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MERINO EWES WITH HIGHER BREEDING VALUES FOR FATNESS AND MUSCLING HAVE IMPROVED MATERNAL EFFICIENCY.

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SUMMARY

Maternal efficiency refers to the ratio of total weight of lamb weaned to the mature weight of the dam. This study utilised information on Merino ewe progeny from six of the Sheep CRC Information Nucleus Flocks born in 2007 and 2008 to test the hypotheses that Estimated Breeding Values for depth of muscle (YEMD) and subcutaneous fat (YFAT) measured at yearling age will be associated with higher maternal efficiency. Maternal efficiency differed significantly between sites ($P<0.001$) and year of lambing ($P<0.001$), and only 10 % of all ewes weaned their own liveweight in either 2009 or 2010. Maternal efficiency was positively related to both YFAT and YEMD and the relationships were consistent across all sites and both lambing years. There were no effects of EBV for yearling weight on kg of lamb weaned per kg of ewe joined.

INTRODUCTION

Improving maternal efficiency offers an opportunity to fine-tune sheep production systems that are already running at the optimum stocking rate. In the context used in this paper, maternal efficiency refers to the ratio of the total weight of lamb weaned to the total amount of energy required to maintain the breeding ewes that produce them. Considering that the energy requirements of ewes is closely linked to their liveweight (Garrett *et al.* 1959), mature ewe liveweight can be used rather than energy requirement. Therefore, the measure of maternal efficiency used here is the ratio of total weight of lamb weaned to the mature weight of the dam. It is thus clear that the drivers of maternal efficiency are the number and weight of lambs weaned and mature ewe liveweight, importantly these traits have a genetic basis (Huisman and Brown 2008; Snowder and Fogarty 2009). Breeding strategies that enable desirable change in either of these traits may deliver economic benefits through improvements in efficiency. In particular, it is important to determine the effects of Estimated Breeding Values (EBVs) on maternal efficiency so that these effects can be considered when developing selection strategies.

There are a range of EBVs that could impact components of maternal efficiency, including the depth of the longisimus dorsi muscle (YEMD) and subcutaneous fat (YFAT) at a point between the 12th and 13th ribs and 45mm from the midline taken at yearling age. Previous work has shown that both YFAT and YEMD are associated with a higher number of lambs born and weaned (Ferguson *et al.* 2007, 2010; Huisman and Brown 2009) which is likely to result in a higher total weight of lamb weaned (Cloete and Scholtz 1998). Furthermore, YEMD has negative genetic and phenotypic correlations with adult weight (Huisman and Brown 2008). We therefore expect that the total weight of lamb weaned as a proportion of the ewe mature liveweight will be higher in ewes with higher EBVs for yearling fat and muscle. In this paper we test the hypthoses that estimated breeding values for YFAT and YEMD will be associated with higher maternal efficiency.

MATERIALS AND METHODS

This study utilised information on Merino ewe progeny from the Sheep CRC Information Nucleus Flocks that were born in 2007 and 2008. A full description of these flocks is provided by

van der Werf *et al*. (2010). These ewes were weighed at regular intervals throughout their life and had extensive data collected including meat and wool traits and reproductive performance. Their lambs were weighed at weaning which occurred 12 to 20 weeks after the start of lambing. The ewes had both full pedigree and Estimated Breeding Values YWT, YFAT and YEMD.

Ewe joining weights and the number and weight of lambs weaned in 2009 and 2010 at six of the sites were extracted from the national database (Table 1). Ewe liveweight was corrected for wool weight, calculated from greasy fleece weights and assuming constant wool growth rates. Only ewes that had successfully weaned a lamb (n=1124) were included in the analysis.

Table 1. The number lambs born to 2007 and 2008 drop Merino ewes and the mean age of their lambs at weaning in 2009 and 2010 in six Information Nucleus Flocks.

