RELATIONSHIP BETWEEN FAECAL WORM EGG COUNTS AND SCOURING IN AUSTRALIAN MERINO SHEEP

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SUMMARY
This trial aimed to determine the relationship between faecal egg count (FEC) and scouring (diarrhoea), as measured by dag score (DS) and whether any genotype x environment interaction may exist for these traits tested in a summer and winter rainfall region. Significant differences were found in DS patterns between the 2 sites. In the summer rainfall environment, DS remained relatively constant throughout the year. In the winter rainfall environment, DS increased rapidly during the late winter and spring period in 1-year-old sheep. It is recommended that in the winter rainfall environment sheep should be selected for both low FEC and low DS.

Keywords: faecal egg count, scouring, correlated response

INTRODUCTION
Internal parasites are a major threat to the Australian sheep industry. This threat will rapidly increase as the problem of anthelmintic resistance increases to a crisis point. A permanent solution is to breed sheep that are resistant against internal parasites. In Australia, the 2 main Merino sheep research flocks dedicated to breeding sheep for resistance to internal parasites are:

- The Rylington Merino flock managed by the Department of Agriculture Western Australia in a winter rainfall environment at Mt. Barker Research Station (Mt. Barker RS), and
- The Haemonchus Line managed by CSIRO in a summer rainfall environment at Chiswick Research Station (Chiswick RS), Armidale, New South Wales.

In the early stages of breeding sheep for low faecal egg count (FEC), there was an expectation that this would result in a correlated response in reduced scouring or diarrhoea. However, New Zealand results indicated that selecting sheep for low FEC could result in an increase in scouring (McEwan *et al.* 1997). An investigation of genetic parameters in sheep not selected for FEC at the Great Southern Agricultural Research Institute, Katanning WA, found no unfavourable (negative) correlations between FEC and scouring (Greeff and Karlsson 1997). In the Rylington Merino selection line for low FEC, an early analysis of the selection response found an unfavourable correlation between FEC and dag scores (Karlsson and Greeff 1996). Subsequently, on further analysis with more records, the correlations were low and generally not significant (Greeff and Karlsson 1999; Karlsson and Greeff 2001).

Scouring is a major problem, directly in terms of wool staining and the associated costs (Larsen *et al.*1995), and indirectly from an increased predisposition to blowfly strike. There are regional and seasonal variations in the prevalence and severity of scouring, suggesting variations in worm species and environmental interactions. In the process of searching for long-term solutions, Greeff and Karlsson (1998) proposed an investigation of genotype by environment interaction for worm resistance and scouring.

The aetiology of scouring in grazing sheep is subject to ongoing research, however, it can be broadly classified into 3 areas; high worm burden (high FEC), hypersensitivity reaction (Larsen *et al.*1994) to worm larvae (low FEC) and non-parasitic (Glastonbury 1990). This paper aims to determine whether selection for low FEC has resulted in a correlated response in scouring, and whether there are differences between winter and summer rainfall environments. The information will facilitate the development of optimum sheep breeding objectives for different climatic regions.

MATERIALS AND METHODS

This trial was conducted at the Mt. Barker and the Chiswick research stations. The Mt. Barker RS is located in a Mediterranean winter rainfall environment, with an average annual rainfall of 650 mm. The predominant feed base is annual pasture, with some perennial pasture in low-lying areas. The Chiswick RS has an average annual rainfall of 800 mm with year-round distribution. The pasture base is predominantly phalaris, with some ryegrass, fescue and clover.

At Mt. Barker RS, the main worm challenge is due to *Trichostrongylus* and *Ostertagia* during the winter and spring green feed period. The station is located on the inland boundary of the endemic *Haemonchus* areas of Western Australia, with some *Haemonchus* larval challenge in most years during late spring and early summer, and usually a smaller challenge during the autumn.

Chiswick RS experiences challenge from *Haemonchus* during the summer rainfall period. *Trichostrongylus* is also an endemic problem in this area, especially in the winter/spring period. The worm challenge at Chiswick follows a more constant pattern compared with the highly seasonal pattern in Western Australian.

