EFFECT OF PRE-WEANING PLANE OF NUTRITION ON SUBSEQUENT GROWTH AND CARCASS QUALITY OF LAMBS

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SUMMARY

Two groups of hill country lambs, differing in liveweight by 5.8 kg at weaning at approximately 14 weeks of age, were run together on good sheep pastures for 10 weeks. Their liveweight growth curves were essentially parallel and the estimated difference in carcass weight between the groups at the beginning of the experimental period was reduced by only 22% at the end of the growth period, suggesting that compensatory growth was of little practical significance. A second group of the low plane lambs took a further 8 weeks to reach the same slaughter liveweight as the initially larger lambs. The same weight of fat was laid down after weaning in the carcasses of the high plane and low plane lambs slaughtered at the same time, and the carcasses of the low plane lambs slaughtered at the same weight as the high plane lambs were similar in composition to these lambs.

IN REVIEWING the literature on compensatory growth after undernutrition in mammals and poultry, Wilson and Osbourn (1960) have indicated that "compensatory growth after a period of undernutrition is a very constant feature amongst higher animals". By compensatory growth is meant the situation whereby "an animal whose growth is retarded exhibits, when the restriction is removed, a rate of growth greater than that which is normal in animals of the same chronological age". The possibility of compensatory growth in lambs was regarded as being of potential practical significance when farmers buy store lambs after weaning for transfer to export lamb farm conditions to put on additional weight before being sent to the freezing works. The farmer usually has the choice of buying large or small store lambs and is likely to be interested to know whether the small lambs will catch up some of the weight difference between them and the larger lambs when transferred to good pastures, or whether the growth curves of the two groups of lambs are likely to be parallel. In the latter case the choice of the smaller lambs means they will have to be kept on the farm longer before slaughter to reach comparable weights.

In a previous experiment with lambs, Bassett (1959) restricted different groups of lambs sufficiently to maintain constant weight between 4 and 8, 8 and 12, and 12 and 16 weeks of age. Only a limited degree of compensatory growth was apparently observed during re-alimentation. Osman and Bradford (1967) described an experiment with ram and wether lambs where half the lambs of each type were restricted for 7 weeks while the other half were placed on a high energy ration. After the restriction period, all lambs were placed on the high energy ration. Although statistically significant compensatory growth was reported, the magnitude of 1 to 2 kg could quite possibly be explained by increases in "fill" in the previously restricted lambs and did little to bridge the gap of approximately 10 kg between the two groups at the beginning of the re-alimentation periods. Meyer *et al.* (1962) reported that the *ad libitum* feeding of groups of lambs previously restricted in either intake, energy, or protein for 6 weeks, resulted in liveweight gains similar to those of unrestricted lambs.

Under New Zealand pasture feeding conditions, J. C. Percival (pers. comm.) and Joblin (1966) have reported that small and large beef weaners when run together until slaughter maintain essentially parallel growth curves. Joblin (1968) presented the results of a pasture feeding experiment where cut pasture was fed *ad lib.* to previously well-fed and restricted steers and reported that after 168 days the restricted steers had compensated for 38% of the difference in liveweight at the beginning of the *ad lib.* feeding period by the end of the trial.

MATERIALS AND METHODS

ANIMALS

Wether lambs of similar genetic background, but which differed in size because of management restricting the nutrition of one group of animals from birth, were available from the Whatawhata Hill Country Research Station high and low plane Romney flocks described by Wodzicka-Tomaszewska *et al.* (1968). The management has produced differences in liveweight of 11 to 16 kg between the means of the two ewe flocks which has been associated with differences of round 4.5 kg in average liveweights of the wether lambs at weaning. All lambs were dosed at weaning and monthly thereafter with thiabendazole to eliminate any effects of internal parasites on growth rates.

Experimental Design

Wether lambs were picked for this experiment after shearing and weighing at weaning on December 10, 1965 (day 344). Twenty-five lambs were selected at random as growth groups from both the high and low plane flocks. An initial slaughter group of 10 lambs covering the range of liveweights available was selected from the remaining lambs in each of the two flocks. This left a group of 14 low plane wethers, with a mean liveweight similar to that of the randomly selected 25, which was used as a further experimental growth group. All lambs were transferred to the Ruakura Animal Research Station and were grazed together on the sheep farm. They were given 5 days to adjust to the new pastures before the growth experiment commenced.

Two control groups of lambs (10 high and 10 low plane) were slaughtered at the beginning of the experiment on December 15 and the regressions of carcass weight and carcass composition on liveweight within these groups were used to estimate the carcass weight and carcass composition of the appropriate remaining groups of lambs at the beginning of the experimental period. Groups of 25 high plane and low plane lambs were slaughtered at the same time, when the high plane lambs had reached normal commercial slaughter weights. The remaining 14 low plane lambs continued on the same pastures until they had reached the same mean liveweight as the 25 high plane lambs.

