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Sheep reproduction RD&A alert

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

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The biology of the ovary – honouring the contributions of Ken P. McNatty and Rex J. Scaramuzzi a Special Collection of Reproduction Fertility and Development. This collection, edited by Jenny L. Juengel and Graeme B. Martin celebrates the work of Rex Scaramuzzi and Ken McNatty, two passionate researchers in the field of reproductive biology whose impact was most profound in the area of ovarian biology in livestock.

Combined effects of the Booroola, Vacaria and Embrapa mutations on ovulation rate in a sheep flock with unique genetic background
Carlos Jose Hoff de Souza, Magda Vieira Benavides and Jose Carlos Ferrugem Moraes
DOI https://doi.org/10.1071/RD25067

The influence of CCN family proteins on ovarian physiology and pathology
El Arbi Abulghasem and Christopher A. Price
DOI https://doi.org/10.1071/RD24199

Is preovulatory follicle selection influenced by the production of oocyte-secreted factors?
Nicholas J. Anderson and Michael W. Pankhurst
DOI https://doi.org/10.1071/RD24149

Expression of platelet derived growth factor (PDGF) ligands and receptors in the ovine ovary and effects of PDGFBB on granulosa cell function
Peter Smith, Karen L. Reader, Michelle C. French, Peter R. Hurst and Jennifer L. Juengel
DOI https://doi.org/10.1071/RD24174

Identifying the composition of large vesicles in the cytoplasm of oocytes
Karen L. Reader, Isabella G. Pratt, Georgia L. Lawson and Robert J. Woolley
DOI https://doi.org/10.1071/RD24131

Genetic regulation of ovulation rate and multiple births
G. W. Montgomery
DOI https://doi.org/10.1071/RD24083

The pattern of LH secretion and the ovarian response to the 'ram effect' in the anoestrous ewe is influenced by body condition but not by short-term nutritional supplementation
R.J. Scaramuzzi, L. Oujagir, J-B. Menassol, S. Freret, A. Piezel, H.M. Brown, J. Cognié and C. Fabre Nys
DOI https://doi.org/10.1071/RD13139

Effect of monosaccharide sugars on LH-induced differentiation and sugar transport facilitator (SLC2A) expression in sheep theca cells in vitro

B.K. Campbell, N.R. Kendall, V. Onions, L. Guo and R.J. Scaramuzzi

DOI https://doi.org/10.1071/RD12064

Regulation of folliculogenesis and the determination of ovulation rate in ruminants

R.J. Scaramuzzi, D.T. Baird, B.K. Campbell, M.-A. Driancourt, J. Dupont, J.E. Fortune, R.B. Gilchrist, G.B. Martin, K.P. McNatty, A.S. McNeilly, P. Monget, D. Monniaux, C. Viñoles and R. Webb

DOI https://doi.org/10.1071/RD09161

A model for follicle selection and the determination of ovulation rate in the ewe

R.J. Scaramuzzi, N.R. Adams, D.T. Baird, B.K. Campbell, J.A. Downing, J.K. Findlay, K.M. Henderson, G.B. Martin, K.P. McNatty, A.S. McNeilly and C.G. Tsonis

DOI https://doi.org/10.1071/RD9930459

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

Resveratrol's therapeutic role in heat stress-induced mitochondria and ER dysfunction in animal reproductive health: A review

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Animal Reproduction Science, Volume 283, December 2025

DOI https://doi.org/10.1016/j.anireprosci.2025.108044

Highlights

- Heat stress disrupts mitochondria & ER, triggering ROS and impairing reproduction.
- Mitochondrial dysfunction lowers ATP, increases ROS, and disrupts reproduction.
- ER stress activates the UPR, leading to apoptosis and reproductive complications.
- Resveratrol improves mitochondrial function, reduces ROS, and regulates UPR.

Abstract

Heat stress is a major environmental factor that causes oxidative stress, mitochondrial dysfunction, and endoplasmic reticulum (ER) stress, which may lead to fertility impairment, decreased fetal growth, and low survival rates. Resveratrol is an antioxidant polyphenolic compound which has been found to have potential in mitigating the damage caused by heat stress. This review explores the therapeutic role of resveratrol in reducing mitochondrial and ER dysfunction in animal reproduction, focusing on its role in enhancing reproductive performance under heat stress. The systematic analysis of the recent studies demonstrates that resveratrol enhances mitochondrial biogenesis, increases mitochondrial dynamics via balanced fission and fusion, and controls the unfolded protein response (UPR), which reduces ER stress. Moreover, resveratrol triggers the SIRT1/AMPK signal transduction pathway that is involved in cellular stress defense and metabolic stability. This review identifies experimental evidence of resveratrol to protect cells related to reproduction against oxidative damage, maintain mitochondrial integrity, and abate apoptosis. Evidence shows that the antioxidant and anti-inflammatory effects of resveratrol are core to its protective effect, and it may be a good potential therapeutic agent enhancing reproductive health and pregnancy outcomes in animals under heat stress. Since it has potential of restoring cellular function and enhancing reproductive efficiency, additional

studies should be conducted to maximize dosages, routes of delivery, and species-specific use, especially in livestock and other animals of economic value.

