

JUNE 2026

Sheep reproduction RD&A alert

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

MLA's [Producer Demonstration Site \(PDS\) program](#) has released its [May Quarterly Project Update](#). The PDS updates provide a snapshot of progress across the program's levy, co-contributor and integrated R&D projects.



The May update provides the latest details from the following projects:

- More Northern Mallee Lambs on the Ground
- Supporting sheep producers to optimise ewe lamb joining outcomes
- Demonstration of Optiweigh use in lamb finishing systems
- More lambs from ewe lambs

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For more details on these projects and others, use the [PDS search tool](#).

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

Magnetic nanoparticle–based sperm selection: Progress and prospects for improving semen quality and fertility in livestock

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Animal Reproduction Science, Volume 291, August 2026

DOI <https://doi.org/10.1016/j.anireprosci.2026.108225>

Highlights

- Careful sperm selection enhances fertilization efficiency and reproductive outcomes.
- Magnetic nano-purification enables molecular-level, non-invasive sperm selection.
- Nano-purified sperm show improved motility, membrane integrity, and DNA quality.
- Magnetic separation minimizes physical stress compared with centrifugation.
- Technique enhances fertilization competence and embryo developmental potential.

Abstract

Semen nano purification represents an innovative advancement in livestock reproductive biotechnology, offering a targeted, non-invasive approach to sperm selection. Traditional semen processing techniques, such as centrifugation, swim-up, and density gradient methods, primarily rely on physical characteristics like motility and morphology, which often fail to eliminate apoptotic, acrosome damaged or functionally

impaired spermatozoa. In contrast, magnetic nano-purification enables selective removal of defective sperm based on molecular surface markers, including phosphatidylserine, ubiquitin, acrosomal glycans and other membrane proteins associated with specific conditions. This review explores how understanding sperm subpopulation diversity and surface biomarker expression provides a foundation for advanced, fertility-driven sperm selection strategies. It further discusses the principles of magnetic nanoparticle synthesis, surface functionalization, and the practical workflow of semen purification. Comparative studies demonstrate that nano-purified spermatozoa exhibit superior membrane integrity, motility, mitochondrial activity, and DNA quality while reducing oxidative stress. Notably, field trials have shown enhanced conception rates with nano-purified semen at half the conventional sperm dose. The method's low cost, safety, and ease of use in field settings make it a practical option for its utility in artificial breeding programs. Future perspectives highlight its potential for multiplexed selection and non-invasive sex-sorting through sperm surface biomarker-specific conjugation. Collectively, magnetic nano purification stands as a transformative strategy to improve sperm quality, enhance reproductive outcomes, and support genetic advancement in livestock production systems.

Scientific papers

Reproductive efficiency in sheep: Estimates and relationships with fertility, fecundity and lamb survival

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Animals, Volume 16, Issue 11, June 2026 **OPEN ACCESS**

DOI <https://doi.org/10.3390/ani16111608>

Simple Summary

Enhanced reproductive efficiency is key to meeting the challenge of the increased demand for sheep meat globally. This can be achieved by improving the pregnancy rate (fertility) and litter size (fecundity) of ewes and the survival of their lambs. Predicting how these parameters interact is important to achieve optimal reproductive efficiency (number of lambs weaned per breeding ewe). The aim was to establish mean values for these parameters and model relationships from world data. Gains in reproductive efficiency increased for each parameter (fertility, fecundity, and survival), but major gains that were made by improving fecundity were limited by reduced survival. Specialist 'wool'-producing sheep were the least efficient, compared with the 'prolific' class, which were the most efficient. Efficiency values for other classes (dual-purpose, meat, milk, fat-tail, wool-shedders) were intermediate. Benchmarking of major breeds within countries for reproductive efficiency and its parameters focused research and educational effort on the parameters that needed the most improvement and was successful. In conclusion, this study provides an overview of the reproductive efficiency of the world's sheep population (though based on <5% of global breeds), establishes how the parameters controlling efficiency interact, and estimates contributions made by breed, country and world region toward reproductive output.

