Breeding sheep for worm resistance

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Sheep production is one of Western Australia's most important agricultural industries. However, it is faced with the serious threat of sheep worm populations becoming increasingly resistant to the available drenches. Although it's not a 'quick fix' solution, part of the long-term answer may be selection for sheep with greater resistance to worms. John Karlsson, Johan Greeff and Julia Harris provide background information on this more sustainable approach to worm control. The Rylington Merino Project based at Boyup Brook has been the core research activity in WA aimed at unravelling the clues to finding the answers.

The research information contained in this article has contributed to a national project which is developing practical recommendations for breeding sheep for worm resistance. The project involves the Western Australian Department of Agriculture and, in New South Wales, the CSIRO and the University of New England working with breeders and advisers across Australia.

One of the biggest threats to sustainable sheep production in Western Australia is that internal parasites are becoming more and more resistant to the available drenches. There doesn't appear to be any new drench group being released in the foreseeable future.

Sheep breeders have been selecting for better wool quality and other desirable characteristics for many years. Selecting for resistance to worms is probably a logical extension to the overall process as there is a growing awareness and acceptance that in terms of environmental, biological and economic aspects, farming systems must aim towards long term sustainability.

Rylington Merino Project

History
Wool growers were in despair in the early to mid-1980s as some had run out of effective drenches for worm control. Two drench groups were then available - 'whites' or benzimidazoles and 'clears' or levamisoles - but both were becoming ineffective on a large number of properties.

Resting, alternating or combining the drench groups offered some improvement. However, it was an apparently endless battle - at least until the release of the new drench ivermectin in 1988. Unfortunately, resistance to ivermectin has already emerged on a small number of properties with more likely to exist, but as yet not reported.

There was an opportunity for a new approach, relying less on chemicals and more on exploiting the natural resistance of sheep. The establishment of the Rylington Merino sheep breeding project was facilitated by Mr Eric Farley's bequest of his 600 hectare Rylington Park property in the Boyup Brook Shire for research and agricultural training.

Rylington Merino is a collaborative project established in 1987 and initially funded by the Australian Wool Corporation. Eight hundred mated ewe hoggets and 18 rams were donated by a membership of
sheep being subjected to very severe worm burdens in certain seasons, and
the need for human intervention to control worm numbers.

**Control methods**

**Chemical control**
- over the past 30 years there has been an increasing reliance upon broad spectrum drenches to control worms,
- this control method is rapidly losing its effectiveness due to a build up of worms which now have resistance to the commonly used drenches.

**Genetic control**

A more 'natural' approach to controlling worms is to breed sheep with genetic resistance to worms. As the sheep become more resistant:
- fewer worm eggs are passed out of the sheep to contaminate pasture,
- less drenching is required,
- money is saved from less drenching,
- reduced selection for drench resistance, and
- there is reduced public concern regarding chemical use.

The Rylington Merino Project is a genetic selection project aimed at breeding sheep with resistance to worms.

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**National project - Helping breeders select worm resistant sheep**

Activities to date include:
- the establishment of a communication network involving researchers, breeders and advisers;
- publication of a newsletter 'Nemesis' (contact the authors of this article to be included on mailing list);
- a series of workshops for breeders and advisers;
- publication of a booklet 'Recommendations for breeding sheep for worm resistance';
- further testing and demonstration of practical aspects of breeding for worm resistance on three breeding units, including the Rylington Merino flock, the Yardstick sire evaluation flock and a stud flock.

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95 farmers from Esperance through Kojonup to Northam and six agricultural research and training organisations from Western Australia and New South Wales.

**Main aims**

- To demonstrate that faecal worm egg count (FWEC) is a heritable trait that will respond to selection under natural field conditions.
- To determine the best time(s) to measure FWEC for selection purposes.
- To estimate the genetic relationships between FWEC and production traits, and
- To show that selecting for reduced FWEC will lead to a reduction in the number of worms in the animal.

**Activities**

The initial ewe flock comprised 700 allocated to a selection line and 100 allocated as controls. Numbers in the control line were kept constant whereas the selected line increased to reach 1100 ewes in 1994. The controls were syndicated with 20 rams randomly selected from their progeny, whereas the selected line was mated in 16 single sire mating groups using rams with the lowest average FWEC from weaning to 15 months of age.

