SELECTION STRATEGIES IN COMMERCIAL MERINO FLOCKS

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Introduction

Wool production from merino sheep is affected by the environment in which they graze, their genetic characteristics and an interaction between the environment and genetic characteristics. Changes to the grazing environment and the genetic characteristics of the sheep will change the profit derived from wool production. A farmer with a merino sheep flock makes decisions about both the grazing environment and the genetic characteristics in an attempt to maximise an objective.

Changes to the genetic characteristics of a merino sheep flock are usually achieved by:

(a) importing rams and, less frequently, ewes from either studs or cooperative breeding schemes such as the Australian Merino Society; and/or

(b) selecting as parents of future generations both rams and ewes bred on the farm.

This paper concentrates its attention on the second option, on-farm selection strategies.

At reproductive rates achieved by most commercial merino farmers in Western Australia, the replacement of older ewes requires most of the ewe lambs reared. The potential for selecting ewes and hence achieving genetic progress is limited. By contrast, the small number of rams required as sires allows the selection of a few of the best ram lambs. In this paper attention is concentrated on selection strategies which achieve genetic progress through rams used to sire future generations.

Hogget shearing (about 17 months) is the earliest that rams can be selected from all rams reared using objective measurements. Rams not selected at this stage are too old to be castrated. The farmer bears an opportunity cost of not castrating. A scheme whereby a small nucleus of the best ewes is used to rear rams minimises these opportunity costs.

Various selection strategies are available to the merino sheep farmer in establishing and running a nucleus breeding programme. In this study the costs and benefits of a few of the options available to a merino farm are assessed. A model of genetic change is used to calculate the benefits from various selection strategies. Before describing this model and the options evaluated, a brief background to genetic progress and nucleus breeding is given.

Genetic Progress

In a flock of merino sheep there is variation between sheep for the important economic traits of fleece weight and fibre diameter. These traits are normally distributed (Falconer 1985). If the environmental factors influencing fleece weight and fibre diameter are constant for all sheep in a flock, then differences between sheep are due mainly to genetic characteristics in that environment. Rams reared under similar environmental conditions to the main merino flock will display genetic characteristics which are relevant to profitability under these conditions.

The economically important characteristics of fleece weight and fibre diameter are determined by many genes (polygenic) (Dalton 1985). When these genes are re-arranged with genes from both parents, only a portion of the superior fleece weight and fibre diameter are inherited from the parents. Heritability is the term used to describe the average proportion of genetic superiority passed on to the progeny from the parents over and above that of their contemporaries (Dalton 1985).

Genetic progress results from selecting only the best animals to be parents of the next generation. Superiority of parents above their contemporaries is termed the selection differential. The selection differential is the difference between the mean of selected parents and the mean of the population from which they come (Falconer 1985).

By multiplying the heritability of a trait by the selection differential of the parents, a prediction is made of genetic change in the offspring. Variability in fleace weight and fibre diameter is maintained for at least five generations. Hence, for at least five generations there is little likelihood that genetic progress will reach its limit (Dalton 1985).

Geneticists have established that some traits are related: improvement in one leads to improvement or decline in another. Fleece weight and fibre diameter are positively correlated with a value of 0.25 (Atkins 1987). A beneficial change in either fleece weight or fibre diameter will lead to small detrimental change in the other.

Nucleus Breeding

Described in this section is a nucleus breeding programme and some aspects of it in which decisions affecting efficiency have to be made (for greater detail see James 1977).

A merino farmer has a requirement for replacement of rams; this is dependent on total number of ewes joined, ratio of rams to ewes, and the number of years a ram is used. With an existing flock size, a farmer needs to decide on the ratio of rams to ewes and the number of years a ram is used. (Both these affect profitability and will be evaluated in future work.) The annual ram requirement can be bred from a nucleus ewe flock on the farm.

Nucleus breeding programmes involve choosing a group of ewes from the whole flock, and this group is termed the nucleus flock. Ram lambs reared from this nucleus flock are not castrated and form the pool from which rams are selected. The farmer is faced with two decisions when establishing a nucleus flock:

(a) Are the costs of objectively measuring all the available ewes and then selecting only the best recoverable from the increase in wool proceeds?

