The effect of weaning weight on subsequent lamb growth rates

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Abstract

The effect of weaning weight on the subsequent growth rate of lambs was estimated from data collected at Winchmore Research Station. The lamb weight data were collected over a 3-year period involving dryland and irrigated farmlets with two contrasting forage systems. Lambs were weighed at 2-weekly intervals with the weights for the periods immediately pre- and post-weaning being used for the comparisons in this study.

Results overall indicated that, following adjustments for pasture type, gender, birth and rearing rank, heavier lambs at weaning had faster growth rates post-weaning than lighter lambs. However, lighter lambs suffered a lower drop in growth rate (defined as growth rate before weaning minus growth rate post-weaning) than heavier lambs. This was universal across both pasture types, both genders and all combinations of birth and rearing ranks. Possible explanations are that the lighter lambs at weaning were receiving less milk from their mothers or that they were under some mob pressure and had limited access to quality pastures. In some cases, the lighter lambs even increased their growth rates post-weaning when compared to pre-weaning. It is suggested that weaning light lambs is an option for farmers, particularly when feed supply is limiting or when dry stock are required to clean up poor quality pastures and set up high quality feed for young stock.

Keywords: dryland, irrigated, lamb growth, lamb weaning, pasture quality, weaning weights

Introduction

Over the past 10 years, there has been a marked shift to heavier lamb carcasses and this, together with an increase in lambing percentages, has meant a greater proportion of lambs are weaned onto pastures before slaughter. This has reopened the time-of-weaning question debated in the 1960s on the problem of how to grow lambs under high stocking rates with low lambing percentages. Today the question has progressed to: how to grow lambs to a heavier carcass weight under higher lambing percentages?

The question of when to wean lambs, and whether to wean only part of a flock, is a complex one. On the one hand, a "good" mother may buffer its lamb from the effects of fluctuations in quantity or quality of the pasture on offer by an increase in milk production (Muir *et al.* 1999). Also, high pasture-quality can influence lamb liveweight gains when ewe milk production is limiting (Muir *et al.* 1999). On the other hand, if the lambs are weaned, they can be given first choice of the pasture in the rotation, with the ewes following behind to clean up low-quality forage and prepare pastures for subsequent grazings. At weaning time, lamb growth rates often fall. Coincidentally, pasture quality often drops with the onset of the reproductive stage of the grass component of the pasture and an increase in fungal toxins. So the question is: would the lamb growth rates have dropped even if the lambs had not been weaned? Related questions are: do the lighter or heavier lambs suffer the largest drop in growth rate at weaning? Should those who suffer the largest drop in growth rate be left on their mothers for longer? Lastly: does the quality of feed on offer affect the change in growth rate at weaning?

This paper summarises relevant data collected at the Winchmore Research Station, and attempts to address these questions. The trial ran for 3 years and involved irrigated and dryland farmlets with "control" and "improved" pastures grazed by sheep.

Materials and methods

Twelve independent farmlets, consisting of three replicate farmlets for each of "control" and "improved" pastures (resident (old) pastures and new pastures based on improved cultivars respectively), under both dryland and irrigated management systems, were set up at Winchmore Research Station, near Ashburton, Canterbury, as detailed in Fraser *et al.* (1999) and Moss *et al.* (2000). Liveweight gain data presented in the current paper are from the lambings in the springs of 1997, 1998 and 1999. For 1999, only data from the dryland farmlets are used, since the lambs from the irrigated farmlets were split at weaning into two mobs, light and heavy, so are unsuitable for the type of analysis used in the current paper.

The six dryland farmlets were all stocked with a similar number of ewes and lambs, as were the irrigated farmlets (Table 1). Lamb gender was fairly evenly split between ewe and ram lambs. There was a predominance of twins in all farmlets, and a majority of the lambs were also reared as twins (Table 1). Triplets were excluded from the current analysis.

