

AUGUST 2026

Sheep reproduction RD&A alert

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

[ABARES' September Agricultural Commodities outlook](#) is forecasting another positive year for the sheep and wool industry, with strong demand for Australian sheepmeat expected to continue in key export markets. While global trade uncertainty remains, Australia's broad range of export customers should help the industry manage any disruptions.



Agricultural Commodities Report

September quarter 2026

Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

Volume 16, Issue 3
September 2026

Sheepmeat production is expected to hold steady, with higher lamb turn-off balancing lower mutton production. Lamb and mutton prices are forecast to ease, but should still remain at good levels by historical standards. Despite the softer price outlook, the overall value of the sheep and wool sector is expected to remain strong, supported by ongoing demand both in Australia and overseas.

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ABARES is forecasting a significant improvement in wool prices, with the Eastern Market Indicator expected to lift by about 15% over the next year. If that eventuates, it would provide a welcome boost to wool returns and farm incomes. Overall, the outlook points to a stable year ahead, with solid market demand and improving wool prices helping to support confidence across the industry.

\$10b
Value of
production
in 2026-27



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

Control of estrus in sheep: Protocol architectures, seasonal effects, and breed-specific reproductive performance

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Animals, Volume 16, Issue 15 **OPEN ACCESS**

DOI <https://doi.org/10.3390/ani16152383>

Simple Summary

Controlling the timing of estrus (heat) in sheep is important for farmers to manage breeding, improve productivity, and use artificial insemination. This review compares different hormonal methods used to synchronize estrus. Progesterone-based treatments work well, especially when combined with another hormone called eCG, because they mimic the natural cycle and help follicles grow. However, using progesterone for too long (12–14 days) can lead to older, lower-quality eggs. Shorter treatments (5–7 days) often give similar or better results while using less hormone. Hormones like GnRH help control the exact time of ovulation and are useful for fixed-time artificial insemination, but they work best during the normal breeding season. Prostaglandin treatments are cheap and effective only in sheep that are already cycling. Emerging technologies, including recombinant hormones and experimental nano-formulated products, show promise in preliminary studies, although further validation across diverse production systems is required. Overall, the best method depends on the sheep breed, the season, and the farm's goals. Future work should focus on fine-tuning hormone doses, reducing drug use, and standardizing how results are reported.

Abstract

Sheep play a crucial role in strengthening food security in different regions, where climates are often variable and resources can be limited. The importance of these animals includes nutrition and income. For sustainable production, manipulating estrous cyclicity is a pivotal, particularly in tropical and dry climate regions. Given the variation in reproductive performance in various breeds with seasons, and management practices, it is difficult to select effective protocols at all times. There is a need for in-depth knowledge on efficiency of available protocols. This review critically synthesizes current estrus synchronization strategies in sheep, integrating physiological principles with comparative evaluation of hormonal molecules, protocol architectures, and reproductive performance data. Progesterone-based systems remain the cornerstone of synchronization, particularly when combined with equine chorionic gonadotropin (eCG), because they simulate luteal activity and promote follicular recruitment during seasonal anestrus. However, prolonged progestogen exposure may induce persistent follicles and compromise oocyte quality, whereas short-term protocols (5–7 days) frequently achieve comparable or improved fertility while reducing hormonal exposure. Gonadotropin-releasing hormone (GnRH)-based approaches improve control of ovulation timing and are particularly useful for fixed-time artificial insemination (FTAI), although their effectiveness declines during deep anestrus without exogenous gonadotropic support. Prostaglandin-only systems provide cost-effective synchronization in cyclic ewes, but their reliability is limited outside the breeding season. Emerging innovations, including recombinant gonadotropins and nano-formulated hormone delivery systems, aim to enhance endocrine precision while addressing welfare, immunogenicity, and regulatory concerns associated with conventional eCG use. Across studies, variation in outcomes reflects the complex interaction among endocrine regulation, follicular dynamics, luteal competence, breed-specific ovarian responsiveness, and seasonal neuroendocrine suppression. Therefore, current evidence suggests that synchronization success depends less on protocol complexity than on physiological compatibility with breed characteristics, seasonal reproductive status, and production objectives. Future research on precision endocrine modulation, reduced hormonal exposure, ethical standardized outcome reporting is warranted.

Sex-specific placental adaptations associated with fetal growth restriction: a review

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Journal of Anima Science, Volume 104, July 2024 **OPEN ACCESS**

DOI <https://doi.org/10.1093/jas/skag210>

Abstract

Fetal growth restriction (FGR) is a major obstetric complication linked to placental insufficiency, increasing the risk of perinatal morbidity, mortality, and long-term health issues. The placenta is central to fetal development and maternal-fetal communication; its dysfunction leads to impaired fetal development. Numerous experimental FGR models exist, from rodents to large animals, but most studies, despite changes to some federal funding requirements, have historically overlooked the impact of fetal sex on placental development, function, and adaptation. Recent evidence indicates that male and female placentas employ distinct adaptive strategies in response to adverse intrauterine conditions, potentially contributing to observed sex differences in neonatal outcomes and adult disease risk. Male fetuses often prioritize growth, reducing resilience to environmental stress, while female fetuses exhibit more pronounced growth restriction but greater placental adaptability, such as altered expression of insulin-like growth factors, angiogenic regulators, and nutrient transporters. This review synthesizes data from human studies and animal models to highlight sex-specific placental adaptations to nutrient restriction, hypoxia, maternal hyperthermia, and other stressors. Understanding these differences is critical for both developing future interventions in humans and enhancing livestock productivity/neonatal survival in agriculture.

