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The effect of peri-conceptual grazing of live pasture on fetal numbers in unsynchronised ewes

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Abstract

Methods of increasing the number of lambs born per ewe that avoid the use of pharmaceutical methods of oestrus synchronisation but which require a short period of increased nutrition are desirable. Four separate experiments evaluated whether peri-conceptual grazing of lucerne, compared with senescent herbage or other live herbage, increased fetal numbers in unsynchronised ewes. Merino ewes that grazed lucerne pasture for seven days before joining and for the first seven days of a five to six week joining produced up to 21 extra (P<0.05) fetuses per 100 ewes joined, compared with ewes grazing cereal stubble with minimal live herbage (experiment 2). In experiments 1, 3 and 4, Merino or First Cross ewes grazing either cereal stubbles or phalaris pasture with as little as 200 kg DM/ha of live herbage produced a similar (P>0.05) number of fetuses per ewe joined as those grazing on lucerne, either because this quantity of live feed was sufficient to increase fetal numbers, or because, for experiment 3, First Cross ewes may not have responded at the commencement of the breeding season. It is concluded that grazing live pasture for seven days prior to joining and for the first seven days of joining during the breeding season can substantially increase fetal numbers in unsynchronised ewes compared to ewes grazing stubbles containing no live herbage. The response appears to occur on a range of plant species, and a small quantity of live herbage can elicit a response. Grazing lucerne in the peri-conceptual period did not increase (P>0.05) the proportion of non-pregnant ewes. Further studies are required to determine how early in the breeding season ewes with a distinct breeding season will respond to nutritional manipulation.

Keywords sheep, nutrition, flushing, reproduction

Introduction

Increased nutrition is a well known means of increasing reproductive rates. The link between ovulation rate and increasing liveweight in the weeks before joining is well known and the term ‘flushing’ describes elevated nutrition in the period around mating (Smith and Stewart 1990) with the purpose of increasing reproductive rates. Ewes will increase ovulation rates in response to flushing when the base level of feeding is either sub-maintenance or above maintenance (Leury et al. 1990). The response appears to result from an increase in energy intake (Teleni et al. 1989; Vinoles et al. 2005) although there is evidence that the response to increased energy may differ at different levels of protein (Smith and Stewart 1990). The ovulatory response to short-term flushing appears to vary with the rate of feeding, with only small increases in the quantity of live pasture available enabling higher ovulation rates, within the responsive range (King et al. 2010), such that it does not appear to be necessary for the
change in energy intake to be great when flushing on senescent pasture. Where lupin grain has been used, feeding as little as 230 g/day to ewes has resulted in an additional 18 ovulations per 100 ewes joined (Knight et al. 1975). The traditional method of flushing, which involves increasing feed for a period of six weeks pre-joining, has resulted in increased ewe ovulation rates and lambs born. The disadvantage of the traditional six week flushing pre-joining is the large quantity of feed required.

Spike feeding in a critical period of the oestrous cycle, around days 10 to 14 (Stewart and Oldham 1986), or during the period 6 days before luteolysis (Nottle et al. 1990) increases ovulation rate. Offering either grain (corn, lupin) or some live pastures (Nottle et al. 1990; Viñoles et al. 2009; King et al. 2010) for up to 12 days pre-mating to synchronised ewes is effective. Short-term feeding minimises the cost of feed, but has only been used with pharmaceutical synchronisation of oestrous cycles so that feeding occurs during the critical period. While there are other benefits of synchronised ewes as part of a ‘focus feeding’ approach (Martin and Kadokawa 2006), synchronisation incurs a substantial cost of chemicals, additional labour and increases the number of rams required. For commercial producers, the added cost can be an important barrier to the adoption of short-term pre-mating feeding.

To develop an application of short-term flushing that is widely relevant to commercial producers, pharmaceutical methods of synchronisation need to be avoided. Lightfoot et al. (1976) showed that feeding 250g/day of lupin grain to unsynchronised ewes for seven days prior to joining and for a further 18 days into joining increased the proportion of ewes with twin ovulations during the first three weeks of joining from 11 to 24%. However, this was not a short feeding period, and the use of lupins has not consistently increased the number of lambs born (Croker et al. 1985). An additional concern with the inability to target a period of high nutrition in unsynchronised ewes accurately is that an energy intake at twice maintenance on days 11 and 12 of pregnancy has been linked to increased embryo mortality and has been shown to reduce pregnancy rates from 68% to 48% (Parr 1992).