Abstract

Addressing increased demand for sheep meat globally is dependent on reproductive efficiency (lambs weaned per 100 breeding ewes). Efficiency is determined by ewe fertility (pregnancy rate) and fecundity (litter size), as well as lamb survival. This paper provides estimates of these components from the world literature and examines their relationships with breed class (wool, dual-purpose, meat, milk, prolific) and within breed class, country and global region. Reproductive efficiency was estimated at 97.7 ± 2.68 , while values for fertility, fecundity and lamb survival were 83.9 ± 0.95 , 144.6 ± 3.48 and $80.8 \pm 0.93\%$, respectively. Efficiency increased for each component, with the response being greatest for fecundity ($R^2 = 0.4896$, $p < 0.001$). Within breed classes, medium- and strong-wool Merinos were more ($p < 0.05$) efficient than fine-

wools, while narrow-tailed meat breeds were more fecund ($p < 0.05$) than fat-tail, wool-shedders and hair types. Efficiencies in the single- versus multiple-gene prolific groups were $124.6 \pm 32.52\%$ and $152.9 \pm 10.1\%$, respectively. In conclusion, these findings provide an overview for the reproductive efficiency of the world's sheep population (though based on $<5\%$ of breeds), quantify how the parameters controlling efficiency interact, and estimate contributions made by breed, country and world region toward reproductive output.

Prenatal stress improves the ability of neonatal lambs to maintain body surface temperature during periods of cold exposure

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International Journal of Biometeorology, Volume 70, Article number 188 **OPEN ACCESS**

DOI <https://doi.org/10.1007/s00484-026-03243-z>

Abstract

Exposure to cold and hypothermia is a significant threat to newborn lamb survival in extensive systems, and the ability to thermoregulate is essential for improved survivability. Lambs exhibit enhanced thermogenic abilities and increased brown fat deposition when ewes experience cold during late-pregnancy. This study evaluated the effects of various prenatal stressors on newborn lamb thermogenesis through three experiments. Experiment 1 examined the impact of mid-pregnancy shearing and wetting on lamb thermogenesis. Experiment 2 involved transporting and cold-exposing late-pregnancy ewes. Experiment 3 combined stressors like yarding, transport, wetting, and cold exposure in mid- or late-pregnancy ewes. Four-hour-old lambs were subjected to a 1-hour cold challenge during which infrared thermal images from the dorsal midline were taken every 10 min. Lambs from ewes shorn and wetted during mid-pregnancy tended to have higher body surface temperatures than those handled during mid-pregnancy (Experiment 1; $P = 0.073$) and they also maintained body surface temperature better during the cold challenge (Experiment 1; $P = 0.025$). Lambs from ewes exposed to late-pregnancy combined stressors showed higher radiated body surface temperatures than both mid-pregnancy stressed and control lambs (Experiment 3; $P < 0.05$) while late-pregnancy stress group lambs maintained radiated body surface temperature longer than both mid-pregnancy stressed and control groups lambs (Experiment 3; $P < 0.01$). The study concludes that cold exposure combined with husbandry stressors leads to differences in lamb thermogenesis, with mechanisms varying based on the timing of stressors.

A plasma metabolomics analysis reveals a panel of metabolic biomarkers for early pregnancy diagnosis in Hu sheep

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Livestock Science, Volume 309, July 2026

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Highlights

- This study utilized an untargeted metabolomics approach combined with Random Forest analysis to identify 353 differentially expressed metabolites (DEMs) in plasma samples from non-pregnant and pregnant ewes, revealing potential early pregnancy biomarkers.
- Four metabolites (N-Acetylcytidine, cAMP, Flavanone 7-O-Glucoside, and Bisdethiobis(methylthio)gliotoxin) were found to decrease progressively during pregnancy, becoming undetectable by day 30, highlighting their potential as diagnostic markers for early pregnancy detection.

- By integrating Random Forest and ROC curve analyses, the study identified 8 metabolites with significant changes during gestation, paving the way for the development of novel molecular diagnostic techniques to enhance reproductive management and productivity in sheep breeding.