Scientific papers

Effect of letrozole administration on reproductive performance and plasma metabolites of ewes during estrus synchronization treatment

Tingting Li, Xihu Wang, Hao Lu, Tingting Lu, Reyimu Reyilaguli, Haibo Lv, Xiaojun Liu, Jianjun Zhang, Shijie Li, Rui Xiao and Guodong Zhao

Life, Volume 16, Issue 7, June 2026 **OPEN ACCESS**

DOI <https://doi.org/10.3390/life16071058>

Abstract

This study investigated the effects of letrozole (LE) on reproductive performance, hormones, and plasma metabolites in Turpan Black ewes. Sixty-six multiparous non-pregnant ewes were randomly assigned to a Control group or an LE group (0.2 mg/kg body weight, added to the basal diet) for 180 days, both receiving estrus synchronization. LE significantly increased the twinning rate ($p < 0.05$), but no significant differences were observed in estrus rate, conception rate, or lambing rate ($p > 0.05$). Hormone analysis revealed significant changes in Luteinizing Hormone (LH), Progesterone (P_4) (group, time, and interaction effects), Estradiol (E_2), Testosterone (T) (time effect), Gonadotropin-Releasing Hormone (GnRH) (group and interaction effects), and Follicle-Stimulating Hormone (FSH) (primarily time effect). Metabolomic analysis identified 3451 differential metabolites. L-saccharopine and 5-hydroxylysine were downregulated ($p < 0.01$), and estrone was decreased ($p < 0.05$). Lysylhistidine was upregulated ($p < 0.05$), while testosterone and LE showed rising trends without statistical significance ($p > 0.05$). These metabolites were mainly enriched in amino acid metabolism and lipid metabolism pathways related to reproduction. Significant correlations were also detected between several metabolites and reproductive hormones. LE improves the twinning rate in Turpan Black ewes, likely by modulating key reproductive hormones (LH, P_4 , GnRH, FSH, E_2 , T) and altering plasma metabolites involved in amino acid and lipid metabolism. These findings provide new insights into the regulatory mechanisms of letrozole on ovine reproduction.

The maternal immune response to semen: implications for reproductive success in livestock

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Reproduction & Fertility, Volume 7, Issue 3, July 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1530/RAF-26-0039>

Abstract

Following semen deposition, the female reproductive tract must balance immune tolerance towards spermatozoa with preservation of antimicrobial defence. To date, much of our understanding of female immune response following insemination has been derived from models of pathogen defence and uterine receptivity in humans, with comparatively little on how these same immune pathways shape successful sperm transport. Here, we summarise the relationship between early sperm transport immediately following semen deposition and acute innate immune activation, characterised by complement engagement and rapid leukocyte recruitment. Polymorphonuclear neutrophils, traditionally viewed as terminal effectors of sperm clearance, are reframed as active mediators of innate surveillance and sperm immune adaptation. Spermatozoa enter the female environment bearing a molecular identity shaped by testicular development, epididymal maturation, and exposure to seminal plasma, yet the link between specific mediators, immunity, and fertility has yet to be explored in livestock. Seminal plasma extracellular vesicles stand out as a promising mediator of complement activity and cytokine signalling. Disruption of this male-derived immune conditioning through processing for cryopreservation is hypothesised to explain impaired sperm transport in sheep. Orchestrating male and female contributions to the maternal immune response reframes reproductive success as coordinated sperm–immune communication. This review identifies knowledge gaps whose resolution will advance our understanding of immune tolerance to spermatozoa, informing strategies to enhance the success of assisted reproductive technologies in livestock.

Pre-breeding body condition score influences reproductive efficiency and ewe productivity but is not associated with late-gestation metabolic status or lamb health in fall-lambing Rambouillet ewes

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Journal of Animal Science, Volume 104, Issue Supplement 4 July 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1093/jas/skag190.008>

Abstract

Pre-breeding nutrition has long been recognized as a major contributor to reproductive success in livestock, influencing dam body condition, health, and reproductive cyclicity. In turn, suboptimal body condition prior to breeding has been consistently linked to reproductive inefficiency, yet its potential downstream effects on incidence of late-term metabolic dysfunction, neonatal health, and ewe productivity, particularly in fall-lambing flocks, are not well characterized. Thus, this study aimed to evaluate the influence of pre-breeding body condition on late-gestation metabolic status, neonatal immune status, lamb survival, and ewe productivity in fall-lambing commercial Rambouillet ewes in a traditional production environment. A total of 358 commercial, fall-lambing Rambouillet ewes (2-6yrs of age), were assigned body condition scores (BCS) using a 1-5 scale prior to breeding and again in late gestation (~135dGA). Plasma metabolites were quantified in late gestation subset of ewes (n = 78) representing a range of pre-breeding BCS (1-4). Conception was determined via ultrasound at mid-gestation (~60-90dGA). Lamb birthweights, birth type, survival until weaning, and adjusted weaning weights were collected for all ewes. Birthing difficulty (BD), lamb vigor (LV), and suckling assistance (SA) scores were also assigned for the subset of ewes selected prior to breeding. Whole-blood and plasma samples were collected at 24-hr of age from lambs born to subset ewes and used to estimate lamb immune status via total white blood count and D2Dx score. To reflect ewe-level productivity, all lamb-level outcomes were aggregated by ewe prior to analysis. Data were analyzed in SAS with pre-breeding BCS as a continuous predictor and ewe age included as a covariate. Continuous outcomes were analyzed using linear mixed models, whereas binary and categorical outcomes were analyzed using generalized linear models. Interactions between ewe age and pre-breeding BCS were tested and were not

