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Ewe movement and ewe-lamb contact levels in shelter is greater at higher stocking rate

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Abstract

This experiment used contact loggers and GPS collars to evaluate the effect of stocking rate during lambing on ewe movement and contact levels between animals. Twin-bearing Merino ewes were placed in 0.5 ha paddocks sheltered with rows of hessian at stocking rates of 16 and 30 ewes/ha for the low and high stocking rates, respectively. The ewes did not spend more time in more sheltered areas of the paddock, and use of shelter was not influenced by stocking rate. Ewes at the high stocking rate travelled 11% further per day but crossed through the hessian rows 37% less than ewes at the low stocking rate. Stocking rate did not change the level of contact between ewes, but higher levels of contact were shown between ewes and their lambs at the high stocking rate. The results suggest for small groups lambing in shelter rows that the interaction between ewes and their lambs is modified by stocking rate and/or flock size.

Keywords sheep, stocking rate, contact logger, GPS

Introduction

The establishment of a strong and exclusive bond between the ewe and her offspring has been shown to be important in the survival of new born lambs and is enhanced by management practices that increase time spent at the birth site(Lindsay et al. 1990; Nowak 1996). This is especially important in the survival of twin lambs.
where the desertion of one lamb by the mother is a major contributor to the high mortality level of twins (Stevens et al. 1982).

Interactions between ewes also influence the formation of an exclusive bond between a ewe and her lambs. While an adult ewe is a social animal that becomes distressed when separated from flock mates, in the period shortly before lambing many ewes isolate themselves from the flock (Alexander et al. 1979; Lindsay et al. 1990; Nowak et al. 2000). Prior to lambing, ewes may display interest in the lambs of other ewes (Alexander 1960; Arnold and Morgan 1975) with this being a major cause of permanent separation of ewes from their lambs (Cloete et al. 1998). Watson et al. (1968) found a significant proportion (52%) of the deserted lambs later died, the majority of which were twins.

Due to these interactions between ewes, the stocking rate of ewes at lambing has the potential to influence the level of contact between ewes and lambs, and therefore survival. However, there is limited data describing these relationships. Alexander et al. (1983) showed that the incidence of separation and fostering increased with the number of ewes lambing per day and suggested a stocking rate of 18 ewes/ha was optimal to minimise these factors, but lamb survival was not recorded. Winfield (1970) found an increased rate of separation of lambs from their mothers at a higher stocking rate (143 cf. 14.3 ewes/ha) with no difference in lamb survival levels. However, Robertson et al. (2012) showed a higher mortality in lambs born at high stocking rates.

Given there is limited consistent information on the effect of stocking rate on ewe and lamb movement and contact, this study used remote sensing collars on ewes and lambs to investigate the effect of increasing stocking rate on ewe movement, shelter use and contact levels between ewes, offspring and non-related animals.

**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 ewe and lamb movement at 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. Poll Dorset and Composite (Poll Dorset x White Suffolk based) rams were introduced to the ewes on 26 February wearing marking harnesses to enable date of service to be determined. 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 in both treatments were fed 0.4 kg lupin grain daily from 22 July until 26 August to minimise the chance of nutritional differences between stocking rates.

During lambing, the ewes were inspected daily. The lambs were identified to ewes at birth, tagged, and birth weight recorded. Dead lambs were removed from the paddocks.

**Remote sensing collars**

Contact loggers (SirTrack Ltd., Havelock North, New Zealand, weight 425 grams) were placed on 35 ewes and their lambs over two deployments. The first deployment collars were placed on 18 ewes, three per treatment in each of the three replicates on 23 July 2010 in sheep yards immediately before the ewes were introduced to the trial paddocks. Of these 18 ewes, eight ewes (two per treatment in two replicates) also had GPS collars (AgTraX L18 GPS, BlueSky Telemetry; Aberfeldy, Scotland, weight 850 grams) attached. The collars were removed on 6 August 2010 in small temporary yards in the lambing paddocks. The second deployment of
contact loggers was attached on 12 August 2010 to 17 ewes that had not yet lambed, using the temporary yards. Three contact loggers were attached per treatment in each of the three replicates; except for one replicate in the low stocking density treatment where only two ewes were able to be collared at this time, the remainder having already lambed. Eight ewes (two per treatment in two replicates) also had GPS collars attached. These collars were removed on 30 August 2010, using the temporary yards. Over the two deployments contact loggers were attached to 35 ewes (17 low – 18 high) and 59 lambs (eight lambs died before collar attachment), with 16 of these ewes also having a GPS collar attached. One ewe (with GPS and contact logger) did not lamb and one GPS collar and two lamb contact loggers failed while attached resulting in available data from 14 GPS collars (seven per treatment) and 57 lamb contact loggers.

The GPS collars were configured to record latitude, longitude and time at 30 second intervals and the contact loggers were configured to record contacts at a distance of approximately 4.3 metres, with a separation time of 10 seconds and could record 16384 contacts. Ewes were selected for collar (contact and/or GPS) attachment according to foetal age to ensure they lambed in as short a time span as possible for maximum data collection. Lambs born to the collared ewes had smaller contact loggers (total weight - 270 grams) attached in the afternoon of the day their birth was recorded. At this time lambs were between four and 28 hours old. After the contact logger collars were attached lambs were observed for up to five minutes to confirm their movement was not impaired.

