

## Breeding for resistance of Merino sheep, Australia

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### About the authors

John Karlsson is a researcher and farmer who has been working on a variety of sheep selection and resistance to parasites for more than 30 years. He is a Senior Veterinary Officer at the Department of Agriculture and Food Western Australia (DAFWA). At DAFWA he has worked on regulatory disease management programmes and providing general advice to livestock farmers since 1978. Al Karlsson is a Zoology and Agricultural Science student at the University of Western Australia.

### Description of Majuba farm – a low-input farming system

In the early 1980s a large anthelmintic (drench) resistance survey in Western Australia revealed an unexpectedly high prevalence of drench resistance to the two broad-spectrum drench groups that were available at the time (Edwards *et al.*, 1986). This led to the establishment of a collaborative research flock called ‘*Rylington Merino*’ in 1987 at the Department of Agriculture in Western Australia. This flock is genetically a very valuable asset for research in breeding for resistance and determining the relative heritability of doing so (Karlsson & Greeff, 2006). At that time John Karlsson also started to practice selection for worm resistance in his own flock.

Globally it is known that there are variations for worm resistance between sheep breeds, with most of the ‘naturally’ resistant breeds having evolved in sub-tropical environments (receiving a high worm challenge). In some production systems it may be possible to introduce resistance by using the naturally resistant breeds. However, with the *Merino* breed, crossbreeding is generally not an option if wool quality is to be maintained (Karlsson & Greeff, 2012).

This study demonstrates that through breeding and selection veterinary inputs can be reduced and sheep can spend longer periods on pasture without being exposed to high risks of common worm occurrence, improving the sustainability of this low-input sheep production system.

The Majuba property was acquired by the Karlsson family in 1979. It is located in the South-West of Western Australia, approximately 260 km South of Perth and 13km from Bridgetown. The land is situated in a narrow portion of the Blackwood River valley with steep gradients, best suited for grazing or forestry. The climate is temperate with predominantly winter rainfall and dry summers (Mediterranean). The soils vary with topography, but are largely duplex soils that are slightly acidic and suffer from Phosphorous deficiency. The property encompasses an area of 130 ha, of which approximately one-third is covered with remnant bushland or very rocky outcrops.

The previous owner had kept his sheep at low stocking densities and allowed pasture quality to decline, with over 95 percent of the pasture consisting of annuals (mainly grasses). Though this provided a relatively good source of stock-feed during the winter and spring months, it was followed

by a decrease in pasture quantity and especially quality during the summer and autumn months (resulting in a “feed-gap”).

Part of the pasture improvement has included introducing annual legumes to the system, mainly subterranean clovers (*Trifolium subterraneum*). Planting some dual-purpose tree varieties including oak (*Quercus robur*) and honey locust (*Gleditsia triacanthos*). These trees deliver benefits for the whole farm as they provide some stock feed (during the autumn period), shelter, landscape stability and they also represent a long-term investment with the residual timber value especially from the oak trees. An effort was also made to remove vast areas of the tenacious bracken fern (*Pteridium esculentum*), which had in the past been allowed to achieve complete canopy coverage in some areas, creating a monoculture as pasture growth was excluded.

### **Finding alternatives to synthetic inputs: breeding for resistance**

The animal enterprise is centred on a self-replacing *Merino* sheep flock comprising of roughly 400 breeding ewes, 400 hoggets (6 to 18 months), 400 lambs and 10 adult rams. The average stocking rate for the property is 12 DSE/ha (the Dry Sheep Equivalent based on the daily requirement of a 50 kg non-reproductive/lactating sheep). Ewes are selected based on visual traits (i.e. plain bodied and general soundness) and measured traits (i.e. body weight, wool production and fertility). On sheep farms it became apparent that the main summer/autumn issues were related to nutrition and the main winter/spring issues involved “Gastro-Intestinal Parasite” (nematodes, sheep worms or worms) challenges, especially in young sheep. Initially, worm control was not based on a good understanding of all interactions involved.

