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The date of onset of puberty in ewe lambs as an indicator of the ability to breed out-of-season

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ABSTRACT

A total of 134 ewe lambs born in 1991 from the Ruakura "Kamo" out-of-season breeding flock were run with harnessed vasectomised rams from weaning and inspected weekly for onset of puberty and subsequent oestrus activity.

The breeding values for date of lambing (BV) for these animals were calculated from a pedigree and performance database. Multiple regression analysis were performed to determine the value of factors associated with hogget oestrus for predicting BV. While all the factors analysed, date of puberty, age and weight at puberty and number of subsequent oestrus cycles, had significant effects, none were as useful a predictor as date of birth (Bday). Season of birth (autumn vs spring) also exerted considerable influence on date of first tup and number of cycles. The results indicate that the best method of selection at present is that based on date of birth. Further research is needed to understand the interaction between season of birth and BV as they influence the onset of puberty.

Keywords: puberty, ewe lambs, out-of-season breeding, breeding values.

INTRODUCTION

In the last decade there has been a continual and increasing interest in the need for an expansion of the sheep breeding season in New Zealand to accommodate the developing requirements of the chilled meat trade (larger lean lambs throughout the year). While hormonal and other techniques have been shown to successfully advance the breeding season of sheep in New Zealand (Smith *et al.*, 1989) these treatments have cost and marketing ramifications.

It has been demonstrated that selection for earlier lambing can result in flocks with advanced lambing patterns, although in New Zealand this has been confirmed to crosses involving the Polled Dorset breed (Andrews, 1983; McQueen and Reid, 1988). In the latter flock it has been shown (Smith, Johnson and Reid, 1992) that date of lambing has a relatively high heritability (0.31) and repeatability (0.43).

Selection of replacement ewe and ram lambs in that flock is currently based on breeding values (BV) for date of lambing which provides an estimate of the genetic merit of that animal to lamb out of season. However, in flocks that do not have a historical pedigree and performance database for early lambing, an early indication of genetic merit is required for the selection of replacement ewes and rams.

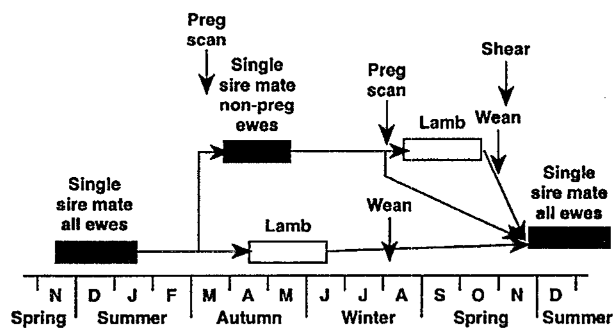
This paper reports on an initial investigation of onset of ewe lamb oestrus (puberty) as a possible selection indicator for female flock replacements using data from the Ruakura out of season breeding flock.

METHOD

Animals

A total of 134 lambs born in either the autumn (106) or spring (28) of 1991 from the Ruakura "Kamo" out of season selection flocks (Smith, Johnson and Reid 1992; see Figure 1 for outline of flock management) were used. The lambs were run with harnessed vasectomised rams from the time of weaning of each group, and were inspected weekly for tup marks to indicate the onset of puberty and subsequent cyclic activity throughout 1992. Liveweight was recorded monthly from weaning onwards.

FIGURE 1: Schematic representation of the breeding management practices throughout the year for the selection flocks.



Breeding Values (BVs)

Breeding values for date of lambing for born 1991 animals were derived simply as the average of the parental BVs which were calculated using BLUP procedures from the information contained in the historical pedigree performance database for this flock (Smith, Johnson and Reid, 1992).

Data analysis

Variates include BV, lamb birth date (Bday), season of birth (autumn or spring), date of puberty (tupday), age at puberty (tupage), weight at puberty (interpolated from weights pre and post that date - tupwt) and number of oestrous cycles (ntup). Addative regression models were used to examine the effects of these factors on either BV or date of puberty or number of oestrous cycles. Correlation co-efficients between the parameters were calculated on an overall basis and also within season of birth.

RESULTS

Ewe lambs were ranked into quartiles on basis of the BV for date of lambing. Ewes with the lowest (-ve) BV (potential early lambers) showed earlier date of puberty and had more oestrus cycles than did higher (+ve) BV lambs (potential late lambers) (see Table 1 and Fig. 2).