Calculations

The output from each contact logger provided a record of the date and time of the commencement of every contact with any of the other contact loggers, each of which has its own individual identification number, and the duration of each contact. Data from the collars were downloaded into a spreadsheet to allow the calculation of contact levels for given time periods. The location data from the GPS collars were converted from latitude and longitude to UTM co-ordinates using Trimble Pathfinder Office 2.90 software. While the mean error for the GPS units throughout the experiment was 5.5m.

The proportion of data points recorded within 2.5 m and 5.0 m from Hessian shelter was calculated daily for each ewe. As the proportion of the total paddock area, these areas varied between treatments and replicates due
to paddock shape. To determine if the ewes actively sought to spend time in these areas, a preference index (PI) was calculated as proposed by Heady (1964).

\[ PI = \frac{\text{proportion of time spent in area of interest}}{\text{proportion of area relative to entire area available}} \]

A PI of greater than 1 indicates more time spent in that area relative to the remainder of the paddock while a PI of less than 1 indicates less time. This concept has been used when calculating preference indices for diet (Hobbs and Bowden 1982; Ganskopp and Bohnert 2009) or landscape (Handcock et al. 2009). The distance travelled by each ewe each day and the number of times ewes crossed through or around the hessian barriers were also calculated as these indicate potential situations for ewe and lamb separation.

**Statistical analyses**

Data were analysed using Genstat 11\textsuperscript{th} edition (GenStat 2008). Data were analysed for up to 11 days per ewe. The first full day (A) after collar attachment and the last full day before (D) collar removal were the same day for all ewes within each deployment. The other nine days ran consecutively from three days before the ewe lambed to five days after (-3 to +5). Data were also analysed combining all pre-lambing and all post-lambing data, the results were no different so these data are not presented. Data were not available for all animals on all days as some ewes lambed less than three days after collar attachment, less than five days before collar removal, or their collars stopped logging data during this period. This resulted in complete 11 day data sets for only nine ewes with contact loggers and three with GPS collars.

The contact logger data were placed into five contact classes, ewe-ewe, ewe-offspring, sibling-sibling and unrelated pairs of ewe-lamb and lamb-lamb. Any contact involving ewes and lambs used the lamb collar only as these provided the more complete data sets. All other contacts used data from both animals’ collars. Data involving the 14 lambs that died before collar removal were deleted leaving 43 lamb collars (27 low – 16 high) for analyses.

Although the memory on some contact loggers was full before detachment, these collars still proved useful as they were still able to transmit their unique identification number which was recorded by any other collars.
within range and therefore was included in their data set. This therefore enabled the reciprocal data to be used in analysis (Swain and Bishop-Hurley 2007; Broster et al. 2012).

Due to significant differences in the parameters measured between animals in the two deployments, the data were blocked by deployment before analysis. Within each replicate the mean for all animals or combination of animals was calculated and this became the value for that replicate. Movement, shelter crossing and contact data were analysed by Analysis of Variance. Data for shelter use in the two stocking rates were compared using two sample t-tests for the different treatments. Data for shelter use relative to shelter area (PI) were analysed using one sample t-tests for the different treatments.

**Results**

*Distance moved per day*

Ewes in the low stocking rate treatment moved 7094 (s.e.m.: 157) m/ day, significantly less (P<0.05, lsd = 715.3) than the 7873 (s.e.m.: 304) m/day travelled in the high stocking rate. There was no difference (P>0.05) between days in the distance moved.

*Shelter use by ewes*

There was no selection or avoidance (P>0.05) of the more sheltered areas, within 2.5 or 5.0 metres of the hessian shelter, by ewes in either treatment and there was no difference (P>0.05) between the treatments in their use of this more sheltered area.

Despite travelling less distance per day, the ewes in the low stocking rate treatment crossed through or around the hessian shelter 58% more (P<0.01) than the ewes in the high stocking rate (Table 1). There were no significant differences (P>0.05) between the days in the number of shelter crossings (Table 1).

*Insert Table 1 here*

*Ewe-ewe contact*
There was no difference (P>0.05) between the treatments in the amount of contact between ewes. Contact levels were highest on Day A, decreased as lambing approached and then increased as lambs became older (P<0.05) (Table 2).

*Insert Table 2 here*

**Related pairs contact**

Contact between related pairs, both ewe with offspring and sibling with sibling, was much higher than between ewes. Overall, lambs averaged 10.94 hours contact per day with their mother and 15.76 hours with a sibling. Contact was 11% higher (P<0.05) between lambs and their mothers (Table 3) and 10% higher (P<0.001) between siblings (Table 4) in the high stocking rate than in the low stocking rate treatment. As the lambs became older (Day 1 to Day D), contact with their mother decreased by 37% (P<0.001) and contact with their sibling increased by up to 26% (P<0.001).

