THE GENETICS OF TEMPERAMENT TRAITS IN MERINO SHEEP

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SUMMARY

Investigations were made into the genetics of temperament in Merino ewes, with emphasis on those aspects which might have associations with maternal behaviour and postnatal survival of lambs. A data set of over 2000 animals and more than 20,000 records was analysed for estimation of genetic parameters. The heritability of ewe mothering temperament was 0.39 ± 0.02, indicating a moderate genetic component to this behavioural trait. Agitation score and flight time were less heritable (0.20 ± 0.05 and 0.12 ± 0.05 respectively). The heritability of litter survival was low (0.09 ± 0.01) and the genetic correlations between this and ewe mothering temperament, agitation score and flight time were 0.18 ± 0.08, 0.39 ± 0.18 and 0.09 ± 0.27 respectively. Estimated genetic correlations between temperament traits and wool traits were low, with the exception of staple length, which was negatively genetically correlated to agitation score (r_g = -0.26 ± 0.03). These results suggest that if temperament is used as a selection criterion, although no antagonistic results will be seen in wool production, there would be no advantage in litter survival compared with undertaking direct selection for the trait. Further, if selection is practised for low agitation score, our results suggest that litter survival may be slightly reduced in future generations.

INTRODUCTION

Lamb survival within Australia averages approximately 80% (Kilgour 1992) suggesting there is considerable opportunity for improvement. Most post partum lamb loss occurs within the first three days of life and is largely caused by starvation, mismothering and exposure (Nowak and Poindron 2006). Previous studies have highlighted that even well managed flocks may not exceed survival rates of 85% (Brand *et al.* 1985). Similar outcomes were identified within the Lifetime Wool Project (Lifetime Wool 2009), which showed when ideal management guidelines are followed twin survival still only averaged approximately 60%. These results suggest that tools in addition to management are required to maximise lamb survival rates.

Although breed and within breed differences in lamb survival have been identified in a number of studies, the heritability of lamb survival has been estimated as being only around 0.03 (Safari *et al.* 2005) suggesting genetic progress from direct selection will be slow. Use of indirect selection on a trait that has a higher heritability and is genetically correlated with lamb survival may provide a better option.

Maternal behaviour is an important determinant of lamb survival but difficult to measure commercially, however temperament could potentially be used as an indicator trait. Murphy (1999) found that in a flock of Merino ewes divergently selected for temperament using willingness to approach a human in order to re-join the flock (arena test) and agitation box scores, ewes from the 'calm' flock had a 10% higher lamb survival rate in twins compared with ewes from the 'nervous' flock.

The evidence indicates an important potential link between temperament and maternal behaviour in the immediate post natal period. Such behaviours have already been shown to significantly influence the formation of the ewe lamb bond, and subsequently lamb survival. However, before recommendations can be made to producers further investigation is required. This study aims to estimate the genetic and phenotypic parameters of temperament and correlations between this trait and important wool production traits.

MATERIALS AND METHODS

The genetic study utilised records from the Selection Demonstration Flocks (SDFs) which have been selected for wool and meat traits and had undergone no previous direct selection for temperament. For a detailed description of the flocks see (Ponzoni *et al.* 1999). Table 1 describes the traits recorded in the SDFs used to generate data sets to calculate genetic parameters for temperament and wool production traits. Ewe mothering temperament is recorded on a subjective five point scale using the distance the ewe moves from its lamb during tagging, agitation score is an objective measure of movement and vocalisations the sheep makes whilst isolated from flock mates and flight time measures the time taken for the sheep to travel 1.7 m after being released from a weight crate.

