FEBRUARY 2026

Sheep reproduction RD&A alert

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

Are you a livestock advisor ready to build your skills and networks? Registrations are now open for the Livestock Advisor Essentials (LAE) program in southern Australia.

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LAE is a professional development program designed for early career professionals working in the livestock industry.

- Gain practical skills, tools and knowledge to apply to your role and enhance your client offering.
- Build confidence and capability to provide holistic, high-quality advice and support to your red meat clients in five key areas.
- Explore new communication approaches to effectively engage with clients and promote your services to potential clients.
- Expand your network of industry contacts to share learnings and advice.

	Workshop	Date	Location
	Feedbase decision making	28–29 April	Launceston, TAS
	Genetics and reproduction	30 April	Launceston, TAS
	Building blocks of business	26–27 August	Sydney, NSW
	Meating the market	20 October	Murray Bridge, SA
	Influence and impact	21–22 October	Murray Bridge, SA

EARLY BIRD Registrations are now open at the discounted cost of $2,750 (incl. GST), After March 31st, registration for the full program will be $3,250 (incl. GST). Register here.

For more information contact livestockadvisoressentials@pinionadvisory.com

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.

Review papers

Principles of sheep behaviour: An overview from a welfare perspective

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Small Ruminant Research, Volume 255, February 2026 **OPEN ACCESS**

DOI https://doi.org/10.1016/j.smallrumres.2025.107687

Highlights

- Integrates dispersed knowledge on sheep behaviour from a welfare perspective.
- Describes sensory systems and their role in shaping sheep behaviour.
- Examines individual, social and maternal behavioural patterns in sheep.
- Reviews abnormal behaviours in sheep and their underlying causes.
- Discusses human–sheep interactions and their behavioural implications.

Abstract

The behaviour of sheep, like that of other animals, is the result of a complex interaction between causal mechanisms, their specific function, their development throughout life and their phylogenetic prevalence in the species. Within the domain of animal welfare, behaviour is of paramount importance, as they provide key insights into how individuals cope with environmental challenges and the way these challenges impact their mental states, biological functioning, and species-typical behavioural repertoires. The aim of this review is to critically and narratively examine key aspects of sheep behaviour to enhance the understanding of their biological needs and support improvements in the welfare of sheep raised under different production systems. The review emphasises the fundamental role of sensory systems in animal behaviour and welfare, along with the motivational systems, underlying individual, social, and maternal behaviours. It's also examines abnormal behaviours in sheep and their implications for human-animal interactions within the production context. The integration of sheep behaviour knowledge with contemporary flock management is strategic to enhance both welfare and productive efficiency. Future research should focus on improving behavioural assessments, improved handling techniques and the possible implementation of precision farming to monitoring sheep behaviour.

Cervical artificial insemination with frozen-thawed semen in sheep: the secret is in the cervix of Norwegian ewe breeds

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Biology of Reproduction, Volume 11,Issue 2, February 2026 **OPEN ACCESS**

DOI https://doi.org/10.1093/biolre/ioaf084

Abstract

In sheep, cervical artificial insemination (AI) of frozen-thawed semen is not practiced worldwide due to the unacceptably low pregnancy rates achieved (typically <30%). The exception to this is in Norway where farmers perform shot-in-the-dark vaginal AI with frozen-thawed semen and achieve pregnancy rates over 60%. Research in Ireland has shown that this is due to the breed of the ewe used in Norway and specifically the ability of sperm to traverse the cervix in some ewe breeds (such as those in Norway) but not others. This review summarizes the published studies performed over the last two decades, which have focused on characterizing the biological differences in the cervix of ewe breeds of divergent fertility. It not only discusses how this unique ewe breed effect can be used to develop our understanding of how frozen-thawed semen can cross the ovine cervix but also provides new in vivo opportunities through the addition of specific biomolecules that will protect sperm, thus improving the success of cervical AI using frozen-thawed semen in sheep.

Application of zona-free cloning technologies to livestock breeding programmes

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Animal Reproduction Science, Volume 287, April 2026 **OPEN ACCESS**

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Highlights

- Nuclear transfer cloning is technically difficult, inefficient and expensive.
- Removing the zona pellucida from oocytes streamlines the cloning process.
- Zona-free cloning has shown improved live birth outcomes in some livestock species.
- Cloning complements other uses of advanced reproductive and genomic technologies.
- Cloning elite, gene-edited embryonic cells could increase the rate of genetic gain.