All animals were recorded individually, and all weights are for unfasted animals. Lambs were weighed at birth and tagged. Gender, birth and rearing rank were recorded. Growth rates were measured in a 2–4-week period before weaning (except for the 1999 dryland farmlets when no suitable pre-weaning weight was available), and in a 2-week period after weaning (Table 1).

The drop in growth rate was calculated as the growth rate for the period before weaning minus the growth rate after weaning (g/lamb/day). For each year and for each of dryland and irrigated farmlets, statistical analysis of the post-weaning growth rate and the drop in growth rate at weaning was carried out using analysis of covariance, with the weaning weight being used as the covariate. This was a way of correlating each of the two growth rate variables with weaning weight, while simultaneously adjusting for differences owing to replicate mob, pasture type, lamb gender and lamb birth/rearing rank. For each "all data" analysis for each year and each of dryland and irrigated, the "analysis of covariance" method (Saville & Wood 1991) involved the fitting of parallel lines within each of 36 subgroups (2 pasture types x 3 replicate mobs x 2 genders x 3 birth/rearing ranks). The analysis was also re-run for control pastures only, for improved pastures only, for each lamb gender separately, and for each birth/rearing rank separately (partly as an insurance against non-parallelism). For example, for the control pasture analysis, there were 18 "control pasture" subgroups (3 replicate mobs x 2 genders x 3 birth/rearing ranks). For each analysis, the assumptions were checked by examining the model residuals for normality and heterogeneity of variance. On the basis of this residual checking, about a dozen unusual values were deleted (in most cases, one of the lamb liveweights was an obvious error when compared with adjacent 2-weekly weights).

Results

The overall relationship between post-weaning growth rate and weaning weight is summarised in the first data column of Table 2(a). All values are positive, but only two out of five are statistically significant ($P<0.01$). This positiveness means that overall, the heavier lambs tended to grow faster after weaning than their lighter counterparts [Tables 2(a) and 3]. A word of explanation is necessary about Table 2(a). The values in this Table can be interpreted as "average regression slopes." For example, the second value in the first column of Table 2(a), which is 4.8, means that the post-weaning growth rate for a lamb weighing 21 kg was 4.8 grams per day greater than for a lamb weighing only 20 kg. As a second example, the post-weaning growth rate for a 30-kg lamb was 48 = 10 x 4.8 grams per day greater than for a lamb weighing only 20 kg. To express this in more concrete terms, Table 3 gives the estimated overall mean post-weaning growth rate for lambs weighing 20, 25 and 30 kg at weaning. The word "estimated" is used since these growth rates are fitted values on the straight line through the overall mean weaning weight and overall mean post-weaning growth rate, with the slope of the line being the "average regression slope" obtained from the analysis of covariance.

Table 1 Details of important dates, mean weight (kg) at weaning (including lambs drafted at weaning), percentage of lambs drafted at weaning, numbers of single and twin-born lambs used in each analysis (excluding drafted lambs), and mean growth rate (liveweight gain in grams per lamb per day) of undrafted lambs in the 2–3 weeks before and after weaning.

	Dryland			Irrigated	
	1997	1998	1999	1997	1998
Mean lambing date	27-8-97	26-8-98	26-8-99	15-9-97	19-9-98
Date of pre-weaning weighing	21-10-97	15-10-98	-	19-11-97	18-11-98
Weaning date	11-11-97	10-11-98	11-11-99	3-12-97	2-12-98
Date of post-weaning weighing	26-11-97	24-11-98	24-11-99	17-12-97	16-12-98
Mean liveweight at weaning	27.3	28.2	24.5	26.9	23.9
% of lambs drafted at weaning	2	10	10	0	0
No. of undrafted singles + twins	425	370	409	606	697
No. of singles raised as singles	81	53	48	73	107
No. of twins raised as singles	59	38	42	63	102
No. of twins raised as twins	285	279	319	470	488
Growth rate 2-3 weeks pre-weaning	284	302	-	255	188
Growth rate 2 weeks post-weaning	255	231	269	291	123
Drop or increase in growth rate?	Drop	Drop	-	Increase	Drop

Table 2 (a) Rate of increase in post-weaning growth rate (grams per lamb per day) per unit increase in weaning weight (kg), and (b) its standard error. For the "all data" column in (a), the rate of increase can be thought of as the regression slope averaged over the 36 subgroups in the analysis of covariance. For each of the other columns, it is the regression slope averaged over subgroups of the particular category.

