
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

Effect of selection for early lambing on the testicular diameter of the male offspring

J.F. SMITH, J. PARR AND D.M. DUGANZICH

AgResearch, Dairy & Beef Division, Ruakura Research Centre, Private Bag 3123, Hamilton, New Zealand.

ABSTRACT

Testicular size has been linked to reproductive efficiency and changes in testicular size could provide an early indicator for the choice of ram lambs to be used in flocks selecting for out-of-season breeding ability. For 3 years, 20 ram lambs from each of the BV(DL)-ve (earlier lambing) and BV(DL)+ve (later lambing) flocks at Ruakura were monitored for testicular diameter (TD) and liveweight (LWT) from weaning until November the following year. In 1991 and 1992, BV(DL) class and season of birth were confounded while in 1993 both BV(DL) classes were represented in both seasons of birth (Autumn and Spring).

At the same age Autumn born BV(DL)-ve rams had larger ($P<0.05$) TD than did Spring born BV(DL)+ve rams in all years. For the 1993 born lambs, the shape of the TD growth curve was different for each BV(DL) x season of birth sub-class ($P<0.001$). However, at any single age point the within sub-class variation in TD (rsd = 4.6 mm) was such that no meaningful selection for BV(DL) could be made within rams for that season of birth. Liveweight interacted with TD and this effect was also influenced by the season of birth.

These data indicate that while TD is influenced by season of birth, the difference in TD between ram lambs of divergent BV(DL; selection for out-of-season breeding ability) was not sufficient for TD to be a useful parameter for early selection.

Keywords: Rams; earlier lambing; testicular diameter.

INTRODUCTION

It has been demonstrated that selection for earlier lambing can result in flocks with an advanced lambing pattern and that date of lambing has a relatively high heritability (0.31) and repeatability (0.43) (Smith *et al.* 1992). Selection of replacement ewe and ram lambs in that flock is currently based on breeding values for date of lambing [BV(DL)] derived from historical pedigree and performance records (Smith *et al.*, 1993). Selection for out-of-season breeding ability in sheep could be enhanced if an early indication of the trait was available especially in the male progeny.

Testicular size has been linked to reproductive efficiency (Land, 1973, Islam and Land 1977). Testicular size can be considered a representative parameter of male seasonal reproductive activity as the testis is the target of both LH and FSH (Pelleteir and Almeida 1987) and changes in testicular growth patterns in young rams could provide the basis for such a selection indicator.

Testicular diameter (TD) is influenced by ram liveweight but the relationship is not a simple linear one - because the relative increases in lamb liveweight and testicular diameter differ with their age. Thus both the age and liveweight of the ram at the time of testicular measurement need to be taken into consideration.

This report examined the question “can testicular diameter (TD) measured in ram lambs be used to predict genetic differences for the date of lambing?”, with the aim of using TD as an early selection indicator in male offspring.

MATERIALS AND METHODS

Animals: Ram lambs (129) born in the Ruakura “Kamo” out of season breeding flock (Smith *et al.*, 1992) in 1991, 1992 and 1993 were used. Approximately 20 ram lambs with the highest and lowest BV(DL) values regardless of their season of birth were retained in each year (see Table 1). Both the BV(DL)-ve (earlier lambing) and the BV(DL)+ve (later lambing) flocks are joined with rams in December-January for an autumn lambing and re-joined in March-April for a spring lambing (Smith *et al.*, 1992).

Breeding values: Breeding values for date of lambing [BV(DL)] used in this report are those derived simply as the average of the estimated parental BV(DL)’s calculated from the flock database using BLUP procedures (Smith *et al.*, 1992). Animals were designated as either BV(DL)-ve (early lambing flock) or BV(DL)+ve (latter lambing flock) and were grouped according to BV(DL) class and season of birth in a particular year (Table 1) for analyses of the data.

Measurements: At 2 weekly intervals from the date of weaning, until the first week of November in the following year, all lambs were weighed and had their testicular diameter (TD) measured. Live weight (LWT) was measured using electronic scales and TD (average of the maximum diameter on each testis) measured using spring loaded callipers connected to an electronic digital read out.

Analysis of data: Analysis was carried out using residual maximum likelihood (REML) procedures of the Genstat statistical package (v5.3 Rothamsted Experimental Station).

