THE CONSTRUCTION OF A SELECTION INDEX COMBINING A MAJOR GENE AND QUANTITATIVE TRAITS

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ABSTRACT

The Massey University Booroola-cross flock was initiated by crossing Booroola Merino x Romney cross rams with Perendale ewes at the Tuapaka hill country farm in 1980. Records were annually kept of the reproductive performance [expressed as number of lambs born (NLB), foetal number (NF) and ovulation rate (OR)], body and fleece weights, and wool quality characteristics.

Segregation criteria were used for sheep with lifetime lambing records (6 lambings), to assign them to one of the three genotypes. Any ewe with all records of NLB, NF or OR smaller than 3 was defined as being the ++ genotype, for ewes with at least one record of 3 or 4 as the F+ genotype and for ewes with at least one record larger than 4 were assigned as the FF genotype. For ewes with 3-5 lambings and reproductive records less than 3, special requirements were set to define sheep into the ++ genotype. For the remaining unclassified sheep, discriminant analysis was employed to estimate their probabilities of being either ++ or F+ genotypes. The FF category was ignored due to only a small number of FF ewes identified in the present study. The method of discriminant analysis was found to be satisfactory, and it overcame some of the problems that occurred when the segregation criteria were used.

A selection objective (H) for lifetime performance for animals in the Massey Booroola flock was defined as:

$$H = 53.79NLW+2.39WW+42.87CFW-8.75MFD+0.29MSL+3.15SCG,$$

where, NLW = number of lambs weaned, WW = weaning weight,

CFW = clean fleece weight, MFD = mean fibre diameter,

MSL = mean staple length, and SCG = scoured colour grade.

Economic weights for wool quality traits were calculated directly from the regression of auction price on level of the traits. For other traits, economic weights were calculated using the marginal profit method. The relativities between the calculated economic weights were generally in good agreement with those of previously published estimates.

For the selection objective defined, various selection indices were examined. It was found that MFD, CFW and hogget liveweight (HLW) were the most important traits, whereas MSL, SCG and WW were almost of no value in the index. The F-locus was chosen to be the selection criterion of NLW, since reproductive rate of the Booroola sheep is largely controlled by the F-locus.

A method for combining the information on the F-locus into the selection index was developed. Under the assumption that there were no correlations between the F genotpye and any of other selection criteria, an index (I) of the form:

$$I = I_F + I_Q,$$

was proposed to select the genetically superior sheep.

Here, I_F was the major gene selection index, set to be half of the dam's breeding value of the individual concerned for the F-locus (BV_F), adjusted by the economic value for the F-locus.

I_Q was the quantitative selection index, composed of the remaining selection criteria. Different selection indices for lambs, ram and ewe hoggets were derived.

Sensitivity analyses to changes of genetic and phenotypic parameters, and the economic weight of CFW were undertaken. Generally, there was little effect on the relative importance of traits in the index or in the rate of change in the objective.

An alternative method to incorporate the information on the F-locus into an index was proposed for situation where the correlation between I_F and I_Q is found to be significant.

In conclusion, it was found that the methods examined for categorising animals into various genotypes (discriminant analysis) and for combining quantitative and qualititative traits into a single index were successful and worthy of consideration for similar situations in other breeds or species.

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