

MARCH 2024

# Sheep reproduction RD&A alert

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

MLA & AWI have opened their biennial survey of sheep producers which will benchmark and track the key metrics that underpin the [Sheep Sustainability Framework \(SSF\)](#).

The survey results will allow the SSF to demonstrate progress against their four key themes:

- caring for our sheep
- enhancing the environment and climate
- looking after people, customer and the community
- ensuring a financially resilient industry.

#### Program coordinator

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The survey is begin undertaken by kynetec and is open now. Please complete the survey by 3 April 2024 by clicking [here](#). *The survey should take about 25 minutes.*

For more information on the National Sheep Producer Survey please contact Courtney Nelson ([cnelson@mla.com.au](mailto:cnelson@mla.com.au)).

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.

## Projects seeking producer involvement

### Supplementary feeding and lamb survival 2024

#### Background

Optimising ewe nutrition during pregnancy and lactation is key for improving lamb survival. Supplementary feeding is often required to meet the nutritional demands of ewes lambing in autumn and when feed-on-offer is limited during winter or early spring. Despite this, there is no industry consensus on the optimal supplementary feeding strategy for lambing ewes.

#### Aim

To evaluate various methods for trail feeding and self-feeders at lambing and quantify the impacts on lamb survival to marking on commercial farms across southern Australia.

#### Producer Expression of Interest (EOI)

The project is seeking producers who are interested in the effect of supplementary feeding during lambing using self-feeders versus trail feeding on lamb survival. To be involved you will need to:

- have at least 300 single bearing and 160 twin bearing adult ewes
- trail feed every 2-3 days
- fill self-feeders weekly (access to self-feeders may be provided).

Producers who do not pregnancy scan are still encouraged to apply.



Scan the QR code to register your EOI.

For more information on the supplementary feeding and lamb survival project contact Serina Hancock (0403 570 825 [s.hancock@murdoch.edu.au](mailto:s.hancock@murdoch.edu.au)) or Susan Robertson (02 6933 4199 [surobertson@csu.edu.au](mailto:surobertson@csu.edu.au)).



## Shelter and lamb survival 2024

### Background

Effective shelter can reduce lamb mortality by up to 50%, particularly for twin born lambs in high chill environments.

### Aim

To compare the survival of twin born lambs in paddocks with shrubs and/or crop with lambs born in pasture paddocks.

### Producer Expression of Interest (EOI)

The project is seeking producers to host lambing comparisons over the next two seasons (2024 or 2025). At each site **twin lamb survival** will be compared on a pasture lambing paddock versus a crop and/or shrub lambing paddock.



Pasture lambing paddock

+

Vegetative cereal crop  
lambing paddock

and/  
or

Shrub lambing paddock

To be involved you will need at least 50 twin-bearing adult ewes per paddock treatments. The research team will collect data on:

- ewe condition score, feed-on-offer and nutritive value at the start and end of lambing
- lamb survival
- microclimates through lambing using remote weather stations.



Scan the QR code to register your EOI.

For more information on the shelter an lamb survival project or general advice on lambing in crops or shrubs contact Georgia Welsh (0409 833 036 [georgia.welsh@murdoch.edu.au](mailto:georgia.welsh@murdoch.edu.au), Serina Hancock (0403 570 825 [s.hancock@murdoch.edu.au](mailto:s.hancock@murdoch.edu.au)) or Gordon Refshauge (0439 607 842 [gordon.refshauge@dpi.nsw.gov.au](mailto:gordon.refshauge@dpi.nsw.gov.au)).



Department of Primary Industries



## Review papers

### L-Proline: a promising tool for boosting cryotolerance and fertilizing ability of cryopreserved sperm in animals

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Animal Reproduction Science, Volume 263, April 2024

DOI <https://doi.org/10.1016/j.anireprosci.2024.107429>

#### Highlights

- L-proline (LP) improves the sperm motion after sperm cryopreservation in various animals.
- This improvement is related to the ability of LP to reduce the OS, sustain the plasma membrane and osmoregulatory agent.
- LP can suppress cell apoptosis by modulating intracellular redox in sperm

#### Abstract

Sperm cryopreservation technology significantly contributes to the safeguarding of genetic resources, particularly for endangered species, and supports the use of artificial insemination in domestic animals. Therefore, cryopreservation can negatively affect sperm health and function leading to reduce the freezing ability and fertility potential. Therefore, it is essential to prioritize the improvement of cryotolerance in cryopreserved sperm to enhance reproductive efficiency and ensure sustainability in livestock herds. The main reason for sperm dysfunction after thawing may be related to the excessive amount of oxidative stress (OS) produced during cryopreservation. Scientists have different ways for counteracting this OS including the use of plant extracts, enzymes, minerals, anti-freezing proteins, and amino acids. Recently, one such amino acid is L-proline (LP), which has multiple roles such as osmotic and OS defense, nitrogen, and carbon metabolism, as well as cell survival and signaling. LP has been found in seminal plasma and has recently been added to the freezing extender to improve the various post-thaw parameters of sperm. This improvement is related to the ability of LP to reduce the OS, sustain the plasma membrane and to act as an osmoregulatory agent. Moreover, LP can suppress cell apoptosis by modulating intracellular redox in sperm. This review addresses the ongoing research on the addition of L-proline as an osmoregulatory agent in freezing extenders to increase the cryotolerance of animal spermatozoa to freeze-thaw.