Testicular diameter (TD) was modelled in terms of age and liveweight polynomials up to cubic order, fitted to all observations. Fixed effect coefficients were tested for differences due to season of birth and for BV(DL) group

TABLE 1: Distribution of animals by BV(DL) class and season of birth for each year and the mean birth dates (Bday) and BV(DL) values for the subclasses.

Year of birth	Season of birth	BV(DL) group	n.	Bday(1)	BV(DL) val(2)
1991	Autumn	-ve	21	148±2.8	-0.149±0.009
		+ve	6	171±3.0	+0.047±0.004
	Spring	-ve	0	—	—
		+ve	14	230±1.7	+0.099±0.013
1992	Autumn	-ve	19	128±4.3	-0.392±0.023
		+ve	0	—	—
	Spring	-ve	0	—	—
		+ve	21	241±1.3	+0.195±0.013
1993	Autumn	-ve	20	158±2.2	-0.493±0.026
		+ve	5	167±0.5	+0.182±0.024
	Spring	-ve	6	234±2.9	-0.364±0.028
		+ve	17	237±1.8	+0.221±0.012

(1) = Bday are expressed as day of the year.

(2) = BV(DL) values are expressed in standard deviation units.

within season of birth, allowing for random coefficient variation between years and rams within a season of birth by BV(DL) group sub-class, as well as overall year, ram and residual measurement day random effects. Effects were deleted if the associated likelihood-ratio test gave a p-value exceeding 5%.

RESULTS

Using age polynomials alone, year and ram variation in cubic coefficients were deleted from the model. Cubic coefficients differed for season of birth (P<0.001) and for BV(DL) group within autumn-born classes (1991; P<0.001 and 1993; P<0.05) but only the linear coefficient differed between BV(DL) groups for the spring born class in 1993 (P<0.01). Residual measurement day variation was retained as a statistically significant (P<0.05) term reflecting both lack-of-fit to age and daily fluctuations. There was no obvious pattern to the estimated parameters.

When liveweight polynomials were also available to the model, the values of the age coefficients changed, but not their pattern of deletion. An overall quadratic (P<0.001) in liveweight was added with year and ram linear coefficient variation and differences in the linear coefficients between season of birth groups (P<0.5).

The quadratic effect of weight was negative in that the per kg effect on TD decreased as the liveweight of the rams increased (-0.8 mm/kg/kg). For rams of the same age a difference of 1 kg in liveweight was associated with an increase of 5.3 mm TD for those born in the autumn and 6.3 mm for those born in the spring.

Use of the ratio of TD to LWT or the ratio of TD and cube root of LWT as parameters completely failed to simplify the models.

The fact that the TD growth curves have significantly different shapes for each BV(DL) by season of birth subclass group shows that at some time of the year differences exist in TD between the season of birth x BV subclasses and that these differences could be used for discrimination among rams for selection purposes. However, examination of the curves for TD against age shown in Figure 1(A,B,C) shows that at any age there are no "usefully large" differences between these BV(DL) x season of birth sub-groups and thus it would appear that TD at any age would be of little "practical" value in predicting the BV (DL) and cannot be recommended as a criteria for selection. This is especially so considering the residual standard deviation (rsd) of 4.6 mm for a single observation on a ram or even the rsd of 2.4 mm from the component of variance for rams within a subclass.

DISCUSSION AND CONCLUSIONS

Selection for testis diameter in ram lambs has produced lines of animals with differences in pituitary gland and/or hypothalamic activity (McNeilly *et al.*, 1986). It is also well accepted that there are seasonal changes in testis diameter of adult rams (Islam and Land 1977; Xu *et al.*, 1991) and that this is controlled by changes in day length (Pelleteir and Almeida 1987). The depression in TD during the winter/spring months was also seen in the present experiment in rams of 9 to 15 months of age.

However, the effect of season of birth on TD seen in the present trial suggests that there could be an *in utero* effect of day length on subsequent testis growth. The higher values of TD found in autumn-born animals at 200-250 days of age is surprising as this would coincide with the October-November period when TD is expected to be low, while for the spring-born animals of that age it would coincide with March-April when TD is reported to be highest (Xu *et al.,* 1991). Phenotypic correlations of liveweight and testicular diameter have been reported in adult rams on a number of occasions (e.g. Islam and Land 1977) but genetic correlations in young rams appears to be influenced by the age of measurement (Nowakowski and Cwikla 1994). These workers also reported that the heritability of TD was only moderate to low (0.14 - 0.25) and also varied depending on age of measurement.

