SELECTING SHEEP FOR NEMATODE RESISTANCE AND CORRELATED RESPONSES IN DAGS IN A WINTER RAINFALL ENVIRONMENT

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SUMMARY
The first twelve years of selection for low worm egg count in the Rylington Merino flock did not result in a correlated decrease in faecal soiling of wool in the breech (dags). Subsequent selection for three years against dags using dags and faecal consistency score in a selection index with reduced worm egg count resulted in a decrease in both dags and worm egg count in this flock.

INTRODUCTION
Diarrhoea or scouring is a major sheep health and management problem especially in the winter rainfall areas of Australia. Karlsson *et al.* (2004) showed a significant genotype-by-environmental interaction for scouring in Merino sheep. Animals born and raised in a winter rainfall environment scoured significantly more than similar animals born in the summer rainfall environment of the Northern Tablelands of Armidale, NSW. Under normal Australian grazing conditions, diarrhoea is due to sheep nematode (worm) species such as *Trichostrongylus and Ostertagia.*

Breeding sheep for resistance to internal parasites has been researched in Australia for over 20 years (Karlsson *et al.* 1991, Woolaston *et al.* 1996). Investigations in the highly nematode-resistant 'Rylington Merino' selection line have found virtually no (genetic or phenotypic) correlation between faecal worm-egg count (WEC) and overall diarrhoea as measured by dag scores (DS) or faecal consistency scores (FS) (Karlsson and Greeff 1996).

In the early 90s it become apparent that in the winter-rainfall areas of Australia, two subtypes of diarrhoea occur; sheep with high WEC and a high level of diarrhoea (high WEC diarrhoea) and sheep with low WEC and a high level of diarrhoea (low WEC diarrhoea) Karlsson *et al.* (2005). Subsequent work on the pathogenesis of low WEC diarrhoea indicated that this was due to a hypersensitivity reaction in some individuals, directed at the ingested infective nematode larvae (Larsen *et al.* 1999). Currently dag scores are not characterised as either high or low WEC sub-types. It is likely that selection for low WEC has resulted in a reduction in the high WEC scouring and at the same time an increase in low WEC scouring resulting in an overall no change of DS. This paper will demonstrate that inclusion of selection for reduced DS in a selection index has resulted in favourable selection response for this trait.

MATERIALS AND METHODS
The Rylington Merino nematode-resistant selection line was established in 1987 (Karlsson and Greeff 2006). Since 1999 the flock has been located at the Mount Barker Research Station owned by the Department of Agriculture and Food WA. The two dominant worm species in this winter-rainfall environment are *Trichostrongylus colubriformis* and *Ostertagia circumcincta.*
Flock structure is briefly as follows:-

1. Control line. This line was based on random selection and culling to achieve an age structure similar to the selected line. Each year 100 ewes are syndicate-mated to 20 rams

2. Selected line. This line initially consisted of 700 ewes but by 1993 it had increased to approximately 900 ewes. In 1994 this line was reduced to 500 ewes and has been maintained at this level ever since. It consists of 10 family groups (FG) of 50 ewes each that are single–sire-mated to their allocated sires.
3. Following weaning, the ewe and ram weaners are run as separate flocks for one year. After the hogget evaluation at 18 months of age, the selected female progeny are returned to their birth FG and the selected replacement rams are used in the next (FG X+1) family group.

Apart from mating and lambing, the control and selected line sheep are run together to minimise environmental differences. Lambing takes place from mid-July to 3rd week of August (5 weeks).

Measurements. Complete pedigrees are recording on animals in the selection line while only dam pedigrees are recorded in the control line. Greasy fleece weight (GFW) and body weight (BWT) are recorded at hogget age. A midside wool sample is collected on each animal and tested for fibre diameter (FD), coefficient of variation of FD (CVFD) and yield, the latter being used to calculate clean fleece weight (CFW). For each animal WEC, FS and DS are measured at weaning in October/November and again at approximately 12 months of age when the monitored WEC reaches an average value of more than 500 eggs per gram. Dags are visually scored on a 0 (no dags) to 4 (high dags) point scale when the incidence of dags is the highest. Faecal consistency is scored at faecal sampling on a 1 (hard pellets) to 5 (fluid) point scale.

