HOW RELIABLE IS PHENOTYPIC BENCHMARKING AS AN INDICATOR OF THE GENETIC MERIT OF A MERINO FLOCK?

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SUMMARY
Australian wether trial data were used to assess bloodline interactions and the environmental regression of fleece weight on fibre diameter. The magnitude of bloodline by region interactions indicate that bloodlines perform very predictably in different environments for fibre diameter and reasonably predictably for clean fleece weight. The significant interaction of bloodline with age for clean fleece weight indicates that knowledge of the across age regression of fleece weight may be useful to bloodline assessment. There was a strong environmental regression and correlation of clean fleece weight with fibre diameter. However, the spatial variation of individual environments from this regression indicates that phenotypic benchmarking can only be used as a rule-of-thumb method for flocks of substantial genetic superiority or inferiority for those two traits in combination.
Keywords: Merino, sheep, benchmarking, phenotypic merit

INTRODUCTION
Genetic comparison between Merino bloodlines or flocks is complicated by the environmental factors of location, management, climate and age of assessment. The Merino Bloodline Comparison (Coelli *et al.* 1998) provides information on genetic differences between 75 commonly used bloodlines after accounting for these environmental factors. However, there are many bloodlines which are not included in this list. An alternative method of comparing bloodlines is an on-farm bloodline comparison. However, this method is time consuming and largely uninformative unless the genetic merit of at least one of the bloodlines is known.

Fleece weight and fibre diameter in combination influence over 90 % of the variation in economic value of Merino bloodlines (Coelli *et al.* 1996). Thus, a rough idea about the genetic merit of these two traits in the current flock would be a useful benchmark for genetic comparison of alternative bloodline sources. Certainly, it would be an indication of whether genetic improvement by introduction of an alternative bloodline was desirable.

This paper estimates bloodline by environment interactions and the environmental regression of site mean clean fleece weight on site mean fibre diameter using data from Australian wether trials. The spread of environments about this regression gives an indication of the accuracy of phenotypic benchmarking.

MATERIALS AND METHODS

Description of sheep. Data came from commercial wether trials conducted throughout Australia during 1987-1998. For this analysis, trials which only had one year of data available were excluded. Also, only those bloodlines reported in the Merino Bloodline Comparison (Coelli *et al.* 1998), and therefore deemed to have sufficient information, were included.

Statistical analysis. A total of 21,261 records representing 6,957 wethers measured for 2, 3 or 4 consecutive years were available. The 75 bloodlines were represented by 716 teams. 57 trials were allocated into 7 regions. Univariate analyses of clean fleece weight and fibre diameter were performed to test for significant genetic effects and significant genetic interactions. The 7 regions were collapsed into 3 regions based on a combination of their fibre diameter and clean fleece weight effects. Once significant genetic effects had been established, the "paddock" (trial by year) effects were estimated. All variance analyses were performed in ASREML (Gilmour *et al.* 1997). The between paddock regression and correlation for fleece weight and fibre diameter was estimated.

RESULTS

Environmental effects. The environmental effects of region and age of assessment are presented in Table 1. The difference between the regions was more significant for clean fleece weight than for fibre diameter. Fibre diameter increased significantly with each year of age. Clean fleece weight only increased between 2 and 3 years of age, beyond this, clean fleece weight did not alter significantly.

Tablel. Clean fleece weight and fibre diameter estimates for environmental effects

Trait	Level	CFW (kg)		FD (um)	
Region	Northern Tablelands (1)	0.00	a	0.00	a
	Southern Tablelands (2)	+0.85	c	+1.35	b
	Southern High Rainfall (3)	+0.33	b	+1.26	b
	Northern Mixed Farming (3)	+0.57	b	+0.89	b
	Southern Mixed Farming (3)	+0.57	b	+1.24	b
	Northern Pastoral (2)	+0.90	c	+1.71	c
	Southern Pastoral (3)	+0.64	b	+1.87	c
Age	1.5 - 2 years	0.00	a	0.00	a
	2.5 - 3 years	+0.47	b	+0.91	b
	3.5 - 4 years	+0.56	b	+1.50	c
	4.5 - 5 years	+0.37	b	+2.21	d

Within each trait and effect, means with different letters differ significantly.
Numbers in brackets following region names indicate collapsed region categories.

Bloodline interactions. Table 2 shows the size and significance of any variance attributed to genetic effects. After fitting the main genetic effects, little variation could be explained by genetic interactions. There was a significant interaction of bloodline with age for both traits. However, this component of variation was only small relative to the bloodline variance, and was much smaller for fibre diameter than it was for clean fleece weight. The interaction of bloodline with trial was not significant for either trait. However, when trials were assigned to particular regions, there was a significant interaction between bloodline and region. The interaction of bloodline with year regression was significant for fibre diameter only.