significant ($P \geq 0.76$); therefore, age was retained as an adjustment factor in all models, and results are presented for the overall population. BCS increased throughout gestation ($P < 0.001$), and pre-breeding BCS was positively associated with BCS in late gestation ($P = 0.05$), the probability of producing multiple lambs ($P = 0.002$), and tended to be associated with LV ($P = 0.076$). Conception rate was quadratically associated with pre-breeding BCS ($P < 0.001$), with maximal conception occurring at a BCS of ~ 2.9 . Total adjusted kg of weaned lamb per ewe increased with pre-breeding BCS ($P < 0.001$), with a significant quadratic effect indicating declining returns at higher pre-breeding BCS ($P < 0.001$), with productivity peaking at a BCS of ~ 3.1 . Among productive ewes, pre-breeding BCS was not associated with total weaned lamb output, nor was it associated with BD, SA, lamb immune measures, lamb mortality through weaning or late-gestation metabolites ($P \geq 0.40$). Collectively, these results indicate that pre-breeding BCS influences reproductive efficiency and ewe-level productivity in fall-lambing ewes but not late-gestation metabolic status or neonatal outcomes.

Repeated low-dose endotoxin exposure elicits maternal endocrine and hematologic alterations in nulliparous ewes

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Journal of Animal Science, Volume 104, Issue Supplement 4 July 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1093/jas/skag190.009>

Abstract

Subclinical immune stress is a critical yet often overlooked factor influencing reproductive efficiency in livestock systems. Exposure to bacterial endotoxin lipopolysaccharide (LPS) can induce inflammatory responses with potential consequences for fertility, particularly in nulliparous ewes that lack prior exposure to pathogens associated with breeding and parturition. The objective of this study was to characterize maternal endocrine, behavioral, and hematologic responses to a repeated low-dose LPS challenge in nulliparous ewes. Fourteen Rambouillet ewes (19 mo; 56.4 ± 1.5 kg) were stratified by body weight and assigned to receive saline (CON; $n = 4$), $1.5 \mu\text{g/kg BW}$ LPS (LOW; $n = 5$), or $3.0 \mu\text{g/kg BW}$ LPS (HIGH; $n = 5$) administered subcutaneously on d 5, 10, and 15 of a synchronized estrous cycle. Rectal temperature and behavioral observations were recorded following each LPS challenge to assess immune response. Blood samples were collected via jugular venipuncture at 0, 2, 4, 6, 12, and 24 h relative to treatment for determination of cortisol, progesterone, and complete blood count. Data were analyzed using mixed models with repeated measures. Administration of LPS induced rapid febrile response as rectal temperatures were elevated 4 h after first LPS challenge (d 5) in LOW and HIGH ewes compared with CON ($P < 0.05$), while subsequent challenges resulted in parallel but muted responses. Similarly, cortisol concentrations were increased following LPS challenge by 2 h and peaked by 4 h following LPS challenge ($P < 0.05$), indicating immune activation. Progesterone concentrations were similar between treatment groups on d 0 and 5 prior to LPS challenge but reduced in HIGH ewes following LPS exposure on d 10 ($P < 0.05$), suggesting inflammatory disruption of luteal function. Endotoxin-treated ewes displayed clinical behaviors such as feed refusal, coughing, and isolation compared with CON following initial LPS exposure and were partially mitigated with repeated challenges. Following LPS administration on d 5, total white blood cell (TWBC) counts tended to decrease ($P \leq 0.10$) at 4 h in HIGH relative to LOW and CON, followed by an increase at 24 h in both LPS-treated groups compared with CON ($P < 0.05$). A sustained immune effect was observed on d 10, as HIGH ewes demonstrated elevated baseline TWBC and lymphocyte counts prior to second LPS-treatment ($P < 0.05$), indicating residual response to the initial endotoxin exposure. Across subsequent challenges on d 10 and 15, LOW and HIGH ewes demonstrated increased immune cell concentrations at 24 h post-injection compared with CON ($P < 0.05$). These findings suggest that repeated low-dose endotoxin exposure

compromises luteal function in this nulliparous model. Such subclinical inflammatory events may compromise female fertility, highlighting the importance of managing low-level infection and immune stressors in breeding females.