Abstract

Advanced reproductive technologies are powerful tools for accelerating genetic gain because they enable both increased selection intensity and the generation of large numbers of offspring from elite animals. Among these, somatic cell nuclear transfer (SCNT) cloning offers a means to rapidly multiply elite genetics from nucleus herds into commercial populations. Genomic estimated breeding values allow for the accurate assessment of genetic merit in embryos and newborns, creating opportunities to identify elite young stock for cloning. Cloning will also be an important complement to gene-editing as a way to generate animals from cell lines carrying targeted genetic modifications. Nevertheless, the widespread application of cloning remains constrained by low efficiency and high costs, underscoring the need for continued optimisation. Zona-free cloning, also known as handmade cloning, has potential as a simpler and more scalable alternative to conventional micromanipulator-based methods to prepare cloned embryos, and has demonstrated promising improvements in pregnancy and live birth rates across several livestock species. This review summarises advances in zona-free cloning, tracing its development from the microblade to the two-pipette and micropipette methods, and evaluates their relative advantages and limitations. Approaches to improve the health and welfare of clones are examined, and potential applications of cloning in livestock breeding programmes, along with associated regulatory considerations, are discussed. Cloning may become increasingly important as a crucial bridge between lines of genetically elite and possibly gene-edited embryonic cells, and their manifestation as breeding animals in livestock improvement programs.

Scientific papers

Body condition score and weight are effective targeted selective treatment indicators for gastrointestinal nematodes in premating ewes

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VetRecord, Volume 198, Issue 3, January/February 2026 **OPEN ACCESS**

DOI https://doi.org/10.1002/vetr.5923

Abstract

Background. Ewe reproductive performance is key for flock profitability but can be impacted upon by gastrointestinal nematode (GIN) infections. Farmers commonly deworm ewes pre-mating, yet concerns regarding anthelmintic resistance increase pressure to reduce wormer use.

Methods. This study retrospectively assessed pre-mating targeted selective treatment (TST) indicators in a flock of 354 ewes split into anthelmintic treatment and control groups. Conway–Maxwell–Poisson and binomial regression analyses were used to identify TST indicators associated with reproductive performance.

Results. There was no significant difference in overall scanned litter size between treated and untreated ewes. However, ewes with a body condition score (BCS) less than 3 or a weight less than 60 kg that were not

dewormed had significantly lower litter sizes (mean 1.2 and 1.41, respectively) than those treated (1.94 and 1.8, respectively) or with higher condition/weight regardless of worming status ($p < 0.05$).
Limitations. Parasite diagnostics were not undertaken on all individual ewes, and the study assumes that differences identified in the reproductive performance of treated and untreated groups were due to GIN infection.
Conclusion. These findings suggest that BCS and weight are effective indicators for implementing TST pre-mating, enabling reduced anthelmintic use without compromising reproductive outcomes.

Interactive mixed reality simulation enhances student knowledge and ultrasound interpretation in sheep pregnancy diagnosis

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Veterinary Sciences, Volume 13, Issue 1 80 February 2026 **OPEN ACCESS**

DOI https://doi.org/10.3390/vetsci13010080

Simple Summary

Learning how to perform pregnancy ultrasound on sheep is an important skill for veterinary and animal science students, but it is difficult to teach using classroom lessons alone. Students must learn to turn a flat, two-dimensional ultrasound picture into an understanding of the 3D structures inside an animal, which many beginners find challenging. At the same time, opportunities to practice on live animals can be limited because of ethical and practical concerns. In this study, we tested the effectiveness of our training tool called Ewe Scan that uses a mixed reality headset to let students explore reproductive anatomy and practice pregnancy scanning in a realistic virtual environment. We compared students who used the Ewe Scan tool with those who received a traditional lecture. Students trained with mixed reality showed stronger understanding of ultrasound interpretation, remembered the material better six weeks later, and felt more confident and engaged during learning. These results show that mixed reality can improve training for important clinical skills in veterinary medicine while reducing pressure on live animals. As this approach supports learning of complex 3D ideas, it could also be adapted for other scientific or medical training where hands-on practice is difficult to provide.

