PASTURE INTAKE BY MERINO EWES AND ITS RELATIONSHIP WITH LIVEWEIGHT AND ULTRASONIC FAT DEPTH

G.J. LEE[1], K.D. ATKINS[2] and S.I. MORTIMER[1]

[1]N.S.W. Agriculture
Agricultural Research Centre, Trangie N.S.W. 2823

[2]N.S.W. Agriculture
Agricultural Research and Veterinary Centre, Orange N.S.W. 2800

SUMMARY

Pasture intake, liveweight and fat depth were measured in 300 ewes in each of two years (126 sires in total) at 4 stages of the reproductive cycle to determine the genetic variation in intake and its relationship with liveweight and fat depth. At the phenotypic level, liveweight was positively related to intake but intake was negatively related to fat depth when liveweight was considered. The phenotypic correlations were estimated reasonably precisely and were consistent across all seasons. The genetic correlations were estimated less precisely. It appeared that the genetic relationship between DOMI and fat depth may be influenced by physiological state. Overall, DOMI was moderately heritable (h^2=0.22).

INTRODUCTION

Pasture is a major cost even under extensively based pasture systems of sheep production. Breeding objectives in Merino sheep need to be based on a profit equation, including both returns and costs. An optimum selection index should include pasture intake as part of the breeding objective (not necessarily as a trait for selection) with an appropriate economic value (James 1982). This would require good estimates for the heritability (h^2) of intake and the genetic correlations between intake and other traits. No such parameter estimates are available in any sheep population. Knowing these parameters will allow sheep breeders to account for the cost of increased pasture requirements accompanying selection for wool production, body weight or reproductive performance.

This paper presents estimates of phenotypic and genetic parameters for pasture intake and its covariation with liveweight and fat depth traits.

EXPERIMENTAL PROCEDURES

Faecal output was estimated in approximately 300 ewes in each of two years using Captec Chrome controlled release devices (Lee et al. 1990). The ewes were sampled from a multiple-bloodline flock which was established to estimate between- and within-flock genetic parameters for traits of economic importance in Merino sheep (Atkins and McGuirk 1979). Three sires were represented in each of 15 bloodlines within each age group, with 3-4 ewes per sire. In total, approximately 500 individual ewes were sampled over the two years of measurement.

Faecal samples were collected over a 2-3 week period at four stages of the annual reproductive cycle - Autumn (early pregnancy), Winter (late pregnancy), Spring (mid-lactation) and Summer (post-weaning).

Liveweights were recorded at the start and end of each collection period, and ultrasonic fat depths (50mm from the midline between the 12-13th ribs) were measured (Gooden et al. 1980) at the start of each period. The ewes grazed an irrigated pasture (24.2 ha), which included white clover, rye grass and phalaris. Pasture quadrats were cut to determine the total availability of green and dead material. Digestible organic matter intake was calculated from the faecal organic matter output and estimated diet digestibility (Freer and Christian 1983).

All analyses were based on the mean for each sampling period within each year. Least squares methods (Gilmour 1988) were used to analyse digestible organic matter intake (DOMI) and DOMI adjusted for liveweight (DOMI/kg) including age, flock, sire, year, reproduction effects, liveweight and fat depth in the model. Genetic and phenotypic parameters and their standard errors were calculated from the estimated variance components according to Becker (1984), after adjusting for significant reproduction effects (previous year's weaning performance and current reproductive status).

Table 1. Pasture availability, digestibility and least square means (s.e.) for intake, liveweight, and fat depth in each season.

	Autumn	Winter	Spring	Summer
Pasture - t DM/ha	2.0	2.1	2.2	1.9
Digestibility	0.66	0.71	0.76	0.65
DOMI - g/d	596.3 (6.3)	705.4 (8.7)	1123.0 (14.3)	770.9 (7.7)
DOMI/kg - g/kg/d	12.35 (0.13)	12.71 (0.16)	19.46 (0.27)	14.44 (0.16)
Liveweight - kg	48.6 (0.3)	55.5 (0.3)	58.7 (0.3)	53.9 (0.3)
Fat depth - mm	3.35 (0.04)	3.44 (0.03)	3.42 (0.05)	3.40 (0.05)

RESULTS AND DISCUSSION

Phenotypic variation and covariation

Least square means for the major traits are shown in Table 1 for each season.

