

NOVEMBER 2024

Sheep reproduction RD&A alert

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

The [October 2024 Sheep Producer Intentions Survey](#) (SPIS) report is now available. The October survey is focussed on estimating the size of the Australian sheep flock, profiling the expected lamb crop and capturing producer intentions for lambs and breeding ewes in 2025.

The survey results indicate that 2025 will continue to be a particularly challenging time for wool and sheep meat producers as they continue to face the challenges of ongoing high on-farm costs (input costs), challenges around workforce shortages as well as supply chain and market pressures (domestic and global).

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.

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Feature project update

Managing Merino weaners to survive and thrive

Background

Merinos play a key role in the Australian sheep meat industry, representing approximately 70% of lambs born and 55% of lambs slaughtered. Merino weaner survival remains an issue with 50% of farms reporting Merino weaner mortality above industry targets. Poor reproductive performance in maiden Merinos also remains an issue compared to adult ewes, with a 24% difference in marking rate relative to mature ewes attributable largely to 22% difference in reproductive rate and to a lesser extent 3% difference in lamb survival. This has important industry impact because maiden ewes represent 25% of Merino x Merino joinings that provide ewe replacements.

Aim

To identify opportunities for post-weaning nutrition and management to deliver cost-effective improvements in weaner survival and subsequent reproductive performance across a range of Merino genotypes.

Project Objectives

- Identify opportunities to use nutrition and management between weaning and joining to improve Merino weaner survival and reproductive performance for a range of Merino genotypes
- Develop models that quantify impact of intervention (genetics, management, nutrition) on survival and lifetime reproductive performance that can be incorporated in decision support tools to inform best-practice for different production systems
- Determine and formulate best practice nutritional management guidelines for Merinos between weaning and joining in regions of southern Australia.

- Demonstrate the impact of genetic selection and best practice management of Merinos between weaning and joining for commercial mixed farms across major sheep production areas in WA, VIC and NSW.
- Contribute to the development of tools targeting practice change for managing maiden ewes that will influence and motivate producers beyond the project.

Current progress

Field studies investigating i) the impact of growth curve on survival and reproductive performance and ii) the effect of additional supplementation on survival and reproductive performance are progressing on schedule. Seven on-farm demonstration sites linked to sheep producer networks are underway.

For more information on the Managing Merino weaners to survive and thrive project contact Caroline Jacobson (C.Jacobson@murdoch.edu.au).

Scientific papers

Damage to mitochondria during the cryopreservation, causing ROS leakage, leading to oxidative stress and decreased quality of ram sperm

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Reproduction in Domestic Animals, Volume 59, Issue 10, October 2024

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Abstract

Semen cryopreservation can achieve long-term preservation of sperm. Ice crystal damage, as well as oxidative stress, result in mitochondrial dysfunction and a reduction in sperm motility after thawing. However, limited information exists regarding the impact of reactive oxygen species (ROS) and mitochondria on the cryopreservation of ram sperm. The primary objective of this study was to investigate the relationship between ROS and mitochondria concerning sperm quality during the cryopreservation of ram sperm. This investigation assessed sperm motility, kinematic characteristics, membrane integrity, acrosome integrity, mitochondrial membrane potential (MMP), adenosine triphosphate (ATP) levels, expression of mitochondrial respiratory genes (NDUFB2, SDHA, CYC1, and COXIV), ROS levels, malondialdehyde (MDA) content, phosphatidylserine externalisation rate, sperm ultrastructure, mtDNA copy number, expression of apoptosis-related genes (Bax, Caspase-3, and Caspase-8), Cytochrome C, and Caspase-3 content. The results showed the cryopreservation significantly ($p < 0.05$) decreased motility, kinetic parameters, membrane integrity, acrosome integrity, MMP, ATP, mRNA expression levels of mitochondrial respiratory-related genes, and significantly ($p < 0.05$) increased ROS levels, MDA content, phosphatidylserine externalisation rate, damage of sperm ultrastructure, mtDNA copy number, mRNA expression levels of apoptosis-related genes, Cytochrome C and Caspase-3 content compared to the fresh semen group. In conclusion, the cryopreservation causes damage to mitochondria, leading to increased ROS and subsequent oxidative stress. This process also initiates mitochondrial dysfunction and interferes with the electron transport chain, ultimately resulting in decreased MMP and ATP production. Furthermore, the liberation of Cytochrome C prompted the increase in Caspase-3 expression and subsequent sperm apoptosis occurred, ultimately leading to a deterioration in sperm quality after thawing.