Abstract

Transitioning from theoretical learning to practical application remains a significant challenge for students in medical and veterinary science education, particularly in the context of medical imaging and ultrasound interpretation. Traditional lecture-based methods offer limited support for developing the spatial reasoning and technical skills required for ultrasound pregnancy diagnosis. This study evaluates the effectiveness of an interactive mixed reality (MR) training tool, Ewe Scan, delivered through the Apple Vision Pro, compared to traditional lecture-based instruction. Forty-two undergraduate students were randomly assigned to either a lecture-trained or MR-trained group and assessed immediately after training and again after six weeks. Results showed that MR-trained students significantly outperformed their lecture-trained peers in both immediate comprehension and retention over time, particularly in ultrasound interpretation skills. The MR-trained group also reported higher levels of engagement, confidence, and satisfaction with their training experience. These findings suggest that MR-based learning enhances educational outcomes by improving spatial understanding, increasing active engagement, and supporting knowledge retention. Integrating MR simulations into ultrasound education offers a scalable, ethical, and effective alternative to traditional training methods, contributing to advancements in medical imagery education.

Assessment of sexual activity in rams stimulated with artificial light and its impact on unstimulated rams during the initial 14 days of male effect

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Small Ruminant Research, Volume 255, February 2026 **OPEN ACCESS**

DOI https://doi.org/10.1016/j.smallrumres.2025.107679

Highlights

- Artificial light increased sexual activity in rams during seasonal anestrus.
- Key behaviours were anogenital sniffing, approaching, and chasing ewes.
- Control rams with stimulated peers showed intermediate sexual activity.
- Afternoon was the peak period for sexual behaviour across all ram groups.

Abstract

Seasonal anoestrous reduces reproductive efficiency in sheep in temperate regions. Artificial photoperiod manipulation is a non-hormonal approach that stimulates ram sexual activity and enhances the "ram effect" on ewes. This study evaluated the sexual behaviour of rams subjected to artificial long-day photoperiods (L group) and their effect on non-stimulated rams (C group) during the first 14 days after introduction to anoestrous ewes. Eleven rams were assigned to photostimulated (n = 6) or control (n = 5) treatments, forming four groups: L, C, L+C (stimulated rams exposed to controls), and C+L (controls exposed to stimulated rams). Continuous video recording documented 5707 behavioural events. Photostimulated rams (L) exhibited higher activity (mean = 747.7 behaviours/ram) than other groups (C+L: 519.5; L+C: 443.0; C: 365.3; $p < 0.01$), with anogenital sniffing, approaching and chasing ewes being the most frequent behaviours. Activity peaked on days 2–5 post-introduction, mainly in the afternoon. Control rams housed with stimulated rams were more active than isolated controls, suggesting a social facilitation effect. These findings confirm that photoperiod manipulation enhances ram sexual activity and may influence non-stimulated rams through social interaction, as the different groups of animals exhibited distinct types and amounts of activity.

Sex-specific differences in expression of pluripotency-related transcription factors in sheep embryos produced in vitro

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Small Ruminant Research, Volume 255, February 2026 **OPEN ACCESS**

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Highlights

- Male embryos produced *in vitro* at high O_2 concentration have more pluripotency ability than females.
- ROS-mediated suppression of energy metabolism and ATP depletion jeopardize developmental potential of female embryos.
- Diminished developmental potential of female embryos showed downregulated expression level of pluripotency markers than male.

Abstract

Embryonic developmental potential and stem cell differentiation are regulated by different pluripotency-related transcription factors (TFs), which are sensitive to micromilieu oxidative status. Embryos lacking these factors have low developmental potential and lose pluripotency. Numerous studies report sex-specific differences in embryo development in relation to oxidative status. However, information on the sexual

dimorphism in the oxidative stress-induced expression levels of pluripotency markers in embryos is not available. Thus, the current study was designed to elucidate the sexual dimorphism in the relative expression levels of ROS-regulated pluripotency-related TFs (*SOX2, NANOG*, *OCT4, c-MYC, FGF4, KLF4, DPPA3, LIFR, and SOCS1)* in sheep embryos produced *in vitro*. Most of the TFs were significantly ($P < 0.05$) downregulated in female embryos as compared to male embryos. Significantly ($P < 0.05$) lower levels of ROS, higher levels of GSH, and fewer total cell numbers were observed in female embryos than in male embryos. The study concluded that male embryos produced *in vitro* have greater pluripotency ability than female embryos. In contrast, the female embryos *in vitro* are more stressed due to ROS-mediated suppression of energy metabolism, resulting in ATP depletion and jeopardizing their developmental potential, which in turn affects the pluripotency ability in association with downregulation of related TFs.

