

# LIFETIME WOOL 11. PROGENY GENOTYPE BY ENVIRONMENT INTERACTION USING THE REACTION NORM MODEL

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The effect of genotype by environment (GxE) interactions in the Merino sheep industry can be severe. Sheep are exposed to different climatic conditions within and between years and different management systems that create different production environments for economically important wool traits. ‘Lifetime Wool’ is a national project funded by Australian Wool Innovation that is developing profitable ewe management guidelines for woolgrowers across Australia. The plot-scale experiments were conducted in two different environments with a minimum of 40% genetic linkage to allow for corrections due to environment if it was necessary (Thompson and Oldham 2004; *these proceedings*). ‘Lifetime Wool’ provides useful information for studying GxE. The reaction norm model (Kolmodin *et al.* 2000) describes the phenotype expressed by a genotype as a function of the environment. This study sought to test the ability of the reaction norm model to quantify GxE in Merino sheep. The data were analysed using the following model:

$y_{ijk} = \mu + f_k + bX_{ij} + s_{a_i} + s_{b_s}X_{ij} + e_{ijk}$ , where  $y$  equals a vector of observations (wool production traits),  $\mu$  is the overall mean,  $f$  is the vector containing fixed effects (sex, birth type dam age),  $b$  is the fixed coefficient of regression of  $y$  on  $X_{ij}$ ,  $s_{a_i}$  is the random intercept of the reaction norm of sire  $I$  also called level,  $s_{b_s}$  is the random linear coefficient of random regression of  $y$  on  $X_{ij}$ ,  $X_{ij}$  is the production environment defined as a deviation of the contemporary group mean from the population mean and  $e$  is the vector of residuals. The contemporary group was defined as the group of all animals sharing the same year, site, plot and level of feed on offer. The relationship matrix used was based on sire-maternal grandsire. All calculations were performed using ASREML software (Gilmour *et al.* 2000).

Table 1 shows the estimates of the parameters of the reaction norm model for some of the wool production traits. For most of the traits included, the variances of the level and slope were significant but the covariance between the level and the slope were insignificant despite the low standard errors. This resulted in genetic correlations between level and slope with very high standard errors. These preliminary results should be viewed as indicative only since the amount of the available data did not permit more comprehensive analyses. Nevertheless, the results indicated that the reaction norm model is suitable for quantification of GxE in Merino sheep data. Reaction norms for all available sires could be calculated and used for specific matings in specific environments that potentially will reduce the bias from possible GxE.

**Table 1. Estimates of reaction norm components from univariate analyses.**

Progeny Trait	Variance (level)	Cov(level,slope)	Variance (slope)	Cor(level,slope)	Var (residual)
Clean fleece wt	0.008 ± 0.00002	0.007 ± 0.00004	0.03 ± 0.0003	0.44 ± 0.34	0.18 ± 0.00009
Greasy fleece wt	0.01 ± 0.00004	0.005 ± 0.00004	0.02 ± 0.0003	0.32 ± 0.34	0.28 ± 0.0002
Staple strength	6.3 ± 7.3	0.4 ± 0.3	0.1 ± 0.01	0.43 ± 0.56	48.8 ± 20.2
Staple length	15.3 ± 18.4	1.4 ± 1.4	0.2 ± 0.08	0.88 ± 0.59	85.9 ± 32.2
Birthweight	0.006 ± 0.0002	0.002 ± 0.00001	0.009 ± 0.00001	0.30 ± 0.48	0.47 ± 0.0002
Liveweight at 12 months	1.4 ± 0.3	0.02 ± 0.0002	0.02 ± 0.00007	0.11 ± 0.30	16.8 ± 0.43

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