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Reproductive performance in ewes fed varying levels of cut lucerne pasture around conception

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ABSTRACT

Elevated intakes of protein and energy may increase embryo mortality, but it is not clear whether fresh lucerne (*Medicago sativa*) pasture poses a risk. A two-year pen study using oestrous synchronised and artificially inseminated Merino ewes ($n = 175$ in 2013 and 215 in 2014) evaluated whether feeding freshly cut lucerne pasture (mean crude protein 19.7%, metabolisable energy 9.4 MJ/kg DM) at maintenance or *ad libitum* during different periods around insemination altered reproductive performance in comparison with ewes fed a Control diet (mean crude protein 7.8%, metabolisable energy 9.0 MJ/kg DM) of pelleted faba bean hulls and oat grain hulls at maintenance. The proportion of pregnant ewes carrying multiple fetuses was reduced ($P = 0.026$) when ewes were fed lucerne *ad libitum* between days 0 and 17 after insemination compared with the Control diet (0.18 and 0.34, respectively), but not when ewes were fed lucerne *ad libitum* between days 0 and 7 after insemination (0.22). Reproductive performance, including the proportion of ewes pregnant and the proportion with multiple fetuses, was not different ($P > 0.05$) when ewes were fed lucerne at maintenance between days 0 and 7 compared with the Control diet. While reproductive performance was similar when ewes were fed lucerne at maintenance between 0 and 17 days after artificial insemination compared with pellets at maintenance, fetal numbers per pregnant ewe were reduced by feeding lucerne *ad libitum* after insemination.

1. Introduction

Peri-conceptional nutritional management which enhances both ovulation rate and embryo survival is required to increase the number of lambsborn. Reproductive potential is limited by ovulation rate, but failure in fertilisation, embryo, fetal and lamb survival all contribute to how much of the potential is attained, with failure of multiple ovulations to result in fetuses an important source of inefficiency in commercial flocks (Kleemann and Walker, 2005). Ovulation rates can be elevated by increasing the energy or protein intake of ewes (Knight et al., 1975; Nottle et al., 1990; Smith and Stewart, 1990; Vinoles et al., 2005), which has been achieved using corn/soybean grain (Viñoles et al., 2009) lupin grain (Nottle et al., 1997) and live pastures (King et al., 2010). While responses in ovulation rate may be achieved most efficiently through short-term increased nutrition between approximately days 10–14 of the oestrous cycle (Stewart and Oldham, 1986), this targeted duration of feeding can only accurately be achieved if oestrus is synchronised. In commercial flocks

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where oestrus is not synchronised, extending the duration of increased nutrition into early pregnancy for some ewes is required in order for a large proportion of ewes to receive elevated nutrition pre-ovulation.

While ovulation rate can be increased by feeding increased energy or protein prior to ovulation, a high intake of energy or protein during early pregnancy may also increase embryo mortality (Parr et al., 1987), which may prevent a net improvement in reproductive performance. Feeding at twice maintenance levels has been shown to cause embryo mortality in both naturally cycling (Cumming et al., 1975) and oestrous synchronised (Parr et al., 1987) ewes, compared with ewes fed at maintenance levels. The clearance rate of progesterone through the liver is higher when feed intake is increased, which leads to reduced circulating concentrations of progesterone (Parr et al., 1993) that may be associated with lower pregnancy rates (Parr et al., 1987). The sheep embryo appears to be most sensitive to reduced progesterone levels on days 11 and 12 post mating (Parr, 1992), although the duration of time for which progesterone is reduced influences the extent to which pregnancy rates are reduced (Ashworth et al., 1987). Embryo mortality may also be increased when ewes consume high levels of dietary protein or nitrogen around conception (Bishonga et al., 2006; McEvoy et al., 1997; Meza-Herrera et al., 2010). This effect has particular relevance where flushing with high protein lupin grain or lucerne pasture is being advocated and some recommendations indicate that ruminants should not graze high nitrogen pastures around mating (Robinson et al., 2006). However, high numbers of fetuses per ewe (1.5) have been achieved by flushing Merino ewes on lucerne pasture containing over 21% crude protein (Robertson et al., 2014).

