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ECONOMIC VALUES FOR SHEEP INTERNAL PARASITE RESISTANCE TRAITS IN NEW ZEALAND AND AUSTRALIA

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SUMMARY

A framework for estimating economic values of adult ewe and lamb faecal egg counts is described. Equations which calculate the economic value for specific farms in Australia and New Zealand are presented but should be considered tentative due to uncertainty about the underlying epidemiological parameters and production loss functions.

Keywords: Economic value, faecal egg count, sheep

INTRODUCTION

The potential for improvement in the genetic resistance of sheep to internal parasites in New Zealand and Australia has been demonstrated in experimental flocks, and is being realised through integration of selection for resistance with existing commercial sheep improvement programmes (McEwan *et al.* 1995, Eady *et al.* 1997). While numerous attempts have been made to quantify the costs of parasitism at industry and national levels, the economic value of selection for resistance is still not well understood (Woolaston and Baker 1996). As faecal egg counts (FEC) have been the primary selection criteria, it is convenient that the economic value be expressed per unit change in average commercial ewe or lamb FEC breeding value over a flock, for one year, on a per animal basis. The objective of this paper is to set out a framework for defining economic values for FEC traits. An equation for FEC economic values in different farming systems is specified and economic values estimated for several scenarios.

MATERIALS AND METHODS

Figure 1 outlines the steps used to include FEC in the selection index. The genetic improvement nucleus and commercial production flock are represented separately in Figure 1, with links between the two resulting from transfer of genetically superior sires. Direct relationships between parasite resistance traits such as FEC and other conventional traits making up the selection criteria (denoted A in Figure 1) and/or breeding objective (denoted B) can be accounted for using a multiple trait evaluation procedure. The link between flock mean breeding value for FEC and average flock performance for commercial production traits has three components. Selection for FEC in the genetic improvement nucleus and transfer of improved sires to the commercial flock results in a change (denoted as C in Figure 1) in disease epidemiology (denoted D) which in turn results in improved production performance (denoted E). The change in profit due to improved production traits such as lamb survival, wool production or lamb growth rates (denoted F) can be calculated as for conventional economic values. Because the direct genetic relationship between FEC traits and production traits has been found to be quite weak in New Zealand and Australian flocks, the main benefits of reducing FEC come from inhibition of the parasite epidemiology and therefore reduced contamination over the whole flock.

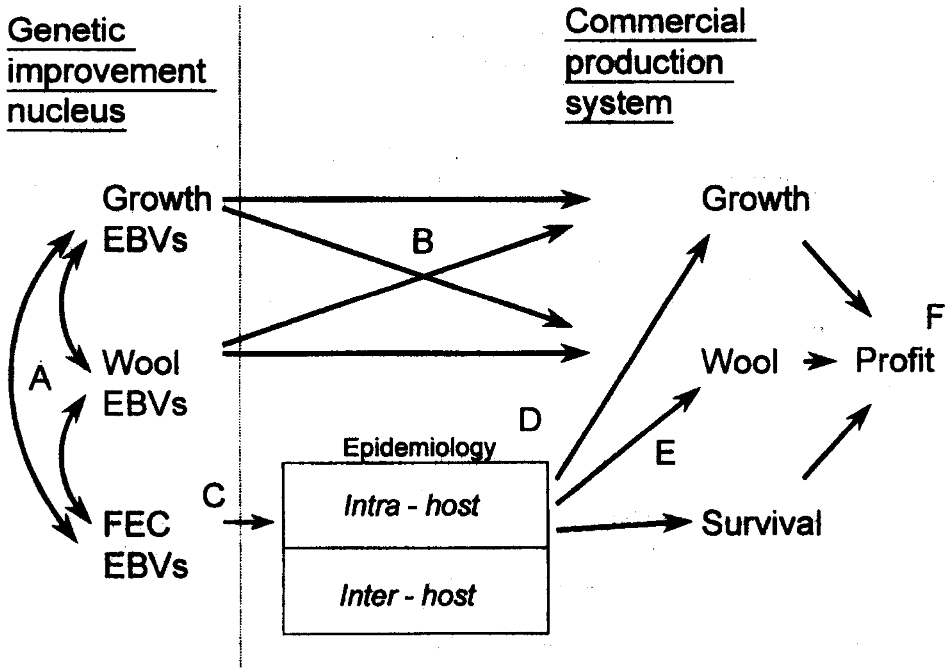

Figure 1. Key relationships for incorporating parasite resistance into a selection index.

In general terms, the economic value of a percentage change in FEC per lamb weaned ($EV_{FEC\%}$) was specified as

$$\begin{multline} EV_{FEC\%} = \underset{i}{\Box}\, \rho_i ?\frac{WB_i}{100} ?\frac{\%\Delta WB}{\%\Delta FEC} ?\Box\frac{\Delta SW}{\Delta WB_i} ?C_{SW} ?PS + \frac{\Delta HLW}{\Delta WB_i} ?C_{HLW} ?(1-PS)?PCG \\ + \frac{\Delta FW}{\Delta WB_i} ?C_{FW} ?(1-PS) + \frac{\Delta LD}{\%\Delta WB_i} ?C_{LD} ?\frac{100}{WB_i} \end{multline}$$

