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It is the paper published as:

**Author:** S. Robertson, B. King, J. Broster and M. Friend  
**Title:** The survival of lambs in shelter declines at high stocking intensities  
**Journal:** Animal Production Science  
**ISSN:** 1836-0939 1836-5787  
**Year:** 2012  
**Volume:** 52  
**Issue:** 7  
**Pages:** 497-501  
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**URLs:** http://dx.doi.org/10.1071/AN11261  ;  http://researchoutput.csu.edu.au/R/-?func=dbin-jump-full&object_id=37432&local_base=GEN01-CSU01  

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**CRO Number:** 37432
The survival of lambs in shelter declines at high stocking intensities

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Short title: Stocking density at lambing
Abstract

This experiment evaluated the effect of stocking intensity at lambing on lamb survival. A randomised block design with three replicates compared stocking rates of 16 and 30 ewes/ha. Twin-bearing Merino ewes (N=69) that had been mated with Poll Dorset x White Suffolk rams were placed in paddocks sheltered with rows of hessian, with 8 or 15 ewes per 0.5 ha plot for the low and high stocking rates, respectively. The survival of lambs born alive at the high stocking rate (63%) was 24% less (P=0.002) than for those at the low stocking rate (83%), and was associated with a higher (P<0.05) proportion of lambs dying from starvation/mismothering/exposure. There were no differences (P>0.05) in lamb birth weight, marking weight, ewe live weight or condition, suggesting nutritional conditions between the stocking rates were similar. The results suggest caution in using lambing strategies which require high stocking rates.

Keywords sheep, nutrition, reproduction, lamb survival, management

Introduction

Lambs born as multiples are more susceptible to exposure than lambs born as singles, resulting in 50% higher mortality rates (Donnelly 1984). Management strategies need to be developed to reduce this wastage to improve reproductive efficiency. Provision of shelter will improve survival of twins in cold, windy conditions (Alexander et al. 1980; Pollard 2006), but is less effective in milder weather conditions (Paganoni et al. 2008; Robertson et al. 2011). Since ewes do not always seek shelter during lambing (Lynch and Alexander 1977), a management strategy to improve lamb survival is to force ewes to lamb in shelter. The term “maternity ward” is used to describe an area of concentrated shelter, where ewes are held during lambing, and the ewes have no choice but to lamb in a sheltered environment. However, areas of land that can be cost effectively dedicated to maternity wards tend to be small. This leads to an increased density of ewes lambing within a maternity ward. An increased density of ewes during lambing is also likely to occur in cell-grazing systems, high stocking rate systems, and in drought conditions where ewes are fed in containment areas.

Desertion and separation of lambs from their mothers, particularly twins, contributes to high mortality rates. Merino ewes are more likely to become separated from their lambs than ewes of other breeds studied (Alexander et al. 1983a), and ewes with prior experience raising twins are less likely to become separated from them than inexperienced ewes (Alexander et al. 1984). The incidence of separation is less for ewes which
remain on the birth site for six hours or more (Alexander et al. 1984), and this is facilitated by high levels of pasture which negate the need for ewes to travel distances to find food and water (Everett-Hincks et al. 2005).

Interference from other parturient ewes is a major cause of permanent separation of ewes from their lambs (Cloete et al. 1998), therefore it is likely that the stocking density during lambing could influence lamb survival. Since ewes do not necessarily seek isolation at parturition (Alexander et al. 1979), and mob together irrespective of paddock size, it is not clear whether stocking density will impact on lamb survival. Winfield (1970) found a higher rate of separation in ewes stocked at 143 compared with 14.3 ewes/ha due to interference from other ewes. However, the overall survival rate was similar between stocking rates, possibly due to fostering of deserted lambs. Alexander et al. (1983b) showed that the incidence of separation, fostering of lambs by other ewes, and therefore error in pedigree recording, increased with the number of ewes lambing per day, but resultant lamb survival was not recorded. They calculated a stocking rate of 18 ewes/ha as the level at which 4.3 ewes would lamb per day, leading to minimal pedigree recording errors, and by association, low mortality. Kleeman et al. (2006), using data from commercially managed flocks, suggested that stocking density at lambing, ranging between 2.9 and 23.9 ewes/ha, did not influence the survival of either single or twin lambs, but the size of flock did, with an optimum of 414 and 386 ewes for single and twin survival, respectively.