To minimise the period of feeding and avoid the risk of high feeding levels in the second week of pregnancy, we hypothesised that approximately two thirds of ewes that mate during the first oestrous cycle could be flushed by grazing live pasture for one week before and one week into an autumn joining. This, we will describe as peri-conceptual grazing. Because not all ewes will graze live pasture during the critical days 10 to 14 of the oestrous cycle, a large response is considered necessary in those ewes which are at the appropriate stage of the cycle in order for the mean flock response to be sufficiently large to increase the number of lambs born and justify this management strategy.
There is, however, limited information on the effectiveness of different pasture types to increase the number of lambs born. Lucerne (*Medicago sativa*), chicory (*Chicorum intybus*) (King et al. 2010), tagasaste (*Chamaecytisus palmensis*) (Wilkins 1997), and *Lotus spp.* (Ramirez-Restrepo et al. 2005; Viñoles et al. 2009) have all been shown to increase ovulation or lambing rates compared with senescent pasture or live grass-based pasture. However, all of these studies used either synchronised ewes, or relatively long grazing periods. Some *Lotus spp.* contain condensed tannins (Viñoles et al. 2009) which may have an additional beneficial effect on reproduction (Min et al. 1999). Apart from lucerne, none of the species listed are commonly used in Australian sheep production and none are grasses which may be the only available live pasture during autumn (perennial grasses, volunteer cereals or weeds) under Australian conditions. The potential for use of both lucerne and live grass species offered to unsynchronised ewes therefore requires evaluation.

Several studies were conducted to determine whether peri-conceptual grazing on live lucerne pastures would increase fetal numbers compared to dead herbage or live grassy pasture in unsynchronised ewes. The aims of the experiments were:

*Experiment 1:* To determine whether grazing of lucerne for 8 days before and during joining could increase fetal numbers compared with grazing senescent phalaris pasture.

*Experiment 2:* To determine whether grazing lucerne for 7 days prior to joining and for the first 7 days of joining (peri-conceptual grazing) could increase fetal numbers compared with grazing dead cereal stubble.

*Experiment 3:* To determine whether peri-conceptual grazing of phalaris or lucerne would increase fetal numbers, compared with grazing cereal stubble.

*Experiment 4:* To determine whether peri-conceptual grazing of summer grass weeds would produce similar fetal numbers as grazing lucerne.

**Materials and methods**

Four experiments were conducted with the approval of the Charles Sturt University Animal Ethics committee in 2010 and 2012.

*Experiment 1.*

This experiment was conducted near Tarcutta south-east of Wagga Wagga NSW (147°31’E 35°12’S). The experiment evaluated two nutritional treatments - senesced phalaris pasture (*Phalaris aquatica* cv. Australian),
and dryland lucerne (*Medicago sativa* cv. Aurora) in a randomised design without blocking with two replicates of each treatment.

For one month prior to the experiment, ewes grazed senesced pasture and were supplementary fed barley grain to maintain liveweight. Grain feeding ceased when the ewes were placed on the treatment pastures. These consisted of two lucerne paddocks each 4.4 ha and two phalaris-based paddocks each 5.5 ha. The flock of 200 medium to large-framed 3 to 5 year old Merino ewes were randomly allocated to treatment groups (n=100) according to body condition (scale 0 (emaciated) to 5 (obese)) (Jefferies 1961) and liveweight. Day -9 (21 January 2010) is the day the ewes were placed on treatment pastures. Composite rams (Poll Dorset based) fitted with crayon harnesses were introduced at a rate of two per plot of 50 ewes on Day 0 (29 January). Crayon marks were recorded on Days 3, 7, 11, 15, 17, 21 and 28 of the experiment. The rams were rotated between plots on each day of oestrus detection to avoid ram performance effects on pregnancy rates. Due to insufficient dry matter availability, ewes were removed from the lucerne plots and placed with ewes in the phalaris plots from Day 17 to Day 21, after which the lucerne had regrown and the ewes were returned to their plots. The rams were removed after 28 days of joining. The ewes were then combined and grazed as one flock on annual pasture. Fetal number and age were measured 56 days after ram removal using trans-abdominal ultrasound. The crayon marks were used to determine whether ewes became pregnant during the first (Day 0 to 17) or second (Day 18 to 28) oestrous cycle. On mornings of Days -9, 7 and 17 (21 January and 5 and 15 February), unfasted weight and condition score (Jefferies 1961) was recorded.

Live and dead pasture biomass were visually estimated the day before ewes entered treatment paddocks (Day -10), the day before rams were added (Day -1), and on days of oestrus detection (Days 3, 7, 11, 15, 17, 21 and 28) using the method of Haydock and Shaw (1975) as described by Cayley and Bird (1996), using calibration quadrats cut at ground level with electric shears. On the first occasion (Day -10), 30 estimates per paddock were recorded; 60 estimates were recorded on all subsequent occasions.

