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

OVULATION-LIVEWEIGHT RELATIONSHIPS IN EWES

J. F. SMITH, P. V. RATTRAY, K. T. JAGUSCH, N. R. COX and H. R. TERVIT

Ruakura Animal Research Station, Hamilton

SUMMARY

Ovulation rate data, from experiments in which different levels of nutrition were imposed on ewes in the pre-mating period, were analysed by the fitting of linear models, following logit transformation, to determine the effect of the nutritional treatments and other explanatory variables (*e.g.* liveweight and liveweight change). Major effects of pasture allowance, pasture yield and silage supplementation over and above that due to liveweight were observed. Static liveweight accounted for less than 30% of the difference between treatments.

INTRODUCTION

The relationship between liveweight, liveweight change and lambing performance has been examined by many investigations over the past 30 years. More recently, relationships between liveweight and ovulation rate have been studied and some of these investigations have been discussed and reviewed by Cumming (1977) and by Allison and Kelly (1978). In general, where a range in both ovulation rate and liveweight existed at mating, strong positive associations were evident. However, the interpretation of these relationships and their use in management decisions require careful consideration of the underlying biology. Morley *et al.* (1978) have questioned the validity of predicitions made from some published data and have presented reanalyses of several experiments. They concluded that "predictions of responses to improved nutrition should not be made from individual liveweights and ovulation rates, but from the between group components of groups, which have been subjected to different nutritional regimes".

This paper presents the analyses of the liveweight-ovulation rate relationship from a number of experiments in which groups of ewes received different nutritional regimes.

MATERIALS AND METHODS

SOURCE OF DATA

The data analysed were obtained from five experiments conducted at Ruakura. These involved different allowances of pasture or supplementation of pasture with silage and have been previously described (Rattray, Jagusch, Smith and Tervit, 1978; Rattray, Jagusch and Smith, 1978). In all trials the number of ovulations on each ovary was determined by laparoscopy.

Statistical Analyses

The variates analysed were the proportion of ewes having multiple ovulations and the proportion having multiple births. The logit transformation was applied to these proportions and linear models involving the relevant treatments and other explanatory variables (*e.g.*, liveweight, liveweight change) were fitted by an iterative weighted regression procedure using the statistical package "GLIM" which uses the methods described by Nelder and Wedderburn (1972). The logit transformation is the logarithm of the odds ratio, *i.e.*, logit = log $(p/\ (1-p))$, where p = proportion of ewes with two or more *corpora lutea* (or lambs).

The proportion of the treatment differences accounted for by static liveweight was determined as follows:

Percent difference accounted for by liveweight = E = $100\ (1-d^*/d)$, where d = the difference in the logit-transformed percent multiple ovulations (or births) for the two treatments, and d^* = the corresponding difference for the two treatments after adjustment to equal weights using the within-treatment regression.

The following factors and their interactions were included in the models for the respective trials:

(a) The 77 and 78 PA trials; liveweight at laparoscopy (LW), pasture yield (PY), pasture allowance (PA) and age (A).

(b) The 77 and 78 SS trials; LW, silage supplement (SS) and A.

(c) The 78 PA + EC trial, LW, initial ewe condition (EC), breed (B), PA and A.

Estimates of the effects of the various treatments were obtained from models that included all other significant treatments.

RESULTS

Multiple Ovulations

Effects of liveweight and liveweight gain: In all trials, liveweight at time of laparoscopy was as effective a predictor of percent multiple ovulations as were initial liveweight and liveweight change (gain) together. Hence, liveweight change gave no extra improvement in prediction above that from liveweight at laparoscopy. The effect of increased weight at laparoscopy was fairly consistent over the five trials (Table 1).

TABLE 1: EFFECT OF STATIC LIVEWEIGHT ON PERCENT MULTIPLE OVULATIONS AND MULTIPLE BIRTHS IN 5 TRIALS[1]

	77 PA	*78 PA*	*78 PA + EC*	*77 SS*	*78 SS*
Multiple ovulations	1.8[2] (±0.3) **	1.5 (±0.4) NS	1.8 (±0.3) *	1.9 (±0.3) **	2.3 (±0.6) ***
Multiple births	—	3.3 (±1.3) **	—	—	1.9 (±0.6) *

[1] PA = pasture allowance, EC = initial ewe condition, SS = silage supplementation.
[2] Multiplicative increases in the odds ratio due to liveweight within treatment groups (per 10 kg increase).