Abstract

In an effort to enhance reproductive management and reduce non-productive periods in sheep breeding, this study utilizes an untargeted metabolomics approach combined with Random Forest analysis for the identification of early pregnancy biomarkers in ewes. We examined differentially expressed metabolites (DEMs) in the plasma samples from non-pregnant ewes (NP, n=7), pregnant ewes at 19 days (P19, n=8) and at 30 days (P30, n=7). This study identified 353 DEMs among three groups, mainly influenced by lipids and lipid-like molecules, organic acids and derivatives, and organoheterocyclic compounds, affecting plasma metabolite changes during pregnancy. Among these, the expression levels of four metabolites (N-Acetylcytidine, cAMP, Flavanone 7-O-Glucoside, and Bisdethiobis(methylthio)gliotoxin) gradually decreased as pregnancy progressed, becoming undetectable by day 30 of gestation, and were identified through ROC (Receiver Operating Characteristic) curve analysis as potential early pregnancy diagnostic markers. Additionally, by combining Random Forest analysis with ROC curve analysis, we identified 2 metabolites that were continuously upregulated with increasing gestational time (Indoxyl Sulfate, PC(17:0/20:4)) and 6 metabolites that were continuously downregulated with increasing gestational time (PS(18:0/20:4), PC(18:0/18:1), PI(17:0/14:1), Altenuene, 4-Hydroxy-3-methoxy-cinnamoylglycine, methyl 2-{2-[9-(4-methylphenyl)-6-oxohydropurin-8-ylthio]acetylaminobenzoate) that could serve as early pregnancy diagnostic markers based on feature importance using Random Forest. This research establishes a robust theoretical foundation for the development of innovative molecular diagnostic techniques and explores new avenues for molecular genetic breeding, ultimately enhancing fertility and productivity in ewe herds.

Scabiosa atropurpurea mitigates oxidative stress and maintains the viability of cryopreserved ram sperm: evidence from oral and extender supplementation

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Highlights

- AES improves biochemical stability of frozen–thawed ram semen.
- Extender supplementation enhances membrane integrity.
- Oral AES strengthens systemic antioxidant defenses.
- Combined strategy reduces cryo-induced sperm damage.
- Natural antioxidant approach for semen preservation.

Abstract

This study evaluated the effects of oral supplementation with *Scabiosa atropurpurea* aqueous extract (AES) and/or its inclusion in the semen extender on the post-thaw semen quality and oxidative status of ram semen. Ten “Queue Fine de l’Ouest” rams were assigned to either a control (n = 5) or a treated group (n = 5) receiving AES orally (50 mL/day, 2 mg/kg). Semen was collected, pooled, and divided into five aliquots, then diluted with extenders containing 0–1 g/L AES, resulting in 10 experimental conditions. After thawing, several parameters were assessed: sperm motility, kinetics, viability, morphology, membrane integrity, oxidative stress markers (TAS, TOS, OSI, MDA), ATP and Ca²⁺ concentrations, DNA fragmentation, and HSP70 levels. Oral AES supplementation did not significantly affect total motility (P > 0.05); however, it improved

antioxidant status by increasing TAS (22.0 ± 0.5 vs. 20.3 ± 0.3 mmol/L; $P < 0.05$) and reducing MDA (5.2 ± 0.3 vs 3.5 ± 0.3 μ mol/L; $p < 0.05$) and OSI (1.1 ± 0.0 vs 0.7 ± 0.0 ; $P < 0.05$). The inclusion of AES in the extender reduced the proportion of damaged spermatozoa ($24.0 \pm 1.1\%$ vs. $37.7 \pm 1.2\%$; $P < 0.05$) and improved both the ATP ratio (2.1 ± 0.0 vs. 0.9 ± 0.0 mg/L per g protein) and Ca^{2+} concentration (32.9 ± 1.0 vs. 22.6 ± 1.1 mg/L per g protein; $P < 0.05$). The combined supplementation protocol (2 mg/kg oral AES + 1 g/L extender AES) provided the most effective protection against oxidative stress and significantly enhanced membrane integrity, ATP production, and Ca^{2+} levels in post-thaw sperm. In conclusion, AES supplementation improves the biochemical stability and cellular integrity of cryopreserved ram semen.

Behavioural patterns of grazing ram lambs exposed to gastrointestinal nematode parasitism

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Veterinary Parasitology, July 2026 **OPEN ACCESS**