(b) What is the optimal percentage of rams selected which, given a ram requirement, determines the number of ewes in the nucleus flock?

Both these questions are addressed following the model and data sections.

Once a nucleus flock has been identified the best rams are used as sires for this flock. At first, these rams are selected from imported rams; in the third year and onwards they are drawn from rams reared in the nucleus. Each year the oldest ewes are culled from the nucleus and replaced with the best ewe hoggets reared from both the nucleus and general flock.

The Data

The costs of a nucleus breeding programme were estimated from such a programme, monitored by the Martindale Research Project in Western Australia. The main costs of the programme are establishment, ram selection and opportunity costs of not castrating rams. The costs used are shown in Appendix 1. Sensitivity analysis is used to assess whether a decision is sensitive to these costs.

Table 1 shows the mean and variance for fleece weight and fibre diameter for a commercial merino flock monitored by Martindale Research Project at New Norcia in Western Australia. These values are typical of commercial merino flocks in Western Australia. It also shows heritabilities taken from Atkins (1987) for both fleece weight and fibre diameter which have been obtained from field trials using merinos in Australia.

Atkins (1987) showed that rams used for two years was most profitable. This approach is followed and the usual practice of a ratio of ram to ewes of 1:50 is followed; hence for each 100 ewes in a flock one ram is required each year.

TABLE 1

Mean, Variance, Heritability and Genetic Correlations for Greasy Fleece Weight, Clean Fleece Weight and Fibre Diameter

		Greasy fleece weight (kg)	Clean fleece weight (kg)	Fibre diameter (micron)
Mean	Ewes*	4.5	3.15	22
	Wethers*	6.0	4.20	22
Variance*		0.4	0.25	3.0
Heritability from hogget shearing†		0.35	0.35	0.5
Genetic correlation				
Greasy fleece weight†		-	0.85	0.25
Clean fleece weight†		0.85	-	0.25

Sources: * Martindale Research Project.
† Atkins (1987).

The Model

Genetic progress is modelled for a total flock consisting of 100 ewes. Results from this 100-ewe flock can be scaled up to the farmer's actual flock size. The farmer is assumed to require one replacement ram each year for his 100-ewe flock. A parameter set by the user is the percentage of rams selected from the total number of rams born. Given the ram requirement of one ram for 100 ewes and the lambing rates, the model determines, at the percentage of rams selected, how many of the 100 ewes are required to form the nucleus. For example, if 50 per cent of rams born are selected and the lambing rate is 70 per cent, 5.7 ewes are requires to form the nucleus in a total ewe flock of 100 ewes.

Genetic progress in both a nucleus flock and general flock is modelled in detail for five generations of nucleus bred rams. The generations are a series of steps with genetic progress occurring between steps. The steps in the current specification last for two years each. Ten years of nucleus-bred rams with five steps in genetic progress are modelled. At the end of the fifth generation the nucleus breeding programme ends. However, genetic progress resulting from the ten years of nucleus-bred rams is modelled for a further 88 years.

Genetic progress is expressed in farm-gate changes to wool proceeds. Changes to wool proceeds with the costs of nucleus breeding are used to calculate a net present value. The net present value is expressed on a ram selected basis for the five generations, at a range of discount rates

An average value for each ram bred is calculated from the net present value; this value is termed the ram annuity. The ram annuity is the net value of genetic progress which, on average, can be attributed to each nucleus-bred ram.

The model is a simulation model and can be specified to simulate most scenarios which may affect profitability of nucleus breeding. By re-specifying the model, the user may identify a strategy which increases the profitability of a nucleus breeding programme.

The model is restricted to genetic changes in fleece weight and fibre diameter. The farmer's selection criterion is assumed to be genetic progress in fleece weight. The associated detrimental change in fibre diameter is accounted for when calculating the wool proceeds.

Profitability of Various Selection Strategies

Percentage of Rams Selected:

One of the decisions a farmer needs to make prior to setting up a nucleus breeding programme is what percentage of rams reared he will select. This decision directly affects the number of ewes in the nucleus flock. At the one extreme a farmer has the option of selecting 3 per cent of rams reared; in this case all the ewes are used in the nucleus. At the other extreme a farmer has the option of selecting 100 per cent of rams reared; in this case the nucleus will be formed from 3 per cent of the ewes. The most profitable percentage of rams selected, and hence the size of the nucleus flock, will most likely fall between these extremes. A series of simulation runs were conducted at 5 per cent intervals between 5 and 50 per cent of rams selected to determine the optimal percentage of rams to select..