### An updated review on the application of proteomics to explore sperm cryoinjury mechanisms in livestock animals

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DOI <https://doi.org/10.1016/j.anireprosci.2024.107441>

### Highlights

- Description of the status related to sperm cryoinjury mechanism.
- Cryopreservation effect on sperm of livestock animals.
- Recent advances on some domestic animals' sperm proteome during cryopreservation.

### Abstract

This comprehensive review critically examines the application of proteomics in understanding sperm cryoinjury mechanisms in livestock animals, in the context of the widespread use of semen cryopreservation for genetic conservation. Despite its global adoption, cryopreservation often detrimentally affects sperm quality and fertility due to cryoinjuries. These injuries primarily arise from ice crystal formation, osmotic shifts, oxidative stress, and the reorganization of membrane proteins and lipids during freezing and thawing, leading to premature capacitation-like changes. Moreover, the cryopreservation process induces proteome remodeling in mammalian sperm. Although there have been technological advances in semen cryopreservation, the precise mechanisms of mammalian sperm cryoinjury remain elusive. This review offers an in-depth exploration of how recent advancements in proteomic technologies have enabled a detailed investigation into these molecular disruptions. It presents an analysis of protein-level alterations post-thaw and their impact on sperm viability and functionality. Additionally, it discusses the role of proteomics in refining cryopreservation techniques to mitigate cryoinjury and enhance reproductive outcomes in livestock. This work synthesizes current knowledge, highlights gaps, and suggests directions for future research in animal reproductive science and biotechnology.

## Scientific papers

### Effects of melatonin implants in late gestation and at lambing on colostrum and milk quality of ewes, birth temperature and growth performance of their lambs

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Small Ruminant Research, Volume 232, March 2024 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.smallrumres.2024.107210>

### Highlights

- Melatonin implanted during pregnancy in sheep improved colostrum quality (fat and lactose).
- Melatonin administered during pregnancy also increased surface temperature in lambs.
- Subcutaneous melatonin in pregnancy and lambing did not affect either milk composition or lamb liveweight.

### Abstract

The objective of this study was to measure the effects of melatonin implants in meat ewes at late pregnancy, at lambing, or both, on colostrum and milk composition, growth of their lambs, and lamb surface and rectal temperatures under intensive conditions. Pregnant Rasa Aragonesa ewes, that were previously synchronized (mean parity number ( $\pm$  SD):  $2.50 \pm 0.82$ , mean live weight:  $55 \pm 4$  kg; mean body condition:  $3.00 \pm 0.25$ ) received a subcutaneous melatonin implant thirty days before lambing (M-0, n = 14), at lambing (0-M, n = 14), at both periods (M-M, n = 10), or did not receive an implant (0-0, n = 12). Mean ( $\pm$  SD) prolificacy (number of lambs born/lambing) was  $1.43 \pm 0.14$ ;  $1.57 \pm 0.13$ ;  $1.40 \pm 0.16$ , and  $1.42 \pm 0.14$  for the M-0, 0-M, M-M and 0-0 groups, resp. The distribution of lambs born according to their sex was: M-0, 7 males, 12 females; 0-M,

10 males, 11 females; M-M, 6 males, 7 females, and O-O, 8 males, 6 females. Fat (F), protein (P), and lactose (L) content were measured in colostrum (collected at lambing) and milk (collected every two weeks), and <sup>9</sup>Brix and IgG were quantified in colostrum. Lamb weight (LW) was recorded at birth and every two weeks until weaning (day 42 of age). At birth, lamb rectal temperature (RT) and thermography images were taken (Eye=ET; shoulder=ST; mid loin=MT; hips=HT). P and L concentrations in colostrum were significantly ( $P < 0.05$ ) higher in the M-O ( $P: 9.01 \pm 0.45$ ,  $L: 8.53 \pm 0.42\%$ ) than they were in the M-M group ( $P: 7.38 \pm 0.34$ ,  $L: 6.99 \pm 0.32$ ), with no significant differences among groups for F content. No significant differences were found for birth weight among groups, as well as considering litter size. However, at weaning, male lambs reared by O-M ( $12.31 \pm 0.57$  kg) ewes had significantly ( $P < 0.05$ ) higher LW than did male lambs reared by M-O ( $9.43 \pm 1.01$ ) or O-O ( $9.65 \pm 0.99$  kg) ewes. Lambs from M-O and M-M ewes had the highest MT and HT, and the effects were most pronounced in male lambs. In conclusion, melatonin implants during pregnancy had positive effects on ewes by improving colostrum quality, and increased the MT and HT in lambs. Implants at lambing enhanced the productive performance of ewes and male lambs, but implants at both moments did not provide beneficial effects.