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Abstract

Nematode parasitism is known to affect animal behaviour. Wearable sensor technologies have the capability of automatically detecting behavioural changes of animals in real-time, which may enable early and timely detection of parasite infection, leading to improvements in treatment protocols. The purpose of this study was to investigate the behavioural changes of grazing lambs, detected with wearable accelerometers, when exposed to an infection challenge of gastrointestinal nematodes (GIN). Thirty-six grazing ram lambs (10 weeks-of-age) wearing Cowmanager ear-tagged tri-axial accelerometer sensors were allocated to one of four groups which were managed as one mob on pasture during a six week infection period. Two groups received a trickle infection with both of the gastrointestinal nematodes *Teladorsagia circumcincta* and *Trichostrongylus colubriformis* (OP) while the other two groups remained not infected (NP). After four weeks, one of each of the OP and NP groups was then treated with an anthelmintic, giving rise to four treatments, viz, Infected and treated (OP1), infected not treated (OP2), not infected and treated (NP1) and not infected and not treated (NP2). Compared with non-parasitised lambs, infection reduced live weight gain ($P = 0.008$), and increased both FEC (faecal egg count) ($P < 0.001$) and IgA antibody titres ($P = 0.011$). Compared with their respective NP counterparts, infected animals (OP1 and OP2 until day 28 and OP2 from day 42) showed reduced eating (-91.7 mins/d) and ruminating (-15.5 mins/d) time, increased time spent inactive ($+88.4$ mins/d), active ($+7.4$ mins/d) and highly active ($+12.7$ mins/d). In addition, diurnal patterns of activity were altered by both parasite infection and anthelmintic treatment of infected animals. Compared with their respective controls, drenching of lambs increased eating duration during the daytime and at sunset, while altered diurnal profiles of the time spent ruminating, being inactive and highly active were also evident. This study shows the potential use of on-animal automated activity recording technologies to detect changes in behavioral patterns caused by nematode parasitism in grazing lambs. However, lambs had already suffered lost production before behavioural differences were evident, bringing into question the suitability of these technologies as an early detection tool.

A comprehensive explainable machine learning framework for predicting sheep body weight

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Highlights

- Explainable ML framework developed for Harnai sheep body weight prediction.

- Extra Trees achieved $R^2 = 0.94$, MAE = 1.63 kg using Optuna-NCV optimization.
- Fat-tail width, face length, and ear length are top SHAP-ranked predictors.
- Isolation Forest and Boruta ensure robust preprocessing and feature selection.
- A user-friendly GUI enables practical field deployment of the prediction model.

Abstract

This study introduced an explainable machine learning (ML) framework that integrates data preprocessing, optimized ensemble tree-based algorithms, and SHapley Additive exPlanations (SHAP) to estimate the body weight (BW) of sheep from various morphometric measurements. The data include records of BW and nine body measurements, such as body length, withers height, face length, chest girth, ear length, length between ears, paunch girth, fat-tail width, and fat-tail length, that served as predictors, from 651 Harnai sheep, an indigenous fat-tailed breed from Pakistan. After checking multicollinearity and identifying anomalies using Isolation Forest, several machine learning models, namely Multilayer Perceptron, Support Vector Regression, and six ensemble tree-based models (Random Forest, Extra Trees, XGBoost, LightGBM, CatBoost, and AdaBoost) were developed. Hyperparameters of models were optimized with Optuna framework inside a nested cross-validation (NCV) setup to avoid overly optimistic performance estimates. Among all models, the Extra Trees performed the best (test $R^2 = 0.94$; MAE = 1.63 kg; RMSE = 2.18 kg; MAPE = 4.45%). SHAP results suggested that fat-tail width, face length, and ear length were the strongest contributors to BW predictions, an outcome that makes biological sense for fat-tailed breeds, where tail morphology can reflect overall body condition. The proposed framework offers a combination of good predictive accuracy, interpretability, and computational efficiency. These characteristics make it potentially useful for precise livestock management, morphometric-based selection programs, and low-cost automated weight estimation in resource-constrained settings. A simple graphical user interface was also developed to make the model easier to use in practical field situations.

T helper cell cytokines and complement pathway are modulated in the ovine duodenum during early pregnancy

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Highlights

- Early pregnancy induces a Th1 to Th2 shift in the duodenum during early pregnancy in sheep.
- Early pregnancy regulates the expression of complement components in the ovine duodenum.
- IL-2, IL-6, C1q, and C2 proteins are located in the villi and intestinal glands.

