock to 73.2 million head. Lamb slaughter is expected to remain elevated in 2025 at 26.2 million head, while mutton slaughter is forecast to ease by 17% to 9.8 million head.



## Program coordinator

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The recording of the [March 2025 Sheep Industry Projections webinar](#) is now available to view.

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.

## Feature project update

### New approaches to increase the weaning rate of the national sheep flock

#### Background

Pre-weaning mortality of twin-born Merino lambs remains a persistent issue for the Australian sheep industry despite advances in genetic, nutrition and management. Maternal nutrition is one of the most important environmental factors affecting peri- and post-natal lamb survival and growth. Adding specific nutrients to the diet of ewes from mid-pregnancy can increase nutrient supply to the developing foetus to boost their energy reserves for thermoregulation following birth and provide some protection from oxygen deprivation that occurs during birth. Development of feeding strategies including these nutrients suitable for pregnant ewes run in commercial conditions may improve survival of twin born lambs to weaning.

#### Aim

To determine whether supplementing pregnant ewes with melatonin, caffeine, betaine, or RP amino acids (methionine-lysine-choline combination, citrulline or arginine) would improve lamb thermoregulatory capacity following birth, and/or protect the lamb/s from the damaging effects of intra-partum oxygen deprivation, thus increasing lamb survival.

#### Project design

The project investigated the neuroprotectant properties of melatonin, caffeine, betaine and rumen-protected amino acids using a three-stage approach:

- Stage 1 - an intensive research environment
- Stage 2 - an extensive grazing research environment

- Stage 3 - commercial validation working with local and regional producer

The three stage process enable the research team to investigate each compound within controlled research environments, then where applicable, validate commercial application to provide producers with an efficient and cost-effective method and pathway for industry adoption.

### Results & key findings

- Melatonin improved lamb survival in Stages One and Two and progressed to Stage Three. However, no improvements to lamb survival were observed on three commercial properties across South Australia and Western Australia.
- Caffeine improved lamb thermoregulation in Stage One. However, in Stage Two, caffeine supplementation reduced lamb survival, and therefore did not progress to Stage Three.
- In Stage One, lambs born to ewes supplemented with betaine in late gestation took less time to attach to the udder and suck following birth compared to lambs born to both control ewes and ewes supplemented with a lower dose of betaine for the duration of pregnancy. Ewes supplemented in late gestation also produced lambs which had greater survival to marking and weaning. However, in Stage Two, there was no effect of betaine supplementation in the second half of gestation compared to control ewes, and therefore, betaine did not progress to Stage Three.
- Several amino acid supplementation strategies were investigated to increase maternal circulating arginine. Citrulline or a combination of methionine, lysine and choline did not increase circulating arginine in pregnant ewes, nor did it affect lamb growth, behaviour, or survival. Rumen protected (RP) arginine supplementation increased circulating arginine concentration in pregnant ewes and improved lamb thermoregulation in Stage One. In Stage Two, RP-arginine supplementation increased lamb survival to weaning by 12.5% and therefore progressed to Stage Three. Results from three commercial properties across South Australia and Victoria indicated no improvement in lamb survival due to treatment. However, a fourth study, conducted concomitantly on Turretfield Research Centre under extensive conditions, found a 12% improvement in survival of lambs within the first 24 hours of life, indicative of neurological protection during the birth process.

### Publications arising from this project

Brougham B-J. *et al.* (2024) Maternal supplementation with dietary betaine during gestation to improve twin lamb survival. *animals* **10**, 1749. <https://doi.org/10.3390/ani10101749>

Flinn T. *et al.* (2020) Maternal melatonin implants improve twin Merino lamb survival. *Journal of Animal Science* **98**(11), 1-5. <https://doi.org/10.1093/jas/skaa344>

Flinn T. *et al.* (2020) Supplementing Merino ewes with melatonin during the last half of pregnancy improves tolerance of prolonged parturition and survival of second-born twin lambs. *Journal of Animal Science* **98** (12), 1-10. <https://doi.org/10.1093/jas/skaa372>

Flinn T. *et al.* (2020) Neonatal lamb mortality: major risk factors and the potential ameliorative role of melatonin. *Journal of Animal Science and Biotechnology* **11**, 104. <https://doi.org/10.1186/s40104-020-00510-w>

McCarthy N. *et al.* (2021) Maternal lysine, methionine and choline supplementation in twin-bearing Merino ewes during mid-to-late gestation does not alter pregnancy outcomes or progeny growth and survival. *Livestock Science* **251**, 104620. <https://doi.org/10.1016/j.livsci.2021.104620>