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## Survival analysis of genetic and non-genetic factors influencing lamb survival of different sheep breeds

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Small Ruminant Research, Volume 232, March 2024

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### Highlights

- Identifying genetic and no-genetic factors that influence lamb survival is vital to improve efficiency of breeding programs.
- Substantial improvement in lamb survival may be achieved by improving the care for small lambs and by paying attention for seasonal variation.
- Low heritability estimates for lamb survival indicates that direct selection aimed to improving this trait is challenging.
- Strong association of birth EBVs and survival suggests indirect selection based on birth EBVs could improve lamb survival.

### Abstract

Data records of 3800 Dorper, Dorper × Menz and Menz lambs born from 2011 to 2023 were used to determine non-genetic factors and to estimate variance components of lamb survival at Debre Birhan Agricultural Research Centre, Ethiopia. The traits investigated were lamb survival from birth to 90, 180, 365 and 90 to 180 days of age. The data was subjected to analysis using the Weibull proportional hazard model. The mortality rates of lambs at different age intervals (90, 180, 365, and 90 to 180 days) were determined for three breeds: Dorper, Dorper × Menz, and Menz. The respective mortality rates for each breed were as follows: 23.96%, 36.85%, 48.72%, and 15.47% for Dorper; 23.64%, 37.33%, 56.32%, and 17.00% for Dorper × Menz; and 12.98%, 23.44%, 39.31%, and 11.44% for Menz respectively. Breed of lamb, year of birth and lamb weight at birth significantly ( $P < 0.05$ ) affected risk of lamb mortality during all the periods studied. On the other hand, except from 90 to 180 days of age, lamb inbreeding coefficient, birth type, parity of dam and season of birth significantly ( $P < 0.05$ ) affected lamb risk of death at all studied periods. However, sex of lamb had a significant ( $P < 0.05$ ) effect during birth to yearling and weaning to six months of age. Dorper and Dorper × Menz lambs had higher ( $P < 0.05$ ) risk of death compared with the local breed (Menz lamb). The likelihood of mortality significantly decreased as the weight of the lamb at birth increased, transitioning from



very low values (less than 2 kg) to higher values (4.00 kg and above). Lambs with a higher inbreeding coefficient (above 6.25%) exhibited the highest risk of death (2.13) compared to lambs with a zero inbreeding coefficient. Lambs born from younger (nulliparous) and older dams (5 parity and above) faced a higher risk of death. The heritability estimates for lamb survival during the birth to yearling age period ranged from 0.004 for Menz to 0.25 for Dorper, indicating variability in the genetic influence on this trait between the two breeds. While direct selection for lamb survival may be challenging due to low heritability specifically for Menz sheep, implementing measures such as improved lamb care, accounting for seasonal variations, and indirect selection based on birth weight can lead to notable improvements in lamb survival rates within the research centre. The significant and alarming lamb mortality rates observed in the research centre necessitate the immediate implementation of measures and strategies.

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## Effect of vitamin D on oxidative stress indices and ram semen parameters

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### Highlights

- We artificially created vitamin D deficiency in Ram's model to investigate vitamin D's impact on oxidative stress indices and ram semen parameters.
- We used two different methods for recovering vitamin D; single-dose (20000 IU/kg) and multi-dose (2000 IU/kg) treatment with Dithrecol.
- vitamin D deficiency decreases sperm quality due to a decrease in TAC, PMI, viability and increased sperm abnormalities, DNA damage, MDA.