Dietary resveratrol improves immunity and antioxidant defense in ewes by regulating the rumen microbiome and metabolome across different reproductive stages

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Abstract

Introduction: Resveratrol (Res), a natural plant antitoxin polyphenol, is widely used in animal husbandry due to its antioxidant and anti-inflammatory properties, and current research has focused on humans, sows, and female mice. This study aimed to analyze the effects of dietary Res supplementation in ewes on antioxidant activity, immune responses, hormone levels, rumen microbiota and metabolites across various reproductive stages (estrus, pregnancy, and lactation).

Methods: Twenty-four healthy ewe lambs (Hu sheep, 2 months old) with a similar body weight (BW) (mean: 21.79 ± 2.09 kg) were selected and randomly divided into two groups: the control group (Con) and the Res group (Res). The Res group received 10 mg/kg Res (based on BW) in addition to their basal diet.

Results: Res increased the levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH), and estradiol (E2) in ewes at sexual maturity ($p < 0.05$). Additionally, Res supplementation induced significant increases in serum glutathione peroxidase (GSH-Px), IgG, FSH, and LH levels during estrus ($p < 0.05$); serum IgA, IgG and IgM during pregnancy and lactation ($p < 0.05$); and serum LH, glucose, GSH-Px, and catalase (CAT) levels during lactation ($p < 0.05$). Meanwhile, serum interleukin 1β (IL- 1β) ($p = 0.005$) and cholesterol levels ($p = 0.041$) during the lactation stage decreased following Res supplementation. Notably, colostrum IgA, IgG, and fat concentrations were significantly higher in the Res group than in the Con group ($p < 0.05$). Moreover, Res altered the rumen microbiota in ewes. Specifically, the relative abundance of Prevotella ($p < 0.05$) during pregnancy and Rikenellaceae_RC9_gut_group ($p < 0.001$) during lactation were significantly increased in ewes under Res treatment. The abundance of Rikenellaceae_RC9_gut_group was positively correlated with the levels of Ig A, Ig M, E2, FSH, LH, GSH-PX, and CAT. Additionally, Res altered the activity of metabolic pathways such as progesterone-mediated oocyte maturation, the estrogen signaling pathway, ovarian steroidogenesis, and the AMPK signaling pathway, and the levels of AICAR and 2-hydroxyestradiol metabolites, both during pregnancy and lactation.

Discussion: These findings show that Res can improve health, antioxidant status, and immune activity throughout the reproductive cycle in ewes by regulating rumen microorganisms and metabolites.

Response of maiden ewes to the ‘ram effect’ is a robust management practice and a candidate selection trait for enhanced reproductive performance in drylands

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Highlights

- The “ram effect” induces oestrus in 50% of maiden ewes during seasonal anoestrus.
- The response varies between years, live weight of the females and vegetation cover.
- The shorter the response to the “ram effect” in days, the higher is fertility.
- Time lag to oestrous response and fertility are genetically highly correlated.
- Days to oestrus is a good candidate to breed for high fertility in drylands.

Abstract

Management of reproduction that relies on naturally based solutions is extremely important to counter the negative perception around hormone-based interventions. In Mediterranean latitudes and wider regions of non-tropical drylands, sheep do not normally ovulate during spring but exposure to a ram can induce oestrus