Murdock N.J. *et al.* (2021) Supplementing pregnant Merino ewes with caffeine to improve neonatal lamb thermoregulation and viability. *Animal Reproduction Science* **226**, 106715. <https://doi.org/10.1016/j.anireprosci.2021.106715>

Swinbourne A.M. *et al.* (2021) Caffeine: A potential strategy to improve survival of neonatal pigs and sheep. *Animal Reproduction Science* **226**, 106700. <https://doi.org/10.1016/j.anireprosci.2021.106700>

McCarthy, N. *et al.* (2022) Maternal oral supplementation with citrulline increases plasma citrulline but not arginine in pregnant Merino ewes and neonatal lambs. *Animal Production Science* **62**(6), 521-528.

<https://doi.org/10.1071/AN21249>

Brougham B-J. *et al.* (2024) Supplementing dietary betaine during late gestation increases plasma betaine and methionine concentrations in pregnant Merino ewes but not neonatal lambs. *Small Ruminant Research* **232**, 107226. <https://doi.org/10.1016/j.smallrumres.2024.107226>

Brougham B-J. *et al.* (2024) Maternal supplementation with dietary betaine during late gestation increased ewe plasma creatine and lamb thermoregulation under field conditions. *animals* **14**, 2605.

<https://doi.org/10.3390/ani14172605>

For more information on the new approaches to increase the weaning rate of the national sheep flock project contact Alyce Lowe [alyce.lowe@adelaide.edu.au](mailto:alyce.lowe@adelaide.edu.au).

## Review papers

### Pregnancy establishment and diagnosis in livestock

Troy L. Ott, Ahmed Tibary, Muhammad Waqas, Rodney Geisert and Julio Giordano

Annual Review of Animal Biosciences, Volume 13, February 2025 **OPEN ACCESS**

DOI <https://doi.org/10.1146/annurev-animal-021022-032214>

#### Abstract

This comprehensive review explores the complex processes of reproduction, pregnancy establishment, and pregnancy diagnostic methods in cattle, sheep, goats, swine, horses, and camelids. It provides an overview of the history of pregnancy detection and an in-depth exploration of the physiology of pregnancy in livestock. The detection of conceptus tissue and fluids, conceptus-produced hormones, and maternal responses to conceptus signals, crucial for pregnancy diagnosis, are also discussed in detail, as are emerging methods for pregnancy diagnosis in livestock species. Overall, this review emphasizes the direct impact of pregnancy diagnosis and efficient pregnancy management for profitability of livestock enterprises.

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### Oral selenium supplementation improves the reproductive performance of rams: A systematic review and meta-analysis

Alfonso Longinos Muñoz-Benitez, Rodolfo Vieyra-Alberto, Juan Hebert Hernandez-Medrano, José Luis Ponce Covarrubias, Erika Georgina Hernández-Rojas, David Alejandro Contreras Caro del Castillo and Juan Carlos Angeles-Hernandez ([juanangeles@fmvz.unam.mx](mailto:juanangeles@fmvz.unam.mx))

Small Ruminant Research, Volume 245, April 2025 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.smallrumres.2025.107465>

#### Highlights

- Se supplementation in rams increases sperm volume, motility and concentration while minimizing abnormalities.
- Inorganic sources of Se are particularly effective in increasing motility and testosterone levels.
- However, factors such as Se source, dosage and geographical location should be considered in supplementation strategies.

#### Abstract

Selenium (Se) plays a key role in maintaining integrity of the sperm membrane and modulating quality of ejaculate. A systematic search was conducted based on the following PICO question: "What is the

effectiveness of Se supplementation (I) compared to no supplementation (C) on semen quality, testicular circumference and testosterone production (O) in rams (P)". The search was carried out by four experts using the PRISMA framework to avoid bias in the scientific database: PubMed, Google Scholar and Web of Science. The response variables were semen volume (SV), sperm cell concentration (SC), sperm progressive motility (SM), abnormal sperm % (AS), scrotal circumference (Scir), semen pH, serum Se concentration (SSe) and blood testosterone (BT). The effect size was estimated through the standardized (SMD) and raw mean difference (RMD). Heterogeneity was quantified using the I<sup>2</sup> index. The sources of heterogeneity were explored through a meta-regression including the covariates: breed, Se source (organic/inorganic), dosage, latitude, geographical zone, and semen collection technique (artificial vagina/electroejaculator). Oral supplementation of Se depicted a positive effect compared with not supplemented rams to SV (+0.15 ml), SM (+4.74 %), SC (+0.22 %), AS (-1.17 %), Scir (+0.86 cm), SSe (+3.98 µg/ml), and ST (+0.47 ng/ml). SM, AS, SC, and ST outcomes showed a better response to inorganic Se supplementation. There was a positive relationship between latitude and response to Se supplementation in SM and BT. In studies using the electroejaculation technique, the response to Se supplementation in SM and AS was significantly lower ( $P < 0.05$ ). In addition, the percentage of abnormal sperm was increased with electroejaculation. In conclusion, oral Se supplementation improves semen quality in rams, which could have a positive effect on flock fertility. However, variables such as Se source, dosage and latitude should be considered when supplementing Se orally.