Mating started in mid-February each year with lambing over five weeks. Full sire and dam pedigrees were collected in the selected line from 1989 but only dam pedigrees from the control line.
Measurements taken on a regular basis include FWEC, faecal consistency scores, dag scores and body weights of all progeny. Fleece measurements are taken at hogget shearing and wool samples tested for fibre diameter and yield.

Since 1994, sheep numbers have been reduced from 1200 to a nucleus of 400 and an unselected control of 100 breeding ewes. This has now become a valuable resource for further work on the mechanisms of resistance. The project is involved in Australia-wide collaboration on worm resistance. Locally there is collaboration with Curtin University on genetic fingerprinting with the aim to find possible genetic markers suitable for selection (see story on page 46).

Each year a field day is held at Rylington Park to show what progress has been made and displays have been taken to other field days. Surplus rams are made available to members of the group.

Genetic variation

Numerous studies suggest that some breeds of sheep are more resistant than others to parasites and their detrimental effects, and that Merinos seem to be a relatively susceptible breed.

A large survey of Merino flocks assessed all possible sources of genetic variation in resistance to worms. Most of the genetic variation is within flocks, that is, it could mostly be accounted for by differences between animals within a flock. Differences between strains and bloodlines were small and unpredictable (see Figure 1). Thus, there is currently little to be gained from choosing different strains or 'bloodlines'.

Improvement in resistance to sheep worms is best achieved by selection from within flocks.

In the Mediterranean environment of Western Australia, the available genetic variation for worm resistance is not constant throughout the year. The Rylington Merino Project demonstrated that genetic variation (as measured by the heritability estimates) changes during the year. Figure 2 shows...
that the highest heritability was found for June and July, which indicates that measuring an animal during these two months will give the best indication of its breeding value for FWEC.

The reduction in the heritability estimates may be caused by stress from weaning, and from a decline in the quality and quantity of feed from November through the following dry summer months.

The increase in the heritability estimates after the break of the season is likely to be due to two main factors:

- a sudden increase in the number of parasitic larvae which could have synchronised the immune response of the weaners;
- and improved nutrition.

Based on the Rylington Merino results a measurement about six to eight weeks after the break of the season would be a logical time to select for increased worm resistance.

Response to selection

The efficient use of genetic variation between animals has been clearly demonstrated in the Rylington Merino selection experiment for lower FWEC. Figure 3 shows the genetic trends of FWEC expressed as deviations from the population mean of the selected and control lines, measured after the break of season. Since 1988, significant genetic gains have been made and it is clear that the selected line of sheep now have a lower FWEC than the unselected control sheep (see Figure 3).

Relationship with other traits

Selection for a low worm egg count should not adversely affect traits for wool production and body weight. Therefore breeders should not be concerned that selection for reduced worm egg counts will lead to lower production. The genetic correlation for worm egg counts and production traits were measured from 60 sires and have shown to be either negative or close to zero. That is, these low values give assurance that wool production traits will not be adversely affected when selecting for low FWEC.

Discussion

It should be noted that the Rylington Merino results apply specifically to Black scour worms (Trichostrongylus species) in a mediterranean (winter rainfall) environment. However, other research has found that selection for resistance to one worm species will also result in useful improvements in resistance to other worm species. The only qualification may be that the optimum time to measure animals for selection purposes may vary.

The Rylington Merino results demonstrate that FWEC is a heritable trait and can be improved by selection. Heritability estimates of FWEC were greatest from June to September but very low to non-existent over summer and late autumn (see Figure 2).

If farmers incorporate the use of FWECs into their overall selection programs, significant improvements in resistance to most sheep worms can be expected within 10 years. This will reduce the need for expensive drenches and lessen the chance of existing drenches becoming ineffective.

Sheep producers now have the choice of remaining on the same old treadmill with chemicals or trying a new approach that should be much more sustainable and acceptable to many consumers.

In the last few years, many consumers have become very conscious of the use of chemicals in the production of both food they eat and even the clothes they wear. In many cases, they are prepared to pay more for 'organically grown' produce or even 'chemical-free' wool. This trend is likely to accelerate, particularly in more affluent countries.

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