Other studies comparing stocking rates tend to confound nutritional level with stocking density at lambing (Donnelly 1984; Lloyd Davies and Southey 2001), and as such lamb survival would be influenced by different ewe behaviours.

Information on the effect of stocking rate on lamb survival is therefore both sparse and conflicting. The aim of this study was to investigate the effect of stocking density at lambing on lamb survival in a sheltered maternity ward environment. It was hypothesised that if pasture availability is adequate, then survival of lambs born in a 'maternity ward' will be similar at high and low stocking densities.

**Materials and methods**

This experiment was conducted with the approval of the Charles Sturt University Animal Ethics committee. The experiment was conducted on a property south-east of Wagga Wagga NSW (35°13’ S; 147° 37’ E) between January and August 2010.
**Experimental design**

The experiment evaluated two stocking intensities, 16 and 30 ewes/ha in a randomised block design with three replicates. All paddocks were sheltered using rows of hessian, 20m apart, and perpendicular to the direction of the prevailing wind. The hessian was strung on boundary fences and, within paddocks, on plain wires 1 m high held by fence posts. The internal hessian rows had 2 to 3 m gaps placed every 25 to 30 m with a 6 m gap at the eastern end of each row to facilitate sheep movement.

**Animal management and measurements**

Oestrous cycles were synchronised in a flock of 200 medium to large-framed 3 to 5 year old Merino ewes of dual-purpose bloodline with two injections of 1ml prostaglandin (Estrumate) on 16 and 25 February 2010. Gonadotrophin (Pregnecol) was also injected at 400 iu on 25 February. On 26 February ten Poll Dorset and Composite (Poll Dorset x White Suffolk based) rams wearing harnesses with green crayons were introduced to the ewes. On 12 March three rams were removed to be used elsewhere. The crayon colour was changed to red on 12 March to enable returns to service to be detected. Raddle marks were recorded on 5, 12, 15 and 22 March. The ewes were shorn on 28 April.

A commercial operator used trans-abdominal ultrasound to determine foetal number and age at 45 days after ram removal. Twin bearing ewes were selected based on a combination of foetal age and date of mating determined by crayon marks. They were randomly allocated to treatment groups (N=69) according to body condition using a scale of 0 (emaciated) to 5 (obese) (Jefferies 1961) and live weight. Fifteen or eight ewes per paddock were allocated to the high and low treatments, respectively, with a paddock size of 0.5 ha.

The ewes were weighed on mornings, unfasted, when they entered paddocks (23 July) and at lamb marking (30 August), 38 days after the ewes entered paddocks. The ewes were side-branded with their unique eartag number using scourable branding fluid. During lambing, the ewes were inspected daily. Ewes were assisted to deliver lambs only when obviously in difficulty. The lambs were identified to ewes at birth, tagged, and birth weight recorded. Dead lambs were removed from paddocks and underwent a post-mortem examination (McFarlane 1965) to attribute cause of death, with lambs which had not breathed fully being classified as ‘born dead’. The
lambs were weighed at lamb marking and lambs which had been tagged at birth but were not present were assumed to have died.

Supplementary feeding was required to minimise the chance of nutritional differences between stocking rates. The ewes in both treatments were fed 0.4 kg lupin grain daily from 22 July until 26 August. Refusals were not measured, although they were observed for the duration of the feeding period.

Pasture measurements
Live pasture biomass was visually estimated on six occasions at weekly intervals from when ewes entered treatment plots until lamb marking, using the method of Haydock and Shaw (1975). 60 estimates were recorded on all occasions, and calibration quadrats were cut at ground level using electric clippers. Botanical composition was estimated on the same 60 quadrats assessed for biomass using the Botanal method (Mannetje and Haydock 1963).