### Abstract

High vitamin D3 receptor and vitamin D3 metabolizing enzyme expression during spermatogenesis reflects the importance of vitamin D in fertility. This project aimed to study the effects of vitamin D3 supplementation on semen parameters and the oxidative system of rams. Twenty sexually active, mature rams were randomly selected. Rams were evenly (based on their age and live weight) categorized into four groups: control group (CG), low-dose vitamin D3 treatment group (LDG), high-dose vitamin D3 treatment group (HDG), and normal group (NG). The CG, LDG, and HDG were kept in a dark place for three months, and the vitamin D3 supplement was removed from the diet to cause vitamin D3 deficiency. The NG was placed in free sunlight, and a vitamin D3 supplement was added to their diet; thus, the vitamin D3 serum levels were normal in this group. After vitamin D3 deficiency (< 75 nmol/L vitamin D in the serum), rams received 2000IU/kg vitamin D3 in the LDG. Rams in the HDG received 20000IU/kg of vitamin D3. The rams in the CG group did not receive vitamin D3 supplementation. Sperm collection was performed three times in the morning for three consecutive months. The results showed a relationship between vitamin D3 serum level, semen parameters, and oxidative stress indices. After the treatment, vitamin D3 serum levels in LDG ( $128.4 \pm 17.3$  nmol/L) and HDG ( $119.3 \pm 10.6$  nmol/L) were statistically ( $P < 0.05$ ) different from CG ( $42.9 \pm 3.6$  nmol/L). Treatment with both doses of vitamin D3 significantly improved sperm parameters ( $P < 0.05$ ). Sperm viability ( $95 \pm 6\%$  in LDG,  $95 \pm 4\%$  in HDG, and  $61 \pm 1.1\%$  in CG), sperm PMI ( $85 \pm 5\%$  in LDG and  $84 \pm 5\%$  in HDG, whereas  $51 \pm 8\%$  in CG), sperm morphology ( $9 \pm 3\%$  in LDG and  $10 \pm 2\%$  in HDG in contrast with  $28 \pm 6\%$  in CG), and DNA fragmentation index ( $10 \pm 3\%$  in LDG,  $11 \pm 1\%$  in HDG, and  $31 \pm 7\%$  in CG) were statistically different ( $P < 0.05$ ). Treatment with both doses of vitamin D3 substantially ( $P < 0.05$ ) declined malondialdehyde concentration ( $1.2 \pm 0.4$   $\mu\text{mol/L}$  in LDG and  $1 \pm 0.3$   $\mu\text{mol/L}$  in HDG in contrast with  $9.7 \pm 0.9$   $\mu\text{mol/L}$  in CG) and total oxidant status level ( $9.9 \pm 3.8$   $\mu\text{mol H}_2\text{O}_2$  equiv/L in LDG and  $10 \pm 3.6$   $\mu\text{mol H}_2\text{O}_2$  equiv/L in HDG whereas  $77 \pm 10.6$   $\mu\text{mol H}_2\text{O}_2$  equiv/L in CG). However, total antioxidant capacity concentration ( $4.17 \pm 0.61$

$\mu\text{mol fe}^{2+}/\text{L}$  in LDG and  $4.86 \pm 0.62 \mu\text{mol fe}^{2+}/\text{L}$  in HDG while  $1.02 \pm 0.29 \mu\text{mol fe}^{2+}/\text{L}$  in CG) and total thiol concentration ( $231.9 \pm 23.8 \mu\text{mol}/\text{mg}$  protein in LDG and  $250.6 \pm 25.9 \mu\text{mol}/\text{mg}$  protein in HDG in contrast with  $31.5 \pm 11.2 \mu\text{mol}/\text{mg}$  protein in CG) statistically ( $P < 0.05$ ) increase in LDG and HDG. In conclusion, vitamin D3 supplementation improved semen quality in rams by its vitamin D3 receptor action and oxidative stress reduction.

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## How early can nonpregnant ewes be detected based on the blood flow of the corpus luteum?

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Small Ruminant Research, Volume 232, March 2024

DOI <https://doi.org/10.1016/j.smallrumres.2024.107211>

### Highlights

- We suggest an objective criterion for diagnosing nonpregnant ewes based on morpho-functional changes of the corpus luteum.
- Differences in corpus luteum vascularization between pregnant and nonpregnant ewes were evident by day 13 post-ovulation.
- Objective assessment of CL vascularization enables precise diagnosis of nonpregnant ewe by day 15 post-ovulation.