Treatment effects: Although treatment effects were associated with liveweight change, the addition of these treatment effects to the analyses improved the prediction.

Pasture allowance (offer) effects: These varied from trial to trial. In the 77 PA trial, the main effect was due to a reduced percentage of multiples at the lowest offer (2 kg DM/e/d) and little difference between the other offers at equal liveweight, while in the 78 PA trial both the 2 and 4 kg/e/d offers showed a reduced percentage. There was no significant effect in the trial involving an initial ewe-condition treatment (78 PA + EC). The effect of allowance is illustrated in Table 2, which presents the estimated percentage of ewes having multiple ovulations with ewes adjusted to 4 years of age and 50 kg liveweight.

TABLE 2: EFFECT OF PASTURE ALLOWANCE ON ESTIMATED PERCENTAGE OF MULTIPLE OVULATIONS (ADJUSTED TO 4 YEARS OF AGE AND 50 kg LIVEWEIGHT)

Offer (kg/DM/e/d)	*77 PA*	*78 PA*		*78 PA + EC*
2	30	31	(16[1])	53
4	55	33	(12)	67
6	57	54	(26)	55
8	67	58	(40[1])	
10	60	58	(44)	
Significance	$P < 0.01$	$P < 0.001$	($P < 0.01$)	NS
E[2]	30%	10%	(15%[1])	—

[1] Effects on multiple birth in the 78 PA trial.
[2] E = estimated proportion of treatment difference accounted for by static liveweight

Pasture yield effects: No significant difference was found in the 77 PA trial, but in the 78 PA trial the odds are doubled at the high yield (3250 kg DM/ha) compared with the low (1810 kg DM/ha). Thus, if ewes were at 50 kg liveweight and 4 years of age, the estimated percentages having multiple ovulations are high yield 56% and low yield 38%.

Silage supplement effects: In the 77 SS trial there was no significant effect over and above that due to liveweight. However, in the 78 SS trial the unsupplemented group on restricted pasture had a lower percentage of multiple ovulations compared with all the supplemented groups (Table 3). Thus at a weight of 50 kg the ewes on restricted pasture had an estimated 13% multiple ovulations compared with 54% for the supplemented ewes.

Age effect: The 6-year-old and older ewes tended to have fewer multiple ovulations, but only in one trial (77 PA) was the effect significant ($P < 0.05$). There was also a tendency towards increased percentage with increased age up to 5 years old.

Breed effect: Only in the 78 PA + EC trial was there a significant effect of breed over and above that due to liveweight. Hence at a liveweight of 50 kg the estimated percentage multiple ovulations were Perendales 59% and Coopworths 72%.

Initial ewe condition: This comparison was made in only one trial (78 PA + EC), and although the odds ratio for the "fat" ewes was 1.4 times greater than that for the "thin" ewes, the effect was not statistically significant.

Proportion of treatment differences accounted for by static liveweight: In none of the significant treatment differences outlined above did the proportion of the difference between treatments that could be accounted for by static liveweight exceed 30%.

MULTIPLE BIRTHS

In the 1978 trials, mating and laparoscopy were suitably coordinated to allow for comparison of lambing performance with the ovulation rate. Only ewes that lambed to the first service, corresponding to the ovulations examined at laparoscopy, were included in the analyses.

Compared with that for ovulation rate, the effect of liveweight on percentage multiple births was greater in the 78 PA trial, similar in the 78 SS trial, and became non-significant in the 78 PA + EC trial (Table 1). In the 78 PA trial the effect of pasture offered over and above that due to liveweight was similar to that on ovulation rate, but the effect of pasture yield became negligible.

TABLE 3: EFFECT OF SILAGE SUPPLEMENTATION ON ESTIMATED PERCENTAGES OF MULTIPLE OVULATIONS AND BIRTHS AT 50 kg LIVEWEIGHT

	77 SS Ovln	*78 SS Ovln*	*78 SS Birth*
Pasture (2 kg DM/e/d)	30	13	14
Pasture + Silage	24	54	53
Significance of difference	NS	$P < 0.001$	$P < 0.05$
E	—	29%	26%

The effect of silage supplementation remained at a similar level (Table 3), while in the 78 PA + EC trial the effect of breed was more pronounced for multiple births than it was for multiple ovulations, with 43% of the Perendales and 73% of the Coopworths having multiple births.