Flock (Site)	Ewe birth year	Weaning 2009		Weaning 2010	
		n	Age (days)	n	Age (days)
IN01 (Kirby)	2007	102	144	98	97
	2008			67	102
IN03 (Cowra)	2007	59	109	57	88
	2008			22	87
IN04 (Rutherglen)	2007	40	94	35	103
	2008			48	105
IN05 (Hamilton)	2007	30	97	27	109
	2008			26	104
IN07 (Turretfield)	2007	72	92	77	99
	2008			69	94
IN08 (Katanning)	2007	72	101	85	84
	2008			138	84

To account for differences in reproductive performance between ewes (such as birth type and rear type) weaning weights were analysed as kg of lamb weaned per kg of dam (joining weight). Linear mixed models (Genstat 2003) were fitted to the kg of lamb weaned per kg of dam data with fixed effects of flock, year of lambing, age at weaning, dam rear type, dam sire, YWT, YFAT and YEMD. Random effects of ewe and ewe birth year were also fitted. First and second order interactions were included in the starting model and non-significant ($P>0.05$) terms were removed.

Results

Maternal efficiency was significantly associated with YFAT ($P<0.05$). For every one unit increase in YFAT there was an increase of 0.04 ± 0.02 kg of lamb weaned per kg of dam joined. In addition maternal efficiency was positively related to YEMD ($P<0.05$) and for every one unit increase YEMD there was an increase of 0.01 ± 0.006 kg of lamb weaned per kg of dam joined (Figure 1). The relationships between YFAT or YEMD and maternal efficiency were consistent across all sites and both lambing years. There were no effects ($P>0.05$) of YWT on kg of lamb weaned per kg of dam joined and the effects of YFAT and YEMD remained the same whether YWT was included in the model or not.

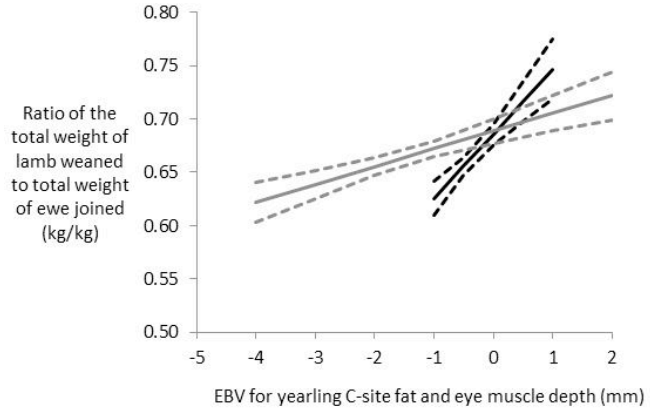

Figure 1: Predicted linear relationship ± standard error between EBV for post-weaning C-site fat (black) and eye muscle depth (grey) and the kg of lamb weaned per kg of dam joined. The data represents the combined analysis across six sites and two lambings.

Maternal efficiency differed significantly between sites (P<0.001), and only 10 % of all ewes weaned their own liveweight (maternal efficiency >1) in either year of lambing. There was a significant interaction between site and lambing year on maternal efficiency; the lowest maternal efficiency was 0.27 kg at site IN01 in 2009 and the highest maternal efficiency was 0.90 kg at site IN03 in 2010 (P<0.001; Table 2).

Table 2: The predicted kg of lamb weaned per kg of dam joined at six sites over two lambing years.

Site	2009		2010	
	Mean ± s.e.	Range	Mean ± s.e.	Range
IN01	0.27 ± 0.03	0.34 - 1.07	0.52 ± 0.01	0.26 - 1.35
IN03	0.90 ± 0.02	0.57 - 1.52	0.86 ± 0.02	0.28 - 1.57
IN04	0.74 ± 0.03	0.42 - 1.20	0.89 ± 0.02	0.46 - 1.59
IN05	0.60 ± 0.03	0.37 - 0.91	0.53 ± 0.02	0.26 - 0.89
IN07	0.60 ± 0.02	0.24 - 0.94	0.65 ± 0.02	0.34 - 1.65
IN08	0.67 ± 0.02	0.43 - 1.12	0.79 ± 0.02	0.30 - 1.24

Maternal efficiency differed significantly between ewes that were born and reared as singles (0.65 ± 0.010) and ewes that were born and reared as twins (0.69 ± 0.009; P<0.001). Maternal efficiency increased by 0.05 ± 0.004 kg for every 1 week increase in age of lambs at weaning (P<0.001). There was no significant effect of dam sire on maternal efficiency.