Slaughter Procedure

Except for the control groups at the beginning of the experiment, all lambs were fasted overnight before slaughter and for all lambs the slaughter procedure and method of carcass analysis followed that described by Kirton *et al.* (1967). Lambs of the control groups were weighed in the morning and slaughtered in the afternoon of December 15.

Taste Panel Assessment

The right leg from each carcass was assessed for palatability by the taste panel described by Kirton (1968) using the 9 point hedonic scale of Peryam and Pilgrim (1957). The legs were distributed to families at random. The taste panel scores were averaged within each participating family to give a mean value for each leg.

Statistical Methods

Correlation and regression analyses were carried out where appropriate and covariance analysis adjusting for differences in initial liveweight was used to test for differences in hot carcass weight between the 25 high plane and low plane lambs.

RESULTS AND DISCUSSION

The terms high plane and low plane as used in this paper are only relative terms for relating the nutritional groups and should not be considered as describing the absolute planes of nutrition which are defined only in terms of growth rate.

Information obtained from the initial slaughter groups is presented in Table 1 and the mean liveweights of the two groups were similar to the mean liveweights of the remaining groups on their respective planes of nutrition. The regressions of carcass weight on liveweight for the two groups are given in the Appendix. These were used to estimate the carcass weights of the lambs in the remaining treatment groups at the beginning of the experiment. The two equations did not differ significantly in coefficient or constant. One feature of the low plane lambs was their very low dressing percentage which would have been even

TABLE 1: SLAUGHTER DATA FOR CONTROL GROUPS OF LAMBS

Item	*10 High Plane* *Mean*	*S.D.*[1]	*10 Low Plane* *Mean*	*S.D.*[1]
Weaning weight (kg)	23.7	5.1	15.6	2.9
Liveweight Dec. 15 (day 349; kg)	24.7	5.2	17.1	2.9
Hot carcass (kg)	11.6	3.1	6.8	1.5
Dressing %[2]	46.3	3.2	39.5	3.1
Stomachs (g)	720	155	600	117
Stomach contents (g)	2,150	575	2,010	591
Intestines + contents (g)	2,550	379	2,330	411
Omental fat (g)	210	126	90	58
Grades				
Prime	2		—	
Y	5		2	
Alpha and Manufacturing	3		8	
Carcass ether extract (kg)	2.18	1.12	0.65	0.35
Carcass protein (kg)	1.86	0.47	1.10	0.30

[1] From non-random sample.

[2] Hot carcass × 100/full liveweight.

lower (37.7%) if based on works carcass weights with shrinkage deducted. Another was their grading which indicates they are the type of carcasses required for some Continental markets. The offal and gastro-intestinal contents recorded in Table 1 comprise 22.8% of the liveweight of the high plane lambs and 29.4% of the liveweight of the low plane lambs which accounts for most of the difference in dressing percentage.

The growth curves of the high plane and two low plane groups of lambs are given in Fig. 1 and mean birth days, liveweights and carcass weights of the three groups of lambs are shown in Table 2. All groups had approximately the same average birth date early in September and the high plane lambs were on average 96 days of age at weaning and the low plane lambs were 95 and 93 days for the larger and smaller groups, respectively.

The liveweight curves in Fig. 1 were roughly parallel for all groups, giving little evidence of compensatory growth. Table 2 shows that, after an initial 5-day period had been allowed on pasture at Ruakura for the animals to settle down to the new pasture conditions, the high plane lambs

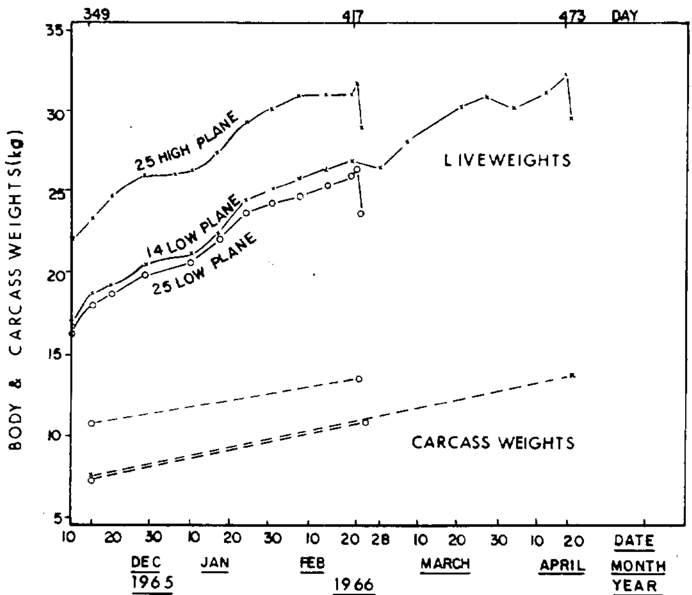

FIG. 1: *Average liveweight and carcass growth curves for wether lambs.*

differed from the low plane lambs slaughtered at the same time, by 5.5 kg initially, and after 69 days running together on good sheep pasture the difference in preslaughter full weights was 5.2 kg. Figures for the smaller low plane group in comparison with the high plane group were similar, with the gap between the two groups being reduced very slightly. It took a further 8 weeks for the 14 low plane lambs to reach the same slaughter liveweight as the high plane lambs.