Samples for herbage quality were taken using the ‘toe-cut’ method (Cayley and Bird 1996) when ewes entered and re-entered paddocks. All quality sub-samples from each replicate were combined for each pasture type and were analysed by the Feed Quality Service of NSW Department of Primary Industries (Wagga Wagga, New South Wales) for crude protein (CP), neutral detergent fibre (NDF), dry matter digestibility (DMD), and digestibility of organic matter (DOMD). The proportion of live lucerne leaf and stem was measured from toe-cut samples collected when ewes entered and re-entered paddocks, and on Day 7 of joining by stripping leaves from stem, drying and weighing.
Experiment 2

This experiment was conducted using medium frame (50 kg) Merino ewes, of 3-5 years age on each of two commercial properties, located near Marrar (34°48'S; 147°26'E; north of Wagga Wagga) and Walbundrie (35°45'S; 146°45'E; south of Wagga Wagga) in southern New South Wales (Table 1). The ewes (280 at Marrar and 200 at Walbundrie), which had been mated in previous years, were allocated to two replicates of two treatments within each property; ewes grazing lucerne or ewes grazing dead cereal crop stubble (Triticum aestivum or Avena sativa). Live herbage had been removed from the stubbles by herbicide application and grazing some weeks prior to the study, which distinguishes this experiment from experiment 4.

Insert Table 1 here

The ewes were grazed on dead herbage for a minimum of three weeks prior to the experiment, and it was estimated that the level of feed available would allow maintenance of liveweight. A schematic diagram of the experiment is given in Fig. 1. Seven days prior to ram introduction (where ram introduction = Day 0 of joining), the ewes were randomly allocated to groups (70 per group at Marrar; 50 per group at Walbundrie), weighed and condition scored and placed in their treatment paddocks. Paddock sizes ranged from 7 to 42 ha. On Day 0, two rams per paddock were introduced wearing crayon harnesses. The rams were rotated between treatments within replicates on Day 4 after introduction to prevent ram bias between groups during the first seven days of joining. On Day 7 of joining, the ewes were weighed and condition scored, crayon marks recorded, and ewes and rams from lucerne plots placed with those on stubble plots in respective replicates. Seven days later (Day 14) crayon marks were again recorded, the harnesses were removed from the rams, and all ewes grazed together until pregnancy scanning. The rams were removed from ewes after a total of 40 (Marrar) or 44 (Walbundrie) days joining. Fetal numbers were determined using ultrasound approximately 50 days after the rams were removed.

Insert Fig. 1 here

Using the methods described in Experiment 1, live and dead herbage available was estimated when ewes entered paddocks, when rams were introduced, and when ewes were removed from lucerne paddocks (Days -7, 0 and 7 of joining). Pasture quality samples were collected at the same dates, and for live lucerne only, the
proportion of leaf and stem was calculated. Pasture composition was estimated (Mannetje and Haydock 1963) when ewes entered plots on Day -7.

Experiment 3

Experiment 3 was conducted near Holbrook (35°41′S 147°15′E) in southern NSW. This experiment comprised two replicates each of ewes grazing one of three treatments - lucerne, phalaris, or cereal stubble. The management (Table 1) and measurements were the same as in Experiment 2, except the flock comprised 600 First Cross (Merino x Border Leicester) ewes, and the ewes in all treatments were fed triticale grain at a rate of 150 to 200 g/day, three times per week, prior to and for the duration of the grazing period, as the owner wanted to avoid the ewes losing weight during joining. Paddock sizes were 4.3 to 6.7 ha.

Experiment 4

Experiment 4 was conducted on a property near The Rock (35°16′S 146°57′E) south of Wagga Wagga, NSW. This experiment comprised two replicates each of Merino ewes (total 200) grazing either lucerne or cereal stubble, the latter having a large quantity of live witch grass (Panicum capillare), commonly incorrectly known as hairy panic, and other weeds (Table 1). In the three weeks immediately prior to the experiment commencing, all ewes grazed together on the stubble, except for an unplanned three days during shearing when they grazed lucerne, which occurred a week before the experiment commenced. Although the stubble had been sprayed to remove live herbage, re-growth of live witch grass was available throughout the pre-experimental and experimental period. While the overall design of this experiment was similar to Experiments 2 and 3, some management practices were altered as a result of unexpected flooding limiting farm management procedures. The rams were not rotated; ewes from both the stubble paddocks were removed to a native pasture, predominantly witch grass, on Day 4 and supplemented with clover/grass hay for several days; and ewes in both replicates of lucerne were combined in one paddock on Day 4 and were not removed from lucerne on Day 7, being grazed on lucerne until Day 14. All ewes were combined and grazed together on weedy stubbles from Day 14, and joining was extended to 60 days. Due to these difficulties, the treatments can be described as ewes grazing lucerne from Day -7 to Day 14, compared with ewes grazing live weed. Recording of crayon marks and the final weighing was delayed until Day 14. Other measurements were the same as in Experiments 2 and 3, but with pasture sampling not occurring on Day 7. Paddock sizes ranged from 13 to 21 ha.
Statistical analyses

Data were analysed using Genstat® 12th edition (Payne et al. 2006).