Effects of modulating CXCL12 signaling on inflammatory cytokines during gestation in sheep

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Journal of Animal Science, Volume 104, Issue Supplement 4 July 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1093/jas/skag190.011>

Abstract

The placenta is critical for fetal development and maternal health, and impairments in placental function negatively impact livestock productivity and reproductive efficiency. Cytokines, which are specialized proteins that regulate immune responses, play key roles in coordinating maternal tolerance, and vascular development during placental development (placentation). Early pregnancy requires a carefully regulated inflammatory environment, and disruptions to the cytokine balance contribute to several pregnancy complications such as implantation failure, recurrent pregnancy loss, IUGR, and placental insufficiency. The CXCL12/CXCR4 chemokine axis plays key roles in immune cell recruitment and cytokine expression in many biological processes, but its role in regulating cytokine balance during implantation and placentation remains unclear. The objective of this study was to determine if manipulating the CXCL12/CXCR4 axis at the fetal-maternal interface influences inflammatory signaling locally and systemically. Ewes were surgically implanted with osmotic pumps on day 12 of gestation to deliver intrauterine treatments for seven days: control saline (CON, n = 7), a CXCR4 inhibitor (AMD) at two different concentrations 1.5X (n = 6) and 3X (n = 7), and a CXCR4 activator (CXCL12) at two different concentrations Lo12 (n = 7) and Hi12 (n = 5). Tissues were collected on day 20 of gestation and included caruncle (CAR), intercaruncle (ICAR), fetal membranes (FM), corpus luteum (CL), and spleen (SP). Gene expression of pro- and anti-inflammatory cytokines, including TNF, IFNG, IL-10, IL-12, and TGFB was assessed using Quantitative Polymerase Chain Reaction (qPCR) with statistical significance defined as $p < 0.05$. In CAR tissue, 1.5X AMD reduced CXCL12 expression and 3X treatment reduced TGFB expression, while Lo12 treatment reduced TGFB expression ($p < 0.05$). In ICAR tissue, both 1.5X and 3X AMD decreased CXCR7, while 3X primarily decreased TNF and TGFB expression. Additionally, Hi12 increased IL12 and TNF expression ($p < 0.05$). In FM, 3X AMD increased CXCR4 and IL12 while both 1.5X and 3X decreased TGFB, and both Lo12 and Hi12 increased IL12 and Lo12 decreased TGFB expression ($p < 0.05$). In the spleen, both 1.5X and 3X AMD decreased CXCL12, CXCR4, IL12, TGFB and 1.5X decreased CXCR7, and TNF expression, while both Lo12 and Hi12 primarily decreased TGFB expression ($p < 0.05$). These findings indicate that targeted manipulation of the CXCL12/CXCR4 axis impacts cytokine and chemokines expression both at the fetal-maternal interface and immunoregulatory organs. Improved understanding of the CXCL12/CXCR4 signaling axis could support the development of strategies to enhance reproductive success and pregnancy outcomes in livestock through manipulating the cytokine balance during placentation.

Understanding lamb behavior during band castration with differing routes of lidocaine administration

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Journal of Animal Science, Volume 104, Issue Supplement 4 July 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1093/jas/skag190.013>

Abstract

Castration is a common livestock production practice for reproduction management, behavioral control, and improving meat quality. Banding is a common method of castration that is known to cause acute pain or discomfort. Therefore, the objective of this study was to investigate pain mitigation strategies for band castration. Lambs were placed into one of three treatment groups: no castration (CON; $n = 3$), castration by an elastrator band impregnated with lidocaine (LB; $n = 7$), or castration by a standard unmedicated elastrator band with a lidocaine injection (LI; $n = 6$). Behavioral observations were collected at -1d, 0h, 6h, 12h, 24h, 3d, and 7d relative to banding to create a behavioral inventory across time. Additionally, the hour immediately following banding was observed specifically for frequency of painful behaviors. There was a treatment by time interaction in which LI and LB lambs spent more ($P < 0.05$) time self-grooming 3d post castration compared to CON, and 7d post banding LB lambs spent more time self-grooming compared to LI or CON, which did not differ. CON lambs spent more ($P < 0.05$) time nursing compared to LI or LB lambs, which did not differ. LI and LB lambs spent more ($P < 0.05$) time lying compared to CON lambs. Lambs from the LI group tended ($P < 0.10$) to spend less time standing compared to CON lambs, while LB lambs did not differ from CON or LI lambs. Additionally, LI and LB lambs tended ($P < 0.10$) to spend more time socializing compared to CON lambs. Time spent exploring or locomoting did not differ between treatments. All assessed behaviors were influenced by time, as proportion of time spent decreased ($P < 0.05$) immediately post-banding for standing, socializing, exploring, locomoting, and nursing, and generally increased at later observation periods. Time spent lying increased ($P < 0.05$) through 12h after banding, followed by consistent decreases through 7d. When considering frequency of behaviors indicative of pain, abnormal locomotion was greater ($P < 0.05$) in LB lambs compared to LI and CON lambs but did not differ by treatment alone for any other painful behaviors or total painful behaviors. There was a treatment by progeny effect in which LB twins tended ($P < 0.10$) to exhibit more abnormal standing compared to twin LI, while triplets did not differ. A progeny effect was also observed in which triplet lambs exhibited more ($P < 0.05$) head turns towards the banding site compared to twins. These preliminary results suggest that while lidocaine interventions altered some post-procedural behaviors, they did not fully normalize behavioral patterns relative to non-castrated lambs. The observed differences between lidocaine groups and progeny groups highlight the importance of administration type and lamb characteristics when considering options for pain mitigation during common production procedures.