	(a) Rate of increase in post-weaning growth rate (g/day) per kg increase in weaning wt[1]							
	All data	---- Pasture type ----		------- Gender -------		-------- Birth/Rearing rank[2] --------		
		Control	Impr.	Ewe	Ram	S-S	T-S	T-T
Dryland								
1997	0.4	-0.8	1.2	-1.1	1.3	-3.2	5.2	0.4
1998	4.8**	2.1	8.2**	2.0	7.0**	12.2*	7.9	3.6*
1999	3.1**	-0.3	6.3**	3.4	2.9*	6.2	3.1	2.8*
Irrigated								
1997	1.1	-0.4	2.7	2.0	0.3	3.8	-1.8	1.2
1998	1.1	1.4	0.7	-0.1	2.0*	1.7	1.2	0.8
	(b) Standard error of rate of increase							
Dryland								
1997	1.3	1.9	1.8	2.0	1.8	3.0	4.2	1.6
1998	1.6	2.1	2.4	2.3	2.2	5.3	4.7	1.8
1999	1.1	1.5	1.7	1.8	1.5	3.9	3.7	1.2
Irrigated								
1997	1.2	1.5	1.8	1.5	1.8	4.6	4.1	1.3
1998	0.7	0.9	1.0	0.9	0.9	1.7	1.5	0.8

[1] * and ** mean that the rate of increase differs significantly from zero at P=0.05 and P=0.01 respectively.
[2] S-S means single reared as single, T-S twin reared as single, and T-T twin reared as twin.

The trend towards a higher post-weaning growth rate for heavier lambs was most consistent in improved pastures [third column of Table 2(a) and Table 4(b)], ram lambs [fifth column of Table 2(a)] and in twin lambs reared as twin lambs [last column of Table 2(a)].

The overall relationship between weaning weight and the drop in growth rate at weaning, is summarised in the first data column of Table 5(a). The values are larger than the corresponding values in Table 2(a). In both 1997 and 1998, and in both dryland and irrigated systems, the values in this column were positive and statistically significant, meaning that in all four data sets there was evidence that the heavier lambs suffered a greater drop in growth rate at weaning than the lighter lambs. To explain what the values in Table 5(a) mean, the first value in this column, 10.7, means that the drop in growth rate at weaning for a lamb weighing 21 kg was 10.7 grams per day greater than for a lamb weighing only 20 kg. As a second example, the drop in growth rate at weaning for a 30-kg lamb was 107 = 10 x 10.7 grams per day greater than for a lamb weighing only 20 kg. Table 6 summarises the overall mean estimated drops in growth rate for lambs weighing 20, 25 and 30 kg at weaning. As in Tables 3 and 4, these values are fitted values on the "average regression line" obtained using analysis of covariance.

Table 3 Estimated post-weaning growth rates (grams per lamb per day) for lambs with weaning weights of 20, 25 and 30 kg, based on the "all data" rates of increase in the first column of Table 2(a) (reproduced in the last column of this Table). Estimates are taken from the "average regression line," and apply to the average over both pasture types, both lamb genders and all three birth/rearing ranks.

	Estimated post-weaning growth rate (g/day) for lambs with weaning weights of:			Rate of increase & significance[1]
	20 kg	25 kg	30 kg	
Dryland				
1997	253	254	256	0.4 (ns)
1998	195	220	244	4.8 (**)
1999	255	270	286	3.1 (**)
Irrigated				
1997	284	289	295	1.1 (ns)
1998	119	124	129	1.1 (ns)

[1] ** indicates P = 0.01

Table 4 Estimated post-weaning growth rates for (a) control and (b) improved pastures, based upon the "pasture type" columns of Table 2(a).