Figure 1 shows the annuity at discount rates of 5, 10 and 15 per cent, for percentages of rams selected ranging from 5 to 50 per cent. As the discount rate is increased from 5 to 15 per cent, so the optimal percentage of rams selected rises from 20 to 40 per cent of ram lambs reared. Genetic progress is greater when a smaller percentage of rams is selected. At the higher discount rates the benefit from long term increases in wool proceeds resulting from genetic progress is not worth as much as for lower discount rates. At high discount rates the early costs of running a nucleus flock are proportionally more important; hence the greater percentage of rams selected leads to a correspondingly smaller nucleus flock.

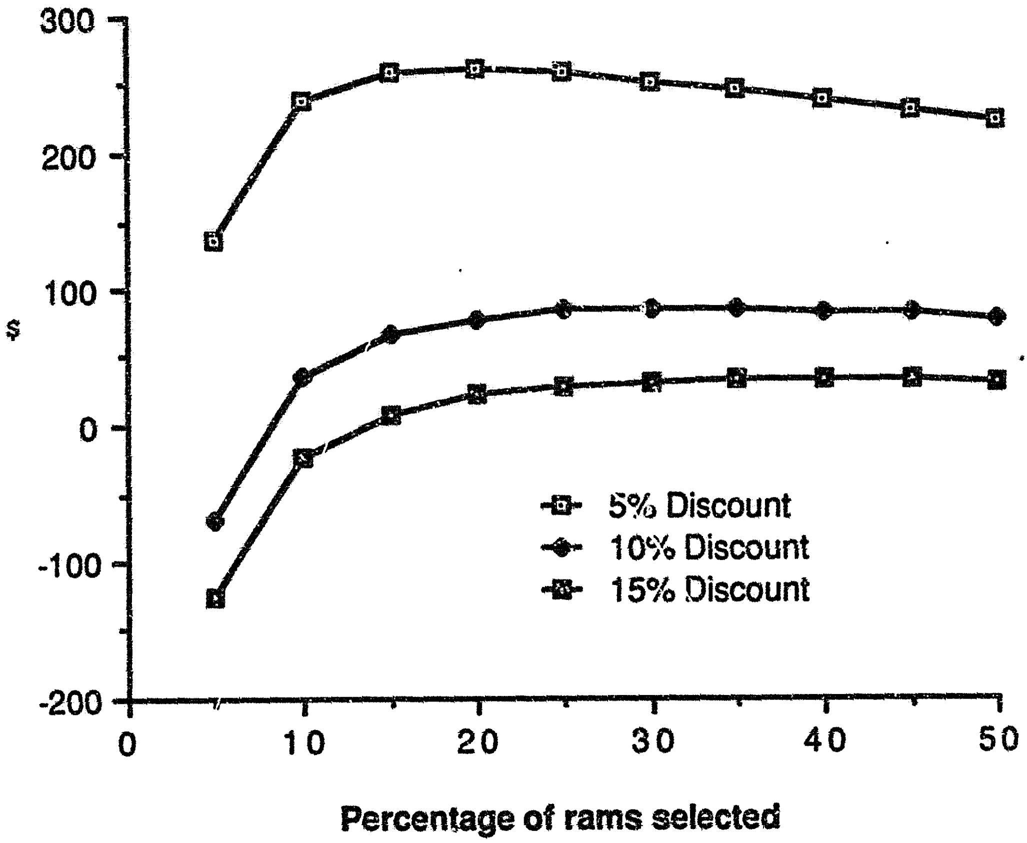

Figure 1: Value of Genetic Progress

For a discount rate of 5 per cent, the profitability rises quickly to $262 per ram as the percentage of rams selected rises from 5 per cent to an optimal rate of 20 per cent rams selected. Thereafter the profitability declines slowly over the range 20 to 50 per cent. The gradual decline with increasing percentage selected is due to:

(a) a large decline in the genetic progress due to a reduction in the ram selection differential,
being offset by:

(a) a saving in the opportunity cost of not castrating rams;

(b) an increase in genetic progress due to fewer ewes being used in the nucleus, hence a greater selection differential in the nucleus flock.