Genetic analysis. The estimated breeding values (EBV) for BWT, CFW, FD, CVFD, WEC, FS and DS were estimated using Pest (Groeneveld 1990). The genetic parameters of Greeff and Karlsson (1998 and 1997) were used in the analysis. Genetic trends were determined by averaging EBV for the different traits within year of birth.

Selection protocol. During the first four years (1987 to 1992), selection was based on the phenotypic average of eleven individual WECs from weaning in November until hogget age in October the following year. From the 1993 birth year, selection was based on BLUP estimated breeding values (EBVs) for WEC collected at hogget age. In 2001 a selection index was developed that placed 50% selection pressure on reduced WEC, 20% on reduced DS and 30% on increased CFW, decreased FD and increased BWT. Traits in the index include BWT, CFW, FD, CVFD, WEC, FS and DS. From 2001 WEC at weaning has also been included in the index.

In the selected line, two rams are used over two years to generate genetic links between years. The replacement hogget rams are selected on the selection index within each birth-family group. The final selection also takes into account classing information on visual industry standards. In the control line, 20 rams are selected at random and half are replaced each year.

RESULTS

The genetic trend for WEC at hogget age is shown in Figure 1. The control line has stayed relatively stable over this time period. In the selected line the average annual genetic gain for reducing WEC is over 2 per cent.

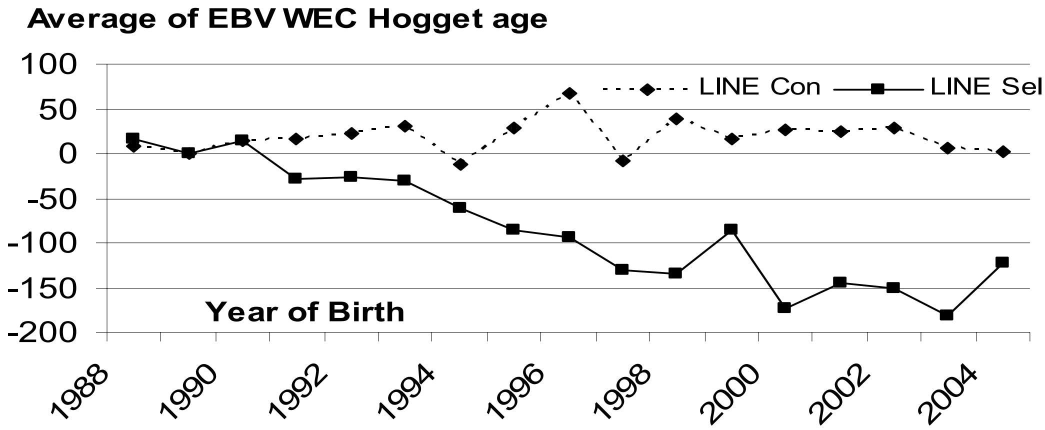

Figure 1. Genetic trend of faecal worm egg count at hogget age in the Rylington Merino flock.

The genetic trend for hogget DS is shown in Figure 2. The control line has stayed relatively stable over this period. For the selected line, DS EBV remained the same as in the control line until 2000, but since then has decreased rapidly following incorporation of selection for low DS from 2001.