### Abstract

The study aimed to characterize morpho-functional changes in corpus luteum (CL) in pregnant and nonpregnant sheep, propose diagnostic criteria for non-pregnancy, and assess diagnostic accuracy around the expected luteolysis period. Crossbred ewes ( $n = 34$ ) underwent estrous synchronization, divided into G1 (unmated,  $n = 20$ ) and G2 (mated,  $n = 14$ ). The day of ovulation was considered as day 0 (D0). Luteal dynamic was monitored from D0 to D17, with blood samples collected every 72 h for progesterone (P4). Pregnancy was definitively diagnosed at day 30. Analyses included CL area (CLA), CL blood flow (CLBF), CLBF:CLA ratio, and serum P4. Statistical models considered group, day, and interactions. Accuracy for early pregnancy diagnosis (days 12–17) was assessed. CLBF:CLA ratio ( $14.3 \pm 8.1$  vs.  $20.3 \pm 10.7$ ;  $10.2 \pm 10.4$  vs.  $17.8 \pm 9.4$ ;  $1.3 \pm 4.1$  vs.  $16.0 \pm 8.2\%$ ), CLBF ( $0.41 \pm 0.3$  vs.  $0.49 \pm 0.3$ ;  $0.26 \pm 0.3$  vs.  $0.45 \pm 0.3$ ;  $0.06 \pm 0.2$  vs.  $0.34 \pm 0.2 \text{ cm}^2$ ), and CLA ( $2.5 \pm 1.1$  vs.  $2.3 \pm 0.9$ ;  $1.9 \pm 1.1$  vs.  $2.3 \pm 1.1$ ;  $0.9 \pm 1.2$  vs.  $2.0 \pm 1.2 \text{ cm}^2$ ) differed ( $P < 0.05$ ) between pregnant and nonpregnant ewes at days 13, 14, and 16 after ovulation, respectively. The early diagnosis of nonpregnancy achieved accuracy values  $> 90\%$  from day 15 on for CLBF and CLBF:CLA ratio, but not for CLA. At this day, CLBF and CLBF:CLA ratio were circa 50-fold greater in pregnant than in nonpregnant ewes ( $p < 0.0001$ ). No ewe classified as in the 1st or 2nd quartiles for CL endpoints or P4 concentration was confirmed as pregnant at day 30. In summary, the diagnosis of nonpregnancy based on the objective evaluation of CLBF could be performed in sheep as early as at day 15 after ovulation.

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## Supplementing dietary betaine during late gestation increases plasma betaine and methionine concentrations in pregnant Merino ewes but not neonatal lambs

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Small Ruminant Research, Volume 232, March 2024 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.smallrumres.2024.107226>

### Highlights

- Betaine supplementation at 2 and 4 g/day increases plasma betaine concentration in single-bearing Merino ewes during late gestation.
- Betaine supplementation at 2 g/day increases plasma methionine concentration in single-bearing Merino ewes during late gestation.
- Betaine supplementation at 2 and 4 g/day does not alter plasma betaine, creatinine, methionine and glycine in neonatal lambs at birth.

### Abstract

Supplementing dietary betaine during pregnancy has improved vigour and post-natal survival rates to day seven in twin lambs, potentially due to improvements in the circulating metabolite profile of these animals. This study determined whether maternal betaine supplementation during late gestation would increase circulating levels of betaine, creatinine and other amino acids in ewes and their newborn lambs, leading to subsequent improvements in lamb viability and growth. Twenty-five single-bearing Merino ewes received dietary betaine at either 0 (Control, CTL), 2 (Low Betaine, LB) or 4 g/day (High Betaine, HB) from day 125 of gestation (dG 125) until parturition ( $150.7 \pm 0.6$  days). Blood samples were collected from the ewes prior to feeding (0 h), and at 2, 4, 6, 8 and 24 h post-feeding on dG 125 and dG 140 prior to feeding and from the lamb within 2 h after birth. Lamb viability measures were taken at 2, 24 and 72 h and day 7 post-partum, marking ( $\sim 30$  days of age) and weaning ( $\sim 104$  days of age). Betaine supplementation at LB and HB increased plasma betaine levels at 6, 8 and 24 h post-feeding on dG 125 ( $P < 0.05$ ) and tended to increase plasma betaine on dG 140 ( $P = 0.085$ ). Plasma methionine levels increased at 2 and 4 h post-feeding on dG 125 relative to baseline levels (0 h) in LB ewes, yet remained unchanged in HB ewes. On dG 125, creatinine levels were higher in CTL ewes compared with betaine-supplemented ewes at 4 and 8 h post-feeding (both  $P < 0.05$ ). While plasma betaine and methionine levels were unchanged in neonatal lambs, plasma concentrations of glutamine and lysine were higher ( $P < 0.05$ ) in HB lambs compared to CTL and LB lambs. HB lambs tended to be heavier at marking ( $P = 0.057$ ) and were heavier at weaning compared to CTL and LB lambs ( $P < 0.05$ ). This study indicated that betaine supplementation increased plasma betaine and methionine levels in ewes, but not in neonatal lambs. Further research is warranted to determine whether higher levels of betaine supplementation increase neonatal concentrations.

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### A protocol to assess the welfare of dairy ewes: From science to the field

Pierre-Alexandre Jolly, Elise Rouyer, Laetitia Bru, Lorie Marin, Elise Meillac, Gabrielle Foubert, Mathilde Roman, Andrew Arthur Ponter, Olivier Patout and Alline de Paula Reis ([alline.reis@vet-alfort.fr](mailto:alline.reis@vet-alfort.fr))

Small Ruminant Research, Volume 232, March 2024 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.smallrumres.2024.107209>

### Highlights

- A protocol to assess animal welfare in the dairy ewe.
- Rapid evaluation: 2 h, including 26 indicators and 5 freedoms.
- Minimal disturbance to animals and farm routine.
- A robust reference database including 81 farm assessments.
- A tool to guide field actions in the animal welfare domain.