Liveweight was related ($P<0.001$) to pasture intakes (DOMI) in all measurement periods but accounted for only 2-8% of the variation. Expressing DOMI on a liveweight basis (DOMI/kg) removed the effects of liveweight on intake in Summer and Winter, however, liveweight remained significant ($P<0.05$) in Autumn and Spring.

Fat depth was related ($P<0.001$) to pasture intakes in all periods except Winter, accounting for 1% (Spring) to 15% (Summer) of variation in DOMI. Expressing DOMI on a liveweight basis increased the variation accounted for by fat depth in Summer by 9%. In Autumn, fat depth still accounted for 4% of variation in DOMI/kg.

In general, phenotypic correlations were remarkably consistent between seasons (Table 2). Correlations between liveweight and DOMI were positive, but only low to moderate (0.21 to 0.30). Phenotypic correlations between DOMI/kg and liveweight were low and negative (-0.24 to -0.13) in all periods, which indicates that an appropriate exponent of liveweight is slightly less than unity. Similarly, the simple correlations of fat depth with DOMI were very low (-0.10 to 0.04), but were greater when DOMI was adjusted for liveweight (-0.15 to -0.30).

The partial phenotypic correlations of liveweight and fat depth on DOMI confirm the independent effects of increasing intake with increasing liveweight (and maintenance requirements) and decreasing intake with increasing fat depth, previously recognised in lactating ewes (Cowan et al. 1980) and dry sheep (Foot 1972).

Table 2. Phenotypic correlations (s.e.) for digestible organic matter intake, liveweight, and fat depth.

	Traits	Autumn	Winter	Spring	Summer
DOMI	DOMI/kg	0.86 (.06)	0.91 (.06)	0.87 (.06)	0.83 (.06)
	Liveweight	0.30 (.06)	0.26 (.05)	0.21 (.05)	0.28 (.06)
	Fat depth	0.00 (.05)	0.04 (.05)	-0.10 (.04)	-0.06 (.05)
DOMI/kg	Liveweight	-0.19 (.05)	-0.13 (.05)	-0.24 (.05)	-0.24 (.05)
	Fat depth	-0.23 (.05)	-0.15 (.05)	-0.30 (.04)	-0.30 (.05)
Live wt	Fat depth	0.47 (.05)	0.48 (.06)	0.48 (.05)	0.50 (.05)

Genetic variation and covariation

Although there were was considerable variation between seasons in some of the estimates these were generally not significant and so estimates were pooled. These estimates of genetic parameters are relatively imprecise. However, it does appear from the pooled estimates (Table 3) that DOMI (and DOMI/kg) is a heritable trait in grazing Merino sheep. Our estimate of DOMI h^2 (0.22) is lower than the estimates of Van Arendonk et al. (1991) for energy intake of 0.31 estimated in stall-fed lactating heifers and of 0.57 in growing heifers, but similar to that for growing bulls (0.24).

Table 3. Pooled estimates of heritability (bold) and genetic correlations (s.e.) for digestible organic matter intake, liveweight, and fat depth.

Trait	DOMI	DOMI/kg	Liveweight	Fat depth
DOMI	**0.22 (.08)**	0.76 (.10)	0.61 (.15)	0.02 (.20)
DOMI/kg		**0.19 (.08)**	-0.27 (.19)	-0.56 (.18)
Liveweight			**0.63 (0.09)**	0.53 (.09)
Fat depth				**0.45 (.09)**

The pooled estimate of h^2 for average liveweight was 0.63. In this experiment, liveweight was an average of two measures which will increase the apparent h^2 of the trait. The h^2 of ultrasonic fat depth (0.45) was higher than the estimates by Atkins et al. (1991) in Australian Poll Dorset sheep and the mean of literature estimates (0.23) for growing animals (Simm et al. 1987).