Early pregnancy detection during the peri-implantation period in sheep using pregnancy associated glycoprotein

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Journal of Animal Science, Volume 104, Issue Supplement 4 July 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1093/jas/skag190.016>

Abstract

Pregnancy determination in sheep traditionally relies on ultrasonography between d40 and d60 and as early as d30. Minimal information exists about the uses of pregnancy associated glycoproteins (PAGs), produced by binucleate cells of the ruminant placenta, and its use to characterize early pregnancy around the time of embryo apposition and maternal recognition of pregnancy in sheep, however, utilization of PAGs has been evaluated to determine number of lambs during pregnancy. Additionally, the use of PAGs during embryo apposition has been used for early pregnancy detection in cattle. Therefore, the objective of the present study was to evaluate if an increase in PAGs during the peri-implantation period could be used as a marker for early pregnancy detection. Ewes ($n = 82$) were subjected to estrus synchronization utilizing an intravaginal progesterone device (CIDR) for 14 days. At CIDR removal, ewes received 2.5ml PG600® and 250µg cloprostenol sodium. Ewes were bred via natural mating ($n = 47$) or laparoscopic artificial insemination ($n = 35$). Blood samples were collected on d15, d21, and d30 via jugular venipuncture into 10-mL evacuated

tubes. Samples were aliquoted and stored until assayed. Serum was assayed for PAGs using a commercially available enzyme-linked immunoassay. Optical density (OD) and PAGs concentrations (ng/ml) were quantified for d15 and d21 and PAGs concentration on d30 were quantified. Sensitivity was defined as the proportion of ewes diagnosed as non-pregnant by OD percent change and diagnosed as non-pregnant by PAGs concentration at d30, whereas specificity is the percentage of ewes determined pregnant by OD percent change and pregnant at d30. Data were analyzed using generalized linear mixed models. No difference ($P > 0.1$) in pregnancy rate was detected at gestation d30 between breeding methods; therefore, all ewes were analyzed as one group. Utilizing the 10% cutoff, the sensitivity for a non-pregnant determination was 84.6%, whereas the specificity was 100%. The positive predictive value was 92.3% and the negative predictive value was 95.7%. Ewes determined pregnant at d30 had a greater ($P = 0.02$) concentration of PAGs at d21 (14.2 ± 0.8 ng/ml) than non-pregnant ewes (0.1 ± 0.1 ng/ml). Preliminary results indicate that an increase of 10% in OD between d15 and 21 may provide an accurate method to determine early pregnancy. These results suggest that PAGs concentration during the peri-implantation period are associated with pregnancy status at d30. An increase of 10% in OD during this period provides high specificity and acceptable sensitivity, yet more research is needed to fully evaluate this method for early determination of pregnancy in sheep.

Ovine reproductive management strategies for successful cervical AI

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Journal of Animal Science, Volume 104, Issue Supplement 4 July 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1093/jas/skag190.018>

Abstract

There have been studies on the estrus synchronization protocols for cattle, but far fewer in small ruminants. A strong synchronization protocol forms the basis for a cervical artificial insemination (AI) program. The objective of this experiment was to assess the effectiveness of two different out-of-season synchronization protocols in hair sheep using cryopreserved semen by assessing pregnancy/AI. Secondly, developing an understanding of the impact of Gonadotropin-Releasing Hormone (GnRH; Factrel) injection has on pregnancy/AI when given at the time of AI. Progesterone impregnated control intravaginal drug release (CIDR) were inserted in ewes on day 0 and removed on day 12. Ewes in the PG600 group were given 3mL injections of PG600 and ewes in the GnRH group were given 2 mL injections of GnRH at the time of CIDR removal (day 12). Ewes were assigned to PG600 by odd ear tag numbers and GnRH by even ear tag numbers. A cervical softening agent (SoftCerv™) developed by Membrane Protective Technologies Inc. was topically applied to the cervical os after estrus detection. This allowed passage of a 0.25cc AI rod. The ewes were inseminated via post-cervical AI on days 13-15 when showing signs of estrus, in which every other ewe in estrus was given 2mL of GnRH regardless of their starting synchronization protocol. These treatment groups were assigned as A (PG600 with GnRH at AI $n = 45$), B (PG600 without GnRH at AI $n = 46$), C (GnRH with additional GnRH at AI $n = 36$), and D (GnRH without additional GnRH at AI $n = 41$). Ewes were bred with thawed semen from three different rams, all with post-thaw sperm parameters meeting $>30\%$ motile, $>60\%$ normal morphology and $< 6\%$ DNA fragmentation. Ewes that were inseminated were then checked for pregnancy via ultrasound using a rectal prob attached to a wand 40 days post-insemination. In total 168 ewes were inseminated ($n = 91$ ewes PG600, $n = 77$ ewes GnRH). Data was statistically evaluated using an ANOVA model to detect differences in pregnancy/AI ($P < 0.05$). The resulting pregnancy/AI for the synchronization groups PG600 was 60% and the GnRH groups was 45% ($P < 0.05$). The pregnancy/AI results for each +/- GnRH group at the time of AI were 62%, 59%, 47%, 44% for A, B, C and D respectively but no significant difference was detected. Giving a GnRH injection at time of AI does not impact pregnancy/AI in the non-seasonal ewe.

