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The effect of live weight at weaning on liveweight gain of early weaned lambs onto a herb-clover mixed sward

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Abstract

Twin lambs that weighed a minimum of 16 kg (n=134 in 2014 and n=124 in 2015) were randomly allocated to one of three treatments: (i) Early weaning (54 and 46 days after the midpoint of lambing in 2014 and 2015, respectively) onto a herb-clover mixed sward (plantain, chicory, red clover and white clover) (Herb_{EW}); (ii) Lambs + dams unweaned on a herb-clover mixed sward until conventional weaning at approximately 13 weeks of age (Herb_{CW}); and (iii) Lambs + dams unweaned on a grass-clover mixed sward until conventional weaning (Grass_{CW}). In 2014, overall greater (P<0.05) liveweight gains were found in Herb_{CW} lambs followed by Herb_{EW} and Grass_{CW} lambs. In 2015, liveweight gains of Herb_{CW} and Grass_{CW} lambs did not differ (P>0.05), but were greater than gains of Herb_{EW} lambs (P<0.05). In 2014, Herb_{EW} lambs that were > 20 kg grew more quickly than Herb_{EW} lambs that were <18 kg (P<0.05). In 2015, Herb_{EW} lambs had similar rate of liveweight gain irrespective of their live weight at treatment allocation (P>0.05). Lambs can be weaned early onto herb-clover mixed swards and achieve greater liveweight gains after weaning compared to lambs unweaned on grass-clover mixed sward. Weaning lambs less than 20 kg onto herb-clover mixed sward, however, can result in lower lamb liveweight gain compared to heavier lambs.

Keywords: lamb; early weaning; herb; weight gain

Introduction

Herb-clover mixed swards containing plantain (*Plantago lanceolata*), chicory (*Cichorium intybus*), red clover (*Trifolium pretense*) and white clover (*Trifolium repens*) increase lamb liveweight gain before and after weaning (Corner-Thomas et al. 2014; Golding et al. 2008; Hutton et al. 2011; Somasiri et al. 2015; 2016). These effects are due to the high nutritive value and digestibility (Cranston et al. 2015; Somasiri et al. 2015; 2016) of herb-clover mixed sward compared to ryegrass. Cranston et al. (2015) reported that herb-clover mixed sward generally has a lower fibre content, similar crude protein content and high organic matter digestibility and metabolisable energy content than ryegrass- and white clover-dominant pasture.

In New Zealand, lambs are conventionally weaned between 10 and 14 weeks of age in a once-a-year-lamb production system with an average weaning live weight of 28-30 kg (Geenty 2010). Previous studies suggested that lambs can be weaned earlier onto ryegrass- and white clover-dominant pasture, although growth rates (180 g/day) were low (Mulvaney et al. 2009). Further, Rattray et al. (1976) reported that lambs weaned at 4-6 weeks of age onto ryegrass- and white clover-dominant pasture were lighter compared to lambs weaned at eight weeks of age. Early weaning can be a useful management tool if the availability of pasture is likely to result in the ewe and lamb being competitors (Kenyon & Webby 2007). Early weaning onto high-quality herbage can reduce overall feed demand, and thus, allow the ewe to gain body condition and allow for adequate liveweight gains of lambs (Muir et al. 2000). We hypothesised, therefore, that weaning lambs at 14 kg of live weight onto herb-clover mixed sward could improve the liveweight gain compared to lambs remaining

with their dam on either a grass-clover mixed sward or a herb-clover mixed sward.

The present study had two aims, firstly to determine the effect of early weaning onto herb-clover mixed sward on lamb liveweight gain, and secondly, the effect of lamb live weight at early weaning on growth after weaning.

Materials and methods

Experimental design

The present study was conducted at Massey University's Keeble farm, 5 km southeast of Palmerston North (40°S, 175°E), New Zealand over two years (2014 and 2015). All manipulations were approved by the Massey University Animal Ethics Committee. Romney ewes (n=120 in 2014 n=121 in 2015) which conceived during the first cycle, diagnosed as twin bearing 48 days after the end of breeding period and those which successfully raised both lambs, were used. Throughout the gestation period, within each year, ewes were managed as one mob under commercial farm conditions. Lambing began on 2 September and 9 September in 2014 and 2015, respectively. All lambs were weighed, ear tagged and identified to their dam within 24 h of birth. Lambs were orally drenched at docking and then every 28 days with Ancare 'Matrix' triple combination drench (Merial Ancare, Manukau City, New Zealand) at a rate of 1 mL per 5 kg live weight to eliminate internal parasites.