The mean number of fetuses per ewe joined was higher when unsynchronised ewes grazed lucerne compared with cereal stubble *ad libitum* for 7 days prior to and only for the first 7 days of joining, with ewes removed at this time in order to avoid high energy and protein intakes during day 11–12 post conception when the embryo is most at risk of loss (Robertson et al., 2014). Removing ewes from lucerne at day 7 of joining, however, limits the proportion of ewes which mate at a flushed ovulation to approximately 65%, potentially restricting the number of lambs born. The effect of feeding lucerne for a longer period of time to increase the proportion of ewes fed pre-mating on subsequent embryo mortality is currently unknown. Therefore, the aim of the current study was to determine whether the quantity of fresh lucerne pasture fed, and the timing of feeding during the peri-conceptual period, influenced estimated embryo mortality and the number of fetuses per ewe.

2. Materials and methods

2.1. Experimental design

The study was approved by the Charles Sturt University Animal Care and Ethics committee (project no. 21/105). The experiment was conducted during 2013 and 2014.

The pen-feeding experiment evaluated five treatments in a randomised block design with two replicates of each treatment. Where day 0 = day of artificial insemination and maintenance (M) = energy requirement for maintenance, the treatments comprised:

1. Control – Fibre pellet Day −7 to 17 at maintenance.
2. Freshly cut lucerne pasture at maintenance from Day 0 to 17.
3. Freshly cut lucerne pasture *ad libitum* from Day 0 to 7.
4. Freshly cut lucerne pasture *ad libitum* from Day 0 to 17.
5. Freshly cut lucerne pasture *ad libitum* from Day −7 to 17.

When not being fed lucerne, ewes were fed the maintenance (Control) pellet for the duration of pen feeding (23 January to 3 March 2013 and 16 January to 25 February 2014, Days −22 to 17). The lucerne cultivars used were Pioneer L56 in 2013, and WL925HQ in 2014. The irrigated lucerne pasture was cut daily with a commercial lawnmower (Iseki SF370 outfront; www.iseki.co.jp) to provide fresh lucerne, and the chop size prevented selection of lucerne components. A low protein and low grain commercial maintenance pellet based on faba bean hulls and oat grain hulls was purchased from a commercial supplier (Fibre Pellet; Conqueror Milling Company, Cootamundra, NSW). The ingredients of the pellet are commercial in-confidence, however the manufacturer stated that the pellet did not contain whole grain or urea.

Ten outdoor group-feeding pens, each measuring 6 m × 8 m and containing feed and water troughs and shade, were randomly allocated to treatment and replicate. In 2013, on Day −22, two weeks prior to the commencement of differential feeding, a mixed age flock of 176 Merino ewes were stratified on age and randomly allocated to the pens based on condition score and live weight. In 2013 replicate 1 and 2 contained 18 or 17 ewes per pen, respectively. In 2014, the same ewes were stratified on pen number and pregnancy status in 2013, then current condition score and liveweight. Half the ewes remained in the same treatment as in 2013, with the remainder being randomly allocated to the other treatments. An additional five or six 18 month old ewes were randomly allocated to each pen, totalling 22 or 21 ewes per pen in replicates 1 and 2, respectively.

2.2. Sheep management

The ewes were vaccinated (1 ml Glanvac 6 in 1; Pfizer Animal Health, West Ryde, Australia) as they entered the pens. Controlled internal release devices (Eazi-breed CIDR sheep and goat; Pfizer Animal Health, a division of Pfizer Australia Pty Ltd, West Ryde, Australia) containing 300 mg progesterone were inserted on Day −16, and removed on Day −2. At CIDR removal the ewes were injected with 1 ml (200 iu) Pregnecol serum gonadotrophin (Bioniche Animal Health (A/Asia) Pty Ltd, Armidale, Australia). Fresh semen from Merino rams was used to artificially inseminate the ewes via laparoscopy on Day 0, after a 12 h fast. Semen from each ram was distributed evenly between treatment groups to avoid potential ram bias. The number of corpora lutea was measured using rectal ultrasound on Days 8 or 9 after insemination (Vinoles et al., 2004) using an Ibex Pro, Portable Ultrasound System with a 5.0 MHz Sector probe (E. I. Medical, Loveland CO, USA). The ewes were removed