GENETIC VARIATION IN MATERNAL BEHAVIOUR SCORE AND LAMB SURVIVAL

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INTRODUCTION

New Zealand sheep farmers have focussed selection pressure on fecundity traits in recent times. The relationship between lambing rate and lamb survival is poorly understood in highly fecund ewes. Lamb survivability is a problem with up to 30% lamb losses recorded between pregnancy scanning and tailing (Aspin 1997). These lamb losses are not acceptable from a production and animal welfare perspective.

There has been some subjective selection for maternal behaviour traits thought to improve lamb survival. An example of such a trait is the maternal behaviour scoring system as described by O'Connor *et al.* (1985). A better understanding of the relationships between production traits such as lamb survival and these adaptation traits, is critical for the development of sustainable breeding programmes (Simm *et al*. 1996).

The aim of this study was to estimate genetic parameters for maternal behaviour score, litter survival as a trait of the dam and lamb survival as a trait of the lamb.

MATERIALS AND METHODS

Animals. Data were edited to remove missing records and any data recording errors. The final dataset used in this study consisted of 1954 ewes with MBS records and 2193 ewes with litter survival records. A total of 4137 lambs were used to obtain lamb survival records. MBS was recorded on Coopworth ewes while litter survival was recorded on Coopworth (n=1947) and ½ East Friesian ½ Coopworth (n=246) ewes. Lamb survival was recorded for progeny of Coopworth ewes, which included Coopworth (n=3691), ½ East Friesian ½ Coopworth (n=214) and ¾ Coopworth ¼ East Friesian (n= 232) lambs. All animals were from a single sheep farm with records from 1997 to 2000.

Measurements.

The shepherd recorded maternal behaviour score (MBS) on a 5-point scale (low, 1 to high, 5) based on the distance a ewe retreats from her lambs when the shepherd is tagging them (O'Connor *et al.* 1985).

Litter survival as a trait of the dam (LSD) was measured from parturition to weaning. It was calculated by dividing rearing rank (number of lambs reared to weaning) by birth rank (number of lambs in litter) and was recorded as a percentage

Lamb survival as a trait of the lamb (LSL) was calculated from tagging (the time MBS was recorded) to weaning. Lambs were tagged between 24 and 48 hours following birth. Lambs that survived to weaning were awarded a score of '1' while those animals that did not survive to weaning were given a score of '0'.

Statistical analyses. Variance and covariance components were estimated using ASREML (Gilmour *et al*. 1998).

The model for MBS included the fixed effects of contemporary group, age of dam at parturition and birth rank. The model also included animal and permanent environmental random effects. Contemporary group was derived by grouping the lamb birth dates into ten-day periods, from 1997 through to 2000. Contemporary group was specified in days. Age of dam was specified in years.

The model for LSD included the fixed effects of birth rank, lambing year, age of dam, genetic group, MBS and animal and permanent environmental random effects. Due to low subclass numbers, MBS was grouped into three categories; scores 1 and 2 were grouped into class 2 and scores 4 and 5 were grouped into class 4. Animals 6 years of age and older were grouped into age group 6. Estimates of variance components were obtained after logit transformation.

The model for LSL included the fixed effects of genetic group, sex of lamb, rearing rank, year of birth, age of dam, MBS and heterosis. Heterosis of the lamb was included as a covariate. All dams greater than 2 years of age were grouped into the 3 year old class. Random effects included a direct additive genetic effect and a maternal genetic effect. Estimates of (co)variance components were obtained after logit transformation.

RESULTS

The heritability for MBS was 0.05 (Table 1). No genetic variation could be attributed to litter survival (Table 1). Variance component estimates for lamb survival (LSL) are presented in Table 2. For LSL the heritability attributed to direct effects was 0.14 while the heritability attributed to maternal effects was 0.07. The genetic correlation between maternal and direct effects for lamb survival was –0.93 ± 0.25. We were unable to calculate the maternal permanent environmental variance for lamb survival due to the small proportion (27%) of dams having at least 2 records.