Abstract

Pregnancy increases the growth of intestinal epithelial villi in mice, and T helper (Th) cell cytokines and complement pathways are related to regulating intestinal immune responses. Nevertheless, it is unclear if early pregnancy has effects on the expression of Th cytokines and complement components in the ovine duodenum. In this study, ovine duodenum were collected at day 16 of the estrous cycle (N16), and at days 13, 16, and 25 of pregnancy (P13, P16, and P25), and mRNA and protein expression of Th cytokines and complement components were analyzed. Our results indicated that early pregnancy enhanced the expression of IL-2, IL-5, IL-6, C1q, C1r, C1s, C2, C4a, C5b, and C9, but decreased the expression of TNF- β , IL-10, and C3b at P25 compared to N16. In addition, the expression of IFN- γ and IL-4 was only significantly downregulated at P13 compared to the other three groups. In summary, early pregnancy induced a Th1 to Th2 shift and regulated the expression of complement components in the ovine duodenum, which may be implicated in intestinal immune homeostasis and adaptation to pregnancy in sheep.

A computer vision end-to-end method for predicting sheep body weight from depth images

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Small Ruminant Research, Volume 261, August 2026 **OPEN ACCESS**

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Highlights

- A ConvNet-based model for predicting sheep body weight from depth images is proposed.
- Automatically locates animals and estimates the weight without explicit segmentation.
- Assess the generalization across distinct coat colors, farms, and weight ranges.
- Use General Linear Mixed Model (GLMM) to investigate influence on performance.

Abstract

Regular monitoring of animal weight is essential in livestock management; however, traditional weighing methods using scales are labor-intensive and stressful for both animals and humans. To address these challenges, computer vision (CV) techniques have been explored for predicting animal weight from images. However, current works with sheep still suffer from low accuracy and generalization. Within the scope of a coarse-to-fine research approach aimed at developing more efficient, non-invasive, and generalizable methods for small ruminants weighing in livestock farms, this study evaluates the accuracy and generalization of predicting the body weight of sheep from dorsal depth images. It was proposed a ConvNet method based on the EfficientNet-B3 network which operates in an end-to-end fashion: it automatically locates the animal, measures the traits most relevant to prediction, and estimates sheep's body weight. Model performance was evaluated using the Coefficient of Determination (R^2), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE). Saliency maps were generated to qualitatively assess feature relevance and model interpretability, and the impacts of combining images from different farms on prediction performance were also analyzed. Moreover, the factors that influenced the performance (experimental, animal, and image-related sources of variation) were investigated using a novel approach based on Generalized Linear Mixed Model (GLMM). The proposed model achieved promising results, with an R^2 of 0.97, MAE of 1.68 kg, and MAPE of 6.74%, demonstrating competitive performance with existing approaches. These findings contribute to advance technological methods for small ruminants meat sector.

Three doses of a synthetic analogue of $\text{PGF}_{2\alpha}$ improves the reproductive performance of ewes at timed artificial insemination

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DOI <https://doi.org/10.1016/j.smallrumres.2026.107802>

Highlights

- A three-dose $\text{PGF}_{2\alpha}$ protocol (3PG) induces a better oestrus synchrony of ewes.
- Greater progesterone levels were observed in luteal phase of ewes treated with 3PG.
- The 3PG protocol improves pregnancy rates in ewes at timed artificial insemination.

Abstract

The study aimed to evaluate a new $\text{PGF}_{2\alpha}$ (PG; Delprostenate 160 $\mu\text{g}/\text{dose}$) protocol for timed AI (TAI) in ewes compared with a long interval PG protocol. Four experiments involving 675 Merino ewes were performed. Ewes were synchronized with two PG doses administered at 15-days interval (2PG protocol), or three PG

doses, administered at 7– and 15–days intervals (3PG protocol). Experiment 1 evaluated the timing of estrus from the last PG treatment (0 h; PG–estrous interval). Experiment 2 studied the timing of ovulation relative to the onset of estrus (estrous–ovulation interval), follicular dynamics and plasma progesterone around 0 h. Experiment 3 observed reproductive outcomes of both protocols following TAI. Experiment 4 assessed cervical mucus characteristics. More ewes showed estrus from 12 up to 96 h in 3PG than 2PG protocol ($P < 0.05$). Estrous synchrony from 24 up to 60 h tended to be greater in 3PG protocol ($P = 0.05$). There were no differences in pre-ovulatory follicle dynamics or mucus characteristics but progesterone concentrations in the early and medium luteal phase were greater in 3PG protocol ($P < 0.05$). The 3PG protocol resulted in higher pregnancy rate ($P < 0.05$) and fecundity rates ($P = 0.07$) compared with 2PG protocol. We conclude that 3PG protocol improves pregnancy rates in ewes after cervical TAI at 68 h with fresh semen, likely due to a better estrous synchrony and progesterone concentrations in the early and medium luteal phase.