Potential of small extracellular vesicles as Cas9 delivery tool: a promising approach for gene editing livestock gametes and embryos

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Biology of Reproduction, Volume 113, Issue 6, December 2025

DOI https://doi.org/10.1093/biolre/ioaf195

Abstract

Genome editing is a rapidly advancing technology with transformative potential in livestock, offering opportunities that range from enhanced production traits to the generation of biomedical models for human disease and xenotransplantation. The CRISPR/Cas9 system, originally identified as a bacterial defense mechanism, has become the most widely used tool for precise genome editing. In this review, we first summarize the potential applications of CRISPR/Cas9 in livestock and highlight notable successes to date. We then address the ongoing challenges associated with delivering CRISPR/Cas9 into gametes and embryos, as current methods such as microinjection and electroporation often result in high mosaicism and cellular damage. We subsequently introduce extracellular vesicles (EVs) as a promising alternative delivery system. Secreted by virtually all cell types, EVs can efficiently transport bioactive molecules and are readily internalized by gametes and embryos. Although EV-mediated delivery of CRISPR/Cas9 has shown success in somatic cells, its use in reproductive cells remains largely unexplored. We review emerging strategies for loading EVs with CRISPR/Cas components and discuss the potential advantages of combining this approach with recently developed smaller Cas variants to overcome delivery barriers. Collectively, these innovations support the promise of EVs as a biologically compatible, efficient, and minimally invasive system for targeted genome editing in livestock reproduction.

Scientific papers

Increasing ewe productivity - challenges of sheep stakeholders across Europe and Turkey

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Livestock Science, Volume 302, December 2025

DOI https://doi.org/10.1016/j.livsci.2025.105852

Highlights

- The main challenges regarding ewe fertility and fecundity from sheep producers across the seven surveyed countries were similar, regardless of production type, flock size, productivity level or environmental conditions.
- The main challenges identified to increase ewe fertility and fecundity were; ewe body condition score, nutrition/grassland management, flock health status and ewe lamb management.
- The main challenges regarding lamb mortality were also similar from sheep producers across the seven surveyed countries, regardless of production type, flock size, productivity level or environmental conditions.

- The main challenges identified to decrease lamb mortality were; advanced preparation for lambing, sheep shed management, nutrition/grassland management, labour availability/organisation, and lambing hygiene.

Abstract

Improving ewe reproductive success and lamb survivability is essential for enhancing flock productivity, farm profitability, and the self-sufficiency of sheep meat and milk production. This study aimed to identify the perceived challenges to improving ewe productivity, through efficient reproduction, gestation, and reducing lamb mortality and determine if these challenges differ between countries. A 22-question survey (14 closed, 8 open-ended) was conducted in 2017 across seven countries participating in the SheepNet project (France, Ireland, Italy, Romania, Spain, UK, and Turkey). A number of press releases were circulated in each of the seven SheepNet countries making stakeholders aware of the survey and asking them to identify their challenges to improving ewe productivity through efficient reproduction, gestation and reduced lamb mortality. The surveys were completed by stakeholders either on the website, by e-mail or written mail or during sheep stakeholder events. Key challenges to improving ewe fertility included ewe body condition, nutrition and grassland management, flock health, and ewe lamb management. Reducing lamb mortality was primarily hindered by challenges related to lambing preparation, shed management, nutrition, labour, and hygiene. The findings suggest that despite diverse production systems, common challenges exist across Europe and Turkey. Addressing these challenges through the dissemination of best management practices can significantly enhance flock productivity. This study provides valuable insights into shared farmer experiences and underscores the importance of knowledge exchange across regions.

Estimation of genetic parameters for fertility and prolificacy in the Lacaune meat sheep population carrying a hyperprolific gene

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Small Ruminant Research, Volume 253, December 2025 **OPEN ACCESS**

DOI https://doi.org/10.1016/j.smallrumres.2025.107630

Highlights

- Reproduction results according to the oestrus type differed in this study.
- Hormonal treatments, used to synchronize oestrus, improved fertility and litter size.
- Mutation of an allele of the FecL gene increased litter size by + 0.5 lambs.
- The FecL gene had no impact on fertility.
- The repeatability and heritability of prolificacy and fertility were low.

Abstract

From an economic perspective, meat sheep farms depend on several components, such as reproductive traits, which can be influenced by numerous factors of variation. In this study, the effects of two kinds of oestrus, a) induced oestrus (IO) and b) the first natural return oestrus (FRO), and of the genotype encoding a hyperprolific gene (FecL) on prolificacy and fertility were tested. The genetic parameters of these two traits were also estimated using BLUP animal models with ASReml software. The data related to 68,652 matings were recorded from 2010 to 2020 for 20,770 ewes from the Lacaune Ovi-Test population. The oestrus type, which is associated with the use of hormonal treatment, improved the two reproductive traits studied. As expected, one copy of the mutated allele of the FecL gene had an effect on the prolificacy of + 0.5 lambs per lambing but had no effect on fertility. Moreover, the animal variances estimated during this study for prolificacy and fertility after IO and on FRO were low but still explained a share of the phenotype variance of ± 0.5 lambs per litter and ± 0.20 fertility points around the average. The repeatabilities and heritabilities of prolificacy and fertility were low but consistent with the literature. Owing to the structural relationship

between the oestrus type in our dataset, less data were available on FRO, making its genetic evaluation less accurate than the genetic evaluation on IO.

