ON-FARM OBJECTIVE MEASUREMENT OF RESISTANCE TO SHEEP PARASITES

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SUMMARY

Merino sheep from a commercial stud, comprising animals from a number of sources, were used in this study, with no changes to the normal management procedures. Of the 1990 lamb drop, 143 animals were selected at random and natural faecal egg counts (FECs) estimated in December 1990 and May 1991, Measurements of the antibody response to vaccination against tetanus and to internal parasites were also made. No significant differences among ram sources were found for any of the measured traits and the effect of sire was significant only on FEC measured in May. In contrast, dam source had a significant effect on FEC in both December and May and also on Haemonchus contortus antibody levels measured in December. Heritability estimates had high standard errors because of low animal numbers but show interesting trends. The heritability estimate for FEC was higher in May (0.62±0.42) than in December (0.13±0.22), and this decline may reflect loss of maternal influences on FEC over this 5 month period. H. contortus antibody levels had a heritability in December of 0.30±0.30, but in May of only 0.07±0.21. Trichostrongylus colubriformis antibody levels were found to be heritable only in December (0.17±0.25). No estimate of the heritability of Clostridium tetani antibody levels was possible because of negative variance components. There was little phenotypic correlation between the consecutive FECs suggesting that they may be separate traits in the Tablelands environment.

INTRODUCTION

Most studies of resistance to nematode parasites of sheep in Australia have been based on faecal egg counts (FECs) measured following artificial challenge. Parasite-free animals are given known doses of infective larvae from single parasitic genera given orally or by intra-rumenal injection, with the infection terminated by anthelmintic treatment. In contrast to these 'artificial' FECs, the protocol used to obtain FECs in the majority of New Zealand studies has involved infections 'naturally' acquired from pasture. Anthelmintic treatment is given at the commencement of the infection period, and after each faecal sampling. The infection is terminated when the FEC of a group of monitor animals reaches a mean of 800 to 1000 epg, or when welfare considerations necessitate. FECs are usually determined on two occasions between 2 and 8 months of age (Baker et al. 1991). The heritability of these 'natural' FECs is moderate, as estimated in five large-scale studies in Australia and New Zealand (Baker et al. 1991; Cummins et al. 1991; Karlsson et al. 1991; Bisset et al 1992), and are comparable with estimates from artificial FECs which have a similar range of 0.2 to 0.6 (Albers et al. 1987; Woolaston et al. 1991). This indicates the potential for natural FECs as selection criteria for resistance in commercial flocks. Antibody levels rise after infection with internal parasites and vary between resistant and susceptible genotypes (Gill 1991) and such responses may play a role in indirect selection for resistance to parasites (Gray 1991). A study was conducted on two properties on the Northern Tablelands of New South Wales to identify practical and technical problems associated with the use of 'natural' faecal egg counts (FECs) as selection criteria for improving resistance of sheep to internal parasites. The cost of each procedure: measuring FEC and antibody levels by ELISA, was also estimated as an important factor in assessing the benefits arising from a breeding approach to parasite control.

MATERIALS AND METHODS

Animals Eleven half-sib groups of fine-medium wool sheep were used from the 'Merinotech' New England elite nucleus flock (Carrick and England 1990). The 143 lambs randomly selected for this study were born in October 1990. In March the ram weaners were moved to a second property for agistment. The lambs used in the experiment were the progeny of 8 different ram sources and 9 different dam sources. Both properties are in an area of non-seasonal rainfall (600-1000mm/year), warm summers and cool winters with regular frosts where, without effective control, H. contortus is the major internal parasite of sheep in summer, with Ostertagia and Trichostrongylus infections being important during most of the year.

Experimental Methods Worm control was according to the'Wormkill' strategic drench program, with adult ewes receiving a controlled-release capsule containing albendazole. Ewes were vaccinated with a commercial vaccine for clostridial diseases (TASVAX 5-in-1™, Coopers), and lambs also received a vaccination at marking and four weeks after marking. As a measure of resistance to mixed parasitic infections, FECs were made on all lambs in December 1990 and May 1991. The protocol used to obtain the FECs following natural pasture infections was similar to that described by Baker et al. (1991).

Laboratory Analyses Faecal egg counts on the samples were performed using a salt flotation method. Blood samples were centrifuged and sera retained for measurement of antibody levels by an ELISA procedure (Gill, 1991). In December, H. contortus, T. colubriformis and Cl. tetani antibody levels were measured whereas for the second sampling only parasite antibody levels were measured.

Statistical Analysis Due to the skewed distribution of data for both FEC and antibody levels, a transformation was applied before statistical analysis. Faecal egg count data are expressed as eggs per gram of faecs (epg) and were transformed as log10 (FEC+25). All antibody data were analysed as log10 transformed, antibody units (AU). Data were analysed by mixed model analysis of variance using a least squares method (Harvey 1977).