During the process of selection the rams undergo much more rigorous selection from as early as weaning where they are continually assessed according to the predetermined weighting for certain traits. At lamb-marking they are ‘mothered-up’ and recorded as being singles or multiples/twins, which not only gives an indication of the fitness of both offspring and the ram, but is also economically significant by increasing returns. The rams also participate in individual faecal worm egg counts (FEC) at weaning and hogget age, to assess their resistance to internal or gastro-intestinal parasites as well as general robustness when stressed. Testicular circumference measurements (at weaning and at yearling age) are recorded, as testicle size is related to both ram fertility as well as ovulation rate in their daughters. At hogget shearing (15 months) a ‘midside’ wool sample is collected and sent to a wool testing laboratory (i.e. for fibre diameter testing).

*From the research flock it became evident that the worm egg count (as a trait) is in the medium heritability range, with the annual genetic gain being a function of the heritability of the trait times the selection differential achieved for the trait.*

Using local experience, it is generally possible to achieve a short period of worm challenge to cause a good differentiation between the individuals in the test population. Although as selection progress continues it will become a self-limiting trait with the current methodology and would then only require ‘maintenance’.

The on-farm selection for worm resistance is focused at the individual level in the rams. Both ewes and rams are scored on a 1 to 5 scale for ‘dags’ which represent faecal build-up from diarrhoea (scouring) in the peri-anal region, this trait is a predisposing factor for ‘breech strike’, as well as

devaluing wool and the cost of 'crutching' (therefore not an easy-care trait). Given the high resistance status of the flock, the farmers now try to target the monitoring to individuals that show clinical signs of not coping with the seasonal conditions. Individuals that are not coping with their worm burden are treated and recorded and then culled at annual selection and culling so as not be included in the following year's breeding program. The WEC is an indirect measure of the female worm population in an individual sheep and is currently the most practical measure for identifying the common worms.

To arrive at an overall selection with multiple traits, two options were generally considered. Firstly a selection index involving a predetermined 'weighting' times the trait (trait 'a' plus trait 'b' etc.), which is the preferred option when pedigree information is available. In this low-input system the farmers don't have full pedigree information. They therefore use the second option based on collating the individual performance information collected through the year and then an annual selection and culling in January.

### **Benefits of selection**

On Majuba farm, the selection of the sheep flock was not initiated to increase resistance to the common sheep worms in the area, as the farmers had access to the Benzimidazole and Levamisole drench groups. However, by the late 1980's sheep developed resistance to these groups. The macrocyclic lactone group was made available in 1988, then there was then a 20 year gap before the next active group was made commercially available. Had the farmers not started to reduce the reliance on anthelmintics in this period they would most likely have been faced the problem of a lack of effective worm control and high veterinary drug expenses.

Breeding for resistance led to accumulative gains that represent a long-term, more permanent solution to a potentially costly problem and is believed to be achievable at industrial level. Current economic evaluations of farming systems generally only take into account input costs and outputs in annual financial terms.

The long-term benefits for the sustainability of this sort of work are currently hard to accurately evaluate by standard economic evaluations and would most likely involve a modelling approach. The genetic implementation of more biologically sustainable sheep farming systems in some areas could be facilitated by having ram breeding flocks that could initially be serviced with the appropriate skill base, the genetic improvement then passed on to the local sheep flock. To help with the dissemination of practical requirements for 'sheep worm' monitoring, Mr Karlsson runs a one-day training course for doing WEC for both farmers and service providers with about 200 participants so far over a 10 year period. There is also a gradual increase in sheep breeders incorporating breeding for improved resistance to sheep worms.

## Lessons learnt

Most host/parasite systems are complex and are unlikely to be managed by a 'quick fix' approach. In general, sustainable solutions require a multidisciplinary approach involving an understanding of the local biology, the environment and socio-economic factors. Integrated control systems need to be implemented. These must aim to minimise the reliance on chemical control agents and encourage people to breed animals that are fit for their environment. In the past there have been many misguided foreign aid programs involving improving the production in local animal based systems by introducing high producing 'European' breeds, but the introduced breeds are mostly unsuitable to the local environment.

Sheep are low input, high output animals that are themselves a true testament to the bigger picture of the role that breeding plays in the system and farmers can achieve on-farm. Apart from the annual application of phosphate fertiliser, virtually no other chemical inputs are used in the Majuba farming system. This production system is based on an easy care sheep flock that is robust and will deliver a clean and green end product. Although the farm is not registered as organic they now have the foundation to do this without compromising animal welfare in what is a potentially high sheep worm challenge environment.

## References

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