	Estimated post-weaning growth rate (g/day) for lambs with weaning weights of:			Rate of increase & significance[1]
	20 kg	25 kg	30 kg	
Dryland	(a) Control pastures			
1997	201	197	194	-0.8 (ns)
1998	171	182	192	2.1 (ns)
1999	225	224	222	-0.3 (ns)
Irrigated				
1997	256	254	252	-0.4 (ns)
1998	143	151	158	1.4 (ns)
Dryland	(b) Improved pastures			
1997	307	313	319	1.2 (ns)
1998	218	259	300	8.2 (**)
1999	279	310	341	6.3 (**)
Irrigated				
1997	313	326	339	2.7 (ns)
1998	94	97	100	0.7 (ns)

[1] ns = non-significant; ** indicates P = 0.01

Table 5 (a) Rate of increase in the drop in growth rate (grams per lamb per day) at weaning per unit increase in weaning weight (kg), which can be thought of as an average regression slope, and (b) its standard error. In 1999, no pre-weaning liveweight was measured on the dryland farmlets, so the drop could not be calculated.

	(a) Rate of increase in the drop in growth rate (g/day) at weaning per kg increase in weaning wt[1]							
	All data	---- Pasture type ---- Control	Impr.	------- Gender ------- Ewe	Ram	-------- Birth/Rearing Rank -------- S-S	T-S	T-T
Dryland								
1997	10.7**	11.2**	10.3**	12.3**	9.6**	14.5**	4.8	10.7**
1998	4.3*	7.7**	0.2	6.3*	2.9	–2.4	1.6	5.5**
Irrigated								
1997	6.8**	11.0**	2.5	3.0	10.5**	5.3	10.4	6.6**
1998	4.4**	3.2**	5.7**	5.4**	3.6*	1.8	7.2*	4.2**
	(b) Standard Error of rate of increase							
Dryland								
1997	1.8	2.5	2.5	2.7	2.3	4.5	5.5	2.0
1998	1.9	2.7	2.6	2.8	2.5	6.2	5.2	2.1
Irrigated								
1997	2.2	2.9	3.1	2.8	3.2	8.2	7.7	2.3
1998	1.3	1.9	1.6	1.7	1.8	3.0	3.0	1.6

[1] * indicates P = 0.05; ** indicates P = 0.01

The second and third data columns of Table 5(a), and Table 7, give the corresponding results for "control" and "improved" pastures separately. In all cases the values in these columns in Table 5(a) are positive, and in six out of eight cases they are statistically significant. The rate of increase in the drop in growth rate with increased weaning weight, is higher in the control than improved in three out of four data sets, with the reverse being true in one data set.

The fourth and fifth data columns of Table 5(a) give the corresponding results for ewe and ram lambs separately. Again, in all cases the values in these two columns in Table 5(a) are positive, and in six out of eight cases they are statistically significant. The rate of increase in the drop in growth rate with increased weaning weight is higher in the ewe lambs than in the ram lambs in three out of four data sets, with the reverse being true in one data set.

The last three columns of Table 5(a), concerning lambs with different birth and rearing ranks, show all values are again positive with just one exception. There do not seem to be any consistent differences in the values between S-S, T-S and T-T lambs (abbreviations are explained in Table 2). The bulk of the lambs were "T-T" lambs, however, so the T-T values in the table were estimated more accurately than the corresponding S-S and T-S values; this may explain the higher variation in the S-S and T-S values.

Table 6 Estimated drop in growth rate (grams per lamb per day) between the 2–3-week period immediately preceding weaning and a similar period post-weaning, for lambs with weaning weights of 20, 25 and 30 kg, based upon the "all data" column of Table 5(a) (reproduced in the last column of this Table). Estimates are taken from the "average regression line," and apply to the average over both pasture types, both lamb genders and all three birth/rearing ranks. Note that a negative drop means that the growth rate increased from pre-weaning to post-weaning.