From the midpoint of lambing (L1) until the onset of the study (L54 in 2014 and L46 in 2015) lambs and ewes were managed as a single mob on grass. Twin lambs that weighed a minimum of 16 kg at L54 (19.0±0.2 kg; n=134) in 2014 and L46 (18.4±0.2; n= 124) in 2015 were randomly

allocated to one of three treatments: (i) Early weaning at L54 (in 2014) and L46 (in 2015) onto a herb-clover mixed sward (plantain [*Plantago lanceolata*], chicory [*Cichorium intybus*], red clover [*Trifolium pratense*] and white clover [*Trifolium repens*]) (Herb_{EW}); (ii) Lambs + dams unweaned on a herb-clover mixed sward until conventional weaning (Herb_{CW}); and (iii) Lambs + dams unweaned on a grass-clover mixed sward (perennial ryegrass [*Lolium perenne* L.] and white clover) until conventional weaning (Grass_{CW}). All groups (n= 44,46,44 in Herb_{EW}, Herb_{CW}, Grass_{CW} in 2014 and n= 40, 44, 40 in Herb_{EW}, Herb_{CW}, Grass_{CW} in 2015, respectively) remained on these treatments until conventional weaning at L93 in 2014 and L88 in 2015. Lambs and ewes assigned into Herb_{EW} and Herb_{CW} treatment groups were gradually introduced to herb-clover mixed sward over a four-day period of increasing duration on each day (i.e. 4 h day 1, 8 h day 2, 12 h day 3, and 24 h day 4) prior to the onset of the study. Lambs and ewes were weighed within 1 h of being bought off pasture on L54, L83 and L93 in 2014 and, L46, L74 and L88 in 2015. At the end of the study, the percentage of lambs that reached slaughter weight (> 35 kg) per each treatment was calculated. During the experimental period, pastures were managed to provide *ad-libitum* intakes. Sward surface heights after grazing were maintained at a minimum of 5 cm in the grass and 7 cm in the herb-clover mixed swards.

Herbage measurements

Herbage mass was measured on L54, L83 and L93 in 2014 and, L46, L74 and L88 in 2015. Four quadrat cuts (0.1 m² each) were taken to ground level from each treatment (4 replicates/treatment), using an electric shearing hand-piece (Frame 1993) and samples were oven dried to estimate herbage mass of treatments. Four grab samples per treatment (4 replicates/treatment) were also collected on these measurement dates to estimate the botanical composition and nutritional composition of each treatment (Frame 1993). A subsample from each sample was sorted

into sown species, weeds and dead matter, and then oven dried to attain the botanical composition. The remaining sample was then freeze dried, ground, sieved (1 mm) and analysed using *in vitro* methods to determine the nutritional quality; metabolisable energy (ME; Roughan & Holland 1977) and acid detergent fibre (ADF; Robertson & Van Soest 1981). Metabolisable energy content of roughages was calculated using the organic matter digestibility (Roughan & Holland 1977).

Statistical analysis

Live weight and liveweight gain of lambs were subjected to analysis of variance using the MIXED procedure in SAS (Statistical Analysis System, version 9.2; SAS Institute Inc., Cary, NC, US). The analysis was performed separately for each year due to the differences in the days in which measurements were collected. The effect of herbage treatments (Herb_{EW}, Herb_{CW} and Grass_{CW}) on average liveweight gain of lambs was analysed using a model that included the fixed effects of herbage treatment and sex of lamb and age of lambs as a covariate. The effect of herbage treatments and weaning weight category of lambs (16-17, 18-19, 20-21, and 22-23 kg) on liveweight gain after weaning was analysed using a model that included the fixed effects of herbage treatment, sex of lamb and live weight category, and age of lambs as a covariate. Herbage masses were analysed using a model that included herbage treatment and measurement dates as fixed effects. The percentage of lamb that reached the target slaughter weight was analysed using the GENMOD procedure in SAS that included herbage treatment as a fixed effect.