Table 1. Definition of traits for which genetic parameters were calculated, and the approximate number of animals and records used in each calculation

Trait	Abbreviation	No. of Animals	No. of Records
Litter survival from birth to weaning	LIS	3500	9000
Ewe mothering temperament	EMT	3700	5700
Agitation Score	AGIT	2000	2000
Flight Time	FT	2000	2000
Greasy Fleece Weight	GFW	6000	23500
Clean Fleece Weight	CFW	6000	23500
Yield	YLD	6000	23500
Fibre Diameter	FD	6000	23500
Standard Deviation of Fibre Diameter	SDFD	6000	23500
Coefficient of Variation of Fibre Diameter	CVFD	6000	23500
Curvature	CURV	6000	23500
Staple Strength	SS	6000	23500
Staple Length	SL	6000	23500

A pedigree file containing the sire, dam and paternal and maternal grandparents of each animal was used to form a relationship matrix. Variance and covariance components were estimated using a bivariate animal model in ASREML. The model included the fixed effects of age (2…7), type of birth and rearing of ewe (11, 21, 22), flock (1…5), drop (1990…2005) and the lamb type of birth and rearing (11, 21, 22) was fitted for ewe mothering temperament only. Any significant interactions were also fitted. Litter survival was analysed as a trait of the dam.

RESULTS

Ewe mothering temperament was moderately heritable ($h^2 = 0.35 \pm 0.02$; Table 2) and exhibited a positive, genetic correlation with both agitation score ($r_g = 0.26 \pm 0.12$) and litter survival ($r_g = 0.18 \pm 0.08$) implying that ewes with higher mothering temperament would have progeny with higher agitation scores and increased litter survival. Agitation score was also moderately heritable ($h^2 = 0.20 \pm 0.05$) and was negatively correlated with flight time ($r_g = -0.26 \pm 0.23$), but positively with litter survival ($r_g = 0.39 \pm 0.18$; Table 2), thus the more agitated the animal, the quicker the flight time and the higher the litter survival in its progeny. The heritability of flight time and litter survival were low ($h^2 = 0.12 \pm 0.05$ and 0.09 ± 0.01 respectively; Table 2) suggesting a low genetic component to these traits. All phenotypic correlations were small with the exception being a positive relationship ($r_p = 0.17 \pm 0.02$) between ewe mothering temperament and litter survival (Table 2).

Table 2. Heritability ± standard error, phenotypic and genetic correlations of ewe mothering temperament (EMT), agitation score (AGT), flight time (FT) and litter survival (LIS)*

	EMT	AGT	FT	LIS
EMT	**0.35 ± 0.02**	0.01 ± 0.02	0.01 ± 0.02	0.17 ± 0.02
AGT	0.26 ± 0.12	**0.20 ± 0.05**	0.03 ± 0.02	0.05 ± 0.02
FT	-0.08 ± 0.15	-0.26 ± 0.23	**0.12 ± 0.05**	0.01 ± 0.06
LIS	0.18 ± 0.08	0.39 ± 0.18	0.09 ± 0.27	**0.09 ± 0.01**

*Phenotypic correlations are presented above the diagonal, genetic correlations below the diagonal and heritabilities in bold on the diagonal

Most genetic and phenotypic correlations between temperament traits and wool production traits were not significantly different to zero (P>0.05, Table 3) with the exception of a negative genetic correlation between agitation score and staple length (r_g = -0.26 ± 0.03, P < 0.05). Thus, the less agitated the ewe the longer the staple length in its progeny.

Table 3. Genetic and phenotypic correlations between ewe mothering temperament (EMT), agitation score (AGT) and flight time (FT) and important wool production traits