Adaptability of Barbados Blackbelly rams towards elevated temperature-humidity index assessed through reproductive physiology and behaviour

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Small Ruminant Research, Volume 253, December 2025

DOI https://doi.org/10.1016/j.smallrumres.2025.107645

Highlights

- BB rams showed thermal tolerance at THI 89–94 in terms of reproductive performance.
- Cortisol decline at Day 14 might suggest physiological adaptation to high-THI.
- First report of altered sexual behaviour patterns in BB rams under heat stress.

Abstract

The influence of heat stress on reproductive performance in tropical-adapted sheep breeds is less described in literature, despite climate projections indicating worsening heat and humidity in tropical regions. Barbados Blackbelly (BB) sheep are highly regarded for their tropical adaptability and prolificacy, yet little empirical evidence proves their thermal tolerance and potential to improve sheep production in tropical countries. In this study, the effects of heat stress induced by elevated temperature-humidity index (THI) on BB ram reproductive performance were examined. Six BB rams were subjected to heat stress treatment (THI = 89–94) in a climatic chamber. After 14 days of heat treatment, rectal temperature, scrotal temperature, and respiration rate significantly increased in the rams. Significant reduction in their scrotal and testicular measurements was observed, as well as changes in their sexual behavioural patterns. BB ram testosterone level also significantly reduced at Day 14 of heat treatment. Cortisol level peaked at Day 7 and declined significantly by Day 14, likely indicating that physiological adaptation towards heat stress had begun to be employed by BB rams by the end of the treatment. Furthermore, despite an overall decline in spermatozoal quality, significant reduction was only observed in some motility and abnormality parameters. Elevated levels of malondialdehyde and hydrogen peroxide were also observed in ram seminal plasma indicating increased oxidative stress status, although the differences were not statistically significant. The present study provides key experimental evidence on the thermal resilience of Barbados Blackbelly rams, which merits the tropical adaptability of this prolific sheep breed.

Machine learning-based prediction of pre-weaning lamb survival using animal-, housing-, and management-related factors

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Small Ruminant Research, Volume 253, December 2025

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Highlights

- Eight machine learning algorithms were used to predict lamb survival status.
- The survival of lambs in the raw dataset was 91.73 %.
- The highest accuracy (0.925) was obtained with Boosting algorithm.
- Birth weight was the variable with the highest relative influence with at 43.4 %.
- Birth month, number of ewes per shepherd, floor space per ewe were high influence.

Abstract

The aim of the study is to classify lambs that will survive or die before weaning by using animal- and farm-related factors as predictors through machine learning (ML) algorithms, and to identify potential risk factors associated with lamb mortality in housed management systems. Survival records from birth to weaning of a total of 5539 lambs were analysed from ten farms, which reared Kivircik sheep. To predict whether the lambs will survive from birth to weaning, Decision Tree (DT), Random Forest (RF), K-Nearest Neighbors (KNN), Naïve Bayes (NB), Boosting, Logistic Regression (LR), Support Vector Machine (SVM) and Multilayer Perceptron (MLP) classifiers were tested. The survival of lambs in the raw dataset was 91.7 %. The highest accuracy (0.925) in classifying living or dead lambs was obtained by Boosting algorithm, while the second highest performance (accuracy of 0.897) was shown by RF. NB, LR, and SVM algorithms achieved relatively lower classification accuracies, ranging between 65 % and 67 %. According to the Boosting algorithm, birth weight was identified as the variable with the highest relative influence with 43.4 %. It was followed by birth month (12.2 %), number of ewes per shepherd (11.2 %), floor space per ewe (10.0 %), and birth rank group (7.0 %). In conclusion, Boosting algorithm demonstrated high classification accuracy in predicting lamb survival. Moreover, the strong predictive influences of birth weight, number of ewes per shepherd, floor space per ewe, and birth rank group indicate the importance of focusing on gestational nutritional management, husbandry conditions, and overall herd management practices in developing intervention strategies to reduce lamb mortality in housed management systems.

Histopathological analysis in placentas of ewes infected with Chlamydia abortus showing different gross lesion severity

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Small Ruminant Research, Volume 253, December 2025 **OPEN ACCESS**

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Highlights

- This study characterises histopathological changes in placentas from ewes experimentally infected with Chlamydia abortus.
- Placentas were grouped by visible lesion severity (Low, Medium, High) and analysed using histopathology and immunohistochemistry (IHC).
- Increasing lesion severity correlated with progressive vascular damage, from thrombosis to vascular necrosis and mineralisation.
- Chlamydial antigen presence (IHC) was highest in the Medium lesion group, indicating a complex host-pathogen interaction beyond mere antigen load.
- Ischaemic necrosis due to vascular pathology, rather than direct cell lysis by chlamydial bodies, was identified as the key driver of placental dysfunction.
- Findings highlight the role of vascular compromise and inflammation-associated oedema in disrupting maternofetal exchange and fetal viability.
- Every finding was objectively examined using a systematic analysis we designed and completed using novel statistical approaches.
- This is the first study to statistically analyse the relationship between gross and histological lesions on Chlamydia abortus-infected placentas.