and ovulation. This study assesses the response of maiden Barbarine ewes in drylands to the 'ram effect' during springtime and estimates the genetic parameters of this response. The study uses a database documenting, for 24 consecutive years, the response of nulliparous 18-month-old ewes when mated after stimulation by the 'ram effect.' In addition to the oestrous and fertility database, a pedigree database was also available. Nearly half of the maiden ewes responded to the 'ram effect,' while 24% exhibited spontaneous reproductive activity and displayed oestrus during the first 14 days following the introduction of rams. Nearly 5% of females did not exhibit oestrus, and these animals are proposed for early culling. Average annual values of Normalised Difference Vegetation Index (NDVI), reflecting vegetation cover, and the percent of maiden ewes spontaneously cycling were positively correlated ($P = 0.006$). Interestingly, NDVI was negatively correlated with the percentage of anoestrus females that did not respond to the 'ram effect' but exhibited oestrus beyond the hypothetical time frame commonly used to describe it. Average fertility was 82.8% and was significantly affected by mating year, live weight at mating, and the response to the 'ram effect.' The highest fertility (88.39%) was for females spontaneously cycling at the time of ram introduction, and the lowest (83.35%) was for females coming into oestrus beyond the time frame for a ram-induced oestrus and ovulation. Heritability from a univariate logit-transformed analysis for fertility was 0.10 and the genetic correlation between fertility and the interval between ram introduction and oestrus was 0.26, suggesting that a shorter interval is associated with higher fertility. Thus, the interval between ram introduction and oestrus is a good candidate for selective breeding for high fertility of maiden ewes in drylands mated out-of-season using the 'ram effect.'

Negative energy balance affects perinatal ewe performance, rumen morphology, rumen flora structure, and placental function

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Abstract

This study investigated the effects of negative energy balance (NEB) on perinatal ewes, with a focus on changes in growth performance, serum biochemical parameters, rumen fermentation, ruminal bacteria composition, placental phenotype-related indicators, and expression levels of genes related to placental function. Twenty ewes at 130 days of gestation were randomly allocated to either the positive energy balance (PEB) or NEB groups. In the experiment, ewes in the PEB group were fed the same amount as their intake during the pre-feeding baseline period, while ewes in the NEB group were restricted to 70% of their individual baseline feed intake. The experiment was conducted until 42 days postpartum, and five double-lamb ewes per group were selected for slaughter. The results demonstrated that NEB led to a significant decrease in body weight, carcass weight, and the birth and weaning weights of lambs ($P < 0.05$). Additionally, NEB caused alterations in serum biochemical parameters, such as increased non-esterified fatty acids and β -hydroxybutyrate levels and decreased cholesterol and albumin levels ($P < 0.05$). Rumen fermentation and epithelial parameters were also affected, with a reduction in the concentrations of acetic acid, butyric acid, total acid and a decrease in the length of the rumen papilla ($P < 0.05$). Moreover, NEB induced changes in the structure and composition of ruminal bacteria, with significant differences in α -diversity indices and rumen microbial community composition ($P < 0.05$). Gene expression in rumen papilla and ewe placenta was also affected, impacting genes associated with glucose and amino acid transport, proliferation, apoptosis, and angiogenesis ($P < 0.05$). These findings screened the key microbiota in the rumen of ewes following NEB and highlighted the critical genes associated with rumen function. Furthermore, this study revealed the impact of NEB on placental function in ewes, providing a foundation for investigating how nutrition in ewes

influences reproductive performance. This research demonstrates how nutrition regulates reproductive performance by considering the combined perspectives of rumen microbiota and placental function.

Plasma progesterone profiles in ewes using different injectable progesterone formulations

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Animal Production Science, Volume 64, Issue 16, November 2024

DOI <https://doi.org/10.1071/AN24182>

Abstract

Context. The use of progesterone vaginal implants in sheep is frequently associated with vaginitis and adhesions; and can hamper fertility in estrus synchronization programs.

Aims. The aim of this study was to characterize the plasma hormone profile induced by two injectable progesterone (iP4) formulations in ewes.

Methods. In Experiment 1, ewes received 20 or 40 mg of an iP4, with a third group as a control. In Experiment 2, 75 or 150 mg of a long-acting iP4 were administered, again with a control group.

Key results. In Experiment 1, progesterone concentrations remained at luteal levels for less than 24 h. The intervals from iP4 treatment to the onset of estrus and ovulation were greater in treated than in control ewes ($P < 0.01$). The proportion of ewes that ovulated within 8 days after treatment was lower in ewes that received 40 mg iP4 than in control ewes ($P < 0.05$). In Experiment 2, mean progesterone concentrations remained at luteal levels for 120 h. The interval from iP4 administration to estrus was longer in 150 mg treated ewes than in control ewes ($P < 0.01$). The interval from treatment to ovulation was longer in ewes treated with 150 mg than 75 mg and control ewes ($P < 0.05$). The proportion of ewes that ovulated was lower at 150 mg ($P < 0.05$).