These data also demonstrate that the PG600 synchronization protocol, which is widely used in sheep, is the ideal protocol for estrus synchronization in out-of-season ewes.

A data-driven approach to assess general resilience in lambs based on variability in cumulative feed intake

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Animal, Volume 20, Issue 8, August 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.animal.2026.101886>

Highlights

- Cumulative feed intake trajectories were used to assess general resilience.
- Five key resilience indicators were identified from an initial set of eleven.
- Resilience responses differed between breeds and sexes.
- Phenotypic trade-offs between resilience and performance traits were observed.
- The indicators may be useful auxiliary traits for future sheep breeding programmes.

Abstract

Animal resilience is a key concept in livestock production, as more resilient animals are better capable of coping with short-term environmental challenges. As resilience is not a directly measured trait, many efforts have been made over the past few years to develop resilience indicators that capture the animals' response to perturbations and may become selection criteria in breeding programmes. In this context, the objectives of this study were to (1) derive lamb resilience indicators based on variability in cumulative feed intake and identify a reduced subset of the most promising indicators, (2) evaluate potential differences in resilience phenotypes between sheep breeds and sexes, and (3) investigate the phenotypic correlation between resilience indicators and performance traits in Texel, Corriedale, and Creole sheep breeds. High-frequency individual feed intake data from 436 lambs (176.2 ± 47.4 days of age) from three breeds (Texel, Corriedale, and Creole) were collected during seven feed efficiency trials, which lasted for 53.1 ± 6.0 days on average. These data were used to estimate target trajectories (in the absence of perturbations) of cumulative feed intake using a smoothing function. Deviations between the observed and predicted cumulative feed intake trajectories were associated with potential perturbations and subsequently used to derive eleven resilience parameters. The resilience indicators derived capture different aspects of the perturbation shape, including its amplitude, variability, temporal dynamics, and recovery patterns. Animals had an average of 1.89 ± 0.91 perturbations ranging from one to five across individuals. Differences in estimated marginal means were found for sex within the Texel breed, where males were generally more resilient. Additionally, differences were found between the three breeds within the male group; however, no clear overall superiority was identified. Unfavourable phenotypic correlations were observed between resilience indicators and production traits such as average daily gain and rib eye area, whereas a favourable correlation was observed between resilience and fat thickness. These results indicate that this data-driven approach is a useful tool to evaluate animals' trajectory and responses to unknown environmental challenges. The phenotypic correlation results highlight an anticipated pattern of potential trade-offs between resilience and production that warrants further investigation, including estimation of genetic parameters and biological validation of the derived resilience indicators to enable genetic selection for improved performance and resilience in sheep populations.

Proteomic dynamics of ovine allantoic and amniotic fluids during gestation

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Reproduction in Domestic Animals, Volume 61, Issue 8, August 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1111/rda.70300>

Abstract

Gestational success in ruminants depends on the maintenance of a dynamic maternal–foetal microenvironment, resulting from complex interactions among the conceptus, extraembryonic membranes, maternal tissues, and gestational fluids. This study performed a comparative and longitudinal proteomic characterization of allantoic and amniotic fluids throughout pregnancy in sheep, aiming to elucidate the molecular mechanisms involved in maternal–foetal communication and embryonic development. Samples of allantoic and amniotic fluids aseptically collected from extraembryonic compartments after uterine opening following animal slaughter and allocated into three gestational groups according to foetal development: early gestation (0–50 days; n = 6), mid gestation (50–100 days; n = 3) and late gestation (100–150 days; n = 5). After centrifugation and protein quantification using the Bradford method, standardized aliquots were subjected to in-solution protein digestion and analysed by nano-LC–ESI-Q-TOF mass spectrometry. A total of 201 proteins were identified in the allantoic fluid and 159 proteins in the amniotic fluid, with five proteins showing significant differences across gestational stages. In the allantoic fluid, differentially abundant proteins included alpha-2-macroglobulin, gelsolin, basement membrane–specific heparan sulphate proteoglycan core protein and alpha-globin chain. In the amniotic fluid, changes were observed in peroxiredoxin-2, mucin-5 AC, fetuin-B, cystatin domain–containing protein and globin domain–containing protein. Multivariate analyses revealed progressive remodelling of the foetal extraembryonic microenvironment, associated with proteolytic control, tissue remodelling, redox homeostasis, epithelial protection and metabolic processes. Collectively, these findings reinforce the active role of foetal extraembryonic fluids in gestational physiology and highlight their potential as sources of biomarkers associated with reproductive success in sheep.