Our data indicates that while differences in LWT at the same age are significantly associated with differences in TD, this effects is in itself modulated by the LWT of the animal as the influence of an increase in LWT diminishes at higher LWTs.

The magnitude of this influence of liveweight on TD differs between the seasons of birth, being greater in spring-born rams.

Breed differences in the annular pattern of TD in rams and the magnitude of these changes have been linked with the timing of the breeding season in ewes of those breeds (Islam and Land 1977, Xu *et al.* 1992). However, there appears to be little evidence for within breed relationships between ram TD changes and the date of onset of breeding of his daughters (Xu *et al.* 1992). While the analysis of our data indicated highly significant differences in the patterns of TD change with age between the BV (DL) classes within a season of birth, examination of these patterns and the large between ram within subclass variance at any given time of measurement suggests that there would be little value in using TD as a selection aid for advancement of lambing date.

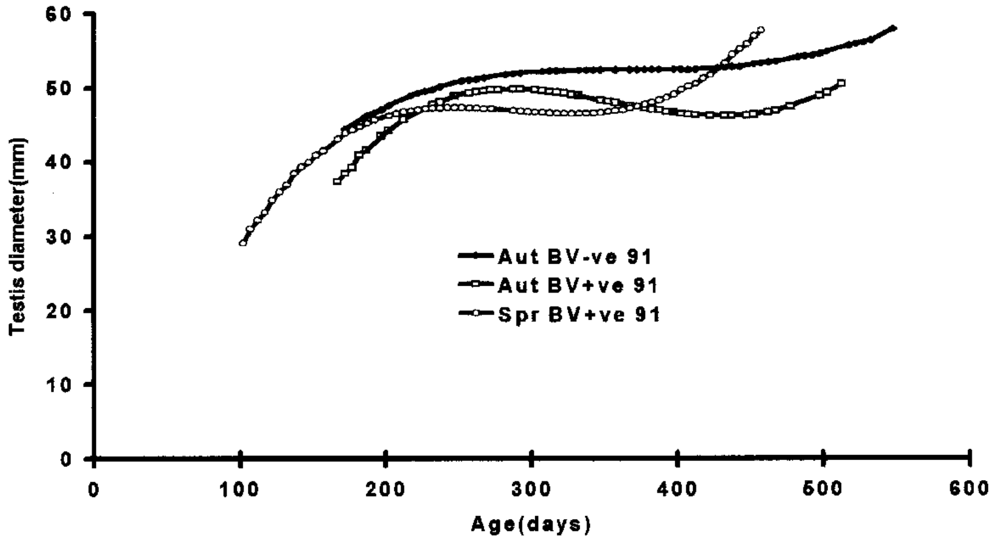
FIGURE 1: Effect of the BV(DL) x season of birth subclasses on changes in testicular diameter with age. Data presented are the fitted curves as predicted from the final model.

A) = Rams born in 1991 and measured during 1991-92.

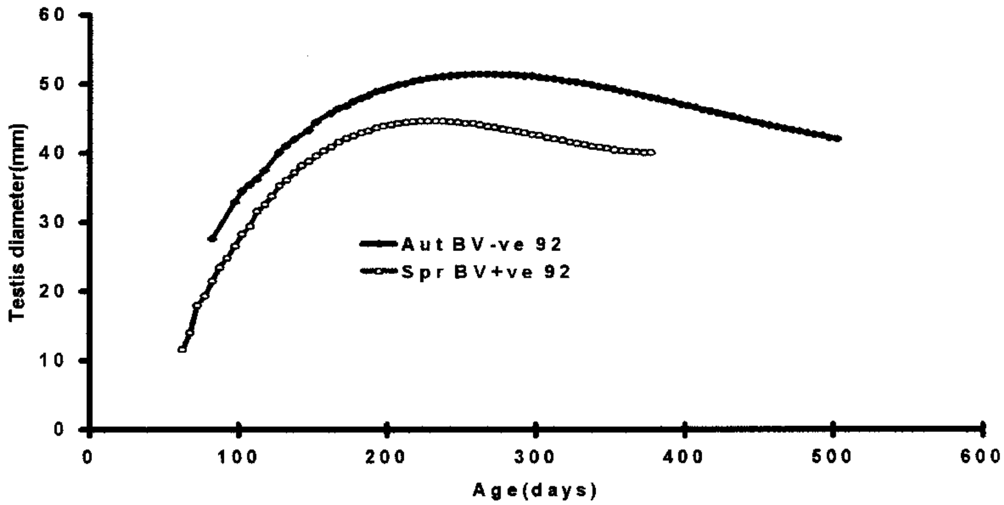
B) = Rams born in 1992 and measured during 1992-93.