Abstract

The placenta plays a vital role in nutrient exchange between the mother and fetus. In pregnant ewes, Chlamydia abortus infection causes suppurative necrotising placentitis, impairing this function. While gross

placental lesions are observable, microscopic analysis is required for detailed characterisation. This study investigated the histopathological changes in placentas showing different severities of visible damage from C. abortus-infected ewes. This study investigated histopathological changes in placentas from ewes experimentally infected with C. abortus, grouped (n = 3 per group) by the extent of visible lesions: Low (0–25 %), Medium (40–60 %), and High (85–100 %). Formalin-fixed placentas were randomly sampled for histopathology and immunohistochemistry (IHC). In the Low group, the placentas showed mild to moderate focal suppurative placentitis. Medium group placentas exhibited severe multifocal suppurative necrotising placentitis with vascular thrombosis, while the High group exhibited severe, diffuse, suppurative necrotising placentitis with vascular necrosis and mineralisation. IHC for chlamydial lipopolysaccharide showed a higher presence in the trophoblast in the Medium group than in the Low or High groups. The histopathological parameters were standardised and statistically analysed to investigate each parameter's relative impact on the disease's pathogenesis. The findings suggest that ischemic necrosis, due to vascular lesions such as vasculitis, mural necrosis, and thrombosis driven by the host response to chlamydial antigens, has a greater impact on pregnancy outcome than cell lysis associated with the release of chlamydial elementary bodies. Reduced perfusion and inflammation-associated oedema increase the thickness of the maternofetal interface, compromising fetal nutrient exchange and fetal survival.

Short communication: salivary cortisol concentrations and lying behavior of ewes in response to semi-laparoscopic and laparoscopic embryo transfer

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Journal of Animal Science, Volume 105, December 2025 **OPEN ACCESS**

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Abstract

This study compared the short-term effects of the laparoscopic and semi-laparoscopic embryo transfer (**ET**) procedures on salivary cortisol concentrations and the lying behavior of ewes. In total, 40 ewes were synchronized for ET and placed randomly into individual pens 2 d before the operations. On the day of the operations, laparoscopic (**L**, *n* = 15) and semi-laparoscopic (**SL**, *n* = 10) ET were performed. At the same time, control animals (**Control**, *n* = 15) were placed into the laparoscopic cradle for 6 min without an ET procedure. Monitoring of standing and lying behaviors started 24 h before the surgery and lasted until 24 h after the procedures were completed. Saliva samples were taken 4 times during the experiment and assayed for cortisol concentrations. Saliva cortisol concentrations were elevated in all groups 1 (Control: 4.8 ± 0.5 ng/mL; L: 5.1 ± 0.5 ng/mL; SL: 4.2 ± 0.7 ng/mL) and 2 (Control: 5.5 ± 0.5 ng/mL; L: 5.9 ± 0.5 ng/mL; SL: 4.8 ± 0.7 mg/mL) hours after the procedures compared to the initial concentration (Control: 3.8 ± 0.5 ng/mL; L: 3.7 ± 0.5 ng/mL; SL: 3.1 ± 0.7 ng/mL), and returned to the basal levels for the end of the 24-h post-surgery period (Control: 3.4 ± 0.5 ng/mL; L: 4.1 ± 0.5 ng/mL; SL: 3.5 ± 0.7 ng/mL). There were no significant differences in the cortisol levels among the groups. There was no difference in the total lying time between the groups 24 h before or after the surgery. The average length of lying bouts calculated for the 24-h post-surgery period increased in all groups from the 24-h pre-surgery period, with a parallel decrement in the number of lying bouts ($P < 0.05$). Our results suggest that the laparoscopic and semi-laparoscopic ET did not cause more stress in the ewes than the handling procedures related to surgery and preparation.

Melatonin mitigates autophagy: unlocking conditional resilience in sheep trophoblast cells exposed to a hypoxic environment

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Reproduction & Fertility, Volume 6, Issue 4, December 2026

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Lay Summary

Melatonin is known for its role in regulating reproduction in sheep; however, very little is known about the role it plays in the development of the placenta. Here, we take you through how melatonin helps the placental cells survive in a low-oxygen environment, a condition called hypoxia. In this environment, we found that melatonin helps the placental cells function and reduces their death rate by helping them recycle damaged parts to survive. Overall, our findings highlight melatonin as a powerful molecule playing a role in placental cells' survival and how they function under stressful conditions. Since hypoxia is a common cause of pregnancy complications, melatonin could be a valuable aid for both animals and humans. Indeed, this study shows that melatonin is not just a sweet little pill; it is mighty and should only be used when truly needed.