In terms of liveweights from the practical farming point of view, this and other experiments (Meyer *et al.*, 1962; Osman and Bradford, 1967) have shown that compensatory growth does little to bridge any weight gap resulting from differences in nutrition early in a lamb's life. However, it should also be pointed out that the 25 low plane lambs had increased their liveweight at the beginning of the experimental period on common nutrition by 47% over the 69-day growth period, whereas the high plane lambs had increased their initial weight by only 34%, providing some evidence for increased growth when absolute weight gain is related to initial size.

Data on carcass weights provided in Table 2 show a similar picture to that for liveweights. The groups of 25 high plane and low plane lambs differed by 3.6 kg in estimated carcass weight at the beginning of the experimental period and 2.8 kg in actual carcass weight at slaughter 70 days later. Thus the difference was reduced by 0.8 kg over the 10-week period, or by 22% when expressed as a proportion of the original difference. Covariance analysis showed that this difference in carcass weight could be accounted for by the initial liveweight difference.

From a different point of view, the results showed that the high plane lambs had increased their initial carcass weight by 26% over the 10-week period of the experiment and the low plane lambs by 50%. Although this is interesting, the overall assessment of the experiment must be that compensatory growth will only very slightly help to bridge a nutritionally caused gap in carcass weight between two similar aged groups of lambs.

Data on the composition of the growth groups of lambs are given in Table 3. The larger high plane lambs had a higher dressing percentage than the low plane lambs slaughtered at the same time, but the difference was very much smaller than for the initial control slaughter groups. The 14 low plane lambs which were taken to the same liveweight as the high plane group at slaughter had a similar dressing percentage to that group, as well as a similar

TABLE 2: AGE, LIVEWEIGHT AND CARCASS WEIGHTS OF LAMBS TRANSFERRED POST-WEANING FROM STEEP HILL COUNTRY TO FAT LAMB CONDITIONS

Item	25 High Plane Mean	25 High Plane S.D.[1]	25 Low Plane Mean	25 Low Plane S.D.[1]	Diff. $H\text{-}L_{25}$	14 Low Plane Mean	14 Low Plane S.D.[1]	Diff. $H\text{-}L_{14}$
Birth day	248	9	249[2]	10	—1	251[3]	10	—3
Liveweights (kg)								
Weaning, Dec. 10 (day 344)	21.9	3.5	16.1	2.4	5.8	16.8	3.8	5.1
Initial (day 349)	23.3	3.9	17.8	2.6	5.5	18.6	3.9	4.7
Day 417	30.6	4.3	25.7	3.1	4.9	26.6	4.2	4.0
Final full, Feb. 23 (day 418)	31.3	4.3	26.1	3.2	5.2	—	—	—
Final full, Apr. 18 (day 473)	—	—	—	—	—	32.0	4.7	—
Liveweight gains (final-initial)	8.0		8.3			13.4		
Pre-slaughter (empty)	28.5	4.0	23.5	2.9	5.0	29.2	4.1	—0.7
Fasting loss (full — empty)	2.8		2.6		0.2	2.8		0
Liveweight gain (kg/day):								
Birth — weaning	0.187		0.125			0.130		
Weaning — Feb. 22	0.119		0.132			0.134		
Feb. 22-Apr. 18	—		—			0.096		
Hot carcass at slaughter (kg)	13.54	2.49	10.76	1.54	2.78	13.67	2.45	—0.13
Estimated[4] initial hot carcass, day 349 (kg)	10.75		7.16		3.59	7.54		3.21
Carcass gain (slaughter-initial; kg)	2.79		3.60		—0.81	6.13		—

[1] Standard deviations not given where means presented are differences between other means in the table.
[2] One birth date missing.
[3] Two birth dates missing.
[4] Estimated from initial slaughter groups.

weight of offal and gastro-intestinal contents. An exception was the stomachs which were heavier for the low plane group.

A comparison of the grading results in Table 1 with those in Table 3 shows a considerable shift towards the Prime end of the scale with a movement from Y to Prime for the high plane lambs and a movement from alpha and manufacturing to Y grade for the low plane lambs. The overall grading picture can be largely explained in terms of the different mean carcass weights of the various groups.

