Effects of season, lactation and plane of nutrition on the reproductive performance and associated plasma LH and progesterone profiles in hormonally treated ewes

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Summary. Two experiments were designed to determine the effects of duration of lactation and plane of nutrition on the reproductive performance of Finn × Dorset Horn ewes mated at a hormonally induced oestrus 9 weeks after lambing. In Exp. 1, ewes were mated on 4 December or 19 March and lactation was terminated at 35 or 15 days before mating or 7 or 35 days after mating. The fertility of ewes lactating at the time of mating was reduced, particularly in ewes mated in March. This was not attributable to differences between lactating and non-lactating ewes for the incidence of oestrus, ovulation rate, litter size or the pattern of LH production. Indirect evidence based on progesterone profiles and returns to service suggest that reproductive failure was due to failure of fertilization and to embryonic death.

In Exp. 2 ewes were mated on 1 July or 15 October. Lactation was terminated 15 days before or 7 days after mating and the ewes in each group were subjected to a high or low plane of nutrition. Lactation depressed fertility in ewes mated in July but not in those mated in October. While the fertility of non-lactating ewes was independent of nutritional treatment, lactating ewes on a low plane and mated in July had a higher lambing rate than those on a high plane of nutrition. Nutritional effects on fertility appeared to be mediated through changes in milk production and reproductive failures were attributed to failure of fertilization and embryonic death. Seasonal and treatment effects on the incidence of oestrus and on ovulation rates, litter sizes and LH production were small and of little importance.

Introduction

Studies in which Finnish Landrace × Dorset Horn ewes were kept under artificial daylength conditions and weaned after 1 month of lactation (Robinson, Fraser & McHattie, 1975) showed that conception rates of about 90% and litter sizes greater than 2 could be obtained consistently in a breeding programme involving a 7-month interval between lambings. This interval was achieved by the synchronization of oestrus using intravaginal pessaries impregnated with progestagen. Subsequent studies (Fraser, Robinson, McHattie & Gill, 1976) showed that a similar level of production could be obtained from ewes of this breed kept under natural daylength conditions, provided that each ewe was given a small dose (400 i.u.) of pregnant mares' serum gonadotrophin (PMSG) at the time of pessary withdrawal. Important features of these studies were the high plane of nutrition (1.75 × maintenance) of the ewes between weaning and remating and the termination of lactation before rebreeding. While weaning before the time of rebreeding eliminates any possibility of adverse effects of lactation on subsequent fertility, it imposes a degree of restriction on the intensive system of sheep production that may not always be acceptable in practice.

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Fertility is generally depressed when ewes are mated during lactation, particularly during the anoestrous season (Cognie, Hernandez-Barreto & Saumande, 1975; Dawe & Fletcher, 1976) or are kept on a low plane of nutrition before mating, particularly when in poor condition (Coop, 1966). Some studies on the fertility of lactating ewes induced to breed during anoestrus have been made (Cognie *et al.*, 1975) but little is known of the effects of time of weaning and plane of nutrition on the fertility of ewes bred more frequently than once a year. Shevah, Black & Land (1975) attempted to breed non-lactating and lactating ewes within 35 days after parturition but obtained poor lambing rates. Their results may have been influenced by the fact that uterine regression was unlikely to have been complete at this time, particularly in lactating ewes (Choffardet, 1971; Honnmode, 1977). In addition the effects of plane of nutrition on the fertility of lactating ewes were not assessed.

The present paper reports the results of two experiments on the effects of duration of lactation, season of breeding and nutritional status on some aspects of the reproductive performance and endocrine status of Finnish Landrace $\times$ Dorset Horn ewes mated at a hormonally-induced oestrus 9 weeks after lambing.

Materials and Methods

Animals and management

Both experiments involved F1 generation ewes that had previously been bred at intervals of 210 days. They were individually penned with their lambs and, although housed at all times, were subjected to daylength conditions natural at 57°10'N 2°04'W. The ewes were randomly allocated to their treatments immediately after parturition. From 2 weeks of age the lambs had free access to a creep feed. Oestrus was synchronized with intravaginal pessaries impregnated with 30 mg Cronolone (G. D. Searle Ltd) plus 400 mg progesterone (Sigma Chemicals, St. Louis, Missouri, U.S.A.) dispersed in fine crystals throughout the pessary as described by Gordon (1971). Pessaries were inserted for 12 days from 53 (s.e. $\pm$ 0.3) days *post partum*, and each ewe was given an intramuscular injection of 400 i.u. MSG (Folligon, batch 1404: Intervet Ltd, Bar Hill, Cambridge, U.K.) in 2 ml sterile saline (9 g NaCl/l) at pessary withdrawal. Two days later all ewes were hand mated to Suffolk rams. Each ewe was mated at approximately 24 and 36 h after the onset of oestrus. In Exp. 1 ewes were mated on 4 December (Flock D) or 19 March (Flock M) and in Exp. 2 on 1 July (Flock J) or 15 October (Flock O).