Abstract

Melatonin is a key molecule in supporting pregnancy success in sheep, particularly under suboptimal conditions. In humans, melatonin is also known for its antioxidant properties. In addition, it has recently been reported that melatonin differentially drives cell fate in normal vs altered trophoblast cells. Given that, we hypothesize that melatonin is a potential partner for trophoblasts to overcome a hypoxic environment during the early stage of pregnancy. Here, we explore the effect of melatonin on early trophoblast cell behavior and its potential mitigating effect in $CoCl_2$-induced hypoxia. Cell functionality and autophagy modulation were studied on ovine primary trophoblast cells (oTCs) 24 h treated with 250 µM melatonin with/without 200 µM $CoCl_2$. First, melatonin exerts its antioxidant effects by reducing H_2O_2 levels under hypoxic cellular conditions ($P < 0.0001$). $CoCl_2$ suppressed cell proliferation and migration ($P < 0.0001$); however, melatonin supplementation partially restored oTCs functionality ($P < 0.05$). Melatonin-mediated cytoprotective effects are manifested even through the modulation of cell fate mechanisms, particularly autophagy and apoptosis. Increased protein expression of autophagic markers (BCLN1 and LC3BII/LC3BI ratio) in concomitance with a decreased phosphorylation of mTOR was observed in $CoCl_2$-treated cells ($P < 0.01$), while a reduced rate of autophagy was detected following melatonin co-treatment ($P < 0.01$). Similarly, melatonin attenuates the $CoCl_2$-induced increase in apoptosis when administered concurrently (5.5 vs 1.8%, $P < 0.01$). These findings suggest that melatonin promotes autophagy over apoptosis, indicating a shift toward cell survival mechanisms. In addition, melatonin enhances cell functionality under hypoxia, suggesting the conceptus benefits from melatonin, particularly when it is forced to grow in a suboptimal environment.

Can vanillic acid, a phenolic substance, be a useful tool to prevent oxidative stress induced by freezing ram sperm?

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Reproduction in Domestic Animals, Volume 60, Issue 12

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Abstract

The objective of the study was to investigate the vanillic acid's (VA) protective effects, a phenolic compound, on the ram semen after freeze–thaw. Semen was obtained from Ramlıç rams and was diluted with control (0 µg/mL VA) and VA-supplemented Tris-based extenders at concentrations of 1, 10 and 50 µg/mL. The

diluted semen was equilibrated for 2 h at +4°C, filled into 0.25 mL straws and frozen in liquid nitrogen vapour. It was then stored in a liquid nitrogen container at −196°C. For analysis, the samples were thawed at 37°C for 30 s in a water bath. There was no difference detected among total and progressive motility as well as velocity parameters ($p > 0.05$) except for rapid progressive motility ($p < 0.05$). The findings support the idea that VA has an outstanding effect on reducing DNA damage ($p < 0.001$). While there was no positive development with regard to total oxidant status ($p > 0.05$), VA enhanced the antioxidant defences of total antioxidant status ($p < 0.05$). VA administered at doses of 10 and 50 µg increased total antioxidant status ($p < 0.01$). Lipid peroxidation was not directly affected by VA application ($p > 0.05$); otherwise, 10 and 50 µg VA treatments showed a positive effect on viability ($p < 0.001$). Based on findings, it was concluded that although VA was put in the semen extender, it did not have an ameliorative potency on sperm motility and velocity properties except for specific sub-parameters such as rapid progressive motility. All applied doses reduced DNA damage, and 10 and 50 µg doses supported cellular viability.

Pregnancy scanning of sheep in southern Australia. 2. Accuracy of pregnancy scanning in field data

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Animal Production Science, Volume 65, Issue 18, December 2025 **OPEN ACCESS**

DOI https://doi.org/10.1071/AN25233

Abstract

Context. Scanning for fetal count enables producers to alter pre-lambing management of ewes according to litter size, for improving lamb and ewe survival outcomes. However, accurate scanning in industry flocks is important to achieve this goal.

Aims. This study aims to characterise accuracy of scanning in current field data and relate this to lambs recorded at both the ewe and flock levels.

Methods. Four experimental flock data sets and two large industry data sets derived from Sheep Genetics were used to demonstrate the repeatability of scanning and investigate how data quality influences the assessment of accuracy of scanning to predict lambing outcomes.

Key results. Scanning for pregnancy determination and fetal count is highly repeatable for experienced scanners, but at higher litter size (> 2 lambs) error rates in fetal count increase. The accuracy of distinguishing singles from multiples can be higher than for fetal counts. However, accuracy in predicting lambs born from scanning results is more strongly influenced by poor quality of recording lambing outcomes against individual ewes than to scanning errors. Scanning for fetal count does not have as high accuracy for predicting lambs reared due to lamb losses, which are also influenced by litter size.

Conclusions. Technical improvements and slower scanning speed might be required to increase accuracy of fetal counts at high litter size, but the overall impact is relatively low at current mean litter sizes, in flocks where triplet litters are relatively scarce.

Implications. Scanning accuracy is facilitated by using experienced scan practitioners requested to distinguish fetal counts, with appropriate pre-scanning preparation, and with all ewes scanned within correct ranges for fetal age at the time of scanning.

MLA Project L.LSM.0021 and AWI project ON-00650 Increasing lambing percentages through better use of pregnancy scanning technology

Accuracy of genomic prediction of mean performance of Merino sheep for traits related to reproduction rate

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Animal Production Science, Volume 65, Issue 18, December 2025 **OPEN ACCESS**

DOI https://doi.org/10.1071/AN25280

Abstract

Context. The Flock Profile is a genomic test delivered to commercial Merino flocks to provide an estimate of their average Australian Sheep Breeding Values (ASBV) using genomic-only breeding values informed from the Sheep Genetics MERINOSELECT analysis.