Conclusions. The iP4 formula used in Experiment 1 could not maintain luteal levels for more than 24 h. The use of long-acting iP4 maintained plasma progesterone concentrations above luteal levels for at least 5 days. The long-acting treatment can therefore be tested for estrous synchronization treatments.

Implications. The long-acting progesterone may be an alternative to short estrous synchronization protocols.

Assessment of loliolide extracted from *Biserula pelecinus*, present during *in vitro* oocyte maturation, on fertilisation and embryo development in sheep

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Abstract

Context. As a 'duty of care', it is important to test whether new forage plants for ruminants contain secondary compounds (PSCs) that affect reproductive performance. We have previously observed, a posteriori, that the presence of a methanolic extract of *Biserrula pelecinus* during maturation of sheep oocytes increased fertilisation rate and blastocyst development. This result needed to be verified *a priori* and, if the outcome was repeated, we needed to identify the plant secondary metabolite responsible.

Aims. To test whether PSCs from *B. pelecinus*, when added to the oocyte maturation medium, improve fertilisation rate and blastocyst development; to test whether loliolide is the active molecule produced by *B. pelecinus*.

Methods. Methanol–chloroform extracts of *B. pelecinus* were fractionated using rapid silica filtration and solvents of increasing polarity. Fractions at final concentrations of 0, 100 or 200 µg mL⁻¹ were added to the medium used to mature sheep cumulus–oocyte complexes (COCs) and effects were determined for maturation, subsequent cleavage rate, blastocyst rate, hatching rate, blastocyst efficiency and total blastocyst cell number (TCN).

Results. Fraction BP-6 at 100 µg mL⁻¹ reduced blastocyst rate ($P < 0.05$), but had no effect when the dose was doubled to 200 µg mL⁻¹. Further fractionation using semi-preparative high-performance liquid chromatography showed loliolide as the most abundant compound in BP-6. Supplementation of the *in vitro* maturation medium with loliolide (0, 2.5, 5, 10 and 25 µg mL⁻¹) did not affect any measure of embryo development. All COCs treated with *B. pelecinus* fractions reached the final stage of embryo development, blastocyst hatching. Total blastocyst cell number was not affected.

Conclusion. The presence of fractions of *B. pelecinus* extract during *in vitro* oocyte maturation can reduce embryo development.

Implications. *In vitro* techniques can detect potential effects of forages on reproduction. Some fractions from an extract of *B. pelecinus* when present during oocyte maturation can reduce embryo development. The abundant PSC, loliolide, was not responsible. There was no indication that a PSC in *B. pelecinus* improves outcomes.

Modelling the impact of increasing supplementary feed allowance on predicted sheep enterprise production, profit and financial risk across southern Australia

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Abstract

Context. Supplementary feeding may alter sheep enterprise production and profit margin, but use may vary across regions, sheep breeds and mating seasons. Supplementary feeding is a means of ensuring adequate nutrition but increases operating costs. Modelling has previously indicated the most profitable sheep enterprises optimise stocking rate and target lamb production, whereas those that minimise supplementary feeding incur the least financial risk.

Aims. To explore the impact of increasing supplementary feed allowance on production, profit and financial risk.

Methods. Seventy-two sheep farm enterprises were simulated across eight southern Australian locations, including three breeds and three mating seasons. For each enterprise a low grain allowance (LGA) of 30 kg/head.year (threshold used in previous modelling) was compared to a high grain allowance (HGA) of 35 kg/head.year and 42 kg/head.year for Merino and non-Merino ewes (current industry recommendations), respectively. The financial risk of each enterprise was determined via Conditional Value at Risk of gross margins over 30 years, exploring downside risk in the worst 20% of scenarios.

Key results. A HGA increased production and profit in 32% of farm enterprises, but financial risk was often increased. Merino enterprises were generally the most profitable, least risky and consumed the greatest amount of supplementary feed, followed by Composite and then Maternal enterprises. Summer and autumn

mating was often most profitable, but high supplement consumption in autumn-mated enterprises increased financial risk.