### Abstract

There is growing societal demand for improved animal welfare. The stakeholders in the industry are also increasingly interested in information and expertise in this area. There is a scientific consensus that an objective assessment should be the foundation for discussions and actions in favour of better animal welfare. However, only a few protocols exist and most of them have been developed for meat-producing sheep and/or are more adapted for an extensive farming context and/or do not include all the five freedoms of



animal welfare. Therefore, references are still scarce especially in the field of dairy ewe welfare. This makes the transition from science to practice difficult. The present study was carried out bearing two objectives in mind: (1) to develop a feasible protocol (EBBEL – Evaluation du Bien-être des Brebis en Elevage Laitier / Assessment of sheep welfare in dairy farms) to assess the welfare of dairy ewes and (2) to implement the protocol on a large scale (n = 81 dairy ewe farms under semi-intensive system) in the Roquefort region of France. The animals and the farms were examined in terms of satisfaction of 26 welfare indicators. The results were very informative about the points of excellence but also about those that need to be improved. The database that we developed can serve the scientific community when comparing different production contexts. Beyond the technical results, stakeholder participation in the design process was clearly positive for acceptance of the protocol in the field.

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### **Reproductive development of male lambs born to undernourished mothers supplemented or not with concentrate during gestation**

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Livestock Science, Volume 281, March 2024

DOI <https://doi.org/10.1016/j.livsci.2024.105428>

#### **Highlights**

- Maternal nutrient restriction reduces lamb birth weight and future performance.
- Ram lambs born to supplemented ewes were heavier until first 4 months old.
- Males born to restricted ewes showed greater sexual activity at 6 and 12 months-old.
- Males from supplemented ewes tended to have a lower sperm count at 6 months of age.

#### **Abstract**

Southern Patagonia offers harsh environmental and nutritional conditions for sheep pregnancy, which may compromise the fetal and postnatal development of lambs. The aim of the study was to compare the sexual behavior and attractiveness, and semen production and quality during the first year of life of ram lambs born to undernourished mothers grazing on natural pastures, supplemented or not with a concentrate. The study was performed under extensive Patagonian conditions, and a supplement was provided from day 44 of gestation until lambing. Twelve ram lambs born to supplemented ewes (group Sup) and 12 born to control underfed ewes (group Con) were used. Both groups of male lambs remained in a common paddock before and after weaning at 4 months-old. Sexual behavior and attractiveness, and semen production and quality of ram lambs were evaluated when they were 6 and 12 months-old. Sup lambs were heavier than Con at birth, and tended to maintain this difference when they were 4 mo-old; afterward, this difference disappeared. At 6 months-old, Con ram lambs displayed greater sexual activity when individually exposed to an estrous ewe, as well as a trend to a greater sperm concentration. Differences between groups in sexual behavior decreased at 12 months-old, and no differences were detected in seminal traits. In conclusion, supplementation of undernourished pregnant ewes with concentrate from mid-pregnancy until lambing slightly impacted the progeny reproductive performance when they were 6 months-old, an effect that was attenuated at 12 months-old. The effects of the nutritional status of pregnant ewes on the reproductive development of the offspring likely were compensated by a greater growth rate during early life before puberty.

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### **Heat stress from current and predicted increases in temperature impairs lambing rates and birth weights in the Australian sheep flock**

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### Abstract

Livestock heat stress threatens production, particularly in semi-arid, arid and tropical regions. Using established temperature thresholds for sheep, we modelled +1 °C and +3 °C temperature increases over the historical baseline, estimating that 2.1 million potential lambs are lost annually due to heat stress alone, increasing to 2.5 and 3.3 million, respectively, as temperatures rise. Heat stress poses risks at key periods of the reproductive cycle, with consequences across the Australian sheep flock.

**MLA Project L.LSM.0024** *Effects of heat stress on reproductive performance on the Australian sheep flock*

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## Additive impacts of liveweight and body condition score at breeding on the reproductive performance of Merino and non-Merino ewe lambs

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### Simple Summary

Fatness is linked to reproductive performance in sheep, and it is realistic to expect that higher body condition scores at breeding would have positive effects on the reproductive rate of ewe lambs, over and above liveweight. Data were analysed from over 17,000 records from Merino and non-Merino ewe lambs from 22 different flocks across Australia. There were significant curvilinear relationships between liveweight or body condition score prior to breeding and reproductive rate for both Merino and non-Merino ewe lambs. When analysed together, there was a significant quadratic effect of body condition score on reproductive rate, independent of correlated changes in liveweight. The results indicated that if only a proportion of ewe lambs were selected for breeding, selection based on both liveweight and body condition scores may only improve overall reproductive rate by 1 to 2% compared to selection based on liveweight alone.