Aims. This study aimed to examine the predictive ability of the Flock Profile genomic test to estimate the mean genetic merit of Merino sheep flocks, estimated through validation using the MERINOSELECT analysis.

Methods. Data from this analysis were used in a validation study to test the accuracy of predicting mean flock genetic performance for reproductive traits. For each validation flock, the pedigree, genotypes and performance data were removed for the entire flock, and then its Flock Profile result was estimated from genomic predictions based on estimated single-nucleotide polymorphism marker effects from single-step genomic BLUP analyses. The Flock Profile results were then compared with the original ASBVs from the full analysis.

Key results. The accuracy of the ranking of mean flock performance was high ($r > 0.79$, median 0.98) for all traits except ewe rearing ability. However, the Flock Profile results were slightly over-dispersed, with an average regression slope across traits of 0.91, and thus had slightly more variation compared with the ASBVs. Genomic predictions for individual animals were also highly correlated ($r > 0.78$) with the full ASBVs.

Conclusions. The results from this study have provided the evidence to enable more reproduction traits to be reported in the Flock Profile test.

Implications. The study also demonstrated variability in genomic connectedness to the reference population across flocks and traits, and thus, the development of an accuracy metric will be important soon. This initial study indicates that further research is needed to evaluate genomic prediction accuracy in less genetically related populations, particularly for flocks lacking phenotypic and pedigree data, to better inform breeding decisions and on-farm management strategies.

Optimized protocols of meiotic arrest maintenance improved in vitro maturation of ovine oocytes

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Reproduction, Fertility and Development, Volume 37, Issue 18, December 2025

DOI https://doi.org/10.1071/RD25074

Abstract

Context. The developmental potential (DP) of in vitro-matured (IVM) oocytes is considerably lower than that of in vivo-matured oocytes, primarily owing to the premature resumption of meiosis without adequate cytoplasmic maturation during IVM. Evidence indicates that meiotic arrest maintenance (MAM) during IVM significantly enhances oocyte DP. However, studies on ovine oocytes remain scarce.

Aims. To optimize MAM protocols for improving maturation of ovine oocytes.

Methods. Ovine oocytes collected from abattoir-derived ovaries were subjected to MAM culture for 24 h, followed by assessment of MAM efficiency and oocyte DP.

Key results. When used individually, roscovitine (RSC), db-cAMP, and U0126 showed suboptimal MAM efficiency. However, their combined application at substantially reduced concentrations yielded markedly improved outcomes. A combination of 12.5 µM RSC, 1000 µM db-cAMP, and 10 µM U0126 achieved high MAM efficiency, and when MAM lasted for 18 h, it resulted in significantly higher oocyte DP than in control

oocytes matured without MAM. Furthermore, oxidative stress was detected during MAM, and the addition of antioxidants during the 24 h MAM period enhanced oocyte DP beyond that of non-MAM controls.

Conclusions. High MAM efficiency and improved oocyte DP were achieved using a combination of RSC, db-cAMP, and U0126 at reduced concentrations, indicating that meiotic arrest in ovine oocytes is regulated through multiple signaling pathways. Antioxidant supplementation is essential for successful extended MAM.

Implications. Findings are critical for refining MAM and IVM protocols and for advancing understanding of mechanisms governing oocyte meiotic arrest and maturation.

Dynamic responses of energy metabolism in ewes during late pregnancy: a meta-regression

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Highlights

- This meta-analysis gathers all data on ewe metabolic status during late gestation.
- Litter size and dietary energy affect metabolism of ewes in late gestation.
- The metabolic challenge is increased for late pregnant ewes with larger litter sizes.
- Data on the energy demands of ewes bearing three or more lambs are scarce.
- This study provides data to better adapt dietary energy based on litter size.

Abstract

Insufficient energy intake throughout late gestation in ewes can induce a negative energy balance, leading to hypoglycemia and hyperketonemia, and increasing the risk of metabolic diseases. Previous studies have investigated the changes in key metabolites related to energy metabolism during late gestation in sheep, focusing on glucose, non-esterified fatty acids (NEFAs), and beta-hydroxybutyrate (BHB). The current meta-analysis was undertaken to gather available data on the kinetic of energy metabolites throughout late gestation to investigate the metabolic status of ewes in relation to dietary energy level and litter size. For the construction of the database, dietary energy concentration of each experiment was classified into two categories: diets covering between 60 and 100% (E60) or covering more than 100% (E100) of the metabolizable energy requirement for twin-bearing ewes at 133 days of gestation according to the National Research Council (NRC, 2007). Treatment groups were also categorized according to average litter size: single ([1.0 – 1.5[), twins ([1.5 – 2.5[), triplets ([2.5 – 3.5[), and quadruplets+ ([3.5 – 5.0]). The analysis of the meta-design revealed a quadratic effect of day to lambing for circulating glucose. For both dietary energy levels, glucose concentration decreased from day –42 to reach a nadir between days –28 and –14, depending on litter size group, and then increased until day –1. A greater decrease in glucose concentration was observed with larger litter sizes and was more pronounced for E60 than E100 groups. For each litter size group, when comparing similar days in gestation, E100 groups showed greater glucose concentrations than E60. Circulating NEFA increased linearly throughout late gestation, and a significant interaction was observed between dietary energy level and litter size group. For a similar litter size, NEFA concentrations were higher for E60 compared with E100, and the increase in NEFA concentrations with litter size was more pronounced for E60 than E100 groups, during the last 42 days in gestation. Circulating BHB increased with gestation. The intercept was higher and the slope steeper for E60 compared with E100, as well as for groups of ewes bearing larger litters. The meta-regression developed demonstrate the impact of litter size on energy requirements of ewes in late gestation. The meta-design also highlighted that data on the energy demands of ewes bearing three or more lambs are scarce. Of all the dietary treatments gathered in this meta-analysis, according to NRC (2007), only three provided an adequate amount of energy for triplet-bearing and none for quadruplet+-bearing ewes.