Poor maternal diet during gestation alters offspring muscle morphometrics, collagen gene expression, and meat tenderness in sheep

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DOI https://doi.org/10.3390/ani16030486

Simple Summary

Poor maternal nutrition during gestation alters the muscle growth of offspring, but how that impacts meat characteristics and quality is not well defined. Male offspring of ewes fed a restricted-fed diet had a greater longissimus muscle fiber size but reduced semitendinosus muscle fiber size, with no differences in longissimus or semitendinosus muscle weight. Offspring of ewes fed an overfed diet had loin chops that were more tender than offspring of restricted- or control-fed ewes. There were no differences in back fat or longissimus muscle collagen content as a result of maternal diet. However, gene expression related to muscle and collagen formation, and epigenetic markers, were altered as a result of maternal diet. These results suggest that a poor maternal diet impacts the meat characteristics that may alter the meat quality of sheep.

Abstract

We hypothesized that maternal overfeeding and restricted feeding during gestation would alter the collagen content, muscle fiber cross-sectional area (CSA), and meat tenderness in offspring. Pregnant ewes were fed 100% (CON), 60% (RES), or 140% (OVER) of their requirements from day 30 of gestation until parturition. Male offspring were necropsied at 282 ± 1.8 days of age. Gene expression and CSA were quantified in the longissimus (LM) and semitendinosus (STN) muscles. The Warner–Bratzler shear force (WBSF) was quantified in LM. Data were analyzed by one-way ANOVA, with diet as a fixed effect. Differences were considered significant at $p \leq 0.05$ or a tendency at $p \leq 0.10$. Semitendinosus CSA was smaller in OVER and RES than CON rams ($p = 0.02$). Longissimus CSA was larger in RES than OVER and CON rams ($p = 0.002$). OVER LM had reduced WBSF compared with CON rams ($p = 0.03$). Myogenic genes *bone morphogenic protein 1* (BMP1) and *paired box 7* were greater in RES LM than OVER ($p \leq 0.02$). Maternal diet altered the fibrogenic genes *fibronectin 1* ($p = 0.07$), *lysyl oxidase* ($p = 0.07$), and *collagen 1A1* (COL1A1; $p = 0.08$) in the LM and *COL1A1*, *COL3A1*, and *BMP1* ($p \leq 0.09$) in the STN. Poor maternal diet during gestation alters muscle and meat characteristics that may impact meat quality.

Prelamb shearing and its long-term benefits: behavioural and physiological responses of weaned male lambs to social isolation

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Highlights

- Shearing ewes during gestation improved weaned lambs' adaptation to social stress.
- Prelambing shearing increased lambs' exploration during social isolation.
- Lambs born to sheared ewes displayed less fear when isolated in a novel environment.
- Lambs born to sheared ewes had slightly increased T3 secretion after social isolation.
- The intrauterine environment influenced how weaned lambs cope with social stress.

Abstract

Prelamb shearing enhances neonatal ability to cope with environmental challenges after birth, but there is scarce information on its long-term effects. The aim of the study was to determine whether the physiological and behavioural responses to social isolation in a novel environment differ in weaned male lambs born to ewes shorn or not at mid-gestation (Sh and Con, respectively). On day 80 of gestation (winter), 12 multiparous Merino ewes carrying a single male foetus were shorn, while 9 were left unshorn. Ninety-day-old lambs were subjected to a social isolation test in a novel environment. Lambs' behaviour was video recorded during the test, and physiological responses were determined before and after the test. A fear index was calculated based on the display of fearful and exploratory behaviours. Serum cortisol, triiodothyronine (**T3**), total protein, albumin, globulin concentrations, maximum eye IR temperature, and glycemia increased immediately after social isolation ended ($P < 0.05$). The area under the curve of T3 concentration tended to be greater in Sh than in Con lambs ($P = 0.069$). However, the other physiological responses did not differ between groups. The mean duration of vocalisations was shorter in Sh than Con lambs ($P = 0.0006$). The number ($P = 0.001$) and the total time sniffing were greater in Sh than in Con lambs ($P = 0.002$). The fear index was greater in Con than in Sh lambs ($P = 0.02$). Lambs born to shorn ewes exhibited reduced fear and increased exploration when isolated in a novel environment, indicating they cope better with an acute stress challenge.