Experiment 1: Liveweight and body condition data for the treatments were analysed by ANOVA using replicate as the blocking factor. The proportions of all ewes not pregnant and the proportion of pregnant ewes recording multiple foetuses were analysed as a binomial trait using logistic regression with treatment as the model fitted. Liveweight change between Days -9 and 17 was also fitted in the model but then removed as it was not significant. Pasture biomass data was analysed by two-way ANOVA using treatment and sampling date as factors, to allow comparison between different sampling dates, and replicate as the blocking factor. Means are shown ± s.e.m.

Experiment 2: Data for ewes that lost eartags by the time of pregnancy scanning were excluded. Where the change in liveweight was greater than 10 kg, this was considered erroneous and both records removed. Liveweight, condition score and fetal number/ewe were analysed using linear mixed models with treatment as the fixed effect and property/replicate as the random effect. Where starting liveweight differed (P<0.05) between treatments, it was included in the models for analysis of fetal numbers, but was removed when not significant. The proportion of ewes which were non-pregnant or bearing multiples was analysed using a binomial distribution and generalised linear mixed modelling procedure. Pasture data was not analysed.

Experiments 3 and 4: Statistical analysis was as for Experiment 2, but with replicate as the random factor.

Results

Experiment 1

Liveweight and condition score

Ewe liveweight and condition score was similar (P>0.05) between treatments both when ewes were placed on plots (60.3 ± 0.6 and 60.1 ± 0.6 kg; condition 2.7 ± 0.03 and 2.8 ± 0.03, for lucerne and phalaris, respectively) but differed (P<0.05) 17 days into the joining period (60.8 ± 0.6 and 58.8 ± 0.5 kg; condition 2.8 ± 0.03 and 2.9 ± 0.02, for lucerne and phalaris, respectively). The change in weight from placement on plots to day 17 of joining differed (P<0.001) because ewes in the lucerne treatment gained 0.5 ± 0.2 kg weight while those grazing phalaris lost 1.3 ± 0.2 kg weight.

Fetal numbers

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The proportion of ewes which became pregnant in the first 17 days of joining (as diagnosed by ultrasound and did not return to service as indicated by crayon marks) and the proportion of pregnant ewes with multiple fetuses in the first 17 days of joining and during the whole mating period was similar (\(P>0.05\)) between the lucerne and phalaris treatments (Table 2). The number of foetuses per ewe joined over the 28 day joining also did not differ (\(P>0.05\)) between treatments.

*Insert Table 2 here*

**Pastures**

The quantity of dead herbage in phalaris pastures was above 2000 kg DM/ha throughout the experiment, which is above levels that would limit pasture intake by sheep (SCA 1990). The quantity of dead lucerne was above 800 kg DM/ha throughout.

The quantity of live herbage in phalaris pastures was less than 100 kg DM/ha except when ewes were first placed on plots, when there was 190 kg live DM/ha. Observations indicated that most of the live herbage in phalaris plots was clammy goosefoot (*Chenopodium pumilio*) except from 19 February (Day 21) after germination of barley grass (*Hordeum leporinum*). The quantity of live lucerne pasture declined (\(P<0.05\)) rapidly from 1270 kg DM/ha at the start (Day -10), to 460 kg DM by Day 7 (5 February). The percentage of live lucerne which was live leaf declined from 49% on Day -10 to 5% on Day 7. No live leaf was present on Day 11. Much of this decline was due to leaf drop and death due to hot weather. Lucerne regrowth from Day 17 (when the ewes were removed from the lucerne) to Day 21 produced 29% lucerne leaf (Day 21).

The live portion of both lucerne and phalaris pastures contained over 21% crude protein and 9 MJ ME/kg DM when ewes entered plots, although the phalaris was slightly higher in digestibility and energy than the lucerne. However, the quality of the live lucerne declined rapidly so that by seven days into the mating period (Day 7), the live lucerne, which was by then mainly stem, was similar in quality to the dead phalaris on Day -10 (lucerne protein 8.3%, 6.3 ME MJ/kg DM, DMD 46%; Phalaris protein 9.6%, 5.4 ME MJ/kg DM, DMD 41%).

**Experiment 2**

The interaction between treatment and property was not significant (\(P>0.05\)) for any variables analysed. Although the liveweight of ewes at the start of the experiment was 1 kg higher (\(P<0.05\)) in the lucerne than the stubble treatment, the condition of ewes was similar (Table 3).
For the lucerne, 81% of ewes were raddled by rams in the first 14 days of joining, and for the stubble, 76% of ewes were raddled in this period. For the five to six week joining period, the proportion of non-pregnant ewes was low and similar (P>0.05) for ewes grazing lucerne or cereal stubble, but the proportion of ewes bearing multiple fetuses was 16% higher (P<0.05) for ewes grazing lucerne. Across the two properties, grazing lucerne increased (P<0.05) fetal numbers by 18 lambs per 100 ewes joined (1.68 ± 0.07 cf. 1.50 ± 0.07 fetuses per ewe). However, on one property (Marrar) the increase in fetal numbers was 21 lambs per 100 ewes joined (P<0.05). Most of the multiple pregnancies were twins, however more (P<0.05) triplet pregnancies occurred in those grazing lucerne (7%) compared with those grazing stubble (1%).

