GENETIC STUDIES ON WOOL QUALITY AND SKIN CHARACTERS OF THE MERINO

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SUMMARY

Changes to selection practices in Merino ram-breeding flocks highlighted the need for knowledge of phenotypic and genetic parameters of production characters at young ages. Preliminary estimates from a long-term project indicate that staple strength, fibre diameter variability and skin quality are moderately to highly heritable at 10 and 16 months of age and that favourable genetic correlations exist between these characters and other important production characters. The value of these characters in Merino breeding programs is discussed.

INTRODUCTION

Traditionally, ram breeders in the Merino wool industry have selected their sire replacements by visual assessment at hogget age (approximately 15 to 16 months of age), on a full 12 months fleece, just prior to the first mating of the sires at 18 months of age. With time, many studs progressed to make the initial selection of potential sires ("reserves") using visual assessment, at younger ages. Where objective data was used in the selection process, generally only reserve rams were measured for fleece weight and fibre diameter at 15 months of age. During the late 1970's significant changes occurred in the selection practices of many ram breeding flocks with whole ram drops being performance recorded before 12 months of age.

Industry practice in some Australian ram breeding flocks is to initially performance record rams at 10 to 12 months of age with 6 to 8 months of wool growth. Then a further assessment is made by retesting a selected proportion of these rams with at least 6 months wool growth, prior to their final selection as sires at hogget age. Breeding values estimated at 10 to 12 months of age are being used to initially select sires to improve the lifetime productivity of progeny in commercial flocks. However, most of the genetic parameter estimates available for wool characters in Australian Merinos have been obtained on sheep aged 15 to 18 months with 12 months' wool growth (Mortimer 1987). Estimates of genetic parameters at early (less than 12 months) and adult (greater than 2 years) ages are required. This applies particularly to those subjective wool and body characters routinely assessed by ram breeders and sheep classers (e.g. skin quality), wool quality characters for which objective measurement has become possible (e.g. staple strength) and novel skin characters (e.g. mean bulb area).

In this paper we describe a large-scale Merino sheep breeding project in which subjectively assessed and objectively measured wool production, wool quality, skin, body and reproductive characters are being studied in the South Australian Merino strain at young ages. Preliminary estimates of genetic parameters for staple strength, fibre diameter variability and skin quality, at 10 and 16 months of age, are discussed.

MATERIALS AND METHODS

A resource flock of 2000 South Australian Merino ewes representative of the Bungaree and Collinsville family groups was established at Turretfield Research Centre in 1988. Details of the formation of the flock, the management program and the characters recorded in all experimental progeny were given by Gifford *et al.* (1992).

Data from 1450 rams recorded at 10 and 16 months of age were analysed. The rams were born in 1989, 1990 and 1991, and were progeny of 116 sires. The mathematical model fitted to the data included the fixed effects of year of birth, stud, age of dam and type of birth and rearing. Day of birth of the individual (within the lambing period) was fitted as a linear covariate. Sires were treated as a random effect nested within year of birth and stud. Variance and covariance components were calculated by restricted maximum likelihood using PROC Mixed in SAS (1992).

RESULTS AND DISCUSSION

Heritabilities

Heritability estimates for a number of characters in rams at 10 and 16 months of age are given in Table 1, and indicate that there is abundant genetic variation for all characters at both ages. The estimates for clean fleece weight were higher than in earlier reports for strong-wool Merinos (e.g. Gregory 1982, James *et al.* 1987, Walkley *et al.* 1987), whereas for yield and mean fibre diameter they were in agreement with previous published values (0.4 to 0.5). Staple strength was moderately to highly heritable, showing slightly higher values than those reported by Rogan (1988) and Newman *et al.* (1990). Heritabilities for fibre diameter variability (both CVFD and SDFD) were high, in support of those reported by James *et al.* (1990).