Extracellular vesicles in ram seminal plasma: transport and transfer of capacitation regulating factors to sperm

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Biology of Reproduction, Volume 114, Issue 2, February 2026

DOI https://doi.org/10.1093/biolre/ioaf248

Abstract

In mammals, seminal plasma is a complex fluid surrounding spermatozoa, composed of secretions from the male reproductive tract. It plays a crucial role in modulating sperm function, but it remains unclear whether the components that regulate sperm physiology, travel freely or within extracellular vesicles secreted by the reproductive tract and accessory glands. This study evaluated three methodologies—ultracentrifugation (UC), size-exclusion chromatography (SEC), and polyethylene glycol precipitation (PEG)—for isolation of ram seminal plasma extracellular vesicles enriched fractions (SP-EVs), assessing their efficiency in terms yield, morphology, protein profile, and functionality. Western blot confirmed the presence of EV-specific markers (CD9, CD63, and HSP70), minimal cytoplasmic and lipoprotein contamination. SEC, particularly the second fraction (P2), yielded SP-EVs with conserved morphology, apparently reduced aggregation, and a unique protein profile enriched in low molecular weight proteins, compatible with most capacitation-modulating proteins. In contrast, UC and PEG resulted in higher particle concentration and aggregation. By CFSE labeling of SP-EVs, all preparations exhibited a targeted binding pattern to spermatozoa, with distinct patterns localized to midpiece, head and post-acrosomal regions. Additionally, western blot analysis showed that SP-

EVs transport and transfer binder of sperm proteins (RSVP20 and RSVP14) to spermatozoa, with RSVP20 showing the highest incorporation, particularly from the P2 fraction. SPINK3, despite being detected in SP-EVs, was not incorporated, indicating selective protein delivery. These findings may be important to understand the role of seminal plasma extracellular vesicles on sperm, and significant for improving the efficiency of reproductive biotechnologies, as these ram SP-EVs enrichment fractions can deliver functional proteins to spermatozoa.

Maternal chromium supplementation increases lamb weaning weight and modulates rumen microbiota

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Animal, Volume 20, Issue 2, February 2026 **OPEN ACCESS**

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Highlights

- Maternal nutrition strategies shape offspring performance and rumen microbial taxa.
- Ewes fed 1.5 mg/day chromium propionate had lambs heavier at weaning.
- Maternal chromium supplementation modulated lamb rumen microbial taxa at slaughter.
- Changes suggested altered carbohydrate fermentation and lower lactic acid potential.
- Maternal chromium propionate may support rumen stability in intensive sheep systems.

Abstract

Maternal nutrition during gestation can program offspring development and may influence the establishment of the rumen microbiome, with implications for growth and rumen health. However, the effects of maternal chromium (Cr) supplementation on offspring rumen microbial communities and performance in sheep remain poorly characterised. This study investigated the effects of maternal Cr supplementation during late gestation and early lactation on the offspring microbiome and performance in lambs. Fifteen pregnant ewes were assigned to two treatments in a randomised design: no Cr supplementation and 1.5 mg chromium propionate per ewe/day. Male Dorper × Santa Inês lambs (n = 19) were weaned at 80 d. They were provided creep feeding from 20 d to weaning, and finished in individual feedlot pens until slaughter at 132 d. The rumen microbiota of the offspring at slaughter was characterised. Feed intake, BW, daily gain, feed efficiency, and carcass yield were measured. Maternal Cr supplementation increased the weaning weight of lambs (P = 0.048), although no differences were observed in the feed intake, daily gain, or carcass weight. While the overall microbial diversity was unchanged, Cr increased Flexilinea (P = 0.042), SP3-e08 (P = 0.040) and U29-B03 (P = 0.037), genera linked to fibre degradation and volatile fatty acid modulation. Conversely, Cr reduced Streptococcus (P = 0.029), potentially lowering lactic acid accumulation and ruminal acidosis risk, and Oribacterium (P = 0.025) and Pseudobutyrivibrio (P = 0.008), genera involved in glycolysis and cell wall biosynthesis. In conclusion, supplementation with 1.5 mg chromium propionate during late gestation and early lactation increased lamb weaning weight and modulated rumen microbial taxa, suggesting potential improvements in nutrient utilisation and rumen stability.