The fat and protein (muscular tissue) contents of the carcasses of the three growth groups are given in Table 3. When the high plane lambs are compared with the low plane group slaughtered at the same time, the results show that the difference in weight of chemical fat between the two groups was almost the same at slaughter as that estimated at the beginning of the experiment. In other words, both groups had laid down almost exactly the same weight of fat. Similar comparisons for protein showed that the low plane lambs had deposited protein at almost twice the rate of the high plane group when the gains over the 10-week growth period are compared.

The low plane lambs slaughtered at the same weight as the high plane lambs had similar composition.

The taste panel scores from the legs of the carcasses within each treatment group were averaged and the means and standard deviations are presented in Table 3. For the groups slaughtered at the same time, there is no suggestion that the low plane of nutrition before weaning has in any way adversely affected the palatability of the meat. When related to the grading results, the comment can also be made that the higher proportion of Y, alpha and manufacturing grade lambs in the low plane group has not adversely affected meat palatability as measured in this trial.

The low plane lambs slaughtered at the same weight as the high plane lambs appear to be slightly more palatable and in particular to be more tender. However, as it is now known that post-slaughter factors can be very much more important than pre-slaughter ones in influencing tenderness (Marsh *et al.*, 1968), and as it is not known whether the post-slaughter conditions were the same for the smaller low plane group as they were for the two groups slaughtered at the same time, no conclusion can be drawn from this apparent difference. All lambs in this experiment were slightly less palatable than previously re-

TABLE 3: SLAUGHTER, CARCASS AND TASTE PANEL DATA ON LAMBS TRANSFERRED POST-WEANING FROM STEEP HILL COUNTRY TO FAT LAMB CONDITIONS

Item	*25 High Plane*		*25 Low Plane*		*Diff.*	*14 Low Plane*		*Diff.*
	Mean	*S.D.*	*Mean*	*S.D.*	$H\text{-}L_{25}$	*Mean*	*S.D.*	$H\text{-}L_{14}$
Dressing %	43.1	2.7	41.2	1.8	1.9	42.6	2.3	0.5
Stomachs (g)	901	113	779	111	122	1,135	115	—234
Stomach contents (g)	2,155	372	1,934	513	221	2,215	392	—60
Intestines + contents (g)	2,674	316	2,183	305	491	2,689	253	—15
Omental fat (g)	351	160	194	72	157	332	143	19
Grades:								
Prime	13		3			7		
Y	9		16			6		
Alpha + manufacturing	3		6			1		
Carcass ether extract (kg):								
At slaughter	3.21	1.21	1.98	0.57	1.23	3.15	0.99	0.06
Estimated initial Dec. 15	1.91		0.72		1.19	0.80		1.11
Gain (slaughter — initial)	1.30		1.26		0.04	2.35		—1.05
Carcass protein (kg):								
At slaughter	2.03	0.32	1.70	0.25	0.33	2.10	0.34	—0.07
Estimated initial Dec. 15	1.74		1.17		0.57	1.25		0.49
Gain (slaughter — initial)	0.29		0.53		—0.24	0.85		0.56
Taste panel data								
No. of tasters	44		43			22		
No. of legs	25		24[1]			13[1]		
Panel scores (taste panel units):								
General preference	6.3	1.8	6.7	1.5		6.9	1.5	
Tenderness	5.5	2.0	5.7	2.0		6.8	1.5	
Flavour	6.4	1.7	6.7	1.3		6.8	1.5	
Juiciness	5.9	1.5	6.1	1.9		6.6	0.7	

[1] One set of taste panel forms covering a leg on this treatment not returned.

ported for lamb legs (Kirton and Pickering, 1967; Kirton *et al.*, 1968).

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APPENDIX

From the liveweights of these slaughter samples on December 15 and their hot carcass weights and weights of carcass protein and ether-extract, relationships were computed for estimating the hot carcass weights and weights of protein and ether extract in the remaining high and low plane lambs at the beginning of the experiment on December 15. Where X = liveweight (kg):

High plane

Carcass weight (kg)	$= 0.583X - 2.84$	$S_{y \cdot x} = 0.60$	$r = 0.98$
Carcass protein (kg)	$= 0.0894X - 0.347$	$S_{y \cdot x} = 0.11$	$r = 0.98$
Carcass ether extract (kg)	$= 0.204X - 2.84$	$S_{y \cdot x} = 0.41$	$r = 0.94$

Low plane

Carcass weight (kg)	$= 0.498X - 1.71$	$S_{y \cdot x} = 0.57$	$r = 0.94$
Carcass protein (kg)	$= 0.0952X - 0.523$	$S_{y \cdot x} = 0.11$	$r = 0.94$
Carcass ether extract (kg)	$= 0.0928X - 0.930$	$S_{y \cdot x} = 0.23$	$r = 0.78$