Table 1. **Heritabilities (h^2) and genetic correlations at 10 and 16 months of age**

Character	h^2 ($\pm$s.e.)		Genetic correlation					
			Staple strength		Skin quality		SD of fibre diameter	
	10mo	16mo	10mo	16mo	10mo	16mo	10mo	16mo
Yield	0.54 (0.024)	0.73 (0.031)	0.46	0.48	0.24	0.31	-0.66	-0.02
Clean fleece weight	0.44 (0.021)	0.54 (0.099)	0.50	0.38	0.72	0.65	0.25	0.16
Mean fibre diameter	0.36 (0.017)	0.47 (0.022)	-0.02	0.36	0.27	0.16	0.46	0.48
CV of fibre diameter	0.73 (0.118)	0.57 (0.026)	-0.18	-0.40	0	-0.05	0.87	0.72
SD of fibre diameter	0.67 (0.113)	0.51 (0.098)	-0.17	-0.14	0.12	0.07		
Skin quality	0.36 (0.020)	0.23 (0.011)	0.31	0.18				
Staple strength	0.24 (0.012)	0.39 (0.019)						

"New" traits for Australian Merino breeding objectives

Traditionally, the only wool traits included in performance recording and genetic evaluation services for Merino sheep have been clean fleece weight and mean fibre diameter. There are, however, other traits that can be objectively recorded, some of which can have an appreciable impact on the value of wool. The formal incorporation of "new" traits into the breeding objectives of Australian wool sheep relies on knowledge of both phenotypic and genetic parameters and the economic value of the traits. In this section we briefly discuss staple strength and fibre diameter variability as potential "new" traits. **Staple strength** is an important determinant of fibre length in the top and there are clear market signals relating price to variation in staple strength, although the relationship is not linear (Piper 1992). We presently lack reliable phenotypic and genetic parameters for the trait. Table 1 shows the genetic correlation between staple strength and a number of production characters. Except for mean fibre diameter, there was consistency between estimates at both ages. All correlations were in a favourable direction, except for mean fibre diameter at 16 months of age. Selection for staple strength would result in genetic improvement in yield, clean fleece weight and skin quality and a decrease in fibre diameter variability. Despite its moderate heritability the genetic improvement of staple strength poses a problem (Ponzoni *et al.* 1990). If staple strength were recorded in the context of a breeding program, typically, it would be recorded in young rams and ewes before they were used for reproduction. Since much of the wool is produced by breeding ewes, the expectation would be that by selecting for staple strength in non-breeding sheep we would achieve a favourable response in breeding ewes. However, breeding ewes are under the stress of pregnancy and lactation. Thus, staple strength measured in one class of sheep may not necessarily be exactly the same trait as that measured in the other class. The work at Turretfield will ultimately provide estimates of the genetic correlation for staple strength measured in young sheep and in adult breeding ewes.

Measurements of **fibre diameter variability**, both the standard deviation (FDSD) and the coefficient of variation (FDCV), are routine measurements in many Australian wool testing laboratories, but their value and role in Merino sheep breeding programs is not clear. The advocates of fibre diameter variability traits as candidates for the breeding objective of wool sheep allude to their importance in wool processing performance and product quality. The logic for the association between processing performance and fibre diameter variability is given by Anderson (1976). At present there are no clear and consistent market signals associated with fibre diameter variability. However, given the high phenotypic correlation between mean fibre diameter and FDSD (0.50 at 10 months and 0.47 at 16 months in our study) it is possible that a premium for lower fibre diameter variability is implied in the premium currently being paid for lower mean fibre diameter. A number of estimates of phenotypic and genetic parameters for fibre diameter variability are available. Our findings support those of James *et al.* (1990), with the genetic correlation between mean fibre diameter and fibre diameter variability being dependent on the measure of variability. It is moderately positive between mean fibre diameter and FDSD, but effectively zero between mean fibre diameter and FDCV (-0.04 and -0.28 at 10 and 16 months). We found weak negative genetic correlations between fibre diameter variability and staple strength, and weak positive relationships between FDSD and clean fleece weight. Breeding programs using selection to reduce mean fibre diameter will also reduce FDSD, but possibly lead to a small increase in FDCV. The value of fibre diameter variability in breeding programs will be dependent on gaining further knowledge of the genetic correlation between its expression in young and adult sheep, and of the genetic correlation between fibre diameter variability in young sheep and other characters (e.g. staple strength) in adult sheep.