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### The role of non-aureus *Staphylococcus* in small ruminant mastitis: A systemic review on etiological agents, risk factors, virulence determinants, and novel treatments

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Small Ruminant Research, Volume 245, April 2025

DOI <https://doi.org/10.1016/j.smallrumres.2025.107475>

#### Highlights

- Mastitis significantly impacts animal health, productivity.
- The main bacterial agents causing mastitis are mainly non-aureus staphylococci (NAS).
- NAS these strains may develop multi-resistance to antibiotics.
- Genetic improvement programs are an efficient tool to improve resistance to mastitis.

#### Abstract

Clinical mastitis is a primary contributor to physical, chemical, and bacteriological changes in milk leading to significant economic loss and welfare impairment. While mastitis in small ruminants can be rooted in varied infectious agents and physical injuries, bacterial infections stand as the predominant cause. *Staphylococci*, *Streptococci*, and *coliforms* are identified as the primary bacterial pathogens responsible for mastitis. Mastitis-causing *staphylococci* are typically categorized into *Staphylococcus aureus* and non-aureus *staphylococci* (NAS). NAS encompasses mainly coagulase-negative *Staphylococcus* species (CNS) and selects coagulase-positive and coagulase-variable *staphylococci*. NAS species exhibit variability in their epidemiology, pathogenicity, virulence, ecological niche, host adaptation, and antimicrobial resistance profiles. Their unique interactions with the udder's microbiome composition may confer protection against other mastitis pathogens. In small ruminants, treatment for NAS mastitis faces challenges such as antibiotic resistance and limited availability of veterinary drugs. Emerging treatments include bacteriophages, probiotics, immunotherapy, phytochemicals, nanotechnology, and peptides. This review will discuss the importance of NAS as a cause of mastitis in small ruminants, the virulence factors of this group, and for greater scientific reach, the species-level interactions within the

microbiome and its interplay with host genetics are crucial to elucidate the role of NAS in mastitis and udder health in small ruminants.

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## Effects of heat stress on reproduction and gene expression in sheep

Galma Boneya Arero ([galmeessa74@gmail.com](mailto:galmeessa74@gmail.com)) and Ozge Ozmen

Animal Reproduction, Volume 22 N1 **OPEN ACCESS**

DOI <http://dx.doi.org/10.1590/1984-3143-AR2024-0067>

### Abstract

Small ruminant farming plays a pivotal role in agriculture, especially in developing countries due to sheep's diverse functions and capacity to acclimate to varying temperatures. This review comprehensively explored the impact of rising temperatures on reproductive processes, reproductive function encoding gene expression, and sheep's ability to adapt to heat stress. Several mechanisms contribute to sheep's resilience to heat stress, encompassing morphological, behavioral, physiological, and genetic adaptations. It has been shown that heat stress compromises fertility by affecting follicular development, ovulation rate, estrous behavior, rates of conception, embryonic survival, and fetal development, while also disrupting sperm production and motility, and increasing the incidence of structurally abnormal sperm in males. Estimates suggested that heat stress may reduce conception rates from 20% to 27%. Essential genes encoding the Gonadotrophin-releasing hormone, Follicle-stimulating hormone receptor, Luteinizing hormone receptor, Estradiol receptor, progesterone receptor, and Inhibin play a critical role in elucidating how heat stress impacts the reproductive performance of sheep. Furthermore, the resilience of sheep in facing heat stress adversities is associated with a specific heat shock factor. When an animal is under heat stress, Heat shock factors get activated and stimulate the production of Heat Shock Proteins (HSPs). Emphasis should be given to identifying specific genes and candidate genes that confer protection against heat stress and conducting comprehensive research to unravel how sheep adapt to demanding local climatic conditions to enhance production and profitability, improve animal welfare, and for genetic conservation and breeding programs.