Nutritional restriction alters uterine one-carbon metabolism and DNA methylation-related gene expression in cyclic ewes during the luteal phase

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Small Ruminant Research, Volume 261, August 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.smallrumres.2026.107812>

Highlights

- Undernutrition in sheep reduces the expression of uterine folate transporters.
- Restricted diets affect genes that regulate DNA methylation in the uterus.
- Uterine global DNA methylation stays stable despite changes in gene expression.
- Nutritional restriction disrupts one-carbon metabolism in the uterus.

Abstract

Nutritional restriction alters uterine physiology in sheep; however, the underlying molecular mechanisms remain poorly understood. Given the essential role of one-carbon metabolism in supplying methyl groups for DNA methylation and gene regulation, this study investigated the effects of undernutrition on uterine one-carbon metabolism and epigenetic regulation in non-pregnant ewes during the late luteal phase. Adult ewes were assigned to either a control or nutritionally restricted diet, and uterine tissue was collected on day 14 of the estrous cycle. The expression of genes involved in folate transport, one-carbon metabolism and DNA methylation was assessed, together with global DNA methylation levels. Undernutrition significantly decreased the uterine expression of the folate transporter *SLC19A1* and folate receptor *FOLR1*, with no changes in *FOLR2* and *FOLR3* expression. Regarding the expression of key enzymes involved in the folate–methionine cycle, methylenetetrahydrofolate reductase (*MTHFR*) was reduced, but methionine synthase (*MTR*) and methionine adenosyltransferase 2 A (*MAT2A*) remained unchanged. Dietary restriction altered the expression of DNA methyltransferases *DNMT1* (decreased) and *DNMT3A* (increased), with no change in *DNMT3B*. However, global DNA methylation levels were similar between the groups. These findings demonstrate that nutritional restriction in sheep directly affects uterine molecular pathways associated with metabolic and epigenetic regulation during the late luteal phase. This study provides insights into uterine sensitivity to nutritional status and establishes a mechanistic framework for future investigations into how nutrition may influence uterine function across reproductive states.

Effect of previous shearing interval on thermoregulatory and metabolic responses to winter shearing in rams

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Highlights

- Rams shorn 12 months earlier showed longer fleece and higher wool weight.
- After winter shearing, they also showed a higher rectal temperature.
- Rams shorn 12 months earlier had higher tympanic and corneal temperatures.
- Heat loss index was higher in rams shorn 12 months earlier.
- Rams shorn 6 months before showed better thermoregulation after a winter-shearing.

Abstract

Winter shearing represents a substantial cold challenge for sheep, requiring rapid thermoregulatory and metabolic adjustments. This study evaluated the effect of prior shearing interval on thermoregulatory and metabolic responses to winter shearing in rams. Nineteen rams were shorn in mid-winter (August 2021). In mid-summer (February 2022), eight rams were re-shorn (Sh6), whereas eleven remained unshorn (Sh12). All animals were shorn again in mid-winter (August 2022). As expected, Sh6 rams presented shorter fleece length and lower total wool weight at shearing compared with Sh12 rams ($P < 0.0001$). Rectal (RT), tympanic (TT), and corneal surface temperatures (CST) were recorded from 24 h before to 240 h after shearing, and a heat loss index was calculated to assess peripheral heat conservation. Serum triiodothyronine (T3) and blood β -hydroxybutyrate (BHB) concentrations were measured at predefined time points relative to shearing. Following winter shearing, Sh6 rams maintained greater RT than Sh12 rams ($P = 0.03$), whereas Sh12 rams exhibited higher TT, CST, and heat loss indexes ($P \leq 0.02$), indicating reduced peripheral heat conservation. In contrast, T3 and BHB concentrations increased after shearing in both groups ($P < 0.0001$), with no between-group differences. These results indicate that the interval between successive shearing sessions influences thermoregulatory responses to winter shearing, with rams shorn six months earlier maintaining core temperature more effectively without additional metabolic activation.

Testicular cryopreservation of prepubertal and adult Morada Nova rams: Slow freezing versus vitrification

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Animal Reproduction Science, Volume 291, August 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.anireprosci.2026.108227>

Highlights

- Cryopreservation alters testicular tissue survival in a protocol-dependent manner.
- Apoptosis-related pathways are differentially regulated after tissue freezing.
- Proteomic profiles reveal biomarkers linked to post-thaw tissue resilience.
- Molecular markers support testicular tissue banking for fertility preservation.