### Abstract

Ewe lambs that are heavier due to improved nutrition pre- and post-weaning achieve puberty at a younger age, are more fertile, and have a higher reproductive rate. Fatness is intimately linked to reproduction, and we hypothesised that higher body condition scores at breeding would have positive effects on the reproductive rate of ewe lambs over and above liveweight. We also expected that if only a proportion of ewe lambs were presented for breeding, then it would be more effective to select them based on both liveweight and body condition score. To test these hypotheses, we analysed data from over 17,000 records from Merino and non-Merino ewe lambs from 22 different flocks across Australia. Non-Merino ewe lambs were more fertile (69.4% vs. 48.7%) and achieved a higher reproductive rate than Merino ewe lambs (96.9% vs. 60.7%). There were significant curvilinear relationships between liveweight ( $p < 0.001$ ) or body condition score ( $p < 0.001$ ) prior to breeding and reproductive rate for both Merino and non-Merino ewe lambs. For both breeds, there was a significant ( $p < 0.001$ ) quadratic effect of body condition score prior to breeding on reproductive rate, independent of the correlated changes in liveweight, and at the same liveweight, an extra 0.5 of a body condition score up to 3.3 improved reproductive rate by about 20%. Nevertheless, the results indicated that if only a proportion of ewe lambs were selected for breeding, then selection based on both liveweight and body condition scores may only improve the overall reproductive rate by 1 to 2% compared to selection based on liveweight alone. We conclude that liveweight is a more effective method than body condition score for selecting ewe lambs for breeding.

**MLA Project L.LSM.0001** *Improving the reproductive performance of ewe lambs – Management guidelines, economic analysis and decision support tools*, **B.LSM.0038** *Increasing lamb supply through improving the reproductive performance of Merino ewe lambs* & **B.PDS.0903** *Improving the reproductive efficiency of ewe lambs*

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## **Chronic undernutrition in Ovine twin pregnancies abolishes differences in birth weight due to sex: An evaluation of the role of nutritional and antioxidant supplementation**

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### **Simple Summary**

The fetal growth pattern in twin pregnancies is usually affected by the sex of the co-twin pairs, among other factors, with females being lighter than males at birth. We aimed to determine the effect of the sex of co-twins on lambs' birth weight in ovine pregnancies developed under natural undernourishment, a condition of sheep farming frequently encountered worldwide. Additionally, we sought to investigate whether the nutritional and/or antioxidant supplementation provided to ewes during pregnancy could modulate the potential effects associated with the sex of co-twins. We found that maternal nutrient restriction abolishes the sex differences in body weight at birth between co-twins. However, improving maternal nutrition and supplementation with antioxidants during gestation not only improves maternal weight and body condition but also tends to restore birth weight and its differences between female and male offspring, an effect that is enhanced with the combined supplementation of concentrated food and antioxidants. These results suggest that undernutrition not only may alter the intrauterine growth through the maternal–fetal relationship, but also through the feto–fetal relationship, which can be normalized via strategically targeting interventions such as maternal nutrient supplementation or antioxidant supplementation during gestation. Thus, a better understanding of the driving factors of this effect is of major relevance to improving fetal growth and lamb survival in harsh environments.

### **Abstract**

In twin pregnancies of discordant sex, the male fetus grows larger than the female co-twin. Our study aimed to determine the effect of the sex of co-twins on lambs' birth weight in ovine pregnancies developed under natural undernourishment. Additionally, we investigated whether the nutritional and/or antioxidant supplementation provided to ewes during pregnancy could modulate the potential effects associated with the sex of co-twins. Ninety-six birth records of twin pregnancies of sheep grazing the natural Patagonian prairies were analyzed. The animals were divided into four groups: control (no supplementation), N (concentrate supplementation, 100% NRC), A (antioxidant supplementation), and NA (concentrate + antioxidant supplementation). Supplementation occurred from day 35 of gestation onwards until lambing. There were no differences in female or male birth weight in the control undernourished group. However, in group N, females or males with sex-discordant co-twins had a higher birth weight than did those with co-twins of the same sex. Group A males with female co-twins had a higher birth weight compared to males whose co-twins were also males. In NA lambs, males had a higher birth weight compared to females, regardless of their co-twin's sex. Therefore, chronic undernutrition abolished the differences in birth weight due to fetal sex. Restoring maternal nutrition or antioxidant supplementation tends to normalize birth weight and restore the differences between females and males. This effect is enhanced with the combined supplementation of concentrated food and antioxidants.