where ρ_i is the proportion of years in which parasite species i reaches significant levels in the commercial production system, $\%\Delta WB_i/\%\Delta FEC$ is the percentage change in average adult worm burden for species i from birth to hogget age when there is a 1 percent change in flock average FEC (depends on whether lamb FEC or adult FEC changed) in a significant year, $\Delta SW/\Delta WB_i$, $\Delta HLW/\Delta WB_i$, and $\Delta FW/\Delta WB_i$, are the changes in lamb slaughter weight (kg), hogget live weight (kg) and hogget fleece weight (kg) with a 1 unit change in cumulative average worm burden respectively, $\Delta LD/\%\Delta WB_i$, is the change in the proportion of lambs dying with a 1 % change in average worm burden, PS is the proportion of lambs born which are slaughtered prior to hogget age and which are assumed not to be shorn, PCG is the proportion of early weight loss due to parasitism expected to be recovered through compensatory growth on normal pasture feed and C_{SW}, C_{HLW}, C_{FW}, and C_{LD} are the net economic costs of a 1 % reduction in lamb slaughter weight, hogget live weight, hogget fleece weight and an increase in lamb deaths respectively. This definition can be considered conservative because the drenching protocol was assumed to remain unchanged and affects of parasitism on adult production were ignored. Beneficial carryover effects from reductions in pasture contamination from one year to the next were also ignored.

Economic values were calculated separately for changes in lamb FEC and adult FEC because most pasture contamination by ewes occurs shortly after lambing, whereas pasture contamination by lambs occurs post weaning. Relationships between FEC and cumulative average worm burdens were calculated from simulation results obtained from either the general New Zealand internal parasite model (Leathwick *et al.* 1992) or the Australian *Trichostrongylus* model (Barnes and Dobson 1990).

For the New Zealand situation, an "average" parasite species was considered under the assumption that parasitic infections by different species take place in equal proportion over time. For Australia, adult worm burdens of three parasite species (*Ostertagia*, *Haemonchus* and *Trichostrongylus*) were assumed to have specific effects on production traits.

The cost of reductions by 1 kg in lamb slaughter liveweight, hogget liveweight, hogget clean fleece weight, and lamb survival were assumed to be NZ$1.35, NZ$0.30, NZ$3.50, and NZ$33 for New Zealand dual purpose sheep and A$0.90, A$1.00, A$6.00 and A$30 for Australian Merinos respectively. Economic costs due to reductions in hogget live weight were based on the marginal costs of supplementary feed to regain lost weight, although it was assumed that 50 % (PCG) of lost hogget live weight could be regained from normal grazing. The increase in the proportion of lambs dying due to parasitism with a 1 % increase in mean adult worm burden was derived based on the assumptions of a negative binomial distribution of worm burdens and a threshold worm burden beyond which death occurs. An approximate function, $0.0325D-.075D^2$ was used, where D is the expected proportion of the flock dying due to parasitism in a year where there is a significant level of infection. Relationships between production losses in the other traits and worm burdens were derived from the published results of trials. For the New Zealand and Australian situations, 75 % and 50 % of lambs were assumed to be slaughtered respectively. Other parameters used in the calculations are in Table 1.

RESULTS

For the New Zealand scenario with effective drench control, the economic values for a 1 % change in Adult FEC and Lamb FEC were NZ$-0.02 and NZ$-0.03 respectively. For Australian scenarios, Adult FEC and Lamb FEC economic values were A$-0.13/ewe/year and A$-0.04/lamb per year for summer dry and A$-0.08/ewe/year and A$-0.03/ewe/year for summer wet areas respectively. For situations where drenches provide ineffective control (such as with anthelmintic resistant parasites), economic values might be expected to increase by 5 and 3 times the value with effective control for NZ and Australia respectively.

Table 1. Parameters used for the calculation of economic values for New Zealand and Australian example scenarios

	ρ	$\frac{WB}{1000}$	$\frac{\%\Delta WB}{\%\Delta FEC}$ Adults	$\frac{\%\Delta WB}{\%\Delta FEC}$ Lambs	$\frac{\%\Delta SW}{\%\Delta WB}$ (x1000)	$\frac{\%\Delta HLW}{\%\Delta WB}$ (x1000)	$\frac{\%\Delta HFW}{\%\Delta WB}$ (x1000)	Lamb deaths
New Zealand	1	1.2	.4	.6	-2.16	-3.24	-0.26	0
Australia summer dry								
	0	-	-	-	-	-	-	-
Haemonchus								
Trichostongylus	.9	4.5	.75	.25	-0.36	-0.54	-.043	.02
Ostertagia	.9	0.8	.75	.25	-2.60	-3.90	-.312	.01
Australia summer wet								
Haemonchus	.7	3.8	.75	.25	0	0	0	.08
Trichostongylus	1	3.5	.75	.25	-0.36	-0.54	-.043	.02
Ostertagia	0	-	-	-	-	-	-	-

DISCUSSION

This paper presents a new approach to the weighting of FEC in genetic selection indexes. A particular advantage of the method is that epidemiological parameters are defined explicitly, rather than having to model the epidemiology to each case in question. This opens the way for much more simple adaptation of breeding objectives incorporating FEC to specific farm situations, and to quantify how economic values for FEC might increase over time as parasites become increasingly resistant to current anthelmintic control measures. However, there are a number of weaknesses in our current understanding of the parameters required when applying the approach. These weaknesses might be overcome in the future, if well designed experiments can further elucidate how selection for reduced FEC inhibits the parasite epidemiological cycle, and the effects of parasitism on production traits.

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