Generally, the genetic correlations were similar to the phenotypic correlations in sign and magnitude. The exceptions were the correlations of liveweight with DOMI, and of fat depth with DOMI/kg. The genetic correlation between liveweight and DOMI (0.61) was stronger than the phenotypic relationship (0.21-0.30). The pooled genetic correlation indicated that DOMI and fat depth were genetically unrelated, although, at the same liveweight, genetically fatter sheep ate less (genetic correlation between DOMI/kg and fat of -0.56). However, there was some indication of variation between seasons in this correlation. The genetic correlation between DOMI and fat in autumn and summer was moderately positive but in spring (lactation) was negative. So this relationship may be altered by physiological state. For example, genetically fatter sheep may eat more when feed is available and their nutrient demands associated with physiological state are relatively low, but to maintain a lactation, genetically lean ewes must eat more to make up the energy put into milk.

CONCLUSIONS

Further work on the estimation of genetic parameters is required because the pooled estimates obtained in this study were relatively imprecise and appeared to vary between measurement seasons. Much of the variation between measurement periods may have been associated with reproductive effects, both past and current. It may be that pasture intakes at the different phases of the reproductive cycle are in fact separate traits. To improve the precision of the estimates of genetic parameters, the extent of physiological variation needs to be controlled. Logically, future work should initially study dry animals, free from the influences of previous and current reproductive performances.

While the genetic relationship between the level of fatness and intake has been demonstrated in mature ewes, the implications of selection in meat sheep for leanness on intake and subsequent growth need to be established for young animals.

ACKNOWLEDGMENTS

This work was supported by a grant from the Wool Research and Development Council on the recommendation of the Australian Wool Corporation.

REFERENCES

ATKINS, K.D., and MCGUIRK, B.J. (1979). In 'Sheep Breeding' p. 147, Eds. G.J. Tomes, D.E. Robertson and R.J. Lightfoot, Butterworths, London.

ATKINS, K.D., MURRAY, J.I., GILMOUR, A.R., and LUFF, A.L. (1991). *Aust. J. Agric. Res.* **42**:629.

BECKER, W.A. (1984). 'Manual of quantitative genetics'. 4th ed. Academic Enterprises, Washington.

COWAN, R.T., ROBINSON, J.J., MCDONALD, I., and SMART, R. (1980). *J. Agric. Sci.* **95**:497.

FOOT, J.Z. (1972). *Anim. Prod.* **14**:131.

FREER, M., and CHRISTIAN, K.R. (1983). In 'Feed Information and Animal Production'. p. 333, Eds. G.E. Robards and R.G. Packham, Commonwealth Agricultural Bureaux, Slough.

GILMOUR, A.R. (1988). REG - A generalised linear models program. 3rd edition. Miscellaneous Bulletin 1. Department of Agriculture N.S.W.

GOODEN, J.M., BEACH, A.D., and PURCHAS, R.W. (1980). *N.Z. J. Agric. Res.* **23**:161.

JAMES, J.W. (1982). In 'Future Developments in the Genetic Improvement of Animals'. p. 107, Eds. J.S.F. Barker, Keith Hammond and A.E. McClintock, Academic Press, Sydney.

LEE, G.J., ATKINS, K.D., and MORTIMER, S.I. (1990). *Proc. Aust. Assoc. Anim. Breed. Genet.* **8**:147.

SIMM, G., YOUNG, M.J., and BEATSON, P.R. (1987). *Anim. Prod.* **45**:465.

VAN ARENDONK, J.A.M., VOS, H., and VAN DER WERF, J.H.J. (1991). *Proc. Aust. Assoc. Anim. Breed. Genet.* **9**:37.