The quantity of live lucerne was above 1300 kg DM/ha throughout the grazing period, and the quantity of live in stubbles less than 25 kg DM/ha for most of the grazing period (Fig. 2). The proportion leaf of live leaf and stem in lucerne was variable, ranging from 29% to 42%. The quantity of dead herbage in the cereal stubble was above 3800 kg DM/ha throughout the grazing period (data not shown).

Experiment 3

The liveweight and condition score of ewes was similar (P>0.05) between treatments at the start of the experiment (Table 3). Crayon mark data from combined treatments indicated that only 15% of ewes had joined during the first seven days of joining, and only 39% during the first 14 days of joining. There were no differences (P>0.05) between treatments in the proportion of non-pregnant ewes, or in fetal numbers per ewe, even if only those ewes which had been raddled in the first 14 days of joining were considered. Among the multiple bearing ewes, the percentage that were raddled and became pregnant in the first two weeks of joining also did not differ (P>0.05) between treatments.

The quantity of live herbage available was above 2000 kg DM/ha throughout the experiment in the lucerne and phalaris treatments (Figure 3). However, there was also a quantity of recently germinated live oats in the cereal stubble; 60 ± 5 kg DM/ha on Day 0 when rams were added, increasing to 170 ± 16 kg DM/ha by Day 7.

Experiment 4

The liveweight and condition of ewes was similar (P>0.05) between treatments at the start of the experiment (Table 3). The proportion of non-pregnant ewes did not differ (P>0.05) (7% and 2% in lucerne and stubble, respectively).
respectively). The proportion of multiple-bearing ewes was high in both (P>0.05) the lucerne and the stubble treatments. A mean 71% of ewes were raddled by rams in the first 14 days of joining.

At least 730 kg DM/ha live lucerne was available during the grazing period (Fig. 3). However, there was also a large quantity of predominantly witch grass in the cereal stubble; 347 ± 32 kg at the start and 580 ± 53 kg by Day 14 of joining.

**Pasture quality experiments 2-4**

There was considerable variation in nutritive value within species in experiments 2 to 4 (Table 4). The range in metabolisable energy content of lucerne, phalaris and weeds (witch grass) was similar. The protein content of lucerne tended to be higher than for other species.

The percentage of available live lucerne which was leaf was 29 to 37% at the commencement of the grazing period. In experiment 2 the percentage of leaf was maintained or increased over the duration of grazing, while in experiments 3 and 4 it fell to 23 or 22%, respectively, by the end of the grazing period.

**Discussion**

The results of experiment 2 show that a 14 day peri-conceptual grazing period of lucerne compared with dead cereal stubble increased fetal number in unsynchronised ewes by, in this case, up to 21 lambs per 100 ewes joined. That grazing live pastures or feeding lupin grain, traditionally over several weeks, around the joining period can increase ovulation rates or lambs born in naturally cycling ewes is well established (Croker *et al.* 1985; Scaramuzzi *et al.* 2006). Our results extend this knowledge by targeting the most effective period and minimising the duration of grazing and so quantity and cost of feed required. Furthermore, the 18% increase in fetal numbers produced in experiment 2 is within the range reported for increases in ovulation rate from up to ten days feeding of lupin grain to synchronised Merino ewes (Leury *et al.* 1990; Vinoles *et al.* 2009) or lambs born after 12 days grazing of *Lotus corniculatus* by synchronised Corriedale ewes (Vinoles *et al.* 2009).

Variation in the response in fetal numbers to grazing lucerne is not surprising given the range in quality and quantity of pastures in the different experiments. As expected, the protein and energy content of live pastures and weed was higher than that of dead cereal stubble such that large differences in nutrient intake would have occurred for these components. Although the protein content of lucerne was often higher than alternative live feeds, the
energy content was relatively similar. Where sufficient live herbage was present, energy intake may well have been similar between pastures and weedy stubbles (experiments 3 and 4, Fig. 2), and not sufficiently different to produce different ovulatory responses. Differences in paddock sizes between groups within experiments 2 to 4 were not important because the proportion of ewes mated (raddled) or falling pregnant did not differ between treatments, and paddock sizes were sufficient to maintain sufficient live pasture for the duration of grazing.