## Sperm traits and seminal plasma proteome of locally adapted hairy rams subjected to intermittent scrotal insulation

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### Highlights

- Heat stress reduced ram testis size, sperm concentration and motility.
- Sperm DNA integrity and BSP binding and seminal proteins were critically altered.
- Variations in seminal protein expressions coincided with changes in sperm criteria.
- Altered seminal proteins were mainly those associated with oxidative stress.
- Know animal response to heat stress is vital in the scenario of climate changes.

### Abstract

The present study evaluated the effects of heat stress on reproductive parameters of hairy rams. Six animals were subjected to scrotal insulation during four consecutive nights (6 PM – 6 AM). Day (D) 0 was the first day of insulation. Scrotal circumference increased from  $30.5 \pm 0.3$  cm (at pre-insulation) to  $31.8 \pm 0.4$  cm on D4, decreased 3.9 cm on D28, returning to  $30.6 \pm 0.6$  cm on D57. Sperm concentration decreased from  $3.7 \pm 0.12 \times 10^9$  sperm/mL before insulation to  $2.6 \pm 0.1 \times 10^9$  on D23, returning to normal on D57. Sperm motility averaged  $75 \pm 2.9\%$  before insulation, was undetectable on D23, and became normal on D77. Sperm with normal morphology reached  $5.9 \pm 2.6\%$  on D35 but recovered ( $86.8 \pm 2.1\%$ ) on D91. Sperm DNA integrity decreased from  $86.5 \pm 4.7\%$  before insulation to  $11.1 \pm 3.7\%$  on D63, returning to pre-insulation values on D120. Sperm BSP immunostaining was reduced after scrotal insulation. Variations in seminal protein abundances coincided with changes in sperm parameters. Seminal plasma superoxide dismutase, carboxypeptidase Q-precursor and NPC intracellular cholesterol transporter 2 decreased on D18, returning to normal after D28. Albumin, inhibitor of carbonic anhydrase precursor, EGF-like repeat and discoid I-like domain-containing protein 3 and polymeric immunoglobulin receptor increased after insulation. In summary, intermittent scrotal insulation drastically altered ram sperm attributes and seminal proteins, especially those associated with oxidative stress. Knowledge of animal's response to thermal stress is vital in the scenario of climate changes.

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## Developmental programming of reproduction in the female animal

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### Highlights

- Developmental programming refers to the impact of environmental factors during fetal and/or neonatal life on normal function of an individual during adulthood.
- Various maternal, fraternal, nutritional, hormonal, pathological and environmental factors can influence the developmental programming of reproduction.
- The effect of developmental processes on reproduction could be through their influence on reproductive and/or non-reproductive organs and systems.
- Identification of factors influencing developmental programming of reproduction is of importance for better management of livestock operations.

## Abstract

Successful reproduction is a cornerstone in food animal industry in order to sustain food production for human. Therefore, various methods focusing on genetics and postnatal environment have been identified and applied to improve fertility in livestock. Yet there is evidence indicating that environmental factors during prenatal and/or neonatal life can also impact the function of reproductive system and fertility in the animals during adulthood, which is called the developmental programming of reproduction. The current review summarizes data associated with the developmental origins of reproduction in the female animals. In this regard, this review focuses on the effect of plane of nutrition, maternal body condition, hypoxia, litter size, maternal age, parity, level of milk production and milk components, lactocrine signaling, stress, thermal stress, exposure to androgens, endocrine disrupting chemicals, mycotoxins and pollutants, affliction with infection and inflammation, and maternal gut microbiota during prenatal and neonatal periods on the neuroendocrine system, puberty, health of reproductive organs and fertility in the female offspring. It is noteworthy that these prenatal and neonatal factors do not always exert their effects on the reproductive performance of the female by compromising the development of organs directly related to reproductive function such as hypothalamus, pituitary, ovary, oviduct and uterus. Since they can impair the development of non-reproductive organs and systems modulating reproductive function as well (e.g., metabolic system and level of milk yield in dairy animals). Furthermore, when these factors affect the epigenetics of the offspring, their adverse effects will not be limited to one generation and can transfer transgenerationally. Hence, pinpointing the factors influencing developmental programming of reproduction and considering them in management of livestock operations could be a potential strategy to help improve fertility in food animals.

## Upcoming events

Date	Event	Location
12 April 2024	<a href="#">StrateFly™</a> AWI	Cumnock, NSW
15 April 2024	<a href="#">Livestock worm control workshop</a> NSW Local Lands Services (Greater Sydney)	Tuggerah, NSW
17 April 2024	<a href="#">Livestock worm control workshop</a> NSW Local Lands Services (Greater Sydney)	Camden, NSW
18 April 2024	<a href="#">Livestock worm control workshop</a> NSW Local Lands Services (Greater Sydney)	Richmond, NSW