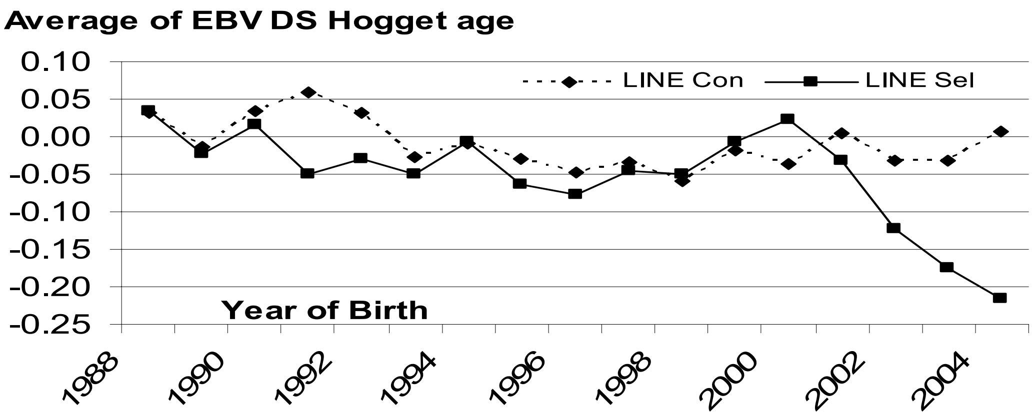

Figure 2. Genetic trend of hogget dag score in the Rylington Merino flock

DISCUSSION

The first twelve years of selection for low WEC resulted in a decline in WEC. However, selection for low WEC did not result in a correlated decrease in DS. This agrees with previous reports from two Australian Merino flocks (Pollott *et al.*, 2004) and from the Katanning resource flocks (Greeff and Karlsson 1997, Greeff and Karlsson 1999) which show that the genetic correlation between DS and WEC is generally low. Considered together, the results suggest that selection for low WEC will not result in a change in DS. Although we are not providing results here we have the data that should allow us to do a further analysis in terms of high and low WEC scouring. It is possible that in the first half of this period there was a decrease in the high WEC scouring followed by a slight increase in low WEC scouring in the second half.

After including FS and DS in the index from 2001 onwards, DS decreased significantly. Thus in high-prevalence diarrhoea environments, selection response for a reduction in both low WEC and low DS can be achieved. As dags are a major problem in the winter-rainfall regions of Australia, selection strategies to reduce DS as well as WEC should be considered in breeding programs in high-prevalence environments.

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REFERENCES

Greeff, J.C. and Karlsson, L.J.E. (1997) *Proc. Assoc. Advmt. Anim. Breed. Genet*. **12**: 333.

Greeff, J.C. and Karlsson, L.J.E. (1998). *Proc. 6th Congr. Genet. Appl. Livest. Prod*. **24**:63.

Greeff, J.C. and Karlsson, L.J.E. (1999 *Proc. Assoc. Advmt. Anim. Breed. Genet*. **13**: 508.

Groeneveld, E. (1990) "Pest User's Manual." Institute of Animal Husbandry and Animal Behaviour, FAL, Neustadt, Germany.

Karlsson, L.J.E., MacLeod,, I.M., Leelawardana, D.H., Sissoev, K. and Simmons, J. (1991). In: "Breeding for Disease Resistance in Sheep"*,* p131, editors G.D. Gray and R.R. Woollaston, Australian Wool Corporation, Melbourne.

Karlsson, L.J.E. and Greeff, J.C. (1996 *Proc. Aust. Soc. Anim. Prod.* **21:** 477.

Karlsson, L.J.E., Pollott, G.E., Eady, S.J. and Greeff, J.C. (2004 *Aust. Soc. Anim. Prod.* **25:** 100.

Karlsson, L.J.E., Greeff, J.C., Eady, S.J. and Pollott G.E. (2005). *VIth Int. Sheep Vet. Congr.*Hersoniossos Greece, p 203.

Karlsson, L.J.E. and Greeff, J.C. (2006 *Aust. J. Exp. Agric.* **46:**1.

Larsen, J., Anderson, N. and Vizard, A (1999). *Int. J Parasit.* **29**: 893.

Pollott, G.E., Karlsson, L.J.E., Eady, S. and Greeff, J.C. (2004). *J. Anim. Sci.* **82:** 2852.

Woolaston, R.R. and Piper, L.P. (1996). *Anim. Sci.* **62**: 451.