Abstract

Cryopreservation of testis is an alternative for preserving the reproductive potential of prepubertal animals that do not yet produce spermatozoa or endangered adult animals that die unexpectedly. This study aimed to evaluate slow freezing (SFR) and vitrification (VIT) for testicular tissue cryopreservation in prepubertal and adult Morada Nova rams. Small testicular fragments ($3 \times 3 \times 1$ mm) were maintained fresh (CTR) or cryopreserved using Mr. Frosty™ for SFR or the ovarian tissue cryosystem for VIT. Fragments were evaluated

for histomorphology, ultrastructure, protein (β -catenin, activated caspase-3), and gene expression (OCT4, β -CATENIN, BAX, BCL2), and proteomic profiles. Morphologically, SFR better preserved seminiferous tubule integrity than VIT, especially in prepubertal animals. Ultrastructural analysis confirmed superior cell preservation with SFR. Immunofluorescence revealed higher β -catenin expression in SFR compared to VIT ($p < 0.05$), and increased caspase-3 activation post-VIT in adults ($p < 0.05$). OCT4 gene expression was upregulated after cryopreservation ($p < 0.05$), suggesting a stress response. Proteomic analysis detected 288 proteins, with distinct expression patterns in prepubertal tissue. PGK2 and EEF1A1 were downregulated, while HNRNPA2B1 was upregulated in cryopreserved groups, especially in VIT, suggesting metabolic suppression and RNA regulation responses. In contrast, adult tissues showed no significant proteomic changes across groups. These results support SFR as the preferable method, particularly for prepubertal testes, due to better structural preservation and more adaptive molecular responses to cryoinjury.

Testicular cryopreservation of prepubertal and adult Morada Nova rams: Slow freezing versus vitrification

R.H. Celiz, D.D. Guerreiro, D.C.C. Brito, M.A.S. Novaes, L.V.S. Ñaupas, N.A.R. Sá, G.J.Q. Palomino, F.D.R. Gomes, A.C.A. Ferreira, T.G. Mbemba, C.C.L. Fernandes, L.A.L. Rufino, C.V.O. Silva, A.R. Silva, A.C. Assis Neto, S. Sheheryar, F.D. Sousa, A.C.O. Monteiro, A.A. Moura, D. Rondina, J.R. Figueiredo and A.P.R. Rodrigues (anapaula.rodrigues@uece.br)

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- Molecular markers support testicular tissue banking for fertility preservation.

Abstract

Cryopreservation of testis is an alternative for preserving the reproductive potential of prepubertal animals that do not yet produce spermatozoa or endangered adult animals that die unexpectedly. This study aimed to evaluate slow freezing (SFR) and vitrification (VIT) for testicular tissue cryopreservation in prepubertal and adult Morada Nova rams. Small testicular fragments ($3 \times 3 \times 1$ mm) were maintained fresh (CTR) or cryopreserved using Mr. Frosty™ for SFR or the ovarian tissue cryosystem for VIT. Fragments were evaluated for histomorphology, ultrastructure, protein (β -catenin, activated caspase-3), and gene expression (OCT4, β -CATENIN, BAX, BCL2), and proteomic profiles. Morphologically, SFR better preserved seminiferous tubule integrity than VIT, especially in prepubertal animals. Ultrastructural analysis confirmed superior cell preservation with SFR. Immunofluorescence revealed higher β -catenin expression in SFR compared to VIT ($p < 0.05$), and increased caspase-3 activation post-VIT in adults ($p < 0.05$). OCT4 gene expression was upregulated after cryopreservation ($p < 0.05$), suggesting a stress response. Proteomic analysis detected 288 proteins, with distinct expression patterns in prepubertal tissue. PGK2 and EEF1A1 were downregulated, while HNRNPA2B1 was upregulated in cryopreserved groups, especially in VIT, suggesting metabolic suppression and RNA regulation responses. In contrast, adult tissues showed no significant proteomic changes across groups. These results support SFR as the preferable method, particularly for prepubertal testes, due to better structural preservation and more adaptive molecular responses to cryoinjury.