Effect of different sources of selenium supplementation on immune function in pregnant and lactating ewes

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Abstract

Background. Selenium (Se) is an essential soil mineral that can be incorporated into animal feedstuffs. Because of a lack of soil Se in some regions, organic or inorganic supplementation strategies must be implemented to prevent deficiencies and promote optimal ovine health. Therefore, the objectives of this study were to assess how inorganic versus organic Se supplementation influenced ewe Se status and immune function during late gestation and postpartum. Dorset Rideau ewes (n = 110) were fed a Se deficient diet from gestation d 110 through postpartum d 49 and received one of four daily oral Se treatments diluted in 5 mL of sugar water: 0 mg Se, 0.3 mg inorganic Se, 0.3 mg organic Se, and 0.6 mg organic Se. Throughout the trial, the ewes received various immune challenges, including intramuscular immunizations with a novel antigen (ovalbumin; OVA) on trial d 0 and 10, an intradermal OVA challenge on d 20, and a lipopolysaccharide (LPS) endotoxin challenge on trial d 49.

Results. The organic Se treatment groups had higher serum Se concentrations on most trial days compared to the 0.3 mg inorganic and control groups ($P < 0.05$). No significant treatment differences were found for the dermal hypersensitivity response to OVA, anti-OVA antibody response, glutathione peroxidase activity, cytokine response, cortisol response, or rectal temperature ($P > 0.05$). However, 4 h post-LPS injection, the serum albumin concentration was significantly lower in the 0.3 mg inorganic group compared to both organic Se groups, potentially indicating a higher degree of inflammation in the ewes supplemented with the inorganic Se.

Conclusions. The results of this study indicate that organic Se supplementation can promote a higher Se status in ewes over time, but Se supplementation during this study period did not affect tested immunological parameters. This lack of difference in immune responsiveness between groups may be due to an absence of true serum Se deficiencies in the Se-deficient group or the levels of Se supplementation being insufficient to significantly improve immunocompetence.

Genetic parameters for direct and maternal effects on pre-weaning growth and efficiency-related traits in inter-cross lamb

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Abstract

The objective of this investigation was to estimate the (co)variance components and genetic parameters for pre-weaning growth traits in inter-cross sheep maintained at NTRS, ICAR-CSWRI, Garsa, India. Data records of 1891 lambs for birth weight (BW) and 1763 lambs for weaning weight (WW) descending from 183 rams and 667 dams, born between 2012 and 2023, were utilised in the study. The live weight was used for the calculation of pre-weaning average daily weight gain (PDWG), pre-weaning Kleiber ratio (PKR), pre-weaning

growth efficiency (PGE) and pre-weaning relative growth rate (PGR). The fixed effects used in the model were birth year, genetic group, sex, type of birth, and parity of dam. Estimation of covariance components was carried out by fitting a series of animal models using the average information restricted maximum likelihood (AIREML) algorithm. The best-fitting model was determined after testing for improvement in log-likelihood values. The overall LSM ± SE for BW, WW, PADG, PKR, PGE, and PGR were 3.29 ± 0.04 kg, 14.83 ± 0.22 kg, 127.87 ± 2.46 g, 16.78 ± 0.13, 357.53 ± 7.13, and 1.66 ± 0.02, respectively. Analysis revealed that pre-weaning traits were significantly ($p < 0.05$) affected by year of birth, parity of dam, type of birth and sex of the lamb. Direct heritability estimates were 0.11 ± 0.04, 0.16 ± 0.04, 0.16 ± 0.04, 0.15 ± 0.06, 0.18 ± 0.06 and 0.17 ± 0.06 for BW, WW, PADG, PKR, PGE, and PGR, respectively. The corresponding maternal heritability estimates for BW, PKR, PGE, and PGR traits were 0.19 ± 0.03, 0.11 ± 0.04, 0.13 ± 0.04, and 0.12 ± 0.04, respectively. For WW and ADWG, only direct effects were significant. The correlations of WW with efficiency-related traits and among the other traits were quite high and positive. Significant impact of maternal care for early growth traits in this breed indicates the importance of considering both direct and maternal effects for genetic evaluation. The moderate estimate of heritability for WW with high and positive genetic correlations with other traits, makes this trait a candidate for selection in the present flock. We therefore recommend the use of WW as a single trait selection criterion for the overall improvement of the growth traits in the sheep flock.

Impact of feeding different selenium (Se) sources to pregnant and lactating ewes on lamb Se enrichment and serum biochemistry profiles

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Abstract

Introduction. Global pre-weaning lamb mortalities have remained above 10%, a detriment to farm profits. Selenium (Se) is a trace mineral vital to several functions in sheep. Se supplementation during late pregnancy and lactation, particularly organic Se supplementation, may produce more robust lambs.