Conclusions. Increasing supplementary feeding may improve production and profit but may also increase financial risk using the parameters examined.

Implications. Producers may be able to improve the production, profit and financial risk of an enterprise through increased supplementary feeding, but this will be dependent on breed, input costs, commodity prices and location.

Using alpacas as guardian animals in Australia: a survey of sheep producers

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Abstract

Context: This is the first survey, to our knowledge, that examines how sheep producers in Australia use alpacas as guardian animals.

Aims: To document current management practices surrounding guardian alpacas to protect sheep and gain an understanding about producers' opinions on the effectiveness of their alpacas in increasing lamb survival, and provide recommendations for producers looking to invest in guardian alpacas.

Methods: An online survey aimed to target sheep producers that use alpacas as guardian animals in Australia. Survey was advertised through social media and mail-out copies were sent to known producers that own guardian alpacas.

Key results: The majority of respondents (72%, n = 65) co-graze 1 alpaca to every 1–50 sheep, with most of respondents (54%, n = 44) introducing alpacas to their flock of sheep 10 weeks before lambing. The majority of respondents (82%, n = 74) noted that the alpacas bonded with the sheep either straight away or within 1–4 weeks, regardless of the number of alpacas placed with sheep ($P < 0.001$ for all alpaca to sheep ratios when comparing bonding time of <4 weeks vs >4 weeks). It was common for respondents to own castrated males aged between 2 and 5 years (58%, n = 52). Approximately half of the respondents were hobby farmers (48%, n = 56). The survey findings suggested that producers believed that alpacas are effective in protecting against foxes, but not as effective against more aggressive predators such as wild dogs. The respondents witnessed alpacas exhibiting a range of guarding behaviours, including staying close to lambs, and chasing, vocalising or killing potential threats. In total, 72% of respondents reported that their lamb survival increased after introducing alpacas and gave the animals an average rating of 7.5 of 10 in relation to their effectiveness. A total of 70 respondents (83%) stated that they would recommend alpacas as guardian animals to other producers and noted that they are highly cost-effective.

Conclusions: Surveyed producers consistently considered alpacas as an effective form of predator deterrent and associated their use with increasing lamb survival.

Implications: Lamb mortality remains a major issue in the sheep industry. This survey highlighted one form of predator deterrent that surveyed sheep producers have used in the effort to increase their lamb survival. Additionally, these findings have provided knowledge, such as how these animals are being used by the respondents and information for producers looking to invest in guardian alpacas.

Energy metabolite, immunity, antioxidant capacity, and rumen microbiota differences between ewes in late gestation carrying single, twin, and triplet fetuses

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Simple summary

Multi-fetal ewes are more likely to suffer from metabolic disorders and pregnancy toxemia than single-fetal ewes in late gestation. The differences in the energy metabolites, immunity, antioxidant capacity, and rumen microbiota of ewes with different numbers of fetuses are unclear. This study found that triplet-fetal ewes were characterized by a lower BCS and antioxidant capacity, and were prone to the triggering of inflammatory responses. With the increase in fetal number, the concentration of BHBA increased, and that of glucose decreased; the relative abundance of Firmicutes was lower, while that of Bacteroidota was higher in triplet-fetal ewes. The differences in the rumen microbiota may be due to differences in the utilization of feed materials by ewes with different numbers of fetuses; multi-fetal ewes tend to ingest more grain-based feed to meet their energy requirements. Therefore, special nutritional strategies and refined feeding management approaches should be developed to meet the physiological requirements of multi-fetal ewes.