Each trial site used 400 Merino ewes typical of their respective regions. The ewes were assumed to have an average resistance status, and were considered to be a random group of ewes each year. On each site, the ewes were allocated at random and mated to 1) Western Australian resistant, 2) Western Australian control, 3) Armidale resistant and 4) Armidale control rams. Five rams from each of the 4 genotype combinations were allocated as per Table 1.

Table 1. Allocation of sire and ewe genotypes.

Sire		Ewe numbers at each region	
Genotype	Number of rams	Winter rainfall	Summer rainfall
Rylington selected (Western Australian resistant)	5	100	100
Rylington control (Western Australian control)	5	100	100
CSIRO selected (Armidale resistance)	5	100	100
CSIRO control (Armidale control)	5	100	100

Measurements

At lambing in 2000 and 2001, the sire and dam pedigrees, type of birth and birth weights were recorded, and each lamb was tagged with a unique identification number. The number of records are indicated in Tables 2 and 3.

Weaning took place in November/December at 3 month of age for Mt. Barker RS, and in February at 4 month of age for Chiswick RS. At weaning, all lambs were weighed (BW), condition scored (CS), and dag scored ((DS) on a scale of 0 for no dags to 5 for high dags). Faecal samples were collected and scored for faecal consistency score (FCS) on a 1 (hard pellets) to 5 (fluid) point scale. Faecal worm egg counts (FEC) were determined using the modified McMaster method (Whitlock 1948).

Subsequently, another 7 recordings were completed up to an average age of 15 months, finishing in October for Mt. Barker RS, and December for Chiswick RS. Measurement timing varied between the winter and summer rainfall environments due to differences in their respective annual worm challenge patterns. However, the final measurement schedule for each region was based on regular monitoring of FEC, DS and general CS. For the winter rainfall site, the last 3 recordings occurred after the break of the season during the winter rainfall period when worm challenge was the highest. The trial was repeated in the following year with a new set of progeny.

Statistical Analysis

The FEC data were transformed to cube roots. An analysis of variance was carried out on the data collected at each recording, using ASREML (Gilmour *et al.* 1999). The model fitted to the data included the effects of year, site, genotype, sex, rearing type and the site by genotype interactions.

RESULTS AND DISCUSSION

Figure 1 provides the general FEC trends for the 4 genotypes at the 2 sites over the 8 recording periods. At both sites, the highest FEC was at weaning. In the winter rainfall site, FEC was very low for the last 2 recording periods. From Figure 2, it can be seen that in the summer rainfall environment, DS remained at a low level throughout the year. However, in the winter rainfall environment, a highly seasonal pattern existed, with a rapid increase in DS for recording periods 6, 7 and 8. This coincides with the late winter and spring season.