The effect of photoperiod on the profile of prolactin, leptin, insulin and the content of bioactive substances in sheep milk during the rearing period of lambs

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Animals, Volume 16, Issue 4, February 2026 **OPEN ACCESS**

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Simple Summary

Seasonal changes in day length strongly influence physiological processes in sheep, including milk production and lamb growth. This study examined how the season of lambing affects milk hormone levels (prolactin, leptin, and insulin), the nutrient composition of milk, and lamb body weight gain. Ewes that lambed under longer daylight hours produced more milk with higher prolactin and insulin levels, and their lambs showed greater daily body weight gains compared to mothers lambing under shorter daylight hours. Differences in milk nutrient content were also found between seasons. These studies demonstrate that seasonal environmental factors can alter both milk quantity and quality, thus influencing offspring growth. Understanding these effects helps improve sheep management practices, optimal planning of production seasons, and strategies that support both milk yield and lamb development, which is important for animal welfare and animal production efficiency.

Abstract

Photoperiod and seasonality influence reproduction and lactation in sheep, but their effects on milk hormones, milk composition, and lamb growth are not fully understood. This study assessed the effect of season on milk prolactin, leptin, and insulin concentrations, milk chemical composition, lactation performance, and lamb growth in Polish Mountain ewes. Forty ewes were divided into the following two groups: short-day (lambing in December, n = 20) and long-day (lambing in May, n = 20). Milk samples were collected on days 5, 15, 25, 35, and 45 of lactation. Ewes in the long-day photoperiod had higher milk yield ($p < 0.01$) and higher prolactin and insulin concentrations ($p < 0.01$), whereas leptin concentrations did not differ seasonally. Milk from short-day ewes was characterized by higher dry matter and fat content ($p < 0.01$) and higher protein and lactose content ($p < 0.05$). Lambs from the long-day group achieved higher mean daily gain ($p < 0.01$). These results indicate that photoperiod influences lactation performance, milk composition, and offspring growth through seasonal hormonal and metabolic mechanisms, suggesting that appropriate lambing timing and day length manipulation can improve milk production efficiency and lamb growth in practical sheep production systems.

Estimating the value of including resilience in a multi-trait selection index designed for Australian Merino sheep

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Journal of Animal Breeding and Genetics, Volume 143, Issues 2, March 2026

DOI https://doi.org/10.1111/jbg.70021

Abstract

General resilience in livestock can be estimated from the variability in longitudinal data and may support balanced breeding objectives by helping animals better cope with environmental stress. However, its economic value and inclusion within multi-trait selection indexes remain largely unexplored. Current genetic improvement programs for sheep primarily focus on wool growth, reproduction and lean meat production. This study developed a bioeconomic model to estimate the economic value of general resilience, using the natural logarithm of variance of wool fibre diameter as a resilience indicator trait in sheep. A commercial Merino sheep enterprise was considered, and the economic value of resilience was derived from its association with health, mortality, and energy allocation for production. The breeding objective included key traits related to meat production, reproduction, and wool quality and quantity, to compare the economic impact of resilience with these traits. Among 13 traits, resilience contributed 2.02% to the total value of the index and ranked 11th in economic importance. After 10 years of simulated selection, resilience was expected to improved by 0.07 genetic standard deviations, translating to a modest economic gain of $0.08

per ewe. A sensitivity analysis was conducted to assess the impacts of increasing the relative contribution of resilience within the index on selection responses under four scenarios: (i) base genetic correlations, (ii) stronger correlations, (iii) weaker correlations, and (iv) adding genomic information. Resilience responded 50%–75% more effectively to selection when it had stronger genetic correlations with production traits or when genomic information was incorporated. However, placing greater emphasis on resilience (> 10% of the index) reduced progress in key production traits. Future research should explore these trade-offs in industry selection indexes to integrate resilience effectively without compromising productivity.

