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# GENETIC AND ENVIRONMENTAL VARIATION AND GENOTYPE X ENVIRONMENT INTERACTIONS IN NEW ZEALAND ROMNEY SHEEP

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# ABSTRACT

Performance records were kept on New Zealand Romney ewes from birth to 5 years of age. These ewes were maintained in two subflocks at different stocking rates. A proportion of the ewes were eliminated at random at about 16 months of age. From this stage until 5 years all ewes were retained unless they died of natural causes. The data represented 1944 hoggets and 919 older ewes, the progeny of 49 sires. Each of these sires were used for two consecutive years. The records were calculated between 1966 and 1983 and represented seven sire periods.

The significance of genotype x environment interactions (GEI) were investigated for a range of hogget and adult traits, including liveweight (LW), greasy fleece weight (GFW), clean fleece weight (CFW), yield (Y), quality number (QN), mean fibre diameter (MFD), staple length (SL), total crimp number (TCN), crimp frequency (CF), staple strength (SST), character (CHG), lustre (LUS), tippiness (TIP), cotting (COT), cotted area (CAG), soundness (SOU), handle (HND), greasy midside colour (GCM), scoured midside colour (SCM), greasy fleece colour (GCF), number of lambs born per ewe mated (NLB), number of lambs weaned per ewe mated (NLW), weight of lamb weaned (WLW), weight per lamb weaned (WPL) and lamb survival percentage (LSP).

The effects of the environmental factors of birth year, age, number of lambs born and weaned, stocking rate and rearing rank and all interactions among them were assessed for ewe liveweight and wool traits. A similar model was developed for hogget traits but included age at weaning rather than reproductive status. Reproductive trait models included ewe liveweight and did not include rearing rank and reproductive status.

Sire x stocking rate and sire x birth year interactions were the only genotype x environment interactions that were

statistically significant.

Intra-trait genetic correlations, the correlation of the record of a trait at one stocking rate with the same trait at the other stocking rate, was used as a measure of the practical importance of sire x stocking rate interactions in selection. Intra-trait genetic correlations for hogget liveweight (0.51) and yield (0.57), and for ewe liveweight (-0.24), greasy fleece weight (0.65), yield (0.42), quality number (0.58), staple length (0.56), total crimp number (0.52) and crimp frequency (0.63) were significantly less than unity. Intra-trait genetic correlations of ewe staple strength and ewe assessed traits were also less than 1.0, but this was more a reflection of the extremely low sire variances rather than significant sire x stocking rate interactions.

Genetic parameters were calculated by different methods, including daughter-dam regression and paternal half-sib correlation techniques. Paternal half-sib estimates were calculated where the genetic variance excluded GxE interactions (EI) and where the genetic variance included GxE interactions (II). In traits where GEI were significant exclusion of the interaction terms from the numerator caused a dramatic reduction in the heritability estimates. Hence, use of the II estimates in selection programs would overestimate the amount of genetic progress likely to be achieved where GxE interactions exist.

Between-trait genetic correlations within age classes and across ages were evaluated in relation to selection policies of New Zealand Romney sheep.

Implications of the results in practical sheep breeding programs are discussed. The connotations of the significant genotype x environment interactions are that selection of rams

should occur at the 'commercial' stocking rate. The environment of the stud should be taken into account when selecting rams.

Significant GEI will also have important implications in relation to breeding systems used to assist genetic improvement of the sheep population. Group breeding schemes and sire reference programs will be affected. If the GBS nucleus is in a different environment from the base flocks, both closed and open schemes can suffer a considerable loss in overall selection response when GEI exist.

Comparison of sires across flocks using sire referencing is currently receiving much attention. If sire x environment interactions are important, inconsistencies are likely to occur in the ranking of sires.

Genotype x year interactions appear likely to be a major cause of inconsistencies in the estimation of breeding values and research to identify the causes of these interactions should be carried out.

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