Results

Herbage mass, ADF and ME

In 2014, at the start of the study (L54) the herbage mass of herb-clover mixed sward was greater ($P<0.05$) than that of grass (Table 1). At L93, however the reverse

Table 1 Herbage mass, acid detergent fibre (ADF) and metabolisable energy (ME) content of herbage treatments (grass-clover and herb-clover mixed sward) samples collected 54, 83, 93 days after the midpoint of lambing in 2014 (L54, L83, L93) and on L46, L74, L88 in 2015 (least-squares mean \pm s.e.).

| Herbage treatment | | Herbage mass (kg DM/ha) | ADF (% DM) | ME (MJ/kg DM) |
|--------------------------|-----|------------------------------|-------------------------------|-----------------------------|
| 2014 | | | | |
| Herb-clover mixed sward | L54 | 3659 \pm 336 ^c | 21.1 \pm 1.8 ^a | 11.1 \pm 0.1 ^d |
| | L83 | 2130 \pm 336 ^a | 22.9b \pm 1.8 ^a | 10.5 \pm 0.1 ^c |
| | L93 | 2688 \pm 336 ^{ab} | 25.9 \pm 1.8 ^{bc} | 10.5 \pm 0.1 ^c |
| Grass-clover mixed sward | L54 | 2335 \pm 336 ^a | 28.2 \pm 1.8 ^{cd} | 9.5 \pm 0.1 ^b |
| | L83 | 2827 \pm 336 ^{ab} | 29.4 \pm 1.8 ^{cde} | 9.3 \pm 0.1 ^b |
| | L93 | 4245 \pm 336 ^c | 33.0 \pm 1.8 ^e | 9.0 \pm 0.1 ^a |
| 2015 | | | | |
| Herb-clover mixed sward | L46 | 4818 \pm 403 ^c | 26.1 \pm 1.4 ^a | 10.5 \pm 0.2 ^b |
| | L74 | 3527 \pm 403 ^b | 36.1 \pm 1.4 ^b | 9.5 \pm 0.2 ^a |
| | L88 | 2219 \pm 403 ^a | 35.0 \pm 1.4 ^b | 9.7 \pm 0.2 ^a |
| Grass-clover mixed sward | L46 | 2739 \pm 403 ^{ab} | 26.2 \pm 1.4 ^a | 9.7 \pm 0.2 ^a |
| | L74 | 2282 \pm 403 ^a | 27.7 \pm 1.4 ^a | 9.5 \pm 0.2 ^a |
| | L88 | 2649 \pm 403 ^{ab} | 29.0 \pm 1.4 ^a | 9.3 \pm 0.2 ^a |

^{a, b, c} Means with different superscripts are significantly different within each year ($P<0.05$)

($P < 0.05$) was observed and no difference was observed at L83. The ME content of the herb-clover mixed swards was greater ($P < 0.05$) than that of grass treatments at all three measurement dates. In addition, ADF was higher in grass-clover mixed sward than in herb-clover mixed swards at all three time points ($P < 0.05$).

In 2015, at L46 and L74 the herbage mass of herb-clover mixed sward was greater ($P < 0.05$) than that of grass (Table 1). At L88 no difference of herbage mass was observed. At the start of the study, no difference of ADF was observed among treatments; however, at L74 and L88 the ADF content of herb-clover mixed swards were greater than that of grass. The ME content of herb-clover mixed swards was greater than that of grass at L46 but did not differ to the ME content of grass at L74 and L88.

Botanical composition of herbage treatments

In both years, ryegrass was the dominant species in the grass-clover mixed sward (Table 2). The clover content of grass-clover mixed sward, however, was higher in 2015 ($10.5 \pm 1.6\%$) than in 2014 ($0.9 \pm 0.2\%$). Chicory was the dominant species in herb-clover mixed sward in both years, and the clover content in the herb-clover mixed sward was $14.1 \pm 8.6\%$ in 2014 and $11.8 \pm 3.0\%$ in 2015.