Combined pathway-based biomarker discovery and ESR2 gene, polymorphism analysis of litter size prediction in sheep using a, multi model bioinformatics toolbox

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Animal Reproduction Science, Volume 286, March 2026

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Highlights

- Sheep litter size genetics were explained by means of an integrated multi-modal approach.
- Genes, exceeding ten, that are strong indicators of a sheep's litter size were discovered.
- LS in sheep was significantly correlated with the ESR2 T/C polymorphism.
- ESR2 and other candidate genes are used as biomarkers to indicate prolificacy in sheep.
- With on-farm data, a new bioinformatics pipeline was integrated.

Abstract

By utilizing a comprehensive multi-modal approach that combined in silico modeling, in vitro molecular assays, in vivo microscopic observations, and on-farm phenotyping, we aimed to improve comprehension of the genetic architecture related to sheep litter size (LS). Our goal was to assess a T/C polymorphism (rs423810437) in the ovine Estrogen Receptor 2 (ESR2) gene and find potential LS biomarkers by applying network and circuit analysis. The sequencing of this polymorphism involved four populations, specifically the Romanov, Ghezel, Lori Bakhtiari, and their crossbreeds. With strong support for BMPR1B, GDF9, and ESR2, our analysis found more than ten candidate genes linked to LS. In purebred Romanov and Romanov-crossbred sheep, the ESR2 C allele was significantly correlated ($p < 0.01$) with increased LS. As our research suggests, the ESR2 polymorphism, among the identified candidate genes, is a valuable biomarker for litter size, offering understanding of follicular development in prolific sheep.

Maternal placental mitochondrial dysfunction, oxidative stress, and autophagy by regulating ferroptosis in pregnant ewe model

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Animal Reproduction Science, Volume 286, March 2026

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Highlights

- Exposure to T causes OS, mitochondrial dysfunction, autophagy, and ferroptosis in ovine trophoblasts and placenta.
- Triggering ferroptosis aggravated T-related OS, autophagy and mitochondrial dysfunction in ovine trophoblasts and placenta.

- Our findings provide unique insights into the mechanism underlying the involvement of ferroptosis in impairments of placenta.

Abstract

Elevated prenatal testosterone (T) induces placental insufficiency and fetal growth restriction (FGR) in sheep, a process hypothesized to involve oxidative stress (OS), mitochondrial dysfunction, autophagy, and ferroptosis. While ferroptosis is recognized as a significant contributor to placental pathophysiology, its specific role in T-mediated ovine placental dysfunction required further investigation. To address this, an in vivo study was conducted wherein pregnant Hu sheep received intramuscular injections of 100 mg T propionate or a control vehicle twice weekly from gestational day (GD) 60–130. Complementarily, in vitro experiments utilized dihydrotestosterone (DHT)-exposed ovine trophoblast cells (OTCs), which were further treated with the ferroptosis activator Erastin or inhibitor Ferrostatin-1 (Fer-1) to directly probe the functional impact of ferroptosis. Our results demonstrated that T administration in vivo recapitulated the pathological phenotype, triggering placental OS, mitochondrial dysfunction, ferroptosis, autophagy, and culminating in FGR. Consistent with these findings, DHT exposure in OTCs induced a similar suite of cellular stresses, including OS, mitochondrial impairment, ferroptosis, and autophagy. Crucially, the inhibition of ferroptosis with Fer-1 in DHT-treated OTCs was found to attenuate these detrimental effects, notably alleviating OS, iron overload, mitochondrial dysfunction, and autophagic activity. Conversely, the co-administration of the ferroptosis inducer Erastin effectively abolished the protective changes conferred by Fer-1, thereby substantiating a central role for ferroptosis in the cascade of T-induced placental dysfunction.

Graphene oxide enhances post-thaw sperm quality in tropically-adapted rams

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Highlights

- Extender supplemented with graphene oxide (GO) improved post-thaw sperm quality.
- Extender + GO at 5 and 50 µg/mL improved post-thaw sperm motility by up to 24.6 %.
- Extender + GO at 5 and 50 µg/mL increased post-thaw sperm viability by up to 18.4 %.
- Extender + GO reduced immotile sperm number and protected sperm DNA after freezing.
- GO has potential use as an additive to extenders for ram semen cryopreservation.