Effects of anethole on meiotic resumption and oxidative balance during in vitro maturation of ovine oocytes

Anderson Nascimento de Andrade, Solano Dantas Martins, Alesandro Silva Ferreira, Naiza Arcângela Ribeiro de Sá, Jonathan Elias Rodrigues Martins, Daniela Ribeiro Alves, Selene Maia de Moraes, José Henrique Leal-Cardoso, Luciana Rocha Faustino, Vânia Marilande Cecatto and Valdevane Rocha Araújo

Reproduction in Domestic Animals, Volume 61, Issue 8, August 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1111/rda.70296>

Abstract

The aim of this study was to evaluate the effect of anethole addition to the ovine oocyte in vitro maturation (IVM) medium on viability and chromatin configuration, intracellular production of reactive oxygen species (ROS), enzymatic activity of superoxide dismutase (SOD) and catalase (CAT), as well as the levels of reduced thiols in IVM medium, in addition to its antioxidant potential (DPPH and ABTS). Cumulus-oocyte complexes (COCs) were randomly matured in IVM medium in the absence (control group, CTRL) or presence of anethole at concentrations of 30 (AN30), 300 (AN300), and 2000 µg/mL (AN2000). COCs were matured in groups under mineral oil at 39°C in a humidified atmosphere containing 5% CO₂ in air for 24 h. At the end of IVM, part of the COCs was used to assess viability and chromatin configuration using Hoechst 33,342. The remaining COCs were used to assess intracellular ROS levels using the fluorescent probe H2DCFDA. Furthermore, the IVM medium was collected to evaluate antioxidant status (SOD, CAT, and reduced thiols). Finally, the antioxidant

potential of different anethole concentrations was evaluated using DPPH and ABTS assays. It was observed that AN300 promoted higher meiotic resumption rates compared to the other treatments ($p < 0.05$) and a lower rate of oocyte degeneration compared to AN30 ($p < 0.05$). However, regarding the proportion of oocytes at MII, it was observed that only AN2000 was lower than AN300 ($p < 0.05$). Moreover, AN30 resulted in lower ROS levels compared to AN300 and AN2000 ($p < 0.05$). SOD activity was lower in AN2000 compared to the other treatments ($p < 0.05$). AN2000 also showed the highest antioxidant capacity in the DPPH and ABTS assays among the anethole concentrations, although it was lower than the control group. In conclusion, anethole supplementation during IVM positively affected oocyte meiotic progression in sheep.

Genetic parameters and genome-wide association studies for fertility and reproduction traits in U.S. Katahdin sheep based on the single-step GBLUP methodology

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Journal of Animal Breeding and Genetics, Volume 143, Issue 5, September 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1111/jbg.70048>

Abstract

Sheep production contributes to a secure and diverse food and fibre supply in the United States, with growing ethnic diversity strengthening demand. Katahdin is a composite hair-type sheep breed developed in the United States that has become the most popular breed in many regions of the country and the first one to have genomic selection implemented in its breeding program. Therefore, the main objectives of this study were to estimate variance components of reproductive traits, including number of lambs born (NLB), number of lambs weaned (NLW), age at first lambing (AFL), and interval from first to second lambing (LI), in Katahdin sheep using the AIREML method and the single-step Genomic Best Linear Unbiased Prediction (ssGBLUP) approach, and to identify genomic regions and candidate genes associated with these traits. The datasets used consisted of 127,536 animals in the pedigree, phenotypic records of 56,128 parities from 24,067 ewes, and genomic data from 10,032 animals with 30,308 single-nucleotide polymorphisms (SNP) after quality control. Analyses were performed using the BLUPF90 family of programs. We observed low heritability estimates for all studied traits (0.09 ± 0.00 for NLB, 0.08 ± 0.00 for NLW, 0.09 ± 0.01 for AFL, and 0.08 ± 0.01 for LI). The genetic correlations between the traits ranged from 0.17 ± 0.02 (AFL and LI) to 0.79 ± 0.02 (NLB and NLW). All traits were found to be highly polygenic with all 14 significant SNP on eight (OAR) chromosomes (3, 6, 7, 8, 9, 12, 13, and 15) having small effects on the total variability on the traits. These SNP were located near or within 18 candidate genes: four genes associated with NLB (AAK1, GFPT1, SLC23A2, and GDAP1), four with NLW (ARHGAP18, TTLL2, UNC93A, and GPR31), six with AFL (NAP1L5, FAM13A, HS3ST1, CCDC181, NME7, and BLZF1), and four with LI (TAF4, CDH4, CADM1, and SEL1L). These candidate genes have been previously associated with fertility, embryonic development, growth, disease resistance, and climatic adaptation traits. Our findings indicate that fertility and reproduction traits in Katahdin sheep can be improved through direct genetic selection. Genetic improvement for these traits will benefit from genomic selection as more accurate estimates of breeding values for selection candidates can be obtained at a younger age. Although the studied traits are influenced by a complex interplay of genetic and environmental factors, the candidate genes identified enabled a better understanding of the biological mechanisms underlying reproductive performance in Katahdin sheep.

Effects of heat wave on physiological and environmental responses of sheep managed in different systems in Eastern Amazon assessed by infrared thermography

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Small Ruminant Research, Volume 262, September 2026 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.smallrumres.2026.107805>

Highlights

- Shading reduced the soil temperature by up to 16.6 °C, mitigating extreme heat stress.
- BTCI indicated lower thermal adaptation in the TS, especially at 12 pm.
- Thermography revealed a distinct thermal gradient between the canopy, trunk, and soil.
- RR rose 28% in the TS at 12 pm., indicating greater respiratory overload.
- RT at TS at 12 am., suggested thermal retention even at night.

Abstract

Infrared thermography is a non-invasive tool widely used to detect heat stress in farm animals under tropical conditions. This study aimed to evaluate physiological and environmental responses of sheep managed under traditional and silvopastoral systems in the Eastern Amazon using infrared thermography. The study was conducted over a period of 187 days, encompassing the less rainy and transition periods. Twenty female Santa Inês sheep, aged 10–18 months and weighing 37.19 ± 6.17 kg, were evaluated monthly at 06:00, 12:00, 18:00, and 00:00 h using physiological, environmental, and thermographic measurements, and were randomly assigned to two groups: Traditional System (TS – n = 10) and Silvopastoral System (SP – n = 10). Both had the same pasture, as well as access to water and mineral salt ad libitum. Measurements were taken with a scientific thermographic camera, and the data were analyzed with 5% significance in the Statistical Analysis System (SAS) software. There was a difference between the thermal windows evaluated in the animals' body regions: head (TS – 38.7 °C and SP – 37.8 °C), armpit (TS – 38.9 °C and SP – 38 °C), back (TS – 39.5 °C and SP – 38 °C), flank (TS – 38.6 °C and SP – 38.1 °C), and rump (TS – 39.2 °C and SP – 37.6 °C) ($p < 0.0001$). Difference was observed between the soil temperature (55.7 °C) and the forage temperature (39.1 °C) within the TS ($p < 0.0001$). In contrast, a difference was noted in the trunk (35.8 °C), canopy (33.5 °C), and soil (39.1 °C) regions in the SP ($p < 0.0001$). It was concluded that the SP promoted lower body and environmental temperatures compared to the TS, indicating improved thermal comfort for sheep managed in the SP.

Molecular and gut–immune basis of heat stress resilience in small ruminants

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Small Ruminant Research, Volume 262, September 2026

DOI <https://doi.org/10.1016/j.smallrumres.2026.107814>

Highlights

- HS disrupts gut integrity and immune homeostasis in sheep and goats.
- Intestinal permeability and dysbiosis link thermal load to systemic inflammation.
- Gut–immune axis integrates metabolic, microbial, and immune stress responses.
- Molecular and microbial signatures offer biomarker based selection for HS resilience.
- Interventions targeting gut–immune linked pathways enable climate-resilient small-ruminant systems.

Abstract

Climate change is aggravating the magnitude of heat stress (HS) occurrences, which is a significant problem to the productivity, wellbeing, and health of small ruminants worldwide. The livestock, especially sheep and goats, which form the main basis of livelihood in the tropical, subtropical and semi-arid regions, are variably susceptible to persistent HS conditions. In addition to decreases in feed consumption and productivity, HS causes multifaceted physiological disequilibrium, which impairs gastrointestinal integrity, changes microbial ecology, and deregulates immune homeostasis. There is an increasing body of evidence to suggest that the gut-immune axis is an extremely important mechanistic interface between thermal exposure and systemic inflammation, metabolic imbalance, and resilience. The present review summarizes the available information on heat stress-mediated changes in gastrointestinal (GI) physiology, intestinal barrier activity, and rumen-intestinal microbiota of small ruminants with special focus on the interaction of these alterations with innate and adaptive immune responses. We point out the contributions of augmented intestinal permeability, translocation of endotoxins, microbial dysbiosis, oxidative stress (OS) and immune signaling pathways in influencing HS outcomes. Recent molecular markers, such as stress associated genes, antioxidants, inflammatory controls, and microbial secondary metabolites are considered biomarkers of thermotolerance and resilience. Combining physiological, microbial, immunological, and omics-based evidence, this review is able to put HS resilience into the context of a systems characteristic and not an adaptive response. We acknowledge that critical knowledge gaps such as longitudinal work in the field and functional confirmation of candidate biomarkers are missing and also give a roadmap on how to translate gut-immune knowledge into climate-resistant small-ruminant production systems.

Upcoming events

Date	Event	Location
4 September 2026	Merino sheep classing AWI	Moolpa, NSW
7 September 2026	Optimising ewe lamb joining outcomes MLA PDS & SheepMetriX	Tallimba, NSW
8 September 2026	RAMping up Repro AWI Extension WA	Kendenup, WA
9 September 2026	Feed to finish bus tour. Explore local solutions for lamb finishing MLA PDS, Facey Group and Grower Group Alliance	Wickepin, WA
16 September 2026	RAMping up Repro AWI Extension NSW	Nyngan, NSW
16 September 2026	Optimising Livestock Health and Nutrition AWI Extension Tas, Tasfarmers, Tas Farm Innovation Hub	Runnymede, Tas
18 September 2026	Can better ram selection deliver better flock performance? MLA PDS, For Flocks Sake & SheepMetriX	Armatree, NSW
25 September 2026	Guardian dogs for predator control NSW Local Land Services	Bathurst, NSW
26 September 2026	Guardian dogs for predator control NSW Local Land Services	Mudgee, NSW
29 September 2026	Using technology in lamb finishing systems MLA PDS, For Flocks Sake, Optiweigh	Boree, NSW
30 September 2026	Optimising Livestock Health and Nutrition AWI Extension Tas, Tasfarmers, Tas Farm Innovation Hub	Bridport, Tas
12 - 14 October 2026	AGBU 50 Celebration	Armidale, NSW

28 October 2026

AGBU

[Optimising Livestock Health and Nutrition](#)

AWI Extension Tas, Tasfarmers, Tas Farm Innovation Hub

Cressy, Tas