Lamb live weight

Mean live weight of lambs before weaning (19.0 ± 0.2 kg in 2014 and 18.4 ± 0.2 kg in 2015) in each treatment group did not differ ($P > 0.05$). At conventional weaning in 2014 (L93), the mean live weight of lambs in the Herb_{EW} (33.6 ± 0.4 kg) and Herb_{CW} (34.4 ± 0.4 kg) treatment groups

Table 2 The botanical composition (% of various herbage species) within herbage treatments (grass-clover and herb-clover mixed sward) samples collected 54, 83, 93 days after the midpoint of lambing in 2014 (L54, L83, L93) and on L46, L74, L88 in 2015.

| Herbage species | Pasture | | | | | Herbage type | | | | |
|-----------------|---------|------|------|------|-----|-------------------------|------|------|------|------|
| | | | | | | Herb-clover mixed sward | | | | |
| | | | | | | 2014 | | | | |
| | L54 | L83 | L93 | Mean | SE | L54 | L83 | L93 | Mean | SE |
| Grass | 92.7 | 91.4 | 93 | 92.4 | 0.5 | 1.2 | 0 | 0 | 0.4 | 0.4 |
| Clover | 1 | 1.2 | 0.5 | 0.9 | 0.2 | 30 | 0.6 | 11.6 | 14.1 | 8.6 |
| Chicory | - | - | - | - | - | 54 | 48 | 69 | 57.0 | 6.2 |
| Plantain | - | - | - | - | - | 12 | 49 | 15.4 | 25.5 | 11.8 |
| Weeds * | 0.5 | 1 | 1 | 0.8 | 0.2 | 0 | 0 | 0 | 0.0 | 0.0 |
| Dead | 5.4 | 6.5 | 5 | 5.6 | 0.4 | 3 | 2 | 3.9 | 3.0 | 0.5 |
| | | | | | | 2015 | | | | |
| | L46 | L74 | L88 | | | L46 | L74 | L88 | | |
| Grass | 88.2 | 77.4 | 74.9 | 80.2 | 4.1 | 21.9 | 10.3 | 8 | 13.4 | 4.3 |
| Clover | 7.3 | 12.7 | 11.6 | 10.5 | 1.6 | 14.7 | 5.9 | 14.9 | 11.8 | 3.0 |
| Chicory | - | - | - | - | - | 37.3 | 42.2 | 38.1 | 39.2 | 1.5 |
| Plantain | - | - | - | - | - | 22.6 | 30 | 25.7 | 26.1 | 2.1 |
| Weeds * | 1.4 | 6.9 | 9.7 | 6.0 | 2.4 | 1.2 | 1.4 | 0.5 | 1.0 | 0.3 |
| Dead | 3.2 | 3 | 3.7 | 3.3 | 0.2 | 2.4 | 10.2 | 12.8 | 8.5 | 3.1 |

*All the other plant species except the main pasture and herb species in the treatments.

Table 3 Effect of herbage treatment; herb early weaning (Herb_{EW}), herb conventional weaning (Herb_{CW}) and grass conventional weaning (Grass_{CW}) on liveweight gain of lambs of different initial live weights (16-17, 18-19, 20-21, and 22-23 kg) between day 54 and 93 after the midpoint of lambing in 2014 (L54-L93), and between L46 and L88 in 2015.