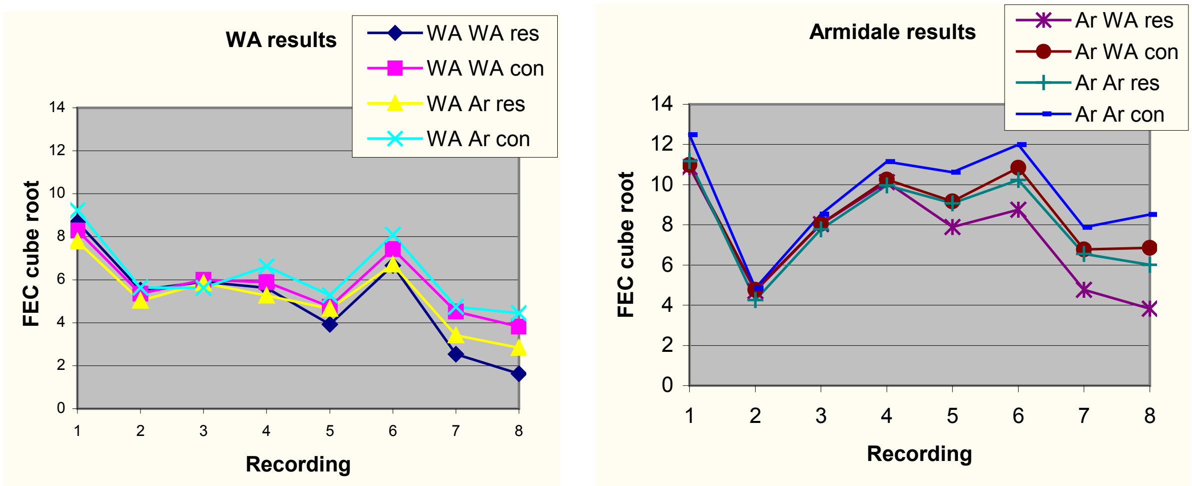

Figure 1. Cube root FEC least-squares means for the 4 genotypes at Western Australia and Armidale over 8 recordings.

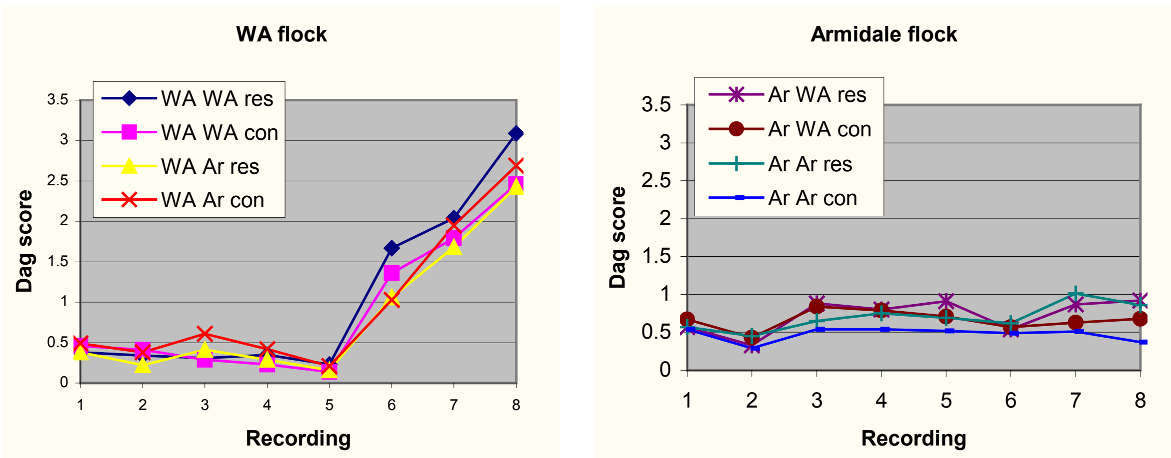

Figure 2. Dag scores in the Western Australian and Armidale flocks for 8 recordings.

The analyses of variance for FEC show that the genotypic differences for FEC were highly significant for all periods apart from recording periods 2 and 3 (Table 2). Site differences for FEC were highly significant at all recording periods. Genotype x site differences were only significant ($P<0.05$) at weaning and at the sixth recording.

Table 2. Summary of the 8 analyses of variance for cube root faecal egg counts (FEC) at each recording time.

	Wean	2nd	3rd	4th	5th	6th	7th	8th
Number of records	1170	1112	1110	1107	885	1083	849	854
Mean FEC$^{0.33}$ count	10.07	4.92	7.24	8.53	7.61	7.16	5.12	4.77
Genotype x 4	***	*	Ns	***	***	***	***	***
Site	***	***	***	***	***	***	***	***
Year	ns	***	***	***	***	***	ns	**
Sex	ns	*	***	**	***	***	***	***
Rearing Type	ns	ns	Ns	ns	ns	*	ns	ns
Genotype x Site	*	ns	Ns	ns	ns	*	ns	ns

ns P>0.05, *P<0.05; ** P<0.01; ***P<0.001

Table 3. A summary of the 8 analyses of variance for dag scores (0-5 scale).