Visually assessed criteria for early selection

Over the years sheep classers and ram breeders have emphasised the importance of considering characters such as skin thickness, "productive, pliable skins", and more-recently "finely-pleated" skins in making selection decisions. This emphasis on skin is based on the fact that it is the skin that nourishes and supports the population of fibre-producing follicles. Skin quality is routinely assessed in many ram breeding flocks. In our study, skin quality of rams at 10 and 16 months of age has a moderate to high heritability. Table 1 shows the genetic correlation between skin quality and a number of production characters. There was consistency between the estimates at both ages. The correlations were favourable with yield, clean fleece weight and staple strength, whereas they were unfavourable with fibre diameter, and near zero with the coefficient of variation of fibre diameter. The correlations with clean fleece weight were high, indicating that selection for skin quality should result in greater wool cut, and selection for clean fleece weight should result in improved skin quality. Lewer and MacLeod (1990) examined the incorporation of visual selection criteria into one-and two-stage selection indexes for Australian wool sheep and found that overall economic gains would only be marginally reduced if subjective criteria were used to reduce the number of rams to be tested to 70% in a two-stage selection program. Skin quality would appear to be one such subjective character useful for undertaking a preliminary culling of rams.

Concluding remarks

On completion of the project in late 1997, a reliable set of phenotypic and genetic parameters for a very broad range of characters of the South Australian Merino, at ages consistent with industry practice, will be available to industry. Because of the widespread influence of the South Australian Merino strain, the information will be applicable to over one-third of the national flock. Furthermore, because of the collaboration of sheep classers and ram breeders in the project, the data will be used in extension and education programs as a focus for discussions on the consequences of different selection strategies, some combining visually assessed and objectively measured criteria.

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REFERENCES

ANDERSON, S.L. (1976) J. Text. Inst., 67 : 175-180.

GIFFORD, D.R., PONZONI, R.W., WALKLEY, J.R.W. and ANCELL, P.M.C. (1992) Wool Tech. Sheep Breed., 40 (4) : 114-116.

GREGORY, I.P. (1982) Aust. J. Agric. Res., 33 : 355-362.

JAMES, P.J., PONZONI, R.W., WALKLEY, J.R.W., WHITELEY, K.J. and STAFFORD, J.E. (1987) In Merino Improvement Programs in Australia. Ed. McGuirk, B.J., 341-345.

JAMES, P.J., PONZONI, R.W., WALKLEY, J.R.W. and WHITELEY, K.J. (1990) Aust. J. Agric. Res., 41 : 583-594.

LEWER, R.P. and MACLEOD, I.M. (1990) Proc. 4th World Congr. Genet. Appl. Livestock Prod., 15 : 61-64.

MORTIMER, S.I. (1987) In Merino Improvement Programs in Australia. Ed. McGuirk, B.J., 159-173.

NEWMAN, S-A.N., RAE, A.L. and WICKHAM, G.A. (1990) Proc. Aust. Assoc. Anim. Breed. Genet., 8 : 299-302.

PIPER, L.R. (1992) In Proceedings of a National Workshop on Management For Wool Quality in Mediterranean Environments. Eds. Doyle, P.T., Fortune, J.A. and Adams, N.R., 99-105.

PONZONI, R.W., ROGAN, I.M. and JAMES, P.J. (1990) Proc. 4th World Congr. Genet. Appl. Livestock Prod., 15 : 149-166.

ROGAN, I.M. (1988) Proc. 3rd World Congr. Sheep and Beef Cattle Bdng., 2 : 383-407.

SAS (1992) Technical Report P-229, SAS/STAT Software : Changes and Enhancements, Release 6.07, Cary, NC : SAS Institute Inc., 1992. 620 pp.

WALKLEY, J.R.W., PONZONI, R.W. and DOLLING, C.H.S. (1987) Aust. J. Exp. Agric., 27 : 205-210.