| Herbage treatment | Live weight category (kg) | | | | | | | | Overall liveweight gain (g/day) | Percentage of lambs that reached slaughter weight | |
|-------------------------|---------------------------|-----------------------|----|----------------------|----|-----------------------|---|-----------------------|---------------------------------|---|-------------------------|
| | n | 16-17 | | 18-19 | | 20-21 | | n | | | 22-23 |
| | | n | | n | | n | | | | | |
| Liveweight gain (g/day) | | | | | | | | | | | |
| 2014 (L54- L93) | | | | | | | | | | | |
| Herb _{EW} | 8 | 325±18 ^{bc} | 14 | 352±12 ^{cd} | 14 | 375±12 ^{de} | 8 | 375±17 ^{de} | 44 | 360±7 ^b | 47 (33-61) ^b |
| Herb _{CW} | 12 | 381±14 ^{de} | 17 | 388±12 ^c | 12 | 410±14 ^e | 5 | 386±22 ^{de} | 46 | 392±7 ^c | 42 (29-60) ^b |
| Grass _{CW} | 8 | 298±19 ^{ab} | 24 | 282±10 ^a | 4 | 310±23 ^{abc} | 8 | 313±15 ^{abc} | 44 | 292±7 ^a | 11 (5-24) ^a |
| 2015 (L46-L88) | | | | | | | | | | | |
| Herb _{EW} | 16 | 272±11 ^a | 14 | 287±11 ^{ab} | 6 | 281±17 ^{ab} | 4 | 295±20 ^{abc} | 40 | 282±7 ^a | 8 (2-21) |
| Herb _{CW} | 11 | 305±12 ^{bc} | 20 | 333±9 ^{cd} | 9 | 305±14 ^{bc} | 4 | 316±24 ^{bcd} | 44 | 318±6 ^b | 16 (8-30) |
| Grass _{CW} | 9 | 307±14 ^{bcd} | 13 | 326±11 ^{cd} | 14 | 342±11 ^d | 4 | 335±21 ^{cd} | 40 | 327±6 ^b | 23 (12-38) |

^{a,b,c,d,e} Means with different superscripts are significantly different within each year ($P < 0.05$).

did not differ ($P>0.05$), but were greater ($P<0.05$) than lambs in the Grass_{CW} (30.4 ± 0.4 kg) treatment group. At conventional weaning in 2015 (L88), the mean live weight of lambs in the Herb_{CW} (31.8 ± 0.4 kg) and Grass_{CW} (32.6 ± 0.4 kg) treatment groups did not differ ($P>0.05$) but were greater than the live weights of lambs in the Herb_{EW} (30.6 ± 0.4 kg) treatment group.

Lamb liveweight gain

In 2014, overall lamb liveweight gain between L54 and L93 was greater in Herb_{CW} (392 ± 7 g/day) lambs compared to Herb_{EW} (360 ± 7 g/day) lambs which was greater than Grass_{CW} (292 ± 7 g/day) lambs ($P<0.05$).

In 2015, the overall liveweight gain between L46 and L88 of Grass_{CW} (327 ± 6 g/day) and Herb_{CW} (318 ± 6 g/day) lambs did not differ ($P>0.05$) but was greater than those of Herb_{EW} (282 ± 7 g/day) lambs.

Lamb liveweight gain based on live weight category

In 2014, in Herb_{EW} treatment group, the mean liveweight gain of heavy lambs (20-21 and 22-23 kg) was greater ($P<0.05$; Table 3) than that of lighter lambs (16-17 kg). Liveweight gain of 18-19 kg lambs in the Herb_{EW} treatment group did not differ ($P>0.05$) from lighter (16-17 kg) or heavier (20-21 and 22-23 kg) lambs. The liveweight gains of lambs in Herb_{CW} and Grass_{CW} treatment groups did not differ ($P>0.05$) between the live weight categories. Both the 16-17 kg and 18-19 kg Herb_{EW} lambs grew more slowly ($P<0.05$) than Herb_{CW} lambs however, this relationship was not observed in the 20-21 and 22-23 kg live weight categories. Herb_{CW} lambs in all weight categories grew faster than Grass_{CW} lambs ($P<0.05$).

In 2015, within each herbage treatment lamb liveweight categories had no effect ($P>0.05$; Table 3) on liveweight gain between L46 and L88. Further, liveweight gain of Herb_{EW} lambs in all weight categories was less than that of Herb_{CW} and Grass_{CW} lambs.

Percentage of lambs that reached slaughter weight

In 2014, the percentage of lambs that reached the target slaughter weight of 35 kg was greater in Herb_{EW} (47%) and Herb_{CW} (42%) treatment groups than in Grass_{CW} (11%) treatment group.

In 2015, the percentage of lambs that reached the target slaughter weight of 35 kg did not differ ($P>0.05$) among treatment groups.