Experiment 1

The mean ($\pm$ s.e.m.) weights of the ewes in Flocks D and M immediately after parturition were 62 ± 1.2 and 69 ± 1.2 kg respectively and the corresponding mean numbers of lambs reared by each ewe were 1.9 ± 0.06 and 2.0 ± 0.06 .

Treatments. Within each flock the animals were allocated to 1 of 4 weaning times. These corresponded to 30, 50, 70 or 100 days after parturition and are designated W30, W50, W70 and W100 respectively. Thus lactation was terminated at 35 or 15 days before mating or 7 or 35 days after mating. During lactation the ewes were given *ad libitum* a complete diet. Their mean daily intakes of metabolizable energy (ME) were over 30 MJ throughout lactation. At weaning the daily ME intake of the W30, W50 and W70 ewes was reduced to 14 MJ and 1 month after mating to 7 MJ whereas W100 ewes had their daily intake reduced directly to 7 MJ at weaning. The changes in ewe liveweight provide an index of their nutritional status and are given in Text-fig. 1.

Mean lamb growth rates, which are an index of milk yield, were 270 ± 6 g/day during the first 30 days of lactation when creep feed intakes were negligible and rose to 360 ± 19 g/day after Day 70 of lactation when the mean daily ME intakes from the creep feed were 3.5 ± 0.47 MJ/lamb.

Text-fig. 1. Changes in mean weights of the ewes in Flock D (mated in December) and Flock M (mated in March) and weaned (W) after approximately 30 (■), 50 (●), 70 (□) or 100 (○) days of lactation.

Experiment 2

The mean ($\pm$ s.e.m.) weights of the ewes in Flocks J and O immediately after parturition were 66 ± 1.5 and 72 ± 1.7 kg respectively and the corresponding mean numbers of lambs reared by each ewe were 2.2 ± 0.10 and 2.0 ± 0.08 .

Treatments. Within each flock the ewes were allocated to 1 of 4 treatments according to a 2×2 factorial design comprising 2 weaning times and 2 planes of nutrition. The weaning times were 50 and 70 days after parturition, i.e. 15 days before and 7 days after mating. After free access for the first 50 days of lactation to a complete diet which resulted in a mean daily ME intake of about 25 MJ, the ewes within each weaning group were allocated to a high (H) or low (L) plane of nutrition. For each plane of nutrition the nutrient intakes were estimated to maintain the same nutritional state in lactating and non-lactating ewes between 50 and 70 days after parturition and to sustain these in all ewes for the next 30 days. The treatment groups were designated W50H, W50L, W70H and W70L. During lactation the daily ME intakes were approximately 25 and 16 MJ for the high and low planes of nutrition respectively. Corresponding values after weaning were 14 and 7 MJ. As in Exp. 1 the changes in ewe liveweight are given in Text-fig. 2 and provide an index of the nutritional status of the ewes.

The lamb weight gains in conjunction with the ME intakes as creep feed were used as an index of ewe milk yield and were 266 ± 7 g and 0.9 ± 0.06 MJ of ME/day respectively in the first 50 days of lactation. Values in the period 50–70 days of lactation for Groups W70H and W70L were 370 ± 21 and 296 ± 15 g ($P < 0.01$) respectively for weight gain and 4.6 ± 0.49 and 5.1 ± 0.35 MJ for creep feed intake.

Measurements

The incidence of oestrus from 2 weeks *post partum* until pessary insertion was assessed by exposing the ewes to a vasectomized ram each day. The time of the onset of oestrus following

Text-fig. 2. Changes in mean weights of the ewes in Flock J (mated in July) and Flock O (mated in October) and subjected to different times of weaning (W) (50 or 70 days) and high or low plane of nutrition: W50L ($\square$), W50H ($\blacksquare$), W70L ($\circ$), W70H ($\bullet$).

hormone treatment was similarly determined with tests every 6 h. Ovulation rates were determined by laparoscopy using the technique of Phillipppo & Rhind (1977).