Abstract

This study investigates the effects of graphene oxide (GO) on the quality of frozen-thawed ram semen. Each of 30 ejaculates from five rams were cryopreserved with a control extender (Optidux®, Reprodux Inc., Brazil) or extender containing GO concentrations at 5, 50, or 100 µg/mL. Post-thaw data were analyzed using Tukey's or Dunn's t test ($p < 0.05$). Graphene oxide at 5 and 50 µg/mL increased frozen-thawed total (50.4 ± 3.15; 52.0 ± 2.76 %), and progressive sperm motility (44.2 ± 3.06; 45.7 ± 2.68 %) vs control (42.0 ± 2.75; 36.7 ± 2.58 %), and sperm viability (56.3 ± 2.17; 57.8 ± 2.82 %) vs control (48.8 ± 2.60 %); and decreased immotile spermatozoa (49.6 ± 3.15; 48.0 ± 2.76 %) vs control (58.0 ± 2.75 %). Both 5 and 100 µg/mL treatments improved DNA integrity (90 ± 0.34; 90.5 ± 0.44 %) vs control (89.1 ± 0.37 %). There were no GO effects on sperm morphology, VCL, VAP. Local motility, an undesirable parameter, increased significantly from 5.42 ± 0.52 % (control) to 6.77 ± 0.43 % (100 µg/mL GO). Supplementation with GO improved post-thaw sperm progressive motility (by up to 24.5 %) and viability (up to 18.4 %), reducing

immotile sperm (up to 17.2 %), compared to extender alone. This potentially supports the practical use of GO as an additive to semen extenders.

Spatial differences in the ovine cervical microenvironment at the follicular and luteal phases of the oestrous cycle; Implications for sperm transport

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Highlights

- Squamous epithelium found within the sheep cervix.
- Cervix cellular height increased during the follicular phase.
- Cervix microgroove tortuosity increases towards the uterine end of the cervix.
- Lectin binding maps mucus-rich regions within the sheep cervix epithelium.
- Mucus composition changes with reproductive phase, aiding sperm passage.

Abstract

The complex anatomy of the ovine cervix presents a significant barrier to transcervical artificial insemination, necessitating sperm deposition at the external cervical Os. This study aimed to evaluate the cervical microarchitecture to elucidate the mechanisms orchestrating sperm transport across the cervix. Cervices from crossbred ewes (n = 13) were harvested during the follicular (n = 6) and luteal (n = 7) phase, sectioned into 10 transverse segments from external to internal Os (1 = External cervical Os; 10 = Internal cervical Os), and analysed for epithelial morphology and microgroove architecture. Columnar epithelium predominated throughout the cervix, with a squamocolumnar junction localised at the external Os. Columnar cell height was significantly greater during the follicular phase (33.3 ± 1.31 µm) than the luteal phase (26.7 ± 1.21 µm; $p < 0.001$). Cervical microgroove surface area increased during the follicular phase ($p < 0.05$). Microgroove surface area, depth, and tortuosity (deviation from a straight line) increased progressively toward the internal Os and were enhanced during the follicular phase ($p < 0.05$). Sialic acid expression was elevated in secondary and tertiary microgrooves during the follicular phase ($p < 0.001$), with mucin-bound sialic acids showing spatial variation along the canal. Segment 4 exhibited the lowest sialic acid expression ($p < 0.01$). Reproductive phase by cervical segment interactions affected both the secondary, tertiary microgroove epithelium, and surrounding luminal region adjacent to the tertiary microgrooves ($p < 0.001$). This study provides a detailed characterisation of the microarchitecture of the ovine cervical canal which is critical to understanding the mechanisms orchestrating sperm transport.

Upcoming events

Date	Event	Location
10 March 2026	Feed Budgeting Masterclass AWI	Narromine, NSW
12 March 2026	No pain, More gain: Enhancing welfare in sheep husbandry Australian Veterinary Association	Webinar
18 March 2026	Sheep Strong: The next chapter for sheep producers WALRC Livestock Matters Forum	Coyrecup, WA
27 March 2026	Making Maidens Weight PDS & Leading Sheep Forum Leading Sheep, MLA PDS & ASI	Longreach, QLD