Discussion

The aim of the present study was to determine the effect of early weaning onto a herb-clover mixed sward and the live weight of lambs at weaning on liveweight gains after weaning. In both years, lambs weaned early onto the herb-clover mix achieved liveweight gains greater than 280 g/day, which was greater than previously reported liveweight gains (180 g/day) of conventionally weaned (10-14 weeks) lambs on a grass-based pasture (Mulvaney et al. 2009).

The first hypothesis was that early weaning onto herb-clover mixed swards could not compromise the liveweight

gains of lambs compared to those of unweaned lambs on grass. This was found to be the case in 2014. Similarly, studies of Golding et al. (2011) and Somasiri et al. (2015; 2016) revealed that the liveweight gain of lambs after weaning on herb-clover mixed swards were greater than the liveweight gain of lambs on grass. In 2015 however, the liveweight gain of lambs weaned early onto herb-clover mixed sward were lower than the liveweight gain of unweaned lambs on grass. In both years, the percentage of lambs that reached the target slaughter weight of 35 kg in each treatment group followed the same pattern as lamb liveweight gains. Cranston et al. (2016) also reported that lambs weaned early onto a plantain-clover mixed sward grew more slowly than lambs which remained with their dam, either on grass or plantain-clover mixed swards. In both years, all herbages were managed to provide *ad-libitum* intake, in excess of 1200 kg DM/ha (Cranston et al. 2015; Morris & Kenyon 2004). Further, animals grazed rotationally allowing for comparison of the effect of herbage treatments on lamb liveweight gains but not the effect of herbage mass differences on lamb liveweight gains over time. Variable liveweight gain responses of lambs, therefore, may have been due to the ME content in herb-clover mixed swards being 1.2-1.6 MJ/kg greater than the ME content in grass in 2014 but similar to that of grass in 2015. This likely attributed to the greater chicory content observed in 2014 compared to 2015 (57 vs 39%). Moreover, chicory is preferred over plantain by lambs (Pain et al. 2010).

Furthermore, in 2014, the clover content was greater in herb-clover mixed swards (14.1%) than in grass (0.9%) but in 2015, similar values were observed between grass (10.5%) and herb-clover mixed swards (11.8%). Moreover, the clover content of grass-clover mixed sward was greater in 2015 than 2014. Lambs are known to selectively graze white clover (Pain 2010; Rutter 2006). White clover has high nutritional value, and lambs achieve greater liveweight gains when fed it is as a pure clover sward (Fraser & Rowarth 1996). Cave et al. (2015) reported that the growth of individual species in herb-clover mixed sward varies according to the environmental conditions, thus resulting in change of botanical composition and nutritional composition between seasons. These results suggest that early weaning onto a herb-clover mixed sward is likely to be more beneficial under conditions in which the clover content is low in grass, and chicory content is high in a herb-clover mixed sward.

In 2014, mean liveweight gains of early weaned heavy lambs (20-21 and 22-23 kg weight categories) on herb-clover mixed swards were greater than those of lighter lambs (16-17 kg weight category). Further, in both years, lighter weight lambs (16-17 kg weight category), that were weaned early grew more slowly on the herb-clover mixed swards than their counterparts that were not weaned early. This suggests that lambs less than 20 kg may be better left with their dam. In 2014, early weaned lambs that were a minimum of 20 kg, however, gained greater live weight

than those on grass, although this was not observed in 2015. These findings suggest that when ME and /or clover content of grass is above, or similar, to herb-clover mixed swards, in terms of growth, lambs are best left with their mothers.

Conclusion

Overall, the results of the study suggest that lambs can be weaned early onto herb-clover mixed swards and achieve high liveweight gains after weaning. However, weaning lambs less than 20 kg onto herb-clover mixed sward can result in lower lamb liveweight gain compared to those of lambs weaned at a conventional age. Therefore, weaning of lighter lambs onto herb-clover mixed sward or grass-clover mixed sward should be undertaken with caution. Further, the benefits, in terms of lamb liveweight gain, from a herb-clover mixed sward compared to those of grass are most apparent when grass clover content is low, regardless of whether lambs are weaned early or not.

Acknowledgement

The authors thank beef+lamb New Zealand for the financial support, and D Burnham and Keeble farm staff for technical assistance.

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