GENETIC AND ENVIRONMENTAL EFFECTS ON GROWTH OF LAMBS RESULTING FROM VARIOUS CROSSES BETWEEN THE DORSET HORN, MERINO AND CORRIEDALE BREEDS OF SHEEP

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INTRODUCTION

Although the aim in producing a lamb carcass should be based on traits demanded by the consumer, the production endpoint for most producers is at marketing. The primary determinant of profitabilty for the producer is, therefore, market weight. This study investigated the relative importance of various genetic and environmental effects on birth weight (BWT), weaning weight (WWT), market weight (MWT), preweaning average daily weight gain (ADG1) and postweaning average daily weight gain (ADG2).

METHODS

The lambs in this study were raised at Arding, near Armidale, NSW. They were born during October of 1983, marked on 1st December 1983, weighed and weaned on 26th January 1984 and weighed on 6th April 1984. Ram lambs were not castrated. Numbers of sheep in each cross are shown in Table 3.

A model including fixed effects of breed or cross (BREED), age of dam (AOD) (2,3,4,5,6,7 years), and type of birth (TBR) (single ram, single ewe, twin ram, twin ewe, triplet ram, triplet ewe), and partial regression on day of birth (DOB) was fitted to all 5 traits using least squares techniques (Harvey 1964). Linear contrasts between least squares means were used to calculate direct genetic (g^I), total maternal (TM), individual heterotic (h^I), and maternal heterotic (h^M) effects, as shown in Alenda et al. (1980).

RESULTS AND DISCUSSION

<u>Environmental effects</u>

Tests of significance for effects in the model are shown in Table 1. Type of birth significantly ($p<.01$) affected all 5 traits and accounted for more variation than the other factors. Note that there is no distinction between those that were born and raised twin and those that were born twin and raised single. Twin born lambs were 10% lighter and triplet born lambs were 14% lighter at market age than single born lambs. Type of birth also included sex effects: ram lambs were significantly heavier ($p<.01$) than ewe lambs for all traits except birth weight. They were 22% heavier at market age.

Age of dam effects were important for all traits except ADG1. Age of dam effects were most important for BWT and ADG2. Lambs with the highest market weight were from 4 year old dams, they were 10% heavier than those from 2 year old dams. This data set is part of a larger data set that includes 33 more breed combinations; when the larger data set was analysed, AOD effects were not significant for ADG2.

The regression on day of birth was negative for WWT & MWT; this was expected because the later born lambs were younger when these weights were taken.

Table 1 Tests of significance.

Trait:	df	BWT	WWT	MWT	ADG1	ADG2
Source:						
BREED	47	<.01[a]	<.01	<.01	<.01	<.01
TBR	5	<.01	<.01	<.01	<.01	<.01
AOD	5	<.01	<.05	<.05	.18	<.01
DAY[b]	1	.07	<.01	<.01	.21	.25
R^2 (%)		40	40	46	32	41
CV[c](%)		14	14	12	17	23

[a] probability that differences were due to chance alone;
[b] partial regression;
[c] Coefficient of variation.

Table 2 Residual correlations between the traits.

Trait:	BWT	WWT	MWT	ADG1	ADG2
BWT	1.00	0.36	0.36	0.17	0.09
WWT		1.00	0.87	0.98	0.01
MWT			1.00	0.84	0:51
ADG1				1.00	0.00
ADG2					1.00

Note the near-zero correlation between ADG2 and WWT or ADG1. It is well known that maternal effects are important in determining weaning weight (Vesely et al. 1977) and that growth rates are affected when lambs are weaned, but it is still surprising to see no correlation between pre- and post-weaning average daily gain. Although there was a near-zero correlation between WWT and ADG2, there was a relatively high correlation between WWT and MWT.

Genetic effects

Variation between the various breeds or crosses was significant for all traits (Table 1). The least squares means are presented in Table 3. Lambs with the highest market weights were from a Dorset Horn sire and Corriedale dam. Overall 3-way cross lambs weighed more than F1 lambs, which weighed more than purebred lambs.

The importance of various genetic effects was calculated following the method of Alenda et al. (1980), these are shown in Table 4. Direct effects (g^I) were significant and positive for WWT, MWT and ADG1 for the Dorset Horn. Merinos and Corriedales were similar for the traits measured. The Corriedale passed on a negative effect on MWT and ADG1.

Table 3. Least squares means of various breed crosses.

Trait:	No.	BWT[a]	WWT	MWT	ADG1	ADG2
DH[c]	25	3.82±.16[b]	22.77±0.84	31.25±0.98	.190±.008	.121±.007
DHxMO[d]	13	4.27±.21	21.02±1.10	30.51±1.28	.167±.011	.136±.009
DHxMOCO	39	4.50±.14	22.45±0.76	31.72±0.88	.179±.007	.132±.006
DHxCOMO	27	4.34±.16	21.94±0.83	31.09±0.96	.176±.008	.131±.007
DHxCO	31	4.39±.15	23.37±0.79	33.40±0.92	.189±.008	.143±.007
MOxDH	6	3.82±.29	22.39±1.50	31.65±1.74	.187±.014	.132±.012
MOxDHCO	38	4.38±.14	22.56±0.74	31.00±0.87	.182±.007	.121±.006
MO	13	4.03±.21	17.44±1.08	25.14±1.25	.132±.010	.110±.009
MOxCODH	24	4.44±.17	23.37±0.87	31.87±1.02	.189±.008	.121±.007
MOxCO	21	3.86±.17	20.42±0.91	28.71±1.06	.165±.009	.118±.008
COxDH	17	4.08±.18	20.96±0.94	30.81±1.10	.169±.009	.141±.008
COxDHMO	21	4.37±.15	23.71±0.78	31.47±0.91	.195±.008	.111±.007
COxMODH	13	4.52±.20	22.20±1.07	30.63±1.24	.176±.010	.120±.009
COxMO	15	4.27±.20	19.65±1.03	27.56±1.20	.153±.010	.113±.009
CO	29	4.17±.16	19.49±0.81	26.73±0.95	.153±.008	.103±.007
mean[e]	332	4.22±.10	21.58±0.53	30.24±0.62	.174±.005	.124±.004