Table 2. Components of variance, expressed as a proportion of residual or within animal variance, for genetic effects and genetic interactions

Source of variation	Number of Terms	CFW		FD	
Tag	6957	1.664	***	3.258	***
Team	716	0.632	***	0.498	***
Bloodline	75	0.548	***	0.979	***
Bloodline.Age	276	0.051	***	0.018	***
Bloodline.Trial	449	0.096	n.s.	0.144	n.s.
Bloodline.Region7#	203	0.143	**	0.065	n.s.
Bloodline.Region3#	127	0.092	*	0.196	**
Bloodline.YearRegression	75	0.000	n.s.	0.008	***

*** = P<0.001; ** = P<0.01; * = P<0.05; n.s. = not significant

#Trials were allocated into seven (Region7) and three (Region3) regions based on environment

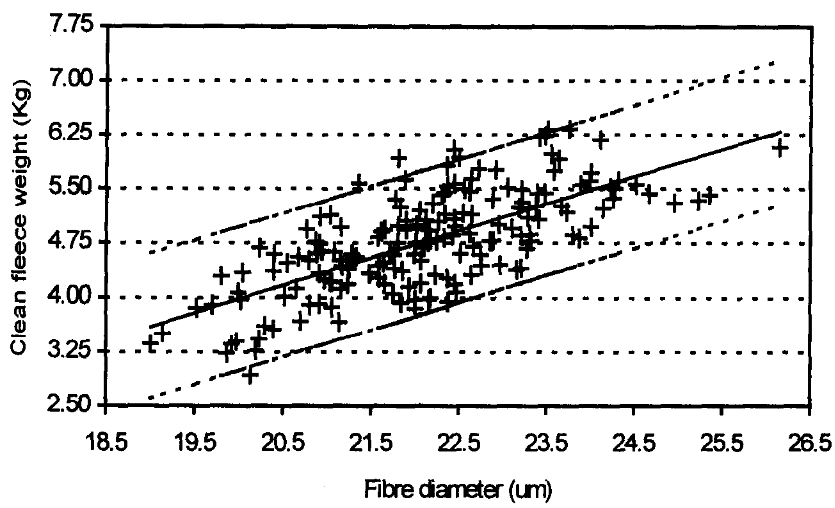

Figure 1. Across paddock regression of clean fleece weight on fibre diameter.

Environmental regression. Figure 1 shows the paddock means for clean fleece weight plotted against the paddock means for fibre diameter. Each paddock represents one year of one comparison trial. The across paddock regression was 0.38±0.03 kg per micron. The correlation of clean fleece weight with fibre diameter was 0.70. The two lines either side of the regression indicate the 95 % confidence limits of individual paddock estimates as deviations from the fitted regression.

DISCUSSION

Bloodlines showed some variation in their level of performance at different ages as indicated by the significant interaction of bloodline with age. Interestingly, the interaction was higher for clean fleece weight than fibre diameter. In the past, the across age regression of fibre diameter has been presented in the bloodline performance results (Coelli *et al.* 1996) because of the industry perception that bloodlines could vary in micron blow-out over time. These results indicate that bloodlines may also vary in there performance level for fleece weight with age. Information on relative fleece weight change with age may be useful when choosing an alternative bloodline source and will be included in future updates of the b!oodline comparison.

There were significant bloodline by region interactions for both traits, indicating some variation in bloodline performance in different environments. Unfortunately, there were not many fine or broad bloodlines represented across all regions. Therefore, we are unable to determine how different classes of bloodlines perform in different environments. Further analysis is required to determine how individual bloodlines compare in different regions.

Benchmarking an average phenotypic flock performance would not seem to be a very accurate process. The results in Figure 1 represent the variation in phenotypic performance of the "average" bloodline across a wide range of locations and years. For clean fleece weight the variation across paddocks was about 3 to 6 kg, and there was a 7um spread in fibre diameter. Using both fleece weight and fibre diameter to benchmark performance does result in a narrower band of expected performance level, as indicated by the 95 % confidence interval in Figure 1. However, only substantial differences in performance from the expected would be deemed informative.

We conclude that relying on average flock performance levels as a means of benchmarking relative genetic level is inaccurate compared with the options of centralised testing in wether comparison trials or on-farm evaluation of alternative ram sources

When calculating the current flocks performance, it is important that measurement procedures are adhered to; random sampling of adult wethers; fibre diameter and yield taken from the midside; wool growth approximately 12 months and greasy weight measured from the unskirted fleece.

REFERENCES

Coelli, K.A., Atkins, K.D., Semple, S.J. and Casey, A.E. (1996) *Wool Tech. Sheep Breed.* **44**:178

Coelli, K.A., Casey, A.E., Atkins, K.D. and Semple, S.J. (1998) Agnote DAI/52, First Edition 1998

Gilmour, A.R., Thompson, R., Cullis, B.R. and Welham, S.J. (1997) ASREML: NSW Agriculture Biometrics Bulletin 3