DISCUSSION

The genetic and permanent environmental variance estimated for MBS were both small suggesting that the major source of variation in this trait was due to temporary environmental effects. The heritability estimate for MBS in this study is different to that reported by Lambe *et al.* (2001). Lambe's team reported larger genetic and permanent environmental variances for MBS, with a heritability of 0.13 and a repeatability of 0.32. In the current study, animals with an MBS of 1 were culled from the flock, thus censoring the data. In an effort to identify the effect of censoring, the data were modified to include dams, which would have been culled on MBS, in the following year with their MBS increased to 2. The permanent environmental variance increased from 0.0015 to 0.0095, therefore increasing the repeatability from 0.07 to

0.19. The heritability remained unchanged at 0.05. Therefore the low heritability found in this study doesn't appear to be the result of censored data.

The major source of variation in LSD appears to be due to temporary environmental effects. No literature estimates for this trait were found for sheep.

Table 1. Estimated variance components for maternal behaviour score (MBS) and litter survival (LSD) (standard errors included).

Dam Traits:	MBS	LSD
Number of records	*1954*	2193
Number of sires used	*55*	59
Trait mean	3.31 ± 0.0362	91.4% ± 0.0198
σ^2 permanent environment	0.0015 ± 0.0044	0.1 x 10^{-6} ± 0
σ^2 genetic	0.0051 ± 0.0032	0.4 x 10^{-6} ± 0
σ^2 total animal	*0.0066 ± 0.0034*	0.5 x 10^{-6} ± 0
σ^2 temporary environment	0.0882 ± 0.0043	3.29 ± 0
σ^2 total phenotypic	0.0948 ± 0.0031	*3.29 ± 0*
h^2 direct	*0.05 ± 0.0337*	0 ± 0
Repeatability	0.07 ± 0.0356	0 ± 0

Table 2. Estimated variance components for lamb survival from tagging to weaning (LSL) (standard error included).

Lamb Trait:	Lamb Survival (LSL)
Number of records	4137
Number of sires used	45
σ^2 direct animal	0.51 ± 0.1881
σ^2 genetic maternal	0.26 ± 0.211
σ direct maternal covariance	-0.34 ± 0.2107
σ^2 total genetic	0.43 ± 0.1543
σ^2 total phenotypic	*3.72 ± 0.1543*
h^2 direct	*0.14 ± 0.0465*
h^2 maternal	*0.07 ± 0.0554*
h^2 total	*0.12 ± 0.0367*

Estimates of total heritability (direct + genetic maternal + direct-maternal covariance) for preweaning lamb survival were greater than that reported by Morris *et al.* (2000) (0.029) and Lopez-Villalobos and Garrick (1999) (0.042). Work by Lopez-Villalobos and Garrick (1999) estimated the value for maternal permanent environment variance to be 0.353 on the logit scale, which accounted for 9% of the total variation. This suggests that the temporary environmental component of the maternal effect is the main contribution to variation in lamb survival.

The genetic correlation between direct and maternal genetic effects for LSL was greater in this study than the value (-0.257) reported by Lopez-Villalobos and Garrick (1999). The negative correlation between maternal and genetic effects of lamb survival suggests that improvement in one component of survival is likely to be associated with a reduction in the other component. Therefore within breed opportunities for genetic improvement of lamb survival appear to be limited.

IMPLICATIONS

There is little benefit to be gained from including maternal behaviour score (MBS), litter survival (LSD) and lamb survival (LSL) in animal selection programmes, as this study shows:

- Genetic variation and consequently heritability for MBS, LSD and LSL are small.
- Permanent environmental variance for both MBS and LSD are small and is assumed to be small for LSL according to Lopez-Villalobos and Garrick (1999).
- The genetic correlation between direct and maternal genetic effects for LSL was negative.
- Repeatabilities for MBS and LSD are low.

This study highlights the need for a new measure of maternal behaviour. The influence of temporary environmental effects on litter survival highlights the importance and significance of farm and animal management practices in extensive New Zealand farming systems. These practices must be reviewed and modified with the aim to improve lamb survival. There is a need to combine favourable management practices with an animal selection policy, which capitalises on animals that can adapt readily to their changing environment.

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