THE EFFECTS OF INCREASING AND DECREASING LIVEWEIGHT ON OVULATION AND EMBRYONIC SURVIVAL IN THE BORDER LEICESTER X MERINO EWE

I. A. CUMMING*

Summary
A flock of 285 Boarder Leicester x Merino ewes was allotted to two groups. For one month, one group was grazed on a high plane of nutrition and the other on a low plane. The nutrition of the groups was then inter-changed and mating commenced 10 days later. One group was decreasing in liveweight and the other increasing in liveweight throughout the mating period. In the two groups, the mean liveweights of ewes at the time each ewe first mated, were similar. Approximately half of the ewes of each group underwent laparotomy and ovulation rates were recorded. All ewes were lambed in a drift system. All analyses were of data obtained from first service.

The rising plane of nutrition did not result in a significantly higher ovulation rate than the falling plane. However, the rising plane of nutrition resulted in a significant increase in both the percentage of ewes lambing (79 per cent v. 63 per cent) and in the number of lambs born per ewe mated (1.15 v. 0.83) or per ewe lambing (1.46 v. 1.32). Embryonic survival was lower in the group of ewes which lost liveweight. This effect was due to more severe embryonic loss in the twin ovulators within this group.

I. INTRODUCTION

Coop (1966) considered “flushing” of ewes increased fecundity through two effects. Firstly, there was the static effect brought about by the increase in live-weight during flushing, this being not specifically related in time to mating. Secondly, there was the dynamic effect brought about by the process of change in liveweight or condition. The experiments of Coop (1966) revealed consistent differences in lambing performance in favour of flushed ewes. However, ovulation rates were not measured, so it is not possible to determine whether a component of the poorer performance in the non-flushed groups resulted from increased embryonic mortality.

Edey (1966) found that poor nutrition during early pregnancy may decrease embryonic survival in Merino ewes, and that the loss of ova from twin ovulators was proportionally greater than that from single ovulators.

It was possible that part of the dynamic effect was exerted through varying levels of embryonic survival. In the investigation described in this paper, ovulation rates and embryonic survival were studied under two nutritional regimes; in one group there was a fall in liveweight and in the other a rise in liveweight throughout the mating period.

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II. MATERIALS AND METHODS

On January 1, 1967, a flock of 285, 5-year-old Border Leicester x Merino ewes were weighed and allotted at random within liveweight groupings to two groups. From January 1, the Submaintenance group (Group S) was given a high plane of nutrition and the other group, the Flushed group (Group F) a low plane of nutrition.

The high plane of nutrition was achieved by running the ewes on an irrigated perennial pasture of ryegrass and white clover at a stocking rate of 20-30 ewes/ha, while the low plane was achieved by running the ewes on poor quality annual pasture comprising mainly Wimmera ryegrass and subterranean clover at a stocking rate of 30-57/ha, with an average daily supplement of 0.2 kg per ewe of early-cut high quality pasture hay.

On February 6, the mean liveweight of Group S was 70.0 kg and Group F was 54.8 kg. The nutritional treatment of the groups was then interchanged. Group S then lost weight and Group F gained (Figure 1). Ten days later when the mean liveweight of the two groups differed only by 6.3 kg, rams were introduced.

All ewes which had mated in Group S were confined with those of Group F on the high plane of nutrition for 30-39 days after each had mated. The data from the nine ewes that had not mated by March 13 were excluded from the analysis. In Groups S and F, respectively, 141 and 135 ewes mated.

Fig. 1.—Liveweight changes of the two groups.

○——○, Flushed; ●——●, Submaintenance.
Mating commenced February 16.
Four Poll Dorset rams were used in both nutritional groups. Oestrus was detected with the aid of Sire Sine crayons which were colour changed every 10 days. The rams on the low plane area received a supplement of good quality pasture hay daily while the ewes were examined for crayon marks. Returns to service were recorded daily until the rams were withdrawn on May 4.

On the 2nd to 6th day after mating, approximately half the ewes in each treatment group underwent midventral laparotomy (Lamond and Urquhart 1961). Ewes were drafted from their flocks on the morning of the laparotomy. The operations were conducted under general anaesthesia using sodium pentobarbitone*. The ovaries were examined and corpora lutea counted.