[a] weights are expressed in kg's;
[b] mean ± standard error;
[c] DH=Dorset Horn, MO=Merino, CO=Corriedale;
[d] The sire breed is given first in the crosses;
[e] Grand mean, not arithmetic mean.

Table 4. Genetic effects.

Trait:	BWT[a]	WWT	MWT	ADG1	ADG2
g^{I}DH[c]	.06±.17[b]	3.21±0.89**	4.03±1.04**	.031±.009**	.012±.007
g^{I}MO	-.26±.18	-1.75±0.96	-1.81±1.12	-.015±.009	-.001±.008
g^{I}CO	.20±.15	-1.47±0.78	-2.22±0.91*	-.016±.008*	-.011±.006
TMDH	-.25±.13*	-0.35±0.66	-0.48±0.77	.000±.006	-.002±.005
TMMO	.29±.13*	-0.71±0.67	-0.76±0.78	-.011±.006	-.001±.006
TMCO	-.03±.10	1.06±0.52*	1.24±0.61*	.011±.005*	.003 ±004
h^{I}DHMO[d]	.12±.20	1.60±1.05	2.88±1.22*	.016±.010	.018±.009*
h^{I}DHCO	.24±.14	1.04±0.72	3.11±0.84**	.008±.007	.030±.006**
h^{I}MOCO	-.03±.15	1.57±0.80	2.20±0.93*	.016±.008*	.009±.007
h^{M}DHMO[e]	.27±.17	2.65±0.87**	1.86±1.01*	.024±.008**	-.011±.007
h^{M}DHCO	.57±.18**	1.56±0.92	1.26±1.07	.009±.009	-.004±.008
h^{M}MOCO	.09±.13	0.00±0.71	-0.55±0.82	.000±.007	-.008±.006

* contrast is significantly different from zero ($p<.05$);
** contrast is significantly different from zero ($p<.01$);
[a] weights are expressed in kg's;
[b] mean ± standard error;
[c] DH=Dorset Horn, MO=Merino, CO=Corriedale;
[d] estimates pooled for the two reciprocal crosses involved;
[e] assuming that individual recombination loss is zero.

Maternal effects were significant for birth weight. The effect was negative for the Dorset Horn, positive for the Merino and very close to the mean for the Corriedale. Other significant maternal effects were the positive effect of the Corriedale on WWT, MWT and ADG1.

Differences have been found in many other studies. For example Pitchford (1987) found that breed maternal effects were more important than breed transmitted effects in determining weaning weight of Rambouillet, Targhee and Columbia cross lambs. The zero correlation between ADG1 and ADG2 (Table 2) also suggests that maternal effects were extremely important in determining growth rate.

Individual heterosis was significant for all crosses for MWT and for all crosses with the Dorset Horn for ADG2. Individual heterosis averaged approximately 10% for MWT. There was a greater h^I effect on ADG2 (18%) than ADG1 (9%). It is impossible to say whether this was the case because the lambs were weaned, ie the maternal ability of the dam was a limiting factor or whether this was just because of the age of the lamb and the nonlinear nature of the lamb growth. McGuirk (1977) reported that heterosis for weaning weight ranged from -1.7 to 16.9% and averaged around 4%, in this study h^I for WWT was approximately 9%.

Maternal heterosis was significant for BWT for Dorset Horn, Corriedale crosses and for WWT, MWT and ADG1 for Dorset Horn, Merino crosses. Maternal heterosis was approximately 3% for MWT. It is known from previous reports of this experiment that much of the gain from h^M is through an increased reproduction rate, so that h^M for weight of lamb weaned per ewe joined is around 57% (Ch'ang and Atkins 1982).

Maternal heterosis, when estimated as above, is confounded with individual recombination loss according to Dickerson's (1969) model of genetic effects. Maternal heterosis was +6% for ADG1 and -6% for ADG2, which may be due to recombination of genes causing a reduction in post-weaning growth rates as well as the reduced advantage of the crossbred dam once the lamb is weaned. As part of the analysis of the larger data set, individual recombination loss was found to be significant for ADG2 but not any of the other traits; this suggests that recombination is the most likely factor causing this negative estimate of maternal heterosis.

SUMMARY

Market weight is an important determinant of profitability for the producer. The most important environmental effect on market weight was type of birth which included sex effects. The largest genetic effects were direct (additive) effects, individual heterotic effects, and maternal heterotic effects in that order. On average, three-way cross lambs were heaviest at market stage.

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