C) = Rams born in 1993 and measured during 1993-94.

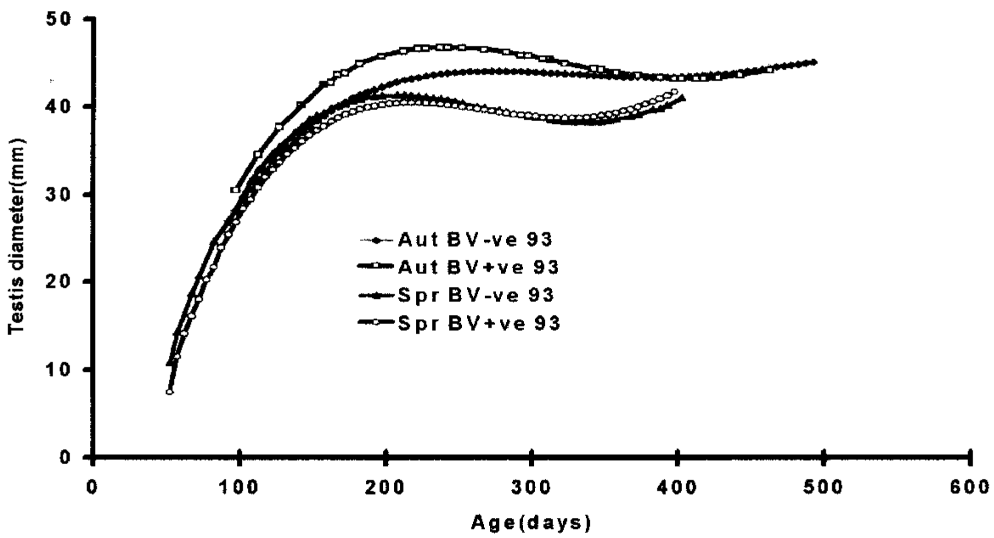
A).



B).



C).



ACKNOWLEDGEMENT

Mr C. Harris for care of the animals and assistance with measurements and Miss. J.K. Smith for data recording.

The research was funded by the Public Good Science Fund (FRST contract C10 204).

REFERENCES

Islam, A.B.M.M. and Land, R.B. 1977. Seasonal variation in testis diameter and sperm output of rams of different prolificacy. *Animal Production* **25:** 311-317.

Land, R.B. 1973. The expression of female sex-limited characters in the male. *Nature, Lond* **241:** 208-209.

McNeilly, J.R., Fordyce, M., Land, R.B. Lee, G.J. and Webb, R. 1986. Endocrine differences in rams after genetic selection for testis size. *Journal Reproduction and Fertility* **76:** 131-140.

Nowakowski, P. and Cwikla, A. 1994. Seasonal variation in testis size in Polish Merino rams and its relationship to reproductive performance in spring. *Theriogenology* **42:** 613-622.

Pelletier, J. and Almeida, G. 1987. Short light cycles induce persistent reproductive activity in Ile-de-France rams. *Journal of Reproduction and Fertility* **34(Suppl.):** 215-226.

Smith, J.F., Johnson, D.L., and Reid, T.G. 1992. Genetic parameters and performance of flocks selected for advanced lambing date. *Proceedings of the New Zealand Society of Animal Production* **52:** 129-131.

Smith, J.F., Parr, J., Johnson, D.L. and Duganzich, D.M. 1993. The date of onset of puberty in ewe lambs as an indicator of the ability to breed out-of-season. *Proceedings of the New Zealand Society of Animal Production* **53:** 299-302.

Xu, Z.Z., McDonald, M.F., McCutchon, S.N. and Blair, H.T. 1991. Seasonal variation in testis size, gonadotrophin secretion and pituitary responsiveness to GnRH in rams of two breeds differing in time of onset of the breeding season. *Animal Reproduction Science* **24:** 281-292.

Xu, Z.Z., McDonald, M.F., McCutchon, S.N. and Blair, H.T. 1992. Testis size and endocrine parameters in rams as predictors of aseasonality in their daughters. *Proceedings of the New Zealand Society of Animal Production* **52:** 195-198.