In experiment 1, the rate of multiple pregnancies (64 to 71%) was very high for Merino ewes grazing both lucerne and phalaris, and twice that of similar ewes in previous years when grazing dead herbage (King et al. 2010). The high fetal numbers and lack of treatment difference suggest that both groups were flushed for a similar time due to the initial quantity of live phalaris and the rapid removal of quality live (leaf) lucerne pasture. Although quality lucerne became available again at Day 21 of joining, by this stage most ewes were pregnant so would be unable to respond. Ovulatory responses have previously been recorded in synchronised ewes with levels of live pasture below 350 kg DM/ha (King et al. 2010), and it has been shown that sheep will obtain 80% of their diet from live plants when as little as 40 kg DM/ha live herbage is available in cereal stubbles (Mulholland et al. 1976). The quantity of live pasture for both lucerne and phalaris was above this level during the first week of joining. Assuming the phalaris group was flushed, this suggests that quantities of live pasture as low as 100 kg DM/ha may produce a response. The implication of these results is that for a difference in fetal numbers to be observed, both the quantity and quality of lucerne must be adequate for the duration of the grazing (flushing) period, and that the control pasture should not contain live herbage.

It is also possible, but less likely, that the maintenance grain feeding for one month prior to the grazing treatments prevented a response to lucerne in experiment 1. While some literature suggests a flushing response occurs only if ewes have been underfed in the weeks prior to ovulation, but not if ewes have been gaining weight (Nottle et al. 1997), other studies have found a response to lupins in ewes which had been gaining weight as well as those losing weight (Leury et al. 1990). Recent studies have shown that an ovulatory response to flushing with live pasture did occur in synchronised ewes which had been fed a maintenance ration of grain in the weeks immediately prior to the grazing period (King et al. 2010).

Due to complications, we were unable to fully test the hypothesis of experiment 3 that both phalaris and lucerne would increase fetal numbers compared with dead stubble. While neither lucerne nor phalaris produced more fetuses than stubble in experiment 3, the most probable cause for this is that the majority of these First Cross ewes were not cycling during the flushing period (Table 3) in early February, as suggested by raddle marks. Alternatively, the rams may not have been working but this seems less likely. Another possibility is that the
presumed high levels of intake on the lucerne and phalaris pastures led to high levels of embryo mortality (Parr 1992). However, even if only those ewes raddled during the first two weeks of joining are considered, most of which would have been flushed, there were no differences in fetal numbers or pregnancy rates between ewes grazing different pasture types. Higher embryo mortality is therefore considered unlikely. In addition, the large quantity of live lucerne pasture in experiment 2 would also have allowed maximum intake, yet in that experiment there was a large increase in fetal numbers and no increase in non-pregnant ewes, suggesting embryo mortality was not an issue.

This leaves another possibility for the lack of treatment effect in experiment 3 - whether or not ewes respond to flushing before or early in the breeding season. Previous studies indicate that there is a seasonal difference in the ovulatory response to flushing, with Merino ewes joined in December, before the natural breeding season, showing no response to flushing with lupins (Gherardi and Lindsay 1982). Likewise, First Cross ewes did not respond to flushing with lupins between October and January in the study of Rizzoli et al. (1976). While details of the base pastures used in these studies were limited, it is considered unlikely in these environments that live pasture would have been available to cause the lack of response in late summer.

It is also unclear whether periconceptual grazing of live pasture would be effective if used outside the natural breeding season; if used then, the timing would need to be modified to target the peak in induced cycling. It is unclear how responsive ewes would be given an out-of-season cycle, particularly if ewes were in high body condition and have had access to ample spring pasture.

It cannot be determined from experiment 3 whether in ewes which were mated (raddled) the lack of difference in response to different pastures was due to an inability to respond to flushing because these First Cross ewes were joined at the start of the breeding season, or whether the quantity of live pasture in the stubble treatment was sufficient to produce similar ovulation rates as for ewes grazing lucerne or phalaris. The latter is consistent with the observations in both experiments 1 and 4 that grazing of lucerne will not produce higher fetal numbers when even small quantities (<200 kg DM/ha) of live pasture are present in the alternative pasture, since this quantity appears to be capable of increasing ovulation rates. This suggests that when evaluating whether a pasture will result in a response in fetal numbers, it is not just the degree of difference in live herbage, but whether the control pasture has any live herbage, which is the major consideration.

Experiment 4 differs from experiments 1 to 3 because ewes were not excluded from live feed during the pre-experimental period due to the management of the collaborating producer. While it is possible that the live feed in the pre-experimental period prevented an ovulatory response when ewes grazed lucerne, the high rates of
multiple pregnancies in these Merino ewes on both the lucerne and weedy stubble treatments (72% and 66%, respectively) suggest both groups were flushed. Such high rates of multiple pregnancy are uncommon, but not unknown in Merino ewes (Packham and Triffitt 1966). If both groups were flushed, the rates of multiple pregnancy indicate a base ovulation rate in line with that implied in experiment 2, and 50% multiples is a reasonable expectation for Merino ewes in good condition mated during the breeding season.

