USE OF OVULATION RATE DATA IN MERINO BREEDING PROGRAMS

J.P. MUELLER*, L.R. PIPER** and J.W. JAMES*

SUMMARY

The incorporation of ovulation rate records in Merino breeding programs is analysed for two different breeding objectives. Progeny testing of young rams selected on wool traits, and use of half sister records of young rams are compared with selection on wool traits only. 'The value of ovulation rate data is strongly dependent on selection objective.

INTRODUCTION

The economic worth of genetic improvement of Australian Merino sheep can be expressed as a function of wool quantity and quality, body weight, and reproduction rate. Wool and body traits are easily used as selection criteria, but lambing rates are measurable only on females, have low heritability and cannot be measured before first mating. A possible solution to some of these problems is to measure ovulation rate (OVR). This information could be used in selection of ewes and in selection of their sires or half brothers. Evaluation of such possibilities requires consideration of its use in selection indices, selection intensities applied, age structure and population size and structure. Our purpose is to analyse some breeding programs which use OVR records to improve two recently proposed breeding objectives.

METHODS

Breeding objectives and genetic parameters

The breeding objectives considered (H_P and H_J) were proposed respectively by Ponzoni (1979) and Jones (1982), and expressed as dollars per ewe per year:

$$H_P = 2.76CFW - 0.39FD + 14.0NLW + 0.24WW + 0.03MBW$$
$$H_J = 2.44HFW - 9.7FD + 8.7NLW - 0.25MBW - 2.14NLB + 0.06HBW + 2.85MFW,$$

where CFW clean fleece weight; FD fibre diameter; NLW number of lambs weaned; WW weaning weight; HFW hogget clean fleece weight; MBW mature body weight; NLB number of lambs born; HBW hogget body weight; MFW mature fleece weight.

Phenotypic and genetic covariances used are those assumed by Ponzoni and Jones which differ only slightly. The parametersfor OVR were taken as the same as for NLW while the genetic and phenotypic correlations between OVR and NLW or NLB were taken as 0.8. In addition, an "optimistic" heritability of 0.4 for OVR was used as well as 0.1 and 0.15.

Selection programs

Three programs are considered: (i) individual performance selection (IS); (ii) progeny testing (PT), and (iii) half sister testing (HS).

(i) Individual selection. This program serves as a basis for comparison, and involves no measurement of OVR. An open nucleus structure is assumed, since this must be used for PT, and all programs should be compared using similar structures.

* UNSW, School of Wool and Pastoral Sciences, Kensington, N.S.W. 2033.
** CSIRO, Division of Animal Production, Armidale, N.S.W. 2350.

All male and female replacements are selected on an index IA which combines measurements of HFW, FD and HBW. The mating ratio (males/females) is MN in the nucleus and MB in the base, with f being the number of progeny per ewe available for selection. Females breed 4 times and males once. Age at first offspring is 2 years for both sexes so the generation length is (2+3.5)/2=2.75 in nucleus and base. In the present work f=0.8, M_B=0.01 and M_N=0.01 or 0.004. Ratios of 0.01 can be attained with natural mating, but more intense use of rams implies use of artificial insemination.

(ii) Progeny testing. Here proven sires are mated in the nucleus and young sires in the base. All prospective sires are born in the nucleus, and a proportion q_1 are selected on index IA for progeny testing in the base. From these a fraction q_2 are selected on an index I_2 combining HFW, FD, HBW and mean OVR of daughters for use in the nucleus. Final sire selection intensity is $q_1q_2=2M_N/f$ equal to 1/40 and 1/100. The number of daughters per tested ram is $f/(2M_B)=40$. All females are selected on an index IF combining HFW, FD, HBW and ewe's own OVR. Age of nucleus sires is 4 years, but other ages are unaltered.

(iii) Half sister testing. Rams in this program are selected on an index IM combining HFW, FD, HBW with mean OVR of half sisters, while ewes are selected on IF as in PT. Population structure and selection intensity is as before. Each nucleus ram has $f/(2M_N)$ half sisters, giving 40 to 100 for the two mating ratios. Generation interval is as in IS. More detail on such open nucleus systems is given in Mueller and James (1984).