From the time at which the first ewes were observed in oestrus until 27 h after the onset of oestrus, blood samples were collected from each ewe, by jugular venepuncture, every 3 h. Plasma samples were assayed for LH by the radioimmunoassay method of Chesworth (1977). The standard was NIH-LH-S17.

Plasma progesterone concentrations were determined once or twice per week during the first 2 months after the induced oestrus to provide a measure of luteal activity and for pregnancy diagnosis. The radioimmunoassay technique was a modification of that of Henricks, Dickey & Hill (1971). The antiserum (Y 29/6) was raised in sheep to 6β -hydroxyprogesterone-hemisuccinyl-BSA and diluted to 1:4000 in PBS-0.1% gelatin. Cross-reactions were 8.8% with 5β -pregnane-3,20-dione, 11.1% with deoxycorticosterone and $\leq 0.2\%$ with other steroids. Average recovery of [^3H]progesterone from plasma for each of 4 concentrations within the range 0.5–9.5 ng/ml was $78 \pm 0.7\%$ ($n = 12$ for each concentration) and intra- and inter-assay coefficients of variation were 12% ($n = 19$) and 22% ($n = 42$) respectively. The sensitivity of the assay was 0.04 ng/tube.

Statistical methods

Most of the results were analysed by a 2-way classification analysis of variance in which the main effects of season and treatment and their interaction were examined. Data concerning ovulation rates and litter sizes were analysed by the Mann-Whitney U-test, a non-parametric test which involves ranking of the data (Siegel, 1956).

Results

Experiment 1

Oestrous activity between parturition and pessary insertion. The proportion of ewes that showed oestrus (Table 1) was greater in Flock M than D ($P < 0.001$) and for ewes of Group W30 than for Groups W50/70/100 combined ($P < 0.05$). The mean interval from parturition to first oestrus was shorter ($P < 0.05$) in Flock M.

Table 1. Incidence and time of occurrence of overt oestrus between lambing and pessary insertion in relation to month of mating and time of weaning (Exp. 1)

Group	Month of mating			
	December (Flock D)		March (Flock M)	
	W30	W50/70/100	W30	W50/70/100
No. of ewes/treatment	10	32	12	35
No. of ewes showing overt oestrus	1	1	7	12
Interval (days) from lambing to overt oestrus (mean and range)	46.0	45.0	42.0 (35–41)	48.3 (45–54)

Oestrous activity and ovulation rates after pessary withdrawal. One ewe (Group W70, Flock M) failed to show oestrus after pessary withdrawal. While there were no significant differences between lactating and non-lactating ewes in the interval between pessary removal and oestrus onset (Table 2) the interval was shorter by about 8 h for Flock M ewes. Overall mean ovulation rates ($\pm$ s.e.m.) were 2.9 ± 0.15 (Flock D) and 3.1 ± 0.16 (Flock M) and the range was similar for all groups.

Table 2. Oestrous activity and ovulation rates of ewes after pessary withdrawal in relation to month of mating and time of weaning (Exp. 1)

	Month of mating and group						Significance of differences		
	December (Flock D)			March (Flock M)					
	W30	W50	W70/100	W30	W50	W70/100	r.s.d.*	Treatments	Season
No. of ewes/treatment	10	10	22	12	12	23			
No. of ewes showing oestrus	10	10	22	12	12	22			
Mean interval from pessary removal to observed oestrus (h)	36.1	40.1	39.5	32.0	30.0	30.8	5.66	N.S.	$P < 0.001$
No. of ewes examined by laparoscopy	6	6	8	5	6	11			
No. of CL									
Mean	2.7	3.2	2.9	2.6	3.2	3.3		N.S.	N.S.
Range	1-4	3-4	2-4	2-3	2-5	2-4			

* Residual standard deviation.

Lambing rates and litter sizes. At least 80% of ewes which had their lambs removed before mating lambled to the induced oestrus (Table 3) at each of the 2 times of year. In contrast, lactating ewes had a significantly lower lambing rate ($P < 0.001$) and this was most marked for those mated in March when just over one-third lambled to the induced oestrus. Although the mean litter size for the ewes that lambled to the induced oestrus was smaller for Flock M (2.2 ± 0.15) than Flock D (2.6 ± 0.16) ewes, this seasonal difference was not significant.

Table 3. Ewes lambing to the induced and repeat oestrus, oestrous activity after mating and mean litter sizes of ewes lambing to the induced oestrus in relation to month of mating and time of weaning (Exp. 1)

	Month of mating and group							
	December (Flock D)				March (Flock M)			
	