Weather data
Weather data was recorded from the first day of lambing until the third day following the last birth. The weather station (Vantage Pro2 - Davis Instruments) was located 4 km east of the trial area, 1.5m above ground level, and recorded temperature, wind speed and rainfall.

Statistical analyses
Data was analysed using Genstat 12\textsuperscript{th} edition (Payne \textit{et al.} 2009). Data from ewes which gave birth to single or triplet lambs was excluded. Data from twin-bearing ewes only was analysed, leaving records for 64 and 40 lambs at the high and low stocking rates, respectively. The proportional lamb survival and cause of death data were analysed with binomial generalised linear mixed modelling with treatment as the fixed effect and replicate/ewe as the random effect. Ewe live weight and body condition, lamb weights and growth rates were analysed using residual maximum likelihood (REML), using treatment as the fixed effect and replicate or tag as the random effect. Pasture biomass data was analysed using REML with treatment by sampling date as the fixed effect and replicate as the random effect. Botanical composition was analysed pre and post-lambing separately, using REML.
Results

Weather

The weather conditions during the experiment were mild with an average maximum daily temperature of 12.7°C, average minimum temperature of 3.5°C, and seven (of 32) days when minimum temperature was below 0°C. Rainfall greater than 5 mm per day occurred on seven days. Average daily wind speed was 5.7 km/hr with eight days when wind speed was above 8 km/hr.

The survival of twin lambs born alive was reduced (P<0.05) by 24% at the higher stocking rate (63 cf. 83%) (Table 1). The proportion of lambs born alive which died from starvation/mismothering/exposure (SME) was 2.5 times larger (P<0.05) in the high compared with the low stocking rate. The proportion of deaths from other causes for lambs born alive was similar (P>0.05) between groups. Most (73%, 11/15 lambs) of the lambs born alive which subsequently died were found with the mother present in the high stocking rate group. The numbers of dead were too small to give a meaningful comparison in the low group. Stocking rate did not (P>0.05) influence the birth weight (P = 0.09), marking weight, or growth of lambs from birth to marking (Table 1).

The lambing distribution resulted in 56% of lambs being born and 49% of deaths occurring during the first three weeks of the lambing period. Of lambs born alive which died, 80 and 89% in the low and high stocking rate groups, respectively, were recorded as dead on or before the fourth day after birth. The prevalence of infection was low with only one lamb death attributed to this cause.

Insert Table 1 here

Liveweight and condition score

The condition score of ewes when allocated to plots was 2.7 ± 0.06 and 2.6 ± 0.07 (P>0.05) for the high and low stocking rate, respectively. The condition score of both treatments declined to the same (P>0.05) extent such that the condition score of ewes at lamb marking was 2.5 ± 0.07 in both groups (P>0.05). The live weight of ewes was similar (P>0.05) between treatments when allocated to paddocks, 67 ± 1.1 and 68 ± 1.5 kg, and at lamb marking 55 ± 1.6 and 57 ± 1.3 kg, for high and low stocking rates, respectively.

Pastures

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The quantity of live pasture on offer varied (P<0.05) between sampling dates, declining during the first two weeks of lambing and then increasing during the final three weeks (Fig. 1). A similar (P>0.05) quantity of live pasture was available at both stocking rates for the first two weeks of lambing (first three pasture sampling occasions), but thereafter a larger (P<0.05) quantity of pasture was available in the lower stocked treatment.

Insert Figure 1 here

The pastures at both stocking rates were dominated by annual grasses (Fig. 2). Pre-lambing, the annual grass content was higher (P<0.05) for the low compared with the high stocking rate, but the clover content was similar (P=0.17) (17 ± 9 cv. 7 ± 4.3 %, respectively). However, post-lambing, the composition of pastures was similar (P>0.05) at both stocking rates.

Insert Fig. 2 here

Discussion

This study indicates that higher stocking rates can reduce the survival of twin-born lambs from Merino ewes. These results are surprising given the low numbers of ewes in each paddock, and the small paddock size, which could be expected to limit any opportunity for mismothering. The small numbers of lambs in this study suggest some caution in interpreting the differences in survival recorded.