The proportion of treatment differences attributable to static liveweight was once again less than 30%.

DISCUSSION

Coop (1966) described a "static" effect of liveweight *per se* on proportion of multiple births. He also defined a "dynamic" effect related to change in liveweight during a 6-week period prior to mating. Similar effects for ovulation rate have been reported by Killeen (1967). However, while the static effect of liveweight has been found in most studies, there has been considerable divergence of opinion in regard to the dynamic effect (Fletcher, 1971; Morley *et al.,* 1978).

The present analyses confirm the static liveweight effect, but liveweight was a poor predictor of percent multiples as there were effects of the various nutritional treatments over and above that due to liveweight. This differs from the findings of Morley *et al.* (1978) that any variations in ovulation rate due to treatments were largely accounted for by the effects of treatment on liveweight and that liveweight was associated with most of the variation in ovulation rates.

The large effects of pasture allowance and yield observed in the present trials, coupled with the variation in effect of silage supplementation between years, indicate that some component of the animals' nutrition has a marked effect on ovulation rate. This effect could also be compared with that obtained following lupin feeding (Knight *et al.,* 1975), where marked changes in ovulation were obtained with little change in liveweight. The nature of the nutritional component is unknown, but it unlikely to be simply the total levels of energy or protein (Corbett and Edey, 1977). It is more likely to involve the availability of particular amino acids or metabolites at a given level of energy. The nutritional level prior to any flushing treatment could also influence the effect (Gunn *et al.*, 1969), although in the 78 PA + EC trial this effect was non-significant.

The changes in magnitude of treatment effects between ovulation and lambing could be due to effects of treatment on embryonic mortality and thus the partial failure of multiple pregnancy (PFMP). One explanation for the increased effect of breed on multiple lambing in the 78 PA + EC trial is a difference in PFMP between breeds, with the Coopworth having 17% of the twin ovulating ewes giving birth to single lambs, while the level for the Perendales was 51%.

Further analyses of these data are being undertaken to determine the factors affecting the incidence of PFMP.

In conclusion, the value of liveweight as a predictor of ovulatory response to nutritional treatment would appear to be very limited. Limitations are imposed not only by such factors as genotype, age and season of year, but also by the effects of nutritional treatment on ovulation that are not associated with liveweight.

ACKNOWLEDGEMENTS

The assistance provided by the staff of the Nutrition and Physiology Sections is acknowledged.

REFERENCES

Allison, A. J.; Kelly, R. W., 1978. *Proc. N.Z. Vet. Ass. Sheep Soc.* (in press).
Coop, I. E., 1966. *J. agric. Sci., Camb., 67*: 305.
Corbett, J. L.; Edey, T. N., 1977. *Aust. J. agric. Res., 28*: 491.
Cumming, I. A., 1977. *Aust. J. exp. agric. anim. Husb., 17*: 234.
Fletcher, I. C., 1971. *Aust. J. agric. Res., 22*: 321.
Gunn, R. G.; Doney, J. M.; Russel, A. J. F., 1969. *J. agric. Sci., Camb., 73*: 289.
Killeen, I. D., 1967. *Aust. J. exp. agric. anim Husb., 7*: 126.
Knight, T. W.; Oldham, C. M.; Lindsay, D. R., 1975. *Aust. J. agric. Res., 26*: 567.
Morley, F. H. W.; White, D. H.; Kenney, P.A.; Davis, I. F., 1978. *Agric. Systems, 3*: 27.
Nelder, J. A.; Wedderburn, R. W. M., 1972. *J. Roy. Stat. Soc., A135*: 370.
Rattray, P. V.; Jagusch, K. T.; Smith, J. F.; Tervit, H. R., 1978. *Proc. N.Z. Soc. Anim. Prod., 38*: 101.
Rattray, P. V.; Jagusch, K. T.; Smith, J. F., 1978. *Proc. Ruakura Fmrs' Conf.*: FPP 155.