Changes in lying behaviour of housed ewes prior to parturition and their association with ewe characteristics, measured using accelerometers

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Highlights

- Ewe body condition score and the time of lambing affect the lying behaviour of housed, pregnant sheep.
- Accelerometers capture changes in lying behaviour of housed sheep relative to parturition.
- Simple algorithms based around measures of lying could be developed to generate alerts for shepherds.

Abstract

Lambing is an important period in the calendar of events for sheep producers, and its success greatly contributes to the financial outcome of sheep enterprises. On-animal technologies utilizing accelerometers to track behaviour could be useful in supporting shepherds during this period for the recognition of parturition events. Using accelerometers fitted to the leg, the aims of this study were to determine whether biological and physical measures of periparturient sheep are associated with their behaviour and whether there are quantifiable changes in the behaviour of housed sheep relative to parturition. Accelerometer data were collected from 77 (36 single-bearing and 41 twin-bearing ewes), housed, Welsh Mule sheep during the 2019 lambing season on a commercial lowland farm. Accelerometer data for the final 48 h relative to parturition for each ewe were processed hourly to determine the response variables total lying time, mean lying bout duration and total lying bouts. Response variables were modelled as a function of ewe age, lamb sex, ewe BCS, lambing difficulty score, lamb birth weight, the number of sheep in the pen when each ewe gave birth, the period when each ewe gave birth and the hour relative to the hour of lambing using hierarchical generalized additive models. Of the five candidate models evaluated, the model that best fitted each response variable was that which assumed a common behaviour pattern across the final 48 h but also allowed for ewe-specific deviations in behaviour. Ewe BCS, the period of lambing and time relative to the hour of lambing were significantly associated with total lying time. Only time relative to the hour of lambing was significantly associated with mean lying bout duration and total lying bouts. We also found a significant reduction in both hourly lying time and mean lying bout duration beginning 8 h before parturition and a significant increase in hourly lying bouts from 4 h before parturition. This is the first study to document that both ewe BCS and the period of lambing were associated with ewe behaviour before parturition and highlights the utility of accelerometers in identifying changes in behaviour relative to parturition. This study could inform the development of alert algorithms for shepherds in the management of impending lambing. However, it should be recognised that some sheep may deviate from a common behaviour pattern which is an important consideration in the prediction of parturition.

Further evaluations on the use of body condition score as target selective treatment criterion to control subclinical gastrointestinal nematode infections on dairy sheep

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Highlights

- Higher EPG values were consistently linked to lower BCS in most sheep groups.

- EPG–BCS correlation was strongest in replacement ewe lambs (R² highest).
- BCS decreased across rising EPG classes in early pregnancy, lactation, and lambs.
- Only late-pregnancy ewes showed no significant EPG–BCS association.
- Adult ewes fit a ≤ 2.75 BCS cut-off; lambs require a higher ≤ 3.0 threshold.

Abstract

Targeted selective treatments (TST) represent a key strategy to delay the development of anthelmintic resistance in gastrointestinal nematodes (GIN) of sheep. The Body Condition Score (BCS) is a well-established criterion for implementing TST in natural infection by non-hematophagous nematodes but the optimal thresholds for different animal categories and production systems remain poorly defined. This study aims to evaluate BCS as a practical TST indicator in Sarda sheep naturally infected with non-bloodsucking nematodes species, by assessing its relationship with fecal egg count (FEC) across reproductive stages and in replacement ewe lambs. A total of 2162 sheep were enrolled and divided into four groups: G1-G3 included ewes at different physiological stages, while G4 comprised replacement ewe lambs. Fecal samples were collected for FEC analysis and BCS was recorded for each animal. GIN prevalence ranged from 88.5% in ewes at 2–3 months of pregnancy to 99.8% in replacement ewe lambs, with the highest mean FEC observed in replacement ewe lambs (524.6 EPG). In all groups, a negative correlation ($p < 0.001$) was observed between BCS and EPG classes. The results obtained suggest that, in Sarda sheep, the TST thresholds based on BCS could be set at ≤ 2.75 for adult ewes during lactation or early pregnancy and at ≤ 3.00 for replacement ewe lambs. No consistent threshold could be established for ewes in late pregnancy.

Upcoming events

Date	Event	Location
23 July 2026	MLP Results seminar	Balmoral, Vic
7 August 2026	Australian Wool Innovation MLP Results seminar	Armidale, NSW
	Australian Wool Innovation	