	EMT		AGT		FT	
	Phenotypic	Genetic	Phenotypic	Genetic	Phenotypic	Genetic
GFW	-0.01± 0.04	0.01± 0.02	0.01± 0.11	0.01 ± 0.03	0.02± 0.12	0.16± 0.03
CFW	-0.01± 0.04	0.01± 0.02	0.01± 0.11	0.03 ± 0.03	0.02± 0.12	0.16± 0.03
YLD	-0.01± 0.04	0.01± 0.02	-0.03 ± 0.01	0.01 ± 0.02	-0.01± 0.12	-0.03± 0.03
FD	-0.01± 0.04	0.03± 0.02	0.06 ± 0.01	0.16 ± 0.03	-0.01± 0.12	-0.04± 0.02
CVFD	-0.01± 0.04	-0.01± 0.02	-0.06 ± 0.01	-0.05 ± 0.03	0.02± 0.12	0.18± 0.02
SS	0.03 ± 0.04	-0.03± 0.02	0.13 ± 0.11	0.1± 0.03	-0.01± 0.13	-0.03± 0.02
SL	-0.01± 0.04	0.01± 0.02	-0.12 ± 0.01	-0.26± 0.03	-0.01± 0.12	0.08± 0.02

DISCUSSION

Overall, temperament heritability estimates in this study were low to moderate, consistent with other studies. In our study, the heritability estimated for EMT of 0.35 was higher than the estimate of 0.09 found by Everett-Hincks *et al*. (2005); several possible causes for this disparity are suggested. Firstly, there was a difference in the timing of EMT scores with those in our study allocated to ewes within 12 hours of birth, whilst the flock analysed by Everett-Hincks *et al.* (2005) recorded EMT 12-36 hours after birth. Secondly, there were differences in prior selection for maternal ability, with no history of such selection in the flock we investigated, whereas the flock studied by Everett-Hincks *et al.* (2005) had undergone culling for poor rearing ability which may have reduced genetic variation. Thirdly, the varying estimates may reflect actual differences in available genetic variation between the Merino flock we investigated and the Coopworth flock investigated by Everett-Hincks *et al.* (2005). The current study estimated a lower heritability of agitation score than found in others (h^2 = 0.41; Blache and Ferguson 2005) however standard errors were high in previous estimates due to limited number of records. In contrast to studies in cattle but in agreement with those conducted in sheep, flight time heritability estimates were low, which coupled with its low genetic correlation with litter survival and low repeatability (Blache and Ferguson 2005) suggests that selection for this temperament trait will result in little genetic gain, both for the trait itself and for lamb survival.

The correlation between agitation score and litter survival was positive, thus the more agitated the ewe (or nervous in temperament) the higher the litter survival. This was unexpected as Murphy

(1999) reported that that ewes selected for calm temperaments had increased lamb survival. The disparity between studies may partly be explained by the fact that the divergent flocks used in Murphy (1999) were selected not only on agitation score but also on arena test results in addition to the smaller number of sires and lambs used in the study. The result of more agitated ewes displaying higher litter survival is concerning as selection for temperament has been suggested as a means of improving meat quality (Voisinet *et al*, 1997), an event which would have detrimental consequences for lamb survival.

The lack of correlations suggest that temperament can be selected for without impacting wool production. In fact, the correlation between agitation score and staple length implies that calmer ewes will tend to have progeny with increased staple length. A similar result in beef cattle has been witnessed whereby less docile animals are less productive (Gauly *et al*, 2001). Additionally, increased corticosterone levels have been shown to retard growth in broiler chickens (Post *et al.* 2003). The results in this study coupled with those obtained in other species suggest that animals that differ in their temperament also differ in physiological characteristics.

Litter survival heritability was low, which is consistent with other studies (Everett-Hincks *et al*, 2005, Fogarty *et al.* 1994) with heritability estimates of lamb survival being similar (Safari *et al.* 2005). These estimates indicate only slow genetic progress when direct selection is employed, explaining why indirect methods of increasing lamb survival were investigated in this study. Although the overall low to moderate heritability of temperament suggests genetic gain in the trait itself can be made through selection, for indirect selection to be more efficient than direct selection, the product of heritability of temperament and the genetic correlation needs to be greater than the heritability for the direct trait (litter survival). This is not the case for any measures of temperament analysed in this study, and coupled with the antagonistic correlation between agitation score and litter survival, suggests that other methods of improving lamb survival should be explored.

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