In any case, there were no significant adverse effects of grazing lucerne compared with witch grass. The fact that similar and high rates of multiple pregnancies and low rates of non-pregnant ewes occurred for ewes grazing lucerne or stubble containing live weed to day 14 of pregnancy indicate that in this experiment, grazing of large quantities of lucerne or live weed past the critical days 11 and 12 of pregnancy (Parr 1992) did not elevate embryo mortality. Bias from rams appears unlikely, since treatments did not differ in the proportion of pregnant or multiple-bearing ewes.

The results from experiments 1, 3 and 4, however, do suggest that the type of live pasture grazed in these experiments was not critical in achieving a response in fetal numbers, since all pastures resulted in high fetal numbers. This contrasts with the study of Vinoles et al. (2009) which found a trend for 12% more lambs born if synchronised ewes had grazed Lotus spp., compared with native pasture. In that study, the higher protein and energy content, and probable higher ruminal undegradable protein of Lotus may be the cause of the difference. Our analyses indicate that the quality of lucerne varies widely, depending on plant maturity and percentage leaf, such that the live herbage of other species may well be of similar quality.

A high level of energy intake (Parr 1992), or high protein or urea intake (McEvoy et al. 1997) are capable of increasing embryo mortality and it has been suggested (Robinson et al. 2006) that joining on lush pasture should be avoided. There was no evidence from our studies of an increase in embryo mortality as a result of grazing lucerne, since the proportion of non-pregnant ewes was similar to that in ewes grazing other pasture types in all studies. This may have been due to removal of ewes from lucerne at Day 7 of joining in experiments 2 and 3, thereby avoiding the effect of high nutritional levels on progesterone clearance rate at days 11 and 12 of pregnancy (Parr 1992), or through limited availability of lucerne in experiment 1. However, in experiment 4, where ewes grazed lucerne until day 14 of joining, there was also no significant difference in conception rates. However, the ewes appeared to gain little weight during the grazing period, unlike those in experiments 1, 2 and 3. Clearly, more work is required to determine whether unrestricted intakes of live lucerne pasture can adversely affect embryo survival.
The results demonstrate that a peri-conceptual period of grazing live pasture for one week prior to joining, and during the first week of joining in naturally cycling ewes, can substantially increase fetal numbers when compared to stubbles containing only dead material. Furthermore, there is little to be gained by offering ewes lucerne if live, edible weeds are available in stubbles in the periconceptional period. This response does not appear to be specific to particular pasture species, with grasses producing similar responses to lucerne.

Acknowledgements

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References


Nottle MB, Seamark RF, Setchell BP (1990) Feeding lupin grain for six days prior to a cloprostenol-induced luteolysis can increase ovulation rate in sheep irrespective of when in the oestrous cycle supplementation commences. *Reproduction, Fertility and Development* 2, 189-192.


Table 1. Treatments, number of ewes per treatment and description of joining on each of the four properties in experiments 2, 3 and 4.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Property</th>
<th>Lucerne</th>
<th>Cereal stubble</th>
<th>Phalaris Cereal stubble + live weeds</th>
<th>Rams joined</th>
<th>Ewe breed</th>
<th>Ram breed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Marrar</td>
<td>140</td>
<td>140</td>
<td>14 Feb Merino</td>
<td>14 Feb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Walbundrie</td>
<td>100</td>
<td>100</td>
<td>17 Feb Merino</td>
<td>17 Feb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Holbrook</td>
<td>200</td>
<td>200</td>
<td>9 Feb First Cross Poll Dorset</td>
<td>9 Feb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>The Rock(^a)</td>
<td>100</td>
<td>100</td>
<td>27 Feb Merino White Suffolk</td>
<td>27 Feb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Non-experimental ewes were run in each paddock with the experimental ewes on this property (150 with each treatment, 75 in each paddock) so that limited ram numbers could be utilised at commercial joining percentages.

Table 2. The proportion (mean ± s.e.m.) of ewes pregnant and with multiple fetuses which mated in the first 17 days and over the 28 day mating period, and number of foetuses/ewe joined in experiment 1

