CAN WEANING WEIGHT IMPROVE THE ACCURACY OF GENETIC EVALUATION FOR FLEECE WEIGHT IN YOUNG MERINO SHEEP?

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SUMMARY

Adjusting fleece weights for environmental effects such as birth date, dam age and birth/rearing status had only a marginal influence on the accuracy of genetic evaluation given the cost of collecting this information. Using weaning weight as a covariate accounted for most of these environmental effects and also reduced direct and maternal environmental variances on yearling and hogget fleece weights, resulting in a higher heritability for the traits. The implications of using weaning weight as a covariate are discussed for Merino genetic evaluation.
Keywords: Merino, fleece weight, variance components, genetic parameters.

INTRODUCTION

A number of factors can affect our ability to predict the genetic merit of a Merino based on its performance records. Early environmental effects are grouped as one such factor and encompass the birth/rearing type of the animal, the date it was born and whether it was born to a maiden or adult ewe. Early environmental effects are both costly and time consuming to collect. Both Swan and Hickson (1994) and Mortimer and Atkins (1994) have shown that the maternal environment might be the cause of some additional variation in clean fleece weight among young animals. Industry discussions have raised the possibility of using weaning weight as a covariate adjustment to account for early environmental effects. This paper investigates this proposal by attempting to quantify the influence of early environmental effects and weaning weight on clean fleece weight over a range of ages. The impact of weaning weight adjustment was assessed both in terms of its ability to account for early age environmental effects and its influence on variance component estimates.

MATERIALS AND METHODS

Data for this study came from the medium wool strain of the Trangie QPLU$ experiment. The details of this experiment, husbandry and sampling procedures are described by Taylor and Atkins (1997). The population consists of a base population and 5 derived selection lines (Taylor and Atkins 1997). Here we use measurements recorded on animals born between 1993 and 1999. All rams and ewes were shorn as lambs at 4 months of age which also corresponded with the time of weaning. Clean fleece weights were available on 2978 yearling rams at 10 months of age (yrcfw), 2852 hogget rams at 16 months of age (hrcfw), 3068 hogget ewes at 16 months of age (hecfw) and 2185 adult ewes at 28 months of age (aecfw). Clean fleece weight for each animal was based on a total weight of the greasy fleece, including belly wool, and a measure of yield from a mid-side sample.

Variance components were estimated from an animal model using ASREML (Gilmour *et al.* 1996). Year of birth as a fixed effect and animal (from pedigree) and dam as random effects were fitted in all models. Current reproductive performance was always fitted for adult ewe fleece weights. At each age, both clean fleece weight and fibre diameter (measured at the same age) were included in a multivariate analysis to account for the effects of selection that had been based on an index of these two traits. All animals had complete pedigrees, with a total of 7238 animals in the pedigree. Fixed effects for birth status, rearing status, age of dam and date of birth (as a linear covariate) were added to the model, as well as a linear covariate for liveweight at weaning.

RESULTS

Influence of environmental effects. The effects of birth date, age of dam and birth/rearing status on fleece weights are shown in Table 1. All effects were significant sources of variation on first assessed fleece weight for rams (10 months of age) and ewes (16 months of age) and largely persisted to the following shearing. After fitting weaning weight as a covariate, the magnitude of these environmental fixed effects were generally reduced (Table 1). Age of dam and birth status effects, while smaller, still persisted as small significant influences. Rearing type and birth date were removed as sources of variation on first fleece weights for both rams and ewes. At the later age, weaning weight adjustment tended to reverse the effect of birth date. The estimated weaning weight regression was equivalent to 2.6% clean fleece weight per kg weaning weight for yearling rams, 2.0% for hogget ewes, 1.1% for hogget rams and 0.9% for adult ewes.

Table 1. Estimated environmental effects (kg) before and after *(italics)* weaning weight adjustment

Trait	Mean (kg)	Maiden Dam[1]	Birth Type[2]	Rearing Type[3]	Birth date (per 7 days)
Yrcfw	**1.97**	-0.09*	-0.15*	-0.06*	-0.07*
(10mths age, 6mths wool)		*(-0.03*)*	*(-0.04*)*	*(0.00)*	*(0.00)*
Hrcfw	**3.49**	-0.14*	-0.11*	-0.03	-0.04*
(16mths age, 6mths wool)		*(-0.09*)*	*(-0.03*)*	*(0.01)*	*(0.01)*
Hecfw	**4.33**	-0.14*	-0.24*	-0.07*	-0.06*
(16mths age, 12mths wool)		*(-0.07*)*	*(-0.09*)*	*(0.01)*	*(0.03*)*
Aecfw	**4.96**	-0.12*	-0.19*	-0.06	0.00
(28mths age, 12mths wool)		*(-0.08*)*	*(-0.11*)*	*(-0.02)*	*(0.05*)*

