VARIANCE COMPONENTS FOR LAMBING EASE AND GESTATION LENGTH IN SHEEP

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SUMMARY
Lambing ease (LE) and gestation length (GL) are two important factors which influence Australian lamb production. Records for both these traits were available from the Sheep Genetic Australia terminal sire database. Lambing ease was scored from 0 to 5, with 0 being not observed and 5 being (other) special assistance such as veterinary intervention. Variance components were estimated with all traits treated as traits of the lamb with maternal genetic and permanent environment due to the dam effects included. Lambing ease had low estimates of direct and maternal heritability of 0.06 and 0.04 respectively. There was however a large permanent environment effect due to dam of 0.24. Gestation length was highly heritable (0.53) with high maternal genetic and permanent environment effects (0.16 and 0.25 respectively). Lambing ease and gestation length were positively genetically correlated with birth, weaning and post weaning weight and negatively correlated with number of lambs weaned. Lambing ease was not significantly correlated with gestation length. Lambing ease and gestation length could be included in the SGA analysis to provide estimated breeding values which could be used to improve lamb survival.

INTRODUCTION
Ease of lambing is an important characteristic that affects profitability in all sheep enterprises, impacting on cost of production through labour cost and production by reducing the number of lambs weaned. Gestation length may also be associated with lamb survival and other production traits.

Selection to increase growth rates and muscling in the sheep industry has been very effective, but could result in correlated responses in birth weight which may eventually increase incidence of lambing difficulties. While selection against birth weight can alleviate some of these problems, direct selection on lambing ease and indirect selection on gestation length are likely to avoid deterioration of ewe and lamb survival due to lambing difficulty. Gestation length and calving ease have both been used as selection criteria for a number of years to improve calf survival in the Australian beef industry (Graser *et al.* 2005).

The aim of this study was to estimate the variance components for lambing ease and gestation length. Genetic correlations with other production traits were also investigated.

MATERIALS AND METHODS
Pedigree and performance records were obtained from the Sheep Genetic Australia (SGA) terminal sire database. This database consists of pedigree and performance records from Australian meat sheep ram breeders and is used for industry genetic evaluation (LAMBPLAN). Data were only extracted for flock-years with greater than 50 ewes assessed for lambing ease. Data were extracted for lambing ease (LE), gestation length in days (GL), birth weight (Bwt), weaning weight (Wwt), post-weaning

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weight (Pwt), post-weaning fat depth (Pfat), post-weaning eye muscle depth (Pemd) and average number of lambs weaned (Nlw). Lambing ease was recorded on a 6 point scale consisting of: 0 for unobserved, 1 for no assistance, 2 for some assistance, 3 for hard assistance, 4 for abnormal presentation and 5 for other (such as veterinary assistance). In these analyses lambing ease scores of 0 were treated as missing values.

The pedigree was built using all available ancestors in the SGA database. The pedigree consisted of between 25,102 and 77,504 animals, depending on the trait, and records were available on between 11,915 and 55,653 animals. There were up to 1,422 sires and 19,116 dams across 26 years and 73 flocks. A summary of the data is shown in Table 1.

Table 1. Summary of the data

	Animals With Data	Total Pedigree	Dams	Sires	Flocks	Years	Mean	SD	Min	Max
LE	55,653	77,504	19,116	1,422	73	26	1.2	0.6	1.0	5.0
GL (days)	14,176	26,506	6,184	547	48	19	147.4	2.3	130.	160.
Bwt (kg)	51,354	74,909	18,204	1,294	70	16	4.7	1.0	0.9	9.1
Wwt (kg)	47,646	71,428	18,728	1,371	73	19	35.0	6.5	13.1	63.8
Pwt (kg)	41,333	63,243	16,633	1,278	70	23	50.0	6.8	23.8	85.1
Pfat (mm)	28,485	47,307	12,605	1,087	60	23	3.2	0.7	0.7	8.2
Pemd (mm)	26,864	45,724	12,207	1,060	60	16	28.1	4.5	11.0	41.0
Nlw	11,915	25,102	7,855	1,098	62	25	1.3	0.7	0.0	5.0

A fixed effects analysis of lambing ease and gestation length was conducted using PROC GLM in SAS (SAS 1990). The models for both traits included sex of lamb, season of lambing, birth type (1 to 5) and ewe age (covariate). Gestation length was also fitted as a covariate for lambing ease. An additional analysis was conducted for each trait with the inclusion of birth weight as a covariate.

Variance component estimates were obtained using an animal model in ASREML (Gilmour *et al.* 2006). The model included the same fixed effects as described above. Birth weight was not included as a covariate and sex and season were fitted as part of a contemporary group effect which was defined as subclasses of breed, flock, year and season of lambing and sex of lamb. Direct and maternal additive genetic effects were both fitted as traits of the lamb, with their covariance fixed at 0. The lambs' maternal environment was also fitted as a random effect. Bivariate analyses were then performed to estimate the correlations between LE and GL with the remaining production traits.

RESULTS AND DISCUSSION

Old ewes, multiple born lambs and lambs with lower birth weights had significantly improved LE (i.e. lower scores). Longer GL was significantly associated with poorer LE (i.e. higher scores). Female lambs had significantly lower GL and better LE scores (Table 2). Season of lambing also significantly influenced GL, with and without birth weight adjustment. While multiple born lambs were associated with shorter GL, after including birth weight in the model this trend was reversed. This suggests that multiples are associated with shorter gestation and lower birth weights. In fact the effects of sex, season, birth type and ewe age on GL appear to be partly related to birth weight. The effects of sex, birth type and birth weight on GL were similar to those reported by Fogarty *et al.*

(2005) in maternal breeds.