<table>
<thead>
<tr>
<th></th>
<th>Lucerne</th>
<th>Phalaris</th>
<th>Significance at P = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnant first 17 days of joining</td>
<td>0.84 ± 0.04</td>
<td>0.89 ± 0.04</td>
<td>ns</td>
</tr>
<tr>
<td>Pregnant 28 day joining</td>
<td>0.87 ± 0.03</td>
<td>0.91 ± 0.03</td>
<td>ns</td>
</tr>
<tr>
<td>Pregnant ewes with multiples in first 17 days of joining</td>
<td>0.71 ± 0.05</td>
<td>0.64 ± 0.06</td>
<td>ns</td>
</tr>
<tr>
<td>Pregnant ewes with multiples 28 day joining</td>
<td>0.66 ± 0.05</td>
<td>0.65 ± 0.05</td>
<td>ns</td>
</tr>
<tr>
<td>No. fetuses/ewe 28 day joining</td>
<td>1.50 ± 0.08</td>
<td>1.56 ± 0.08</td>
<td>ns</td>
</tr>
</tbody>
</table>

ns = not significant at P = 0.05.
Table 3. Mean reproductive performance of ewes joined on lucerne, phalaris, stubble, or stubble with witch grass in experiments 2, 3 and 4.

<table>
<thead>
<tr>
<th></th>
<th>Experiment 2</th>
<th>Experiment 3</th>
<th>Experiment 4</th>
<th>sem range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lucerne</td>
<td>Stubble</td>
<td>Lucerne</td>
<td>Phalaris</td>
</tr>
<tr>
<td>Start live weight (kg)</td>
<td>53.6 b</td>
<td>52.5 a</td>
<td>66.2</td>
<td>67.0</td>
</tr>
<tr>
<td>Start CS</td>
<td>3.3</td>
<td>3.2</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Change weight (kg)</td>
<td>2.5 b</td>
<td>0.8 a</td>
<td>4.4 y</td>
<td>1.4 x</td>
</tr>
<tr>
<td>No. fetuses per ewe</td>
<td>1.68 b</td>
<td>1.50 a</td>
<td>1.43</td>
<td>1.45</td>
</tr>
<tr>
<td>Proportion non-pregnant ewes</td>
<td>0.06</td>
<td>0.05</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>Proportion ewes with multiples</td>
<td>0.69 b</td>
<td>0.53 a</td>
<td>0.55</td>
<td>0.57</td>
</tr>
<tr>
<td>Proportion of ewes raddled a b</td>
<td>81</td>
<td>76</td>
<td>39</td>
<td>35</td>
</tr>
<tr>
<td>Proportion of raddled ewes with multiples</td>
<td>0.74 b</td>
<td>0.54 a</td>
<td>0.56</td>
<td>0.65</td>
</tr>
<tr>
<td>Proportion of raddled ewes not pregnant</td>
<td>0.04</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
</tr>
</tbody>
</table>

a,b; x,y,z; d,e: Different letters within experiments within rows indicate means differ at P<0.05.

aCrayon raddle indicated ewes were mated in the first 14 days of joining.
Table 4. Mean (± sem) metabolisable energy (ME, MJ/kg DM), crude protein (CP, %) and digestibility of the dry matter (DMD, %) of dead stubble and live lucerne, phalaris and weed in stubble in paddocks in experiments 2 to 4.

<table>
<thead>
<tr>
<th>ME (MJ/kg DM)</th>
<th>CP (%)</th>
<th>DMD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dead stubble</td>
<td>4.5 ± 0.09</td>
<td>3.2 ± 0.98</td>
</tr>
<tr>
<td>Live weed in stubble</td>
<td>7.3 ± 0</td>
<td>6.3 ± 0</td>
</tr>
<tr>
<td>Live lucerne</td>
<td>7.8 ± 0.25</td>
<td>12.0 ± 1.41</td>
</tr>
<tr>
<td><strong>Experiment 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dead stubble</td>
<td>4.7 ± 0.42</td>
<td>3.7 ± 0.99</td>
</tr>
<tr>
<td>Live weed in stubble</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Live lucerne</td>
<td>7.6 ± 1.27</td>
<td>14.6 ± 5.16</td>
</tr>
<tr>
<td>Live phalaris</td>
<td>7.8 ± 1.13</td>
<td>6.3 ± 1.91</td>
</tr>
<tr>
<td><strong>Experiment 4</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dead stubble</td>
<td>5.4 ± 0.57</td>
<td>3.2 ± 0.49</td>
</tr>
<tr>
<td>Live weed in stubble</td>
<td>7.2 ± 0.49</td>
<td>9.3 ± 3.0</td>
</tr>
<tr>
<td>Live lucerne</td>
<td>7.8 ± 0.85</td>
<td>16.3 ± 3.68</td>
</tr>
</tbody>
</table>
Grazing period 14 days

Day -7 0 7 14 40 or 44 92

To plots Rams in Off lucerne – all ewes to stubble in replicates Combine all ewes Rams out Preg scan

Fig. 1. Timeline of experiment 2 and 3.
Fig. 2. Mean quantity of live herbage available (t DM/ha ± s.e.m.) in different treatments at the start (Day -7), mid (Day 0) and end (Day 7; or day 14 in experiment 4) of the lucerne grazing period, in experiments 2, 3 and 4.