All ewes were weighed directly off pasture at least twice weekly. Liveweights for individual sheep on the day of mating were then either directly available from the records or calculated by interpolation. Ewes lambed under twice daily supervision, and lambs were identified to their dams. Results were analysed using χ² tests.

II I. RESULTS

(a) Liveweight

The mean liveweights of ewes in the two groups on the day each first mated were similar (59 kg, range 43-72 kg). Ewes with liveweights greater than the mean had a mean ovulation rate significantly higher than the ewes with liveweights less than the mean (Table 1). The heavier ewes also had a higher incidence of multiple births (46 per cent) than the lighter ewes (30 per cent), P<0.05 (Table 2). Liveweight was not related to the number of ewes returning to service.

<table>
<thead>
<tr>
<th>Group</th>
<th>Liveweight at mating (kg)</th>
<th>Total number of ewes</th>
<th>Mean ovulation rate (No. of corpora lutea/ewe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submaintenance</td>
<td>≤ 58.9</td>
<td>33</td>
<td>1.45</td>
</tr>
<tr>
<td></td>
<td>≥ 59.0</td>
<td>37</td>
<td>1.68</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>70</td>
<td>1.57</td>
</tr>
<tr>
<td>Flushed</td>
<td>≤ 58.9</td>
<td>35</td>
<td>1.51</td>
</tr>
<tr>
<td></td>
<td>≥ 59.0</td>
<td>29</td>
<td>1.90</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>64</td>
<td>1.69</td>
</tr>
<tr>
<td>Total</td>
<td>≤ 58.9</td>
<td>68</td>
<td>1.49</td>
</tr>
<tr>
<td></td>
<td>≥ 59.0</td>
<td>66</td>
<td>1.77</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>134</td>
<td>1.63</td>
</tr>
</tbody>
</table>

χ² values (for ewes having multiple ovulations)

Heavy (≥ 59.0 kg) v. light ewes (≤ 58.9 kg) \( \chi^2_1 = 8.26, \ P < 0.01 \)

Submaintenance v. flushed ewes \( \chi^2_1 = 0.69, \ N.S. \)

Interaction \( \chi^2_1 = 0.04, \ N.S. \)

*"Nembutal" — Abbott.
Fig. 2. — Returns to service of the flushed and submaintenance groups.  
☐, 1 corpus luteum; ■, 2 corpora lutea; ■, Unoperated.

### TABLE 2

**Lamming results* to first service**

<table>
<thead>
<tr>
<th>Group</th>
<th>Percentage of ewes</th>
<th>Total number of ewes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lambing singles</td>
<td>Lambing twins</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submaintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>operated</td>
<td>46</td>
<td>13</td>
</tr>
<tr>
<td>not operated</td>
<td>41</td>
<td>24</td>
</tr>
<tr>
<td>all ewes</td>
<td>43</td>
<td>18</td>
</tr>
<tr>
<td>Flushed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>operated</td>
<td>38</td>
<td>31</td>
</tr>
<tr>
<td>not operated</td>
<td>43</td>
<td>37</td>
</tr>
<tr>
<td>all ewes</td>
<td>43</td>
<td>34</td>
</tr>
</tbody>
</table>

*The data were further partitioned within groups of Heavy (≥59.0 kg) and Light ewes (≤58.9 kg). As there was only one significant main effect (see below) and this was unrelated to nutritional treatment or surgical technique the partitioned data is not presented.

χ² values:

(a) For all ewes lambing —

Operated v. unoperated ewe χ²₁ = 3.58, 0.10 > P > 0.05

Submaintenance v. flushed ewes χ²₁ = 7.77, P < 0.01

(b) For all ewes lambing multiples —

Operated v. unoperated ewes χ²₁ = 0.85, N.S.

Submaintenance v. flushed ewes χ²₁ = 3.44, 0.10 > P > 0.05

Heavy v. light ewes χ²₁ = 4.50, P < 0.05

(c) There were no significant interactions.