The model used was;

$$Y = RS + S{:}RS + DS + MG/SEX + BT + b1.BWT + b2.BDAY + ERROR$$

Where;

Y = individual measurement of a trait (eg. log10 (FEC+25));
RS = ram source;
S:RS = sire nested within ram source;
DS = dam source;
MG/SEX = management group/sex of lamb (ewe or ram), as after weaning ewes and rams were grazed separately;
BT = birth type of lamb (single, twin or triplet);
BWT = birth weight of lamb fitted as a covariate;
BDAY = birthday of lamb fitted as a covariate;
b1 & b2 = regression coefficients;
ERROR = deviation of individual observations from value predicted by the model.

RESULTS

General FECs were higher in December than in May (arithmetic means of 2090 epg and 316 epg respectively. An opposite trend was apparent in antibody levels, with the highest levels recorded in May of 692 and 915 antibody units (AU) for H. contortus and T. colubriformis, respectively, compared to those in December (78 and 101 AU). No significant differences among ram sources were found for any of the

measured traits but the effect of sire was significant on FEC measured in May ($P<0.05$). In contrast, dam source had a significant effect on FEC in both December and May ($P<0.05$ for both), and also on H.contortus antibody levels measured in December ($P<0.01$). Sex/management group of the lamb had no significant effect on any of the traits. The birth type of lambs had a significant effect ($P<0.01$) on FEC measured in December, with FEC increasing from singles to triplets. Fitted as a covariate, birth weight showed a significant association with H. contortus antibody levels in December ($P<0.01$): heavier lambs tended to have higher antibody levels. Similarly, when fitted as a covariate, birthday also showed a significant association with H. contortus antibody levels in December ($P<0.05$): younger lambs had higher antibody levels. In contrast, birthday had an opposite effect on C.tetani antibody levels, with antibody level tending to increase with lamb age ($P<0.05$). The phenotypic correlation between FEC in December and in May was 0.01.

Heritability Estimates Heritability estimates for all traits are shown in Table 1 .

Table 1. The heritability[1] of faecal egg counts, parasite antibody and Cl. tetani antibody levels in December 1990 and May 1991

Trait	Sampling time	
	December 1990	May 1991
Faecal egg count	0.13 ± 0.22	0.62 ± 0.42
H. contortus antibody level	0.30 ± 0.30	0.07 ± 0.25
T. colubriformis antibody level	0.17 ± 0.25	-2
Cl. tetani antibody level	-2	No sample

Footnotes [1] Based on 11 sires and 143 animals in December and 125 animals in May.
[2] No estimate possible because of negative variance components

Cost Estimates Cost estimates for the measurement of FECs and antibody levels are shown in Table 2.

Table 2. Estimates of the costs associated with the measurement of faecal egg counts and antibody levels measured by ELISA based on the assessment of 200 lambs on a property located 50km from the laboratory

Item	Faecal egg count	Antibody (ELISA)
Travel	$30.00	$30.00
Labour[1]	$313.00	$268.00
Materials[2]	$5.00	$270.00
Capital Depreciation[3]	$10.00	$44.00
Total	$358.00	$612.00
Total per sample	$1.79	$3.06

Footnotes [1] Mustering, sample collection, travel time, laboratory time and data entry.
[2] Material for sample collection and laboratory reagents and disposables
[3] Depreciation on capital items at 20% p.a. and opportunity cost of 10% p.a..

DISCUSSION

The structure of the flock used in this study was not designed to give accurate estimates of genetic parameters. Despite this, heritability estimates for FEC showed a marked increase from the December to May sampling. In a study of natural FECs, Baker et al. (1991) reported an increase in the estimates of heritability for FEC from 0.35±0.12 at the first sampling to 0.66±0.18 at a third sampling. This may be

related to the age-dependent development of immunity or to the strong influence of the maternal environment. The low phenotypic correlation between FECs in December and May suggests that these may be two separate traits in the Tablelands environment. If this is correct then it would be inappropriate to estimate the heritability of FEC from the average of the two FECs, as done by Baker et al. (1991) in a New Zealand study. Low phenotypic correlations have also been reported for FECs taken greater than a month apart in a Mediterranean climate zone of Western Australia (Karlsson et al. 1991). Between repeated infection cycles Cummins et al. 1991 reported a repeatbility of 0.2. In contrast, FECs taken close together in the same infection cycle had a repeatability of about 0.6 (Woolaston et al. 1991). Antibody levels to two of the parasitic genera of major economic importance were heritable and a larger study to assess their potential as indirect predictors of resistance is warranted.

The cost of measurements must be considered, but is often ignored in evaluation of alternative selection criteria. Measurement of FEC is relatively simple and with minimal training, producers could collect the faecal samples themselves. In comparison, collection of blood samples for antibody measurements requires a trained collector, and in the commercial situation may require a veterinarian. Consequently, with the length of time and additional materials involved in laboratory analyses, the cost per sample for antibody measurements is higher than for FECs. Development of new technology, which may allow considerable cost savings in the ELISA technique, and the favorable genetic associations between antibody response and FEC as reported by Baker et al. (1991), suggest that there is the potential for parasite antibody levels to be used as an indirect predictor of resistance. Resistance to other diseases could also be measured in the same blood sample. For example, in areas where sheep are prone to facial eczema, serum gamma glutamyltransferase is used as an indirect predictor of resistance (Towers and Stratton 1978).

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