	Estimated drop in growth rate (g/day) at weaning for lambs with weaning weights of: 20 kg	25 kg	30 kg	Rate of increase & significance[1]
Dryland				
1997	-46	8	61	10.7 (**)
1998	39	61	82	4.3 (*)
Irrigated				
1997	-80	-46	-12	6.8 (**)
1998	48	70	92	4.4 (**)

[1] * indicates P = 0.05; ** indicates P = 0.01

Table 7 Estimated drop in growth rate at weaning for (a) control and (b) improved pastures, based upon the "pasture type" columns of Table 5(a).

	Estimated drop in growth rate (g/day) at weaning for lambs with weaning weights of: 20 kg	25 kg	30 kg	Rate of increase & significance[1]
Dryland	(a) Control pastures			
1997	19	75	131	11.2 (**)
1998	60	99	137	7.7 (**)
Irrigated				
1997	-56	0	55	11.0 (**)
1998	38	54	70	3.2 (**)
Dryland	(b) Improved pastures			
1997	-114	-62	-11	10.3 (**)
1998	21	22	23	0.2 (ns)
Irrigated				
1997	-107	-95	-82	2.5 (ns)
1998	58	86	115	5.7 (**)

[1] ns = non-significant; ** indicates P = 0.01

Discussion

Overall, heavier lambs suffered a greater drop in growth rate at weaning than lighter lambs. This result appeared to apply universally, for both irrigated and dryland systems, for both control and improved pastures, for both ewe and ram lambs, and regardless of birth or rearing rank (as evidenced by the fact that the values in Table 5(a) are universally positive, with just one exception). The obvious explanation is that the lighter lambs were light because they had been receiving less milk from their mothers, so that their growth rate was less affected by weaning than that of their heavier contemporaries.

In 1997, lambs which weighed only 20 kg at weaning increased their growth rates at weaning by about 110 g/day on the improved pastures (Table 7). This suggests that in 1997, the lighter lambs on the improved pastures had access to better quality pasture after weaning, offsetting any effect of the removal of the milk supply. By comparison, in 1998 the growth rate of the 20-kg lambs dropped in all systems (Table 7), suggesting that the quality of the feed on offer did not improve so markedly in this year. These data suggest that it could be advantageous to wean the lighter lambs in a mob earlier than the heavier lambs, putting the lighter lambs on to the best pastures available on the farm. However, the question of the optimum time to wean is still unanswered.

Turning to the question of which lambs grew faster after weaning (light or heavy?), data in Table 2(a) suggest that on the improved pastures, and with ram lambs, the heavier lambs continued to grow faster after weaning than their lighter contemporaries (this is evidenced by the fact that all values are positive in these columns). How can this be, when the heavier lambs suffered a greater drop in growth rate at weaning? The answer is simple. The heavier lambs were growing much faster than the lighter lambs in the 2–3 weeks before weaning, so even with their greater drop in growth rate, they continued to grow faster, though with a much reduced difference in growth rate between light and heavy lambs.

These results suggest that farmers have the option of weaning their lighter lambs early if required, as may be the case when feed supply is limiting, or as often happens when feed quality declines in the late spring period. Early weaning also means that a farmer has the option of having a large mob of ewes that can clean up poor quality pastures and set up high quality pastures for lambs.

REFERENCES

Fraser, T.J; Moss, R.A.; Daly, M.J.; Knight, T.L 1999. The effect of pasture species on lamb performance in dryland systems. *Proceedings of the New Zealand Grassland Association 61*: 23–29.

Moss, R.A.; Fraser, T.J.; Daly, M.J.; Knight, T.L. 2000. The effect of pasture species on pasture and animal performances in irrigated systems. *Proceedings of the New Zealand Grassland Association 62*: 59–66.

Muir, P.D.; Wallace, G.J.; McCall, D.G.; Dodd, C.J. 1999. Effect of ewe milk production on profitability of dryland lamb production systems. *Proceedings of the New Zealand Grassland Association 61*: 101–105.

Saville, D.J.; Wood, G.R. 1991. Statistical Methods: The Geometric Approach. New York, Springer-Verlag.

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