Table 2. Estimates of birth type, sex, season effects and regression coefficients for ewe age and birth weight for gestation length (GL) and lambing ease (LE) (standard errors in parenthesises)

Trait[A]		R^2	Sex[B]	Season[C] Spring	Season[C] Summer	Season[C] Autumn	BT 2[D]	BT 3[D]	Ewe age	Bwt	GL
LE	- Bwt	0.20	-0.05 (0.01)	0.03 (0.03)	0.04 (0.12)	0.04 (0.02)	-0.07 (0.02)	-0.03 (0.02)	-0.01 (0.002)		0.01 (0.003)
	+ Bwt	0.22	-0.06 (0.01)	0.02 (0.03)	-0.10 (0.28)	0.05 (0.03)	-0.04 (0.02)	0.04 (0.02)	-0.01 (0.002)	0.04 (0.01)	0.01 (0.004)
GL	- Bwt	0.40	-0.18 (0.03)	0.67 (0.12)	-2.70 (0.54)	-0.86 (0.09)	-0.25 (0.09)	-0.38 (0.09)	0.09 (0.01)		
	+ Bwt	0.43	-0.18 (0.04)	0.36 (0.13)	-0.91 (1.16)	-0.63 (0.09)	0.19 (0.09)	0.40 (0.09)	0.05 (0.02)	0.49 (0.02)	

[A] GL = Gestation length (days) and LE lambing ease score, [B] Sex effect is females lambs relative to males, [C] Season effect relative to winter, [D] BT = birth type relative to a single, and estimates in bold are significant ($P<0.05$).

Lambing ease had low direct and maternal heritabilities but a moderate dam permanent environment effect (Table 3). While no estimates for variance components for lambing ease could be located in the literature, the results were generally similar to those observed in beef cattle (Cubas *et al.* 1991). Gestation length was highly heritable with moderate maternal heritability and permanent environment effects. Other than having a higher direct heritability the results were again generally similar to those observed in beef cattle (Wray *et al.* 1987).

Table 3. Phenotypic variance (σ^2_p), direct heritability (h^2), maternal heritability (m^2) and permanent environment due to dam (pe^2). Standard errors are in parentheses

Trait	LE	GL	Bwt	Wwt	Pwt	Pfat	Pemd	Nlw
σ^2_p	0.23 (0.01)	5.63 (0.10)	0.72 (0.01)	25.70 (0.21)	36.73 (0.32)	0.38 (0.01)	3.53 (0.04)	0.91 (0.01)
h^2	0.06 (0.01)	0.53 (0.02)	0.16 (0.01)	0.17 (0.01)	0.22 (0.01)	0.22 (0.02)	0.32 (0.02)	0.07 (0.02)
m^2	0.04 (0.01)	0.16 (0.02)	0.14 (0.01)	0.06 (0.01)	0.05 (0.01)			
pe^2	0.24 (0.01)	0.25 (0.02)	0.12 (0.01)	0.10 (0.01)	0.07 (0.01)			

Lambing ease and gestation length had positive genetic correlations with birth, weaning and post weaning weight and negative correlations with number of lambs weaned (Table 4). Osinowo *et al.* (1993) observed negative genetic correlations between gestation length and litter size in sheep. A similar correlation between gestation length and birth weight has been observed in beef cattle (Swan and Graser 1988). There were also negative correlations between lambing ease score and fatness. These results suggest that genetically fatter or more fecund ewes tend to have better lambing ease. Lambing ease had a small non-significant positive correlation with gestation length which is contradictory to observations in beef cattle, where the estimated correlation is higher (Tier and Graser 1995). Additional analyses were conducted to estimate the correlation of breeding values for LE and GL with the standard Carcase Plus index which for both traits was not significantly different to 0.

Table 4. Genetic (r_g) and phenotypic (r_p) correlations of lambing ease (LE) and gestation length (GL) with other production traits. Standard errors are in parentheses

Trait	Corr	Bwt	Wwt	Pwt	Pfat	Pemd	Nlw	GL
LE	r_g	0.41 (0.04)	0.25 (0.05)	0.26 (0.04)	-0.29 (0.06)	-0.11 (0.05)	-0.26 (0.09)	0.07 (0.05)
	r_p	0.08 (0.01)	0.03 (0.01)	0.04 (0.01)	-0.04 (0.01)	-0.03 (0.01)	-0.03 (0.01)	0.02 (0.01)
GL	r_g	0.24 (0.05)	0.09 (0.05)	0.01 (0.05)	0.05 (0.07)	0.01 (0.04)	-0.20 (0.08)	
	r_p	0.13 (0.01)	0.04 (0.01)	0.03 (0.01)	-0.01 (0.01)	-0.02 (0.01)	-0.03 (0.02)	

CONCLUSIONS

Lambing ease scores and gestation length are heritable traits and could be used as selection criteria to improve lamb survival. The traits could both be included in the SGA analysis to improve the efficiency of lamb production by improving components of lamb survival. Based on the genetic correlations with production traits, selection for growth, fat and muscle without consideration of lambing ease could lead to a decline in lamb survival. Thus inclusion of the traits in both breeding objectives and genetic evaluations is warranted. Further investigation of the importance of random litter effects and correlations between direct and maternal genetic effects are also needed.

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