INCLUDING DAG SCORE IN MERINO BREEDING PROGRAMS

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SUMMARY
The association between dags and resistance to roundworms was examined in the CSIRO *Haemonchus* selection lines. Reduced scouring was significantly associated with susceptibility, but increased scouring was not associated with resistance. In the context of a commercial Merino breeding objective, preliminary information suggests that this association is of little consequence. Dag score (DS) appears to be of insufficient value to drive a rapid change in DS in an objective that also includes production and a moderate amount of emphasis on improving resistance. If DS is ignored, it should not get worse. Using DS as a selection criterion will have virtually no effect on reducing Faecal Egg Count (FEC) unless FEC is also measured in at least one sex.
Keywords: Sheep, roundworms, selection, scouring, dags

INTRODUCTION
Breeding sheep for resistance to internal parasites is being adopted in an attempt to reduce losses from worms and as a safeguard against anthelmintic failure. Scouring and dag formation present an ancillary problem to the production losses caused by worms. Worms are frequently implicated in the development of scours in sheep, but the relationship is complex (IWS 1998). Sheep with the ability to resist roundworm infection, don't necessarily scour any less or have lower dag scores. In fact, there are occasions when the reverse is true, but the relationship is inconsistent and on average, very weak (see Pocock *et al.* 1995 and Table 1). Emery (1999) explained, in layman's terms, the immunological reasons behind this poor association. He suggested that if dags and scouring are perceived to be a problem, then it is better to breed for improvements in both traits simultaneously than to discount breeding for worm resistance on the premise that it increases the incidence of scouring. In this paper we seek further evidence of the association between worm resistance (as measured by faecal egg count, FEC) and dag score (DS) in the CSIRO *Haemonchus* selection lines, and predict the consequences of including DS in Merino breeding programs, using parameters from the literature.

MATERIALS AND METHODS
The CSIRO *Haemonchus* lines (Woolaston and Piper 1996) comprise flocks selected since 1978 for increased (IRH) or decreased (DRH) resistance to *Haemonchus contortus*, and their unselected controls (CH). Lambs born in 1992 and 1998 had sufficient dags to be differentiated on a 0 (no dag) to 5 (heavy dag) scale, similar to Larsen *et al* (1994). The 1992 drop lambs were scored at an average age of 84 days in early summer, the third faecal sampling period of Ward *et al* (1999). The 1998 drop lambs averaged 122 days of age when scored in mid-summer. Rainfall registrations for the four months immediately prior to recording, as a crude indicator of pasture growth and condition, were 29,62,99,135 mm (from Aug 7 1991) and 100,104,61,56 mm (from Sep 6 1998). Data were

pooled for analysis and effects fitted included line-birth year and sire (nested within line-birth year). Sex, age, birth-rearing type and dam age were not significant and thus excluded from the model. FEC data from 1992 drop were analysed as described by Ward *et al* (1999). There were insufficient FEC data from the 1998 drop to warrant inclusion. For genetic gain calculations (Cunningham and Mahon 1974), parameters from the literature were assumed. Due to the paucity of relevant information from Australian Merinos, data from other breeds in NZ contributed most to the estimates (Table 1).

Table 1. Assumed phenotypic standard deviations (psd) and heritabilities (h^2) of dag score (DS) and cube root transformed faecal egg count (CFEC) and their genetic and phenotypic correlations with greasy fleece weight (GFW), clean fleece weight (CFW), average fibre diameter (FD), number of lambs weaned (NLW), hogget weight (HW) and mature weight (MW)

Trait		GFW	CFW	FD	NLW	HW	MW	CFEC
	Psd			Phenotypic correlations				
CFEC[1]	1.00	0.00	0.00	-0.05	-0.05	-0.05	-0.10	1.00
DS[2,3]	1.66	-0.05	-0.05	0.00	0.00	-0.05	-0.05	-0.05
	h^2			Genetic correlations				
CFEC[1]	0.25	0.10	0.10	-0.05	-0.20	-0.20	-0.20	1.00
DS[3]	0.25	0.05	0.05	0.00	0.00	-0.15	0.00	-0.05

1. From Eady *et al* (1998);
2. psd from Larsen *et al* (1994);
3. Other parameters from Meyer *et al* (1983); Watson *et al* (1986); McEwan *et al* (1992); Bisset *et al* (1992; 1994;1996); Douch *et al* (1995); Karlsson and Greeff (1996); this paper

Relative economic values (REVs) were from Ponzoni (1988). A 50 % worm index was assumed, which is designed to improve FEC at 50 % of the maximum (REV=-25.5 per sd reduction in cube-root transformed FEC). REVs for DS were derived from the methodology of Ponzoni (1988), with assumptions for DS based on Larsen *et al* (1995). In the first of three scenarios, no value is assigned to DS (Zero). For the Medium scenario, a reduction in DS from score 1 to 0 was worth \$0.90 per breeding ewe lifetime, calculated from the per sheep difference in wool value (\$0.02) and the cost of crutching (\$0.10) multiplied by 7.24, the number of expressions. This implies that DS is the same trait at all ages. For the High scenario, a DS reduction from score 5 to 4 was valued at \$5.08 per breeding ewe lifetime, calculated from a \$0.45 increase in wool value (increased from \$0.37 to match prices of Ponzoni 1988), a \$0.10 decrease in crutching cost plus an arbitrary decrease of \$0.15 in the cost of jetting. Proportions selected were assumed to be 6 % and 50 % and generation intervals were 2.5 and 4 years for males and females respectively.