	Wean	2nd	3rd	4th	5th	6th	7th	8th
Number of records	1175	1118	1113	1113	1102	1094	863	857
Mean	0.53	0.36	0.58	0.59	0.49	0.85	1.34	1.56
Genotype	ns	ns	Ns	ns	ns	**	ns	**
Site	**	ns	***	***	***	***	***	***
Year	***	***	Ns	***	ns	ns	ns	***
Sex	ns	ns	NS	ns	ns	ns	ns	ns
Rearing Type	ns	ns	NS	ns	ns	ns	ns	ns
Genotype x Site	ns	ns	**	ns	ns	***	**	*

ns P>0.05, *P<0.05; ** P<0.01; ***P<0.001

The analyses of variance in Table 3 show that dag scores between sites were highly significantly different (P<0.001) for all periods apart for the second recording period. The significant genotype x site interactions at the sixth and seventh recordings were due to higher DS in the Western Australian resistant genotype compared with the Western Australian unselected genotype, and the Armidale genotypes, in the winter rainfall environment. Thus, it appears that genotype x environmental factors may be important for dags, especially where selection is practiced for low FEC in a winter rainfall environment. This needs to be further investigated.

Table 4. Correlation between faecal worm egg counts (FEC) and dag scores (DS) at each of 8 recordings.

	Weaning	2nd	3rd	4th	5th	6th	7th	8th
FEC *v.* DS	0.05 ns	0.02 ns	0.14***	-0.00 ns	-0.07*	-0.03 ns	0.03 ns	0.06 ns

ns P>0.05, ***P<0.001

The phenotypic correlations between FEC and DS (Table 4) were very low, and only significant for Periods 3 and 5. This confirms that scouring is not a good indirect indicator trait for FEC and should, for practical purposes, be regarded as a separate trait from worm resistance as measured by low FEC. Since scouring is a serious problem in winter rainfall environments, and as it is a heritable trait (Greeff and Karlsson 1999), sheep should be selected for both low FEC and low DS in these environments.

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REFERENCES

GILMOUR, A.R., CULLIS, B.R., WELHAM, S.J. and THOMPSON, R. (1999). 'ASREML Manual.' (NSW Agriculture Biometric Bulletin No.3: Orange.)

GLASTONBURY, J. (1990). *In* 'Uni. Syd. Post Grad. Commun. Vet. Sci.' **141**, 459-479.

GREEFF, J.C. and KARLSSON, L.J.E. (1997). *Proc. Assoc. Advmt. Anim. Breed. Genet.* **12**, 333-337.

GREEFF, J.C. and KARLSSON, L.J.E. (1998). *In* 'Sustainable Worm Control/Sheep Scouring Workshops.' (International Wool Secretariat: Melbourne.)

GREEFF, J.C. and KARLSSON, L.J.E. (1999). *Proc. Assoc. Advmt. Anim. Breed. Genet.* **13**, 508-511.

KARLSSON, L.J.E. and GREEFF, J.C. (1996). *Proc. Aust. Soc. Anim. Prod.* **21**, 477.

KARLSSON, L.J.E. and GREEFF, J.C. (2001). *Fifth Int. Sheep Vet. Congr.* (Pretoria, South Africa).

LARSEN, J.W.A., ANDERSON, N.,VIZARD, A.L., ANDERSON, G.A. and HOSTE, H. (1994). *Aust. Vet. J.* **71** 365-372.

LARSEN, J.W.A.,VIZARD, A.L. and ANDERSON, N. (1995). *Aust. Vet. J.* **72**, 58-63.

MCEWAN, J.C., BISSET, S.A and MORRIS, C.A. (1997). *In* 'Sustainable Control of Internal Parasites in Ruminants.' (Ed. G.K. Barrell.) pp. 161-182. (Lincoln University: Canterbury, New Zealand.)

WHITLOCK, H.V. (1948). *J. Council Scientific Indust. Res.* **21**, 177-180.

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