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

A THESIS PRESENTED IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF AGRICULTURAL SCIENCE
IN
ANIMAL SCIENCE
AT
MASSEY UNIVERSITY

MENG JIAO SHI
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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 genotype 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 qualitative traits into a single index were successful and worthy of consideration for similar situations in other breeds or species.
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