Abstract

The objective of this study was to investigate the differences in the energy metabolites, immunity, antioxidant capacity, and rumen microbiota of ewes with different numbers of fetuses. Thirty healthy ewes were selected and divided into single- (SL, n = 10), twin- (TL, n = 10), and triplet-fetal (PL, n = 10) ewes according to the number of fetuses. Sampling was carried out on days 21 (Q21) and 7 (Q7) before lambing. The results show no differences ($p > 0.05$) in the DMI and BW of ewes with different numbers of fetuses, and the body condition score (BCS) of PL ewes was lower ($p < 0.05$) than that of SL ewes. The concentrations of β -hydroxybutyric acid (BHBA), non-esterified fatty acids (NEFA), interleukin-2 (IL-2), interleukin-6 (IL-6), and tumor necrosis factor α (TNF- α) in the PL ewes were higher ($p < 0.05$), while the glucose (Glu), triglyceride (TG), total cholesterol (TC), superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), and total antioxidant capacity (T-AOC) values were lower ($p < 0.05$) than those of the SL ewes. ANOSIM analysis showed that the rumen bacterial structure of the SL, TL, and PL ewes was different on days Q21 and Q7. The relative abundance of Firmicutes and Bacteroidota in the rumen was affected ($p < 0.05$) by the number of fetuses: the relative abundance of Firmicutes (*Ruminococcus*, *Butyrivibrio*, *Christensenellaceae_R-7_group*, *Lachnospiraceae_AC2044_group*, *Lachnospiraceae_XPB1014_group*, and *Anaeroplasma*) was higher ($p < 0.05$), while that of Bacteroidota (*Prevotella*, *Prevotellaceae_UCG-003*, and *Prevotellaceae_UCG-001*) was lower ($p < 0.05$) in the SL ewes than in the PL ewes. In summary, the rumen microbial structure and energy metabolites of ewes in late gestation with different numbers of fetuses were different. Triplet-fetal ewes were characterized by lower BCS and antioxidant capacity and were prone to the triggering of inflammatory responses.

Risk factors associated with increased *Toxoplasma gondii* seroprevalence in South Australian Sheep

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Veterinary Parasitology, Volume 332, December 2024

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Highlights

- 39 % of sheep tested seropositive to the protozoan parasite *Toxoplasma gondii*.
- Flock-level seroprevalence of 100 % in screened South Australian sheep farms.

- Significantly higher seroprevalence in sheep exposed to surface water compared to reticulated mains water.
- Increasing age was strongly associated with exposure to *Toxoplasma gondii*.
- On-farm water sources may be an important factor in transmission of *Toxoplasma gondii*.

Abstract

Toxoplasma gondii (*T. gondii*) is a protozoan parasite of substantial impact to small ruminants, with reproductive failure a possible outcome of exposure. This observational study assessed *T. gondii* prevalence within the South Australian sheep population and investigated on-farm risk factors to *T. gondii* exposure via a cross-sectional survey. 1433 individual animals, consisting of 1282 mixed-age ewes and 151 mixed-age rams were blood sampled and serologically screened for *T. gondii*-specific antibodies. A risk-analysis questionnaire was conducted for each participating property. Of the 1433 animals sampled, 530 tested positive, with seroprevalence observed to be 39 % (95 % CI 28.7–49.3 %) after accounting for clustering within properties. All properties returned at least one positive result, indicating a flock level seroprevalence of 100 %. *T. gondii* seroprevalence was found to be higher in sheep on Kangaroo Island (46.6 %; 95 % CI 32.1–61.1 %) compared to the South Australian mainland (31.3 %; 95 % CI 18.4–44.2 %), however this difference was not statistically significant ($P=0.125$). A significant association was observed between *T. gondii* seroprevalence and age, with seroprevalence increasing from 30.2 % (95 % CI 17.7–42.6 %) in one year old sheep, to 69.7 % (95 % CI 47.0–92.5 %) in sheep older than six years ($P=0.001$). *T. gondii* seroprevalence was significantly higher in animals drinking water from surface water sources (55.9 %; 95 % CI 35.2–76.6 %), compared to those exclusively sourcing reticulated mains water (19.1 %; 95 % CI 0 %–39.0 %) ($P=0.028$). An individual animal exposed to a surface water source was found to be more than ten times as likely to be exposed to *T. gondii*, than an animal sourcing only reticulated mains water (odds ratio:10.68; 95 % CI 1.30–87.88). Water source is important in the transmission of *T. gondii* to South Australian sheep. Mitigation strategies should be developed and targeted at reducing contact between oocysts and water sources and reducing interaction between livestock and contaminated water.