RESULTS

The overall mean DS (±sd) was 0.88±1.32. Line and birth year were significant ($P<0.05$), as was their interaction, and sire effects. IRH lambs had significantly higher DS than DRH lambs in both years (Table 2) as did CH lambs in 1992. There was no significant difference in DS between IRH and CH lambs. The phenotypic correlation of DS with CFEC (1992 drop) was -0.03 and the estimated heritability of DS was 0.09±0.07. Predicted responses in DS and FEC are shown in Table

3. Annual FEC changes were calculated by back-transforming CFEC and assuming a coefficient of variation of CFEC of 30 %. DS changes little over 10 years in the Zero and Medium objectives (Table 3). With a high weighting on DS, improvement only occurs if DS itself is recorded, but slowly (reduction of 0.2 to 0.3 units over 10 years).

Table 2. Least square mean (±se) dag scores (DS) in the increased resistance (IRH), decreased resistance (DRH) and control (CH) lines. Species composition of faecal cultures is also shown

Year		IRH		CH		DRH	*Species composition (%)*			
	n	Mean	n	Mean	n	Mean	*Hc.*[1]	*Tc.*[2]	*Oc.*[3]	*Nem*[4]
1992	89	1.45±0.16[a]	92	1.33±0.16[a]	75	0.80±0.17[b]	See Ward *et al* (1999)			
1998	148	0.89±0.14[a]	164	0.70±0.13[ab]	142	0.50±0.14[b]	22	54	22	2

1. *Haemonchus contortus;* 2. *Trichostrongylus colubriformis;* 3. *Ostertagia circumcincta;* 4. *Nematodirus spp.*
Means within rows having different superscripts differ ($P<0.05$)

If all selection pressure is used to improve DS, a reduction in one DS unit will occur in 5-6 years (not shown). Genetic progress in reducing FEC is essentially unaffected by including DS, either as a selection criterion or in the objective, unless FEC is not measured at all (Table 3). Dag score will not get worse if it is totally ignored. Failure to measure FEC reduces gain in the objective by 12-13 % and measuring it in both sexes improves gain in the objective by 6-7 % (not shown).

Table 3. Responses in dag score (DS) and faecal egg count in objectives with Zero, Medium or High economic value of DS, using a range of selection criteria. For abbreviations, see Table 1

Selection Criteria		Dag Score			FEC		
Male	Female	DS change in 10yrs			Annual reduction in FEC		
CFW, FD, HW plus	GFW, HW plus	Zero	Medium	High	Zero	Medium	High
FEC	-	-0.08	-0.08	-0.09	3.9%	3.9%	4.0%
FEC	DS	0.00	-0.02	-0.17	3.9%	3.9%	3.9%
DS	DS	0.08	0.03	-0.33	0.4%	0.4%	0.4%
FEC,DS	DS	0.07	0.03	-0.29	3.9%	3.9%	3.9%
FEC	FEC	-0.04	-0.04	-0.05	5.6%	5.6%	5.6%

DISCUSSION

Results from the CSIRO *Haemonchus* lines support previous findings of a very weak association between worm resistance and dags. Notably, the association was asymmetrical, with selection for resistance having an insignificant effect on DS and selection for susceptibility significantly reducing DS. In the context of a commercial breeding objective, this unfavorable, but very weak, association is of little or no consequence. It does, however, put paid to the frequently held belief that the most daggy sheep are necessarily the most wormy.

Scouring and dags are often a very visible aspect of sheep production, particularly in winter rainfall areas. Daggy sheep are considered to detract from the enjoyment of sheep farming (K. Bell, see IWS 1998). Thus dags probably have an additional intangible cost that we have not quantified.

Ignoring this lifestyle cost, the High objective represents close to a worst case scenario for the cost of dags, and even then, the data do not support an economic argument for selecting against dags. If DS is included as a selection criterion and FEC is also measured in one or both sexes, DS can be improved, albeit very slowly, without a detrimental effect on progress in FEC. Including DS as a selection criterion will have virtually no effect on reducing FEC.

A sustainable solution to the dual problems of scouring and dagginess requires a better understanding of the conditions conducive to hypersensitive scouring. Genetic selection can perhaps provide a solution in the long term, but these preliminary findings indicate that in environments where losses from worms are considered to be serious enough to include FEC in a breeding objective, selection pressure would generally appear to be better directed at traits other than DS.

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