TABLE 1: Mean values by quartile of breeding value for date of lambing (BV) and season of birth on date of puberty (tupday), weight at puberty (tupwt), age at puberty (tupage) and number of oestrous cycles (ntup).

Quartile	n	BV	tup day (day of year and date)	tupwt (kg)	tupage (days)	ntup
1	34	-0.173	70.9 (13.03.92)	41.2	294	7.8
2	33	-0.078	78.8 (21.03.92)	40.7	296	7.3
3	34	-0.025	91.1 (02.04.92)	39.6	296	6.8
4	33	+0.075	122.3 (03.05.92)	36.9	284	4.3
Season of birth						
Autumn:	106	-0.084	79.7 (22.03.92)	40.6	296	7.1
Spring:	28	+0.070	138.0 (19.05.92)	35.6	274	3.9

There was a significant effect of BV on date of puberty with the lower (-ve) BV animals being earlier. However this was confounded with season of birth as all of the spring born lambs (+ve BV) were in the last two quartiles of BV (Fig. 3). The spring born lambs although reaching puberty at a later date were on average lighter in bodyweight and younger at that date.

The overall correlation matrix and also that within season of birth are presented in Table 2. All the overall correlations were significant, with birth day having the strongest correlation to BV. However, this was reduced considerably when examined within season of birth. Similar effects were seen with the relationship between BV and date of puberty and between birth day and date of puberty. In contrast the correlation between date of puberty and age at puberty was increased by examination within season of birth. There was a high correlation between age and weight at time of puberty and this was unaffected by examination within season.

Regression analysis of factors affecting prediction of breeding value (BV) showed that the greatest reduction in residual standard deviation (RSD) by single factors was achieved by fitting birth date (Table 3). Season of birth

FIGURE 2: The pattern of onset of oestrus and oestrus cycle data for the first (autumn born) and fourth (spring born) quartiles of ewes (based on BV).

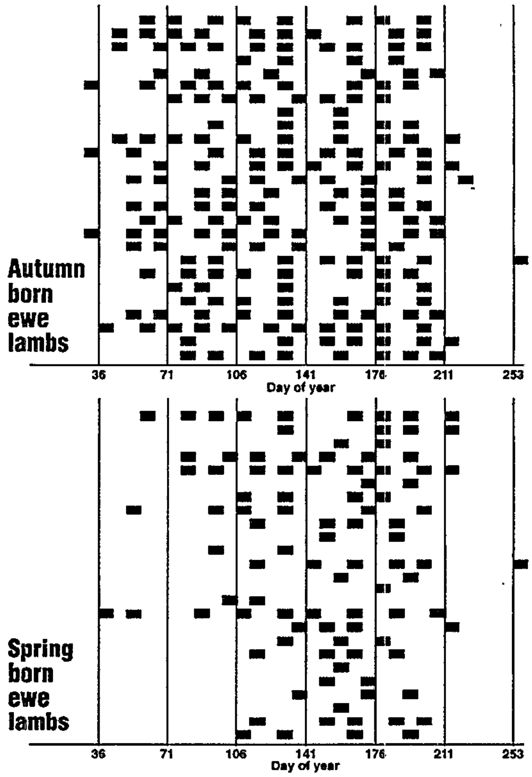


FIGURE 3: Distribution of ewes within BV ranges for season of birth.

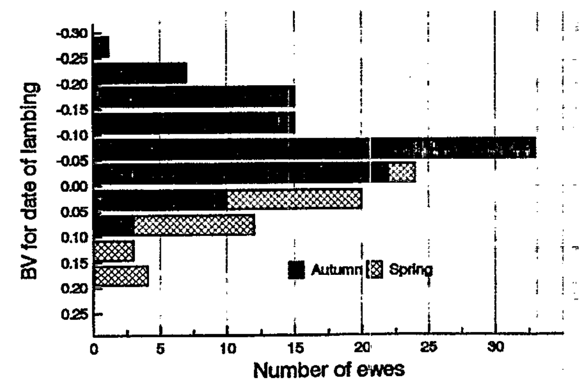


TABLE 2: Correlation matrix for traits examined. Overall values (df = 120) and those for within season of birth ( ).

Date of birth (Bday)	0.650 (0.299)			
Date of puberty (tupday)	0.511 (0.210)	0.201 (0.423)		
Weight at puberty (tupwt)	-0.280 (-0.108)	-0.490 (-0.440)	-0.390 (-0.257)	
Age at puberty (tupage)	-0.200 (0.013)	-0.416 (-0.254)	0.358 (0.769)	0.986 (0.984)
	BV	Bday	tupday	tupwt
Critical values of r				
	P < 0.05	-	0.178	
	P < 0.01	-	0.232	
	P < 0.001	-	0.294	

(autumn vs spring) was the next best factor, however the effect was not significant when season was fitted after date of birth ($0.05<P<0.1$).