DISCUSSION

Estimated Breeding Values for depth of muscle and subcutaneous fat at yearling age were associated with higher maternal efficiency. These results provide strong support for our hypothesis, and are consistent with the known effects of these traits on the number of lambs weaned (Ferguson *et al.* 2007, 2010; Huisman and Brown 2009) and adult ewe weight (Huisman and Brown 2008). Across the range of YEMD and YFAT in this analysis (-4.4 to 2.0 mm and -1.0 to 2.5 mm, respectively) there is a predicted increase in maternal efficiency of 4 to 8 kg for a 60 kg ewe. Whilst this current analysis is based on a relatively small sample size, we have confirmed

these responses to YEMD and YFAT in an analysis of data from another flock (M. Ferguson *et al*. unpublished data). It is clear that large differences exist in maternal efficiency and there is scope to improve efficiency through selection for higher YEMD and YFAT.

The relationships between YEMD and YFAT and maternal efficiency were consistent across all sites and both lambing years. This result is consistent with the analysis of the Sheep Genetics database that suggested a positive effect of breeding values for fat and muscle on number of lambs born (Ferguson unpublished data), a key component of maternal efficiency. By contrast, Ferguson *et al*. (2010) found that the effects of breeding values for fatness on the number of lambs born were evident in some years but not others. These authors suggested that the higher responses in number of lambs born to genetic fatness were probably evident in poorer years, and that understanding the differences in the responses of maternal efficiency or its components to YFAT between production years and sites required further investigation because of the potentially large differences in whole farm profitability associated with them. In the current analysis, the relationship between YFAT and maternal efficiency may not have differed between flocks because all six sites managed ewes to the same condition score targets.

There were no effects of EBV for yearling weight on kg of lamb weaned per kg of dam joined. The EBV for yearling liveweight (YWT) has been associated with higher reproductive output through higher numbers of lambs born and weaned and also heavier weights at weaning (Ferguson *et al.* 2007; Huisman and Brown 2008). However, YWT is also positively correlated with adult weight (Huisman and Brown 2008) so it could be that these factors will cancel themselves out in the ratio and there will be no net effect of YWT on maternal efficiency. Snowder and Fogarty (2009) suggest that there is merit in selecting for a composite trait such as litter weight weaned rather than component traits, importantly their review of the literature revealed very few undesirable side effects of that selection strategy. However selection for higher litter weight weaned would result in higher adult ewe weight (Ercanbrack and Knight 1998). Therefore selection on the composite trait maternal efficiency may result in greater improvements in farm profits, but more information is needed to determine the full effects of that selection strategy on component and correlated traits before it can be recommended.

REFERENCES

Cloete, S.W.P. and Scholtz, A.J. (1998) *Aust. J. Exp. Agric.* **38**: 801.

Ercanbrack, S.K. and Knight, A.D. (1998*) J. Anim. Sci*. **76**: 1311.

Ferguson, M. B.; Adams, N. R.; Robertson, I. R. D. (2007) *Proc. Assoc. Advmt. Anin. Breed. Genet.* **17**: 195.

Ferguson, M.B., Young, J.M., Kearney, G. A., Gardner, G.E., Robertson I.R.D. and Thompson A.N. (2010) *Anim. Prod. Sci.* **50**: 1011.

Garrett, W. N., Meyer, J. H. and Lofgreen, G. P. (1959) *J. Anim. Sci.* **18**: 528.

Genstat (2003). Release 7.1 Reference Manual – Part 2: Directives, by the GenStat Committee. Published by VSN International, ISBN 1-904375-12-X.

Huisman, A.E. and Brown, D. J. (2008). *Aust. J. Exp. Agric.* **48**: 1186.

Huisman, A.E. and Brown, D. J. (2009). *Anim. Prod. Sci.* **49**: 283.

van der Werf JHJ, Kinghorn, B.P., Banks, R.G. (2010). *Anim. Prod. Sci.* **50**: 998.

Snowder, G.D. and Fogarty, N.M. (2009) *Anim. Prod. Sci.* **49**: 9.