Selecting Ewes:

Before setting up a nucleus flock, a merino farmer is faced with a decision as to whether the cost of fleece-weighing and measuring fibre diameter is warranted. Atkins (1987) found that only a small benefit resulted from measuring fibre diameter and concluded that in ewes this is not profitable. However, Atkins (1987) does not consider the profitability of fleece-weighing the ewes. The profitability of fleece-weighing all the ewes prior to forming a nucleus flock is assessed.

Table 2 shows the net present value and annuity of establishing a nucleus flock with and without fleece-weighing prior to forming the flock. The difference between with and without fleece-weighing is small, ranging from an annuity difference of $7 to $2 for 50 per cent and 10 per cent of rams selected, respectively. Even though the difference in profit is small for with and without fleece-weighing, the result is insensitive to the cost of fleece-weighing. At a 5 per cent discount rate and selecting 20 per cent of rams, the cost needs to double before a farmer is indifferent to fleece-weighing the ewes.

TABLE 2

Net Present Value and Annuity of Selection Strategies With and Without Fleece-Weighing Ewes Prior to Establishing a Nucleus Flock

Percentage of rams used	With fleece-weighing ewes		Without fleece-weighing ewes	
	NPV*	Annuity	NPV	Annuity
50	1719	223	1668	216
40	1844	239	1797	233
30	1953	253	1912	248
20	2025	262	1992	258
10	1842	238	1825	236

* All values at 5 per cent discount rate.

The greatest benefit of fleece-weighing ewes results from the scenario where 50 per cent of nucleus bred rams is used. This is due to the smaller number of ewes required to form the nucleus and hence the greater selection differential being applied in this case. The greater selection differential results in more genetic progress from the ewes forming the nucleus.

Discussion of Selection Strategies

If a merino farmer chooses a nucleus breeding programme then he will form a nucleus flock which includes between 20 and 40 per cent of rams being selected, depending on his discount rate. Given that, at all discount rates, ram selection percentages greater than 20 per cent do not greatly change the profitability, the farmer would most likely consider both the profitability and other management aspects in determining the percentage of rams selected. This would result in a nucleus flock where more than 20 per cent of the rams is selected.

In forming a nucleus flock, the benefit resulting from fleece-weighing all ewes is small. However, the cost would need to rise appreciably before fleece-weighing is not profitable. Hence in setting up a nucleus, fleece-weighing all the ewes is warranted.

The model has been useful in assessing the profitability of percentage of rams selected and fleece-weighing ewes prior to forming a nucleus. Further work will include incorporating both fleece weight and fibre diameter in the selection criteria, evaluating shorter and longer generation intervals, and comparing the profit from nucleus breeding with importing from studs.

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APPENDIX 1

Flock Costs and Returns Assumptions

Flock, costs and returns assumptions were drawn from a sheep flock monitored by the Martindale Research Project, University of Western Australia.

Flock Assumptions

Self-replacing ewe flock. Animals culled for age after their fourth adult shearing.

Hogget greasy fleece weights are 66 per cent of adult weights of 4.5 kg and 6 kg for ewes and wethers respectively (shown in Table 1).

Hogget fibre diameter is one micron finer than the 22 micron shown in Table 1.

Seventy lambs are tailed per 100 ewes joined.

Ninety-five per cent of ewe hoggets are retained to replace ewe deaths and culled-for-age.

Eighty per cent of wether hoggets are retained to replace wether deaths and culled-for-age.

Death rates per year: ewes 5 per cent, wethers 2.5 per cent, rams 10 per cent.

Costs and Returns

Wool Returns:

Farm gate value for 22 micron	$5.00 kg greasy
Change in wool proceeds per micron shift	$1.00 kg greasy

Costs:

Greasy fleece-weighing all ewes prior to establishing a nucleus	$0.35/head
Greasy fleece-weighing all ewe hoggets each year for selection of nucleus replacements	$0.35/head
Opportunity cost of leaving rams entire	$10.00/head
Ear tagging, fleece-weighing and fibre diameter measurement of ram hoggets	$5.00/head