*Insert Table 3 here

*Insert Table 4 here*

**Non-related pairs contact**

Contact levels between non-related animals (both ewe-lamb and lamb-lamb) increased (P<0.001) with the age of the lamb. In both categories contact increased by approximately 10 fold (ewe-lamb 2.03 min/day cf. 18.68; lamb-lamb 4.15 min/day cf. 48.27 from day one to day D). For non-related lambs daily contact was 41% higher (P<0.05) in the low stocking rate treatment (Table 5), however, there was no difference (P>0.05) between the two stocking rate treatments in the level of contact between non-related ewes and lambs (Table 6).

*Insert Table 5 here*

**Lamb survival**

The survival percentage of lambs born to twin bearing ewes in the low stocking rate was 83% compared to 63% in the high stocking rate (see Robertson *et al.* 2012). The survival of lambs born to the ewes with collars was 84% and 59% in the low and high stocking rates respectively.
**Discussion**

Distance travelled, contact duration between ewe and offspring, and contact duration between siblings were all greater at the high stocking rate. In contrast, non related lambs had greater contact duration and ewes crossed shelter more frequently at the low stocking rate. The greater contact between ewes and offspring at the high stocking rate is somewhat counter-intuitive, given lamb survival was lower at the high stocking rate (Robertson *et al.* 2012). The nature of contact, rather than simply the duration of contact, may therefore be important in enhancing lamb survival. The greater distance travelled yet less frequent shelter crossings by ewes in the high stocking rate suggests that the type of movement differed from that of ewes in the low stocking rate. Given the lower contact between ewes and lambs in the low stocking rate and shorter distance travelled, we suggest ewes in this treatment may have been more aware of their lamb’s location. In contrast, ewes in the high stocking rate, having more non-related lambs in their lambing environment, may have spent more time searching for their lambs, resulting in a greater difference travelled. The hessian shelter may have exacerbated the situation, with ewes in the high stocking rate searching between shelter rows, thereby crossing shelter less frequently. Detailed observations would be required to establish if this was the case, but it does imply that the number of animals in sheltered environments, rather than stocking rate *per se*, may be important in establishing a lambing environment that reduces the time required by ewes to find their lambs. Given Kleemann *et al.* (2006), suggested flock size rather than stocking rate or paddock size influences lamb survival, clearly more work is warranted to explore the relationships between stocking rate/flock size and ewe-lamb behaviour in both sheltered and unsheltered environments.

The difference in stocking rate in this experiment was achieved by altering ewe numbers rather than paddock size. The use of low animal numbers in this experiment may have also influenced the expression of behaviour. Differences in grazing behaviour have been shown to occur when there are low numbers of animals in a paddock (Penning *et al.* 1993) and other behaviours such as spatial distribution (Arnold and Maller 1985) and maternal behaviour may also be influenced. Furthermore, the potential for sheep behaviour in this experiment to be influenced by adjoining mobs should be acknowledged, with (Arnold and Maller 1985) observing that sheep in adjoining paddocks often acted as a single flock. While increasing the paddock size of the low stocking rate treatment would have enabled the stocking rates to be compared with identical flock sizes,
differences in paddock size may have then influenced the animals’ behaviour. The results of this study must be interpreted within the context of these constraints.

The provision of shelter has been shown to result in increases in lamb survival (Bird et al. 1984; Robertson et al. 2011) but can be expensive to provide (McEachern and Sackett 2008). To limit the amount of shelter required (and therefore costs associated with shelter provision), higher stocking rates are required over lambing. However, if the increased stocking rate in shelter results in decreased lamb survival, gains resulting from shelter provision may be eroded. Clearly more work is required to understand the influence of stocking rate/flock size on lamb survival in sheltered environments, and on shelter design to not only provide protection from the elements but an environment conducive to maintaining the ewe-lamb bond.

Acknowledgements

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References


Lindsay DR, Nowak R, Putu IG, McNeill D (1990) Behavioural interactions between the ewe and her young at parturition: A vital step for the lamb. In 'Reproductive physiology of Merino sheep - concepts and consequences'. eds CM Oldham, GB Martin and IW Purvis pp. 191-205. (School of Agriculture (Animal Science), The University of Western Australia)


Table 1: Hessian crossings (number/day) by ewes before and after lambing

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<th>3</th>
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a,b: Different letters within column indicates means differ at P<0.01 (l.s.d. = 4.70).
Table 2: Mean contact duration (minutes) between ewes at two stocking rates before and after lambing

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a,b: Different letters within row indicates means differ at P<0.05 (l.s.d. = 14.93).
Table 3: Mean contact duration (hours) between ewes and their offspring

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a,b: Different letters within row indicates means differ at P<0.001 (l.s.d. = 1.92).

x,y: Different letters within column indicates means differ at P<0.05 (l.s.d. = 1.11).
Table 4: Mean contact duration (hours) between siblings

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a,b: Different letters within row indicates means differ at P<0.001 (l.s.d. = 1.33).
x,y: Different letters within column indicates means differ at P<0.001 (l.s.d. = 0.77).
Table 5: Mean contact duration (minutes) between non related lambs

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a,b: Different letters within row indicates means differ at P<0.001 (l.s.d. = 11.73).

x,y: Different letters within column indicates means differ at P<0.05 (l.s.d. = 6.77).