Starvation/mismothering/exposure was higher in lambs born at high stocking densities. Although the data suggests that the majority of lambs born alive which died were not permanently mismothered because the ewe was present when the dead lamb was found, we would expect that mismothering would have contributed to the differences in survival. It is well-established that interference from other ewes causes separation of ewes from their lambs (Cloete et al. 1998). Interference increases as the number of ewes lambing at a similar time increases (Alexander et al. 1983b), so should increase at a higher lambing density.

It is possible that interference from other ewes at parturition and in the days after birth may have delayed suckling and the strength of the mother to lamb bond, resulting in lower milk intake and increased susceptibility to exposure, even though the lamb was not abandoned. Arnold and Morgan (1975) showed that a delay
grooming of 10 minutes increased the time taken for a lamb to first suck. Suckling is important in developing a preferential ewe-lamb bond (Nowak et al. 1997). If interference delays suckling or the strength of the ewe-lamb bond, affected lambs are likely to be more susceptible to exposure. Observations during lambing would be required to determine whether interference from other ewes contributes to starvation/exposure in lambs which are not permanently mismothered, since behavioural data from our study (Broster et al, this proceedings) suggests that ewes spent more time with their lambs at the high compared with the low stocking rate.

The higher level of pasture available in the low stocking rate paddocks during the last two weeks of the trial are unlikely to have influenced the differences in lamb survival. Similar lamb birth weights, marking weights and growth rates and similar change in ewe condition score suggest that there were no nutritional differences between the groups. In addition, GrazFeed (Freer et al. 1997) predictions suggest that the ewes would be consuming 95% of their potential intake when available live pasture was 1.5 T DM/ha, such that increasing available pasture makes little difference to production. Also, half of the lamb births and deaths had occurred prior to differences in available pasture becoming apparent.

It is unclear whether the type of shelter used, rows of hessian, could have influenced lamb survival. It is possible that as stocking rate increases, there is a greater potential for mismothering if a shelter type is used which obstructs visual contact between ewes and lambs. Previous studies (Stevens et al. 1984) have shown a non-significant trend for paddocks sheltered by grass hedges to result in greater separation of twins from their mothers than open paddocks. Hessian shelter the same as used in our study caused ewes to have 17% less contact (ewes or lambs within 4 m of another) with their twin lambs than ewes lambing in more open space sheltered by shrub belts (Broster et al. 2010). However, it is not clear whether lower contact levels reduce survival.

**Conclusion**

High stocking rates at lambing of ewes bearing twin lambs can have a substantial adverse effect on lamb survival. It is not clear whether this also occurs in open paddocks or with different designs of shelter.

**Acknowledgements**
This work was funded by EverGraze® - *More livestock from perennials*. EverGraze is a Future Farm Industries CRC, Meat and Livestock Australia and Australian Wool Innovation research and delivery partnership.

**References**


Broster JC, Rathbone DP, Robertson, SM, King, BJ and Friend, MF (2012) Ewe movement and ewe-lamb contact levels in shelter is greater at high stocking rate. *Animal Production Science, accepted, this proceedings*


Table 1. Lamb production (mean s.e.m) from ewes at high and low stocking rates.

<table>
<thead>
<tr>
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<th>High</th>
<th>Low</th>
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<tbody>
<tr>
<td>Lamb deaths/100 lambs born live (%)</td>
<td>37 ± 7 b</td>
<td>17 ± 6 a</td>
</tr>
<tr>
<td>SME of live births (%)</td>
<td>25 ± 6 b</td>
<td>10 ± 5 a</td>
</tr>
<tr>
<td>Birth weight (kg)</td>
<td>5.2 ± 0.1</td>
<td>5.5 ± 0.1</td>
</tr>
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Marking weight (kg) 10.6 ±0.5 10.6 ±0.6
Growth from birth to marking (g/day) 214 ± 12 204 ± 14

a,b: Different letters within rows indicate means differ at P<0.05.

Fig. 1. Mean live pasture on offer at weekly intervals during the lambing period.

Fig. 2. Botanical composition of pastures at high and low stocking rates pre and post-lambing.