* Significant effect ($p<0.05$) based on an approximate F-test in ASREML

[1] Progeny of maiden ewe (2-year old) Vs progeny of adult ewes (3-7 years old)

[2] Born as twin Vs single born

[3] Reared as twin Vs single reared

Components of variance. An appropriate statistical model for all fleece weights was an animal model with an additional effect for dam as a maternal environment component. The estimated variance components for additive genetic (animal), maternal environment (dam) and direct environment (residual) are shown in Table 2 for models without (Nil) or with (A) environmental fixed effects, or with weaning weight fitted as a covariate (W). A further model fitting both weaning weight and the environmental fixed effects produced estimates of variance components that were almost identical to those for model W.

Table 2. Estimated components of variance for clean fleece weight

	Maternal			***Genetic***			***Environmental***		
	Nil	**A**	**W**	**Nil**	**A**	**W**	**Nil**	**A**	**W**
yrcfw	0.010	0.007	0.002	0.032	0.027	0.026	0.082	0.073	0.053
hrcfw	0.014	0.009	0.012	0.064	0.065	0.056	0.152	0.148	0.135
hecfw	0.039	0.030	0.014	0.123	0.125	0.115	0.183	0.163	0.135
aecfw	0.000	0.000	0.000	0.204	0.209	0.204	0.238	0.222	0.217

A significant maternal component was evident for first assessment fleece weights in both rams (10 months) and ewes (16 months). The size of this component was smaller when the environmental fixed effects were fitted and substantially smaller in the presence of the weaning weight covariate. The second assessment fleece weights in rams (16 months) had an associated maternal component that was not altered by weaning weight covariance, while adult ewe fleece weights had no estimable maternal effect. Adjustment for environmental fixed effects reduced the magnitude of the direct environmental variance, more so in first assessment fleece weight (>10%) than in hogget rams (3%) or adult ewes (7%). A more substantial reduction in direct environmental variance was apparent when weaning weight was used as a covariable. For yearling rams and hogget ewes this reduction was 35% and 27% respectively, but only 11% and 8% for the subsequent fleece weights in each sex. The net effect of these changes, and the limited reduction in genetic variance can be seen in the heritability estimates in Table 3. For yearling rams and hogget ewes, heritability was higher for fleece weights adjusted for weaning weight, compared with the heritability estimates for fleece weight either adjusted or unadjusted for environmental fixed effects.

Table 3. Heritability estimates (± standard errors) for clean fleece weight

	Nil	**A**	**W**
yrcfw	**0.26 ± .045**	**0.26 ± .044**	**0.32 ± .047**
hrcfw	**0.28 ± .046**	**0.29 ± .047**	**0.28 ± .046**
hecfw	**0.36 ± .040**	**0.39 ± .041**	**0.43 ± .040**
aecfw	**0.46 ± .046**	**0.48 ± .046**	**0.48 ± .046**

DISCUSSION AND IMPLICATIONS

Collecting information on environmental factors such as birth date, dam age and birth/rearing status can be a significant cost to a breeding program. The improvement that comes from including this information in genetic evaluation is very marginal in terms of both reducing environmental variance and increasing heritability. Using weaning weight as a covariate removed most of the influence of specific environmental factors and also reduced the non-specific maternal effects and direct environmental effects on early age fleece weights. The result is a trait that is more valuable for genetic evaluation through its higher heritability. Whether the same effect would be achieved by using liveweight at a different age as the covariate is not clear and requires further study. Further, in many situations, the first measured fleece weight will include wool growth from birth (no lamb shearing). Again it would be worthwhile to test the result under such conditions.

This result could have important implications for Merino evaluation in a number of scenarios. For example, in Central Test Sire Evaluation, the cost of recording lambing and weaning information has often precluded its collection. A simple measure of weaning weight could be useful in improving the accuracy of sires based on first stage measurements, commonly collected at 10 to 12 months of age. Similarly, in two stage ram selection, improved accuracy in evaluation of young rams would allow more intense selection at first stage by including animals that may be influenced by early environmental effects. In addition, sire evaluation on-farm relies on this first stage assessment since selection is usually applied before second stage records are available. Weaning weight adjustment would make such sire evaluations more accurate and useful. Flock rams are commonly sold with measurements only available on first stage or early age assessments. By including weaning weight in the assessment, measured information on sale rams would become more accurate for the buyer. Finally, the weaning weight measurement itself may be of some value to those ram breeders attempting to include body weight or growth rate in their selection objective.

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