RESULTS

For each program the optimum proportion of the population in the nucleus (p) and the optimum proportions of females transferred between nucleus and base were determined. These optima differed to some extent between programs but taking p=0.1, using half of the nucleus ewe replacements from top ranking base progeny and allowing all surplus nucleus females to breed in the base were near optimum conditions for all cases. This situation is used as a further basis of comparison.

Results are summarised in Table 1. It is clear that different genetic progress rates can be expected for the two breeding objectives. More importantly, the relative value of the different programs varies markedly between objectives. For HJ, for instance, the incorporation of OVR in the indices in the HS program is only marginally better than IS, and in fact PT would do about 10% worse than IS. On the other hand, for Ponzoni's objective a PT or a HS program improves 30% and 40% over individual selection when heritability is 0.4. With low heritability the improvement would still be about 10% and 20%.

In order to allow a fair comparison we used an open nucleus structure for the HS program. It was assumed that females in the nucleus and base were all recorded on OVR, so that both PT and HS require the same amount of OVR measurements. Table 1 shows that with little loss of efficiency we may restrict the HS program to a single layer which would reduce population size by a factor of l-p. Alternatively a single layer HS program with the same size as PT would enable the use of more sires.

As is expected the assumed heritability of OVR is more important for the breeding objective placing higher weight on reproductive traits. The effect of different mating ratios in the nucleus is also expected, more intense use of rams increasing gains. In this context it may be noted that for N sires in the nucleus the total population size is $N/(M_Np)$. With N=2 and M_N=0.004 we have the same population size as with N=5 and M_N=0.01, that is 5000 ewes. In the former flock we would expect 5% to 10% higher gains, but it can be shown that the annual rate of inbreeding would be 0.25% as against 0.1% with N=5.

TABLE 1 Annual rate of genetic gain in three breeding programs aimed at the improvement of two breeding objectives proposed for Australian Merinos (in dollars per ewe per year)

Breeding objective	Mating ratio in nucleus	Heritability of ovulation rate	Progeny testing scheme	Half sister program		Individual selection	
				open nucleus	single layer	open nucleus	single layer
JONES	0.004	0.15	0.59	0.71	0.66	0.68	0.63
	0.004	0.4	0.61	0.73	0.67	0.68	0.63
	0.01	0.15	0.55	0.65	0.58	0.63	0.57
	0.01	0.4	0.58	0.68	0.60	0.63	0.57
PONZONI	0.004	0.1	0.65	0.72	0.68	0.58	0.54
	0.004	0.4	0.79	0.84	0.75	0.58	0.54
	0.01	0.1	0.60	0.64	0.58	0.54	0.49
	0.01	0.4	0.72	0.77	0.67	0.54	0.49

DISCUSSION

The results show that the benefits from using OVR data in Merino breeding depend on the weight placed on reproductive performance in the breeding objective. In Ponzoni's breeding objective (HP) the weight for NLW is about two times the weight given to NLW + NLB in Jones' objective (H_J). The negative value for NLB in H_J accounts for the penalty due to lower wool production in ewes producing more lambs, and the lower weight placed on NLW arises from extra cost considerations made by Jones. This suggests that the use of OVR data becomes particularly relevant in conditions in which production costs do not increase markedly with increasing reproductive performance. The best breeding program for the conditions studied is the half-sister program because although half sibs have only half of the genetic covariance of parent and offspring, the increased generation interval inevitable in progeny testing dilutes much of the gain in accuracy. Considerations of population size would also favour the HS program.

It must be stressed that only a narrow set of designs within each program was tested. The effect of different fertility rates and varying mating ratios for different nucleus sizes as well as the possibility of optimising age structure should be considered in the evaluation of any specific case.

As far as the selection indices are concerned, the efficiency in the use of OVR data can be enhanced if dam-offspring pairs were known. This possibility was avoided in order to restrict pedigree recording to the identification of paternal half sibs.

ACKNOWLEDGEMENT

J.P.M. wishes to acknowledge the support received from the Instituto Nacional de Tecnologia Agropecuaria (INTA) Argentina.

REFERENCES

JONES, L.P. (1982). In "Future developments in the genetic improvements of animals", p.119, editors J.S. Barker, K. Hammond and A.E. McClintock. (Academic Press: Australia).

MUELLER, J.P. and JAMES, J.W. (1984). Anim. Prod. (in press).

PONZONI, R.W. (1979). Proc. Aust. Assoc. Anim. Breed. Genet. 1: 320.