TABLE 3: Summary of the regression analysis for factors influencing prediction of BV (mean -0.0520 SD 0.0936).

Factors	RSD	adjusted r^2	
Age at puberty (tupage)	0.0930	0.013	
Weight at puberty (tup wt)	0.0893	0.091	
Number of cycles (ntup)	0.0809	0.253	
Date of puberty (tupday)	0.0807	0.257	
Season of birth (season)	0.0713	0.419	
Season + ntup	0.0702	0.438	(*)
Season + tupday	0.0700	0.441	(**)
Date of birth (Bday)	0.0689	0.458	
Bday + tupday	0.0689	0.458	
Bday + season	0.0683	0.467	(+)
Bday + season + tupday	0.0683	0.468	

Parenthesis indicate significance level of improvement over the previously fitted single factor.

The best prediction was achieved with the fitting of 3 variables - date of birth, season and date of puberty although this only improved the adjusted r^2 by 1% over that for date of birth alone.

Regression analysis on factors influencing the date of puberty and the number of oestrous cycles were also performed. All factors had significant effects with date of birth being the most influential of the single factors and no other single factor having a significant additional effect once late of birth was fitted. Maximum reduction in RSD was obtained by fitting age at puberty, weight at puberty, BV and season which gave an adjusted $r^2 = 0.852$.

Similar findings were obtained with the number of cycles for each individual ewe where the r^2 for the same final model was 0.630.

More detailed analysis of the within season effects showed that the major influence was derived from the autumn born animals. This is mainly due to the small number of spring born animals and their relatively synchronised birth date.

DISCUSSION

Breeding value for date of lambing is an indicator of the genetic potential for that animal to lamb out-of-season. Examination of factors associated with hogget oestrus as potential predictors of this ability (BV) has indicated that while age at puberty, weight at puberty, number of cycles in the year, and date of puberty all had significant effects, they were not as good predictors as was the date of birth of the animal or its season of birth. The best prediction was obtained with combination of date of birth, season of birth and date of puberty. This means that in the selection of replacement ewes for a breeding flock, that wishes to increase its potential for out of season breeding, emphasis should be placed on birth date of the lamb and on the date of its first hogget oestrus.

The relationship between the breeding value for date of lambing and date of puberty seen in these data was most interesting. Superficially there appeared to be a strong linear progression in date of puberty as BV increased. However, because of the confounding between BV and season of birth and also the relatively small number of animals in the spring born group the relationship is not so certain.

There are a number of possibe reasons for the earlier onset of hogget oestrus in the autumn born lambs. Firstly, because of their low (-ve) BV, the environmental window (determined by changes in day length) during which they can express oestrus is wider due to genetic changes in sensitivity to seasonal patterns of day length. Secondly, because of an earlier date of birth they have simply reached the required age and liveweight needed for the expression of puberty at the opening of the environmental window while the spring born lambs are later because, although the environmental window is open, they have not reached sufficient age and weight for puberty to be expressed. This possibility is supported by the data which showed that although the spring born ewes have a later date of first tup, that on average, they were younger and lighter than the autumn born lambs were when they were first tupped. This is supported by the data of Dufour (1975) with Dorset cross ewes in Canada. Thirdly, the early puberty of the autumn born lambs is due to the photoperiodic signals (long days) they received whilst in utero via maternal melatonin levels (Helliwell and Williams 1990).

Recent data (Helliwell *et al.*, 1992) has shown that the photoperiod the ewe was exposed to during pregnancy influenced the interval to puberty in the lambs, with lambs from ewes experiencing long days in pregnancy having an earlier puberty.

These results highlight the need for further data to be obtained on this relationship. However to avoid the confounding between BV and season of birth it seems that collection and freezing of both -ve and +ve BV embryos is required with transfer of both classes of embryos to recipients scheduled to lamb in autumn and spring.

The mean date of first oestrus for the autumn born ewes the present trial (22 March) is well in advance of the previously earliest onset reported in New Zealand (Edey, Kilgour and Bremner, 1978) with a median date of April 27. However the mean date of first oestrus for the spring born lambs (19 May) was more in line with the average reported date for New Zealand flocks (W.H. McMillan pers. comm.).

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