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Lambing results to first service of the ewes which underwent a laparotomy

<table>
<thead>
<tr>
<th>Number of corpora lutea*</th>
<th>1</th>
<th>2</th>
<th>Submaintenance group</th>
<th>Flushed group</th>
<th>Submaintenance group</th>
<th>Flushed group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of ewes not lambing</td>
<td>45</td>
<td>50</td>
<td>37</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of ewes lambing singles</td>
<td>55</td>
<td>50</td>
<td>40</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of ewes lambing twins</td>
<td>—</td>
<td>—</td>
<td>23</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of ewes</td>
<td>24</td>
<td>20</td>
<td>40</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of lambs</td>
<td>16</td>
<td>10</td>
<td>34</td>
<td>50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*In the flushed group 2 ewes had 3 corpora lutea.

χ² values for comparisons between Group F and S ewes with 2 corpora lutea:

- Proportion of ewes lambing twins: χ²₁ = 4.53, P < 0.05
- Proportion of mated ewes lambing: χ²₂ = 2.20, N.S.
- Proportion of ewes lambing that lambed singles: χ²₃ = 2.31, N.S.
- Proportion of ewes not lambing, lambing singles, or lambing twins or allowing for linear trend: χ²₄ = 5.26, N.S., χ²₅ = 5.14, P < 0.05

(b) Plane of nutrition

The percentage of ewes with two or three corpora lutea was not: significantly higher in ewes of Group F (66 per cent) than ewes of Group S (57 per cent) (Table 1). A significantly greater number of ewes in Group S returned to service after and including day 18 (χ²₁ = 4.75, P < 0.05, Figure 2). More ewes lambed to first service in Group F (79 per cent) than in Group S (63 per cent) (P < 0.01, Table 1).

In ewes with a single corpus luteum, nutritional treatment did not affect the percentage which lambed to first service (Table 3). However, there was a trend to higher embryonic survival among those with two corpora lutea in Group F than in Group S (χ²₁ = 4.53, P < 0.05, Table 3).

When all operated ewes with two corpora lutea from both Group F and Group S were considered together, it was found that of the ewes that were non-pregnant to first service, 35 per cent were from Group F; also that 47 per cent and 68 per cent of the total ewes having single and twin births, respectively, were from Group F. These percentages were shown to be linear, and this allowed a reduction in the degrees of freedom in the χ² analysis from 2 to 1 (χ²₁ = 5.14, P < 0.05) (Table 3).

Of all ewes which had two or three corpora lutea at laparotomy, 71 per cent lambed to first service, while of those with one corpus luteum, 53 per cent lambed.

In Group F, the survival rates of ova from ewes with one, two or three corpora lutea were 50 per cent, 63 per cent and 67 per cent respectively. In Group S, survival rates of ova from ewes with one or two corpora lutea were 55 per cent and 43 per cent respectively (Table 3).
In each group there was a lower lambing percentage among those sheep which were laparotomised than the intact controls — Group S, 60 per cent vs 66 per cent and in Group F 72 per cent vs 86 per cent — ($x^2 = 3.58, 0.10 > P > 0.05$) (Table 2).

IV. DISCUSSION

With ewes at the same mean liveweight at mating, a falling plane of nutrition did not result in a significantly lower ovulation rate than a rising plane of nutrition. In all treatments heavy sheep had a higher proportion of multiple ovulations and a higher proportion of multiple births. The percentage of ewes which lambed tended to increase with increase in percentage of multiple ovulations.

There is little documentation of the effect of nutrition on embryonic mortality in sheep. Experiments reported in the literature have involved different levels and duration of nutritional treatment with a wide range in the time treatments were imposed. Some experiments have shown differences between nutritional treatments dependent upon the year in which treatments were imposed (Foote et al. 1959).

In the present study embryonic survival was affected by nutritional treatment and this effect was greatest in the ewes with two corpora lutea. Cumming (1972) confirmed this effect of nutritional restriction in early pregnancy. Cumming found that as the period of restriction increased, so, within the twin ovulating ewes, the percentage of ewes with no viable embryo increased.

In the submaintenance group there was a significantly greater proportion of ewes returning to service after and including day 18. This is indicative of early embryonic death. However, further experiments are required to define at which period in early pregnancy the developing embryo is most severely affected as a result of poor nutrition.

Killeen (1967), using Border Leicester x Merino ewes (the same breed as used in the present study), found no major effect of level of nutrition on the level of reproductive failure in early gestation. However, the results of the work reported in this paper suggest that where twin births are required, the liveweight of the ewes at mating should be as high as possible, and the ewes should not be subjected to any nutritional restriction until they are at least three weeks pregnant.

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VI. REFERENCES