Developmental programming of reproduction in sheep and goat: Association of fraternity size and sex ratio with reproductive performance of ewes and does at the first pregnancy

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Highlights

- Does prenatally exposed to male littermate conceived at younger ages.
- Does prenatally exposed to male littermate produced larger litters.
- Ewes and does prenatally exposed to male littermate produced male-biased litters.

Abstract

Various prenatal factors including the number of littermates (fraternity size) and exposure to male littermate (fraternity sex ratio) during fetal period have been reported to influence postnatal fertility in the mammals. The present research was conducted to study the association of fraternity size and sex ratio with reproductive performance of nulliparous ewes and does. To this end, data associated with number of littermates, exposure to male littermate, birth weight, age at first pregnancy, as well as litter size, sex ratio of offspring, litter weight, and birth weight of female and male offspring after the first parturition retrieved from the database of sheep ($n = 536$ Romane and 289 Blanche du Massif Central ewes) and goat ($n = 174$ Alpine and 267 Saanen does) flocks. Fraternity size was negatively associated with birth weight of ewes and does ($P < 0.05$). Exposure

to male littermate during fetal period was associated with younger age at first pregnancy and larger litter size in the does ($P < 0.05$), but not in the ewes ($P > 0.05$). Exposure to male littermate during fetal period was positively associated with the odds of male-biased litters in the ewes and does ($P < 0.05$). Fraternity size was positively associated with litter weight in the does ($P < 0.05$), but not in the ewes ($P > 0.05$). In conclusion, the present study showed that the number and sex of littermates during fetal period could impact postnatal reproduction of ewes and does. In this context, some associations, particularly those related to exposure to male littermate during fetal period, were only observed in does, which implicates that the effect of androgens on developmental programming of reproduction may be species-specific.

Multiparous ewes have greater mating success when competing with nulliparous ones

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Abstract

The hypothesis of this study was that multiparous ewes are more attractive to rams than nulliparous ewes, leading to more intense courtship and mating displays by rams in competitive environments. Thus, this study aimed to compare the sexual interactions of multiparous or nulliparous estrous ewes tested together or individually with sexually active males. Seven sexually experienced Corriedale rams, 21 multiparous, and 21 nulliparous Corriedale ewes were used. Competitive and individual sexual behavior tests were performed for 3 consecutive days immediately after estrous detection. Seven rams were tested with seven different dyads of one multiparous and one nulliparous female daily, totaling 14 ewes per day. The competitive sexual behavioral test evaluated a ram together in a pen with one multiparous ewe and one nulliparous ewe for 10 min. In the individual sexual behavioral test, each ram was tested twice for 10 min, with the same multiparous and nulliparous females used in the competitive sexual tests. The sexual behaviors of rams were recorded in both tests, and ewes' behaviors were registered in the competitive sexual tests. During the competitive sexual tests, rams approached, mated, and tended to sniff the multiparous ewes before the nulliparous ewes ($p=0.03$; $p=0.01$; $p=0.056$, respectively). In those tests, rams mated the multiparous ewes more efficiently than nulliparous ones ($p=0.002$), meaning that rams mounted multiparous fewer times to ejaculate. The number of flehmens and their length were greater in nulliparous than in multiparous (0.01 and 0.002, respectively). The nulliparous ewes urinated more times and tended to do it in greater duration and tended to walk more than the multiparous ($p=0.01$; $p=0.06$; $p=0.08$, respectively). During the individual sexual behavioral tests, rams showed no differences in the sexual behaviors displayed toward multiparous and nulliparous females. In conclusion, multiparous ewes were preferred as sexual partners over nulliparous ewes, with rams showing greater efficiency in ejaculating with multiparous ewes. This increased sexual attractiveness was primarily due to the ewes' attractive signals rather than their proceptive behaviors. However, multiparous and nulliparous ewes were courted and mated similarly when rams had no choice, increasing the likelihood of reproduction in both groups. While nulliparous ewes signaled their reproductive status more frequently through urination, this signal did not compensate for the other signals provided by multiparous ewes, which contributed to their higher sexual attractiveness. These findings offer practical insights, emphasizing the importance of separating multiparous and nulliparous ewes to optimize reproductive outcomes in collective breedings.