## Scientific papers

### Prenatal administration of lipophilic macrocyclic lactone anthelmintics can alter neonatal lamb behavioural development

Melissa N. Hempstead ([melissa.hempstead@agresearch.co.nz](mailto:melissa.hempstead@agresearch.co.nz)), Chris M. Miller, Madeleine Jones, Paul M. Candy, Christian W. Sauermann, Sarah M. Rosanowski and Dave M. Leathwick

Applied Animal Behaviour Science, Volume 284, March 2025 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.applanim.2025.106554>

### Highlights

- Prenatal administration of ewes with persistent anthelmintics is common on farms.
- Abamectin had no effect on ewe or lamb behaviour after parturition.
- Lambs from moxidectin-treated ewes showed delayed behavioural development.

### Abstract

The treatment of pregnant ewes with persistent macrocyclic lactone (ML) anthelmintic products is common in some countries, with the intent of alleviating the potential negative impacts of gastrointestinal nematode parasites on production, health and welfare. However, some MLs such as moxidectin, are lipophilic compounds that can cross the placenta, and many are secreted into colostrum and milk, yet the effect of MLs on neonatal lamb behaviour remains unknown. The objective of this study was to evaluate the effect of

prenatal administration of persistent ML anthelmintics on the behaviour of ewes and their new-born lambs. Sixty mixed-age pregnant twin-bearing ewes were randomly allocated to one of three groups (n = 20/group): 1) administered a subcutaneous injection containing moxidectin 2–3 weeks prior to lambing (MOX), 2) administered one controlled-release capsule containing abamectin and albendazole 2–3 weeks prior to lambing (CRC), and 3) a control group that was not treated or handled other than routine care (CON). The ewes were housed indoors 4 weeks before parturition was expected to commence and remained in the same pens (n = 2 ewes / treatment) until 1 week after lambing. Behaviour of the ewes and lambs was monitored continuously using security cameras positioned above each pen. Ewe and lamb behaviour was evaluated for 3 h after parturition. Ewe grooming of the lamb, and lamb head shaking, standing, udder seeking and suckling behaviour was assessed using Cox Proportional hazard models. There was no evidence that abamectin (and albendazole) affected ewe or lamb behaviour ( $P > 0.10$ ). Neonatal lambs from ewes administered moxidectin tended to be slower to shake their heads after parturition (hazard ratio: 0.65;  $P = 0.08$ ), and were slower to attempt to stand (hazard ratio: 0.61;  $P = 0.05$ ) compared with lambs from control ewes. These are the first known data to indicate changes in neonatal lamb behaviour associated with anthelmintic treatment of their dam. Further research is required to validate these findings and understand whether the delayed neonatal lamb behavioural development associated with moxidectin has implications for lamb vigour or survivability.

## Fertility preservation of vacuum-dried ram spermatozoa stored for four years at room temperature

Margherita Moncada, Martina Lo Sterzo, Luca Palazzese, Francesca Boffa, Debora Agata Anzalone, Domenico Iuso, Marta Czernik, Luisa Gioia, Federica Turri, Beatrice Mislei, Diego Bucci, Jacques Bonnet, Marthe Colotte, Sophie Tuffet, Michał Bochenek and Pasqualino Loi ([ploi@unite.it](mailto:ploi@unite.it))

Theriogenology, Volume 239, June 2025

DOI <https://doi.org/10.1016/j.theriogenology.2025.117390>

### Abstract

Dry storage at room temperature (RT) could simplify spermatozoa banking. Here, we explored DNA stability and in vitro and in vivo development of embryos derived from vacuum-dried encapsulated (VDE) ram spermatozoa stored for four years or after accelerated aging. While some genomic damage was detected at time 0, DNA fragmentation increased from  $3.32 \pm 3 \%$  (time 0) to  $37.64 \pm 4 \%$  (4 years). A decrease in blastocyst rate was observed after four years of storage and 6.7 years of simulated storage (10.2 % and 9 % versus 13.16 % at time 0). Embryo quality, assessed based on Cdx2 and Inf- $\tau$  gene expression, declined over time. Only two of the 23 embryos transferred into synchronized ewes were implanted but were lost by day 40.

In conclusion, dry spermatozoa generated blastocysts after four years of RT storage, but their post-implantation development was impaired. Optimization of the water extraction and storage conditions could better preserve the spermatozoa's DNA integrity, resulting in improved embryo quality, compatible with development to term.

## Upcoming events

Date	Event	Location
7 April 2025	<a href="#">SSF Industry Forum 2025</a> Sheep Sustainability Framework	Sydney, NSW

Funding calls

Program	Open	Close
<a href="#">MLA Producer Demonstration Site (PDS)</a>	1 April 2025	12 May 2025