Objective. To determine how differences in maternal Se supplementation impact lamb health within 10 days postpartum (ppd 10).

Methods. Ewes (n = 110) were enrolled in a feeding trial from gestation day (gd) 110 to ppd 10, and supplemented with either no Se, 0.3 mg/day inorganic Se, or 0.3 or 0.6 mg/day organic Se. Lambs only received Se via maternal nursing. Lamb serum was collected on ppd 0, 2, and 10 to assess maternal transfer of Se, and muscle samples were collected on ppd 10 to assess lamb Se stores. Serum glutathione peroxidase (GPx) levels, thyroid hormone triiodothyronine (T3) levels, and a complete ovine 23-parameter biochemistry panel were assessed on ppds 0 and 10.

Results. Maternal organic Se supplementation significantly increased Se levels in lamb serum ($P < 0.0001$) and muscle ($P < 0.0001$) as compared to other treatments. Organic Se supplementation significantly increased GPx activity at birth ($P > 0.001$), but T3 levels were not affected. From the biochemical panel, serum levels of non-esterified fatty acid, potassium, chloride, albumin, total bilirubin, creatine kinase, aspartate aminotransferase, and glutamate dehydrogenase showed significant treatment differences.

Conclusions. Organic Se supplementation to ewes during late gestation and lactation improved lamb Se status and antioxidant capacity at birth. Other serum biochemistry parameters were only marginally affected by Se treatment.

Older yet more attractive: Multiparous ewes are preferentially courted, and elicit more mountings and ejaculations than nulliparous ewes in group breeding

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Highlights

- Multiparous ewes were ranked as more attractive than nulliparous ones.
- This was unrelated to the proportion of ewes from each parity available.
- Rams ejaculated more often in multiparous ewes.

Abstract

High ewe density in group breeding enhances ram selectivity and favors the most attractive ewes. This study aimed to compare the sexual attractiveness of multiparous and nulliparous ewes. We hypothesize that multiparous ewes will be ranked as more attractive. Forty-two ewes, 21 multiparous and 21 nulliparous, Santa Ines × Dorper in estrus were tested. Each ewe was observed for five minutes, and behaviour was recorded from live and video observations. After each 5-minute test, the ewe courted for the longest time was removed and ranked as most attractive (rank 1), and this procedure continued until all six ewes in a group were ranked (1 = most to 6 = least attractive). Ewe ranking, ram behavior, and the odds of mounting acceptance were analyzed using the Friedman test, generalized mixed-effects models, and mixed-effects logistic regression, respectively. Mean attractiveness ranks were higher for multiparous than nulliparous ewes (2 ± 0.17 vs. 5 ± 0.17, P = 0.008). Rams also exhibited longer mean mounting duration (2.46 ± 0.91 s vs. 1.59 ± 0.91 s, P = 0.045) and a higher number of ejaculations (0.90 ± 0.31 vs. 0.14 ± 0.31, P = 0.0015) with multiparous ewes. While odds of accepting mounts were similar between categories (odds ratio = 0.45; 95 % CI: 0.08–2.75; P = 0.369). All first-ranked ewes were multiparous, and last two ranks were nulliparous. These results indicate multiparous estrous ewes as more attractive to rams, suggesting separating breeding groups per parity may improve fertilization rates in nulliparous ewes.

A pilot study on anogenital distance in non-pregnant and pregnant Merino ewes and ewe hoggets measured by calipers and image analysis

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Highlights

- AGD has the potential to predict pregnancy status in Merino ewe hoggets.
- AGD measurements cannot be used to predict pregnancy rates in Merino ewes.
- Image analysis for AGD had the highest correlation between the two measurements.
- Pregnancy detection sensitivity, 72.7 % AF (ewes) and 76 % VV (ewe hoggets).

Abstract

Reproductive traits are fundamental phenotypic traits selected to achieve optimal production efficiency. The aim of this study was to evaluate the use of four measurements of anogenital distances (AGD; in mm) and compare them with ewe pregnancy status, measured via pregnancy scanning, using data collected from 80 Merino ewes and 80 ewe hoggets. Digital calipers were used to measure AGDs (AC – anus to clitoris, AVV – anus to ventral vulva commissure, AF – anus to fourchette and VV – vulva length) in each sheep twice by

three assessors. High-resolution images were taken for each sheep to conduct further measurements of AGD using an image analysis software. The measurements conducted with the image analysis were correlated with the pregnancy status of ewe hoggets for AF ($P < 0.002$), VV ($P < 0.001$) and AVV ($P < 0.002$), but no association was found for AC ($P > 0.05$). The measurements performed with calipers by three assessors were more variable compared to image analysis, resulting in lower correlations between the first and second measurements taken on the same animal. The relationship found between three AGD measurements (AF, AVV and VV), and pregnancy status in the ewe hoggets, demonstrates the potential to use this trait as an inexpensive method to estimate pregnancy status. The association with pregnancy status, especially in ewe hoggets, could be easily adopted by producers.

Funding calls

Program	Open	Close
AWI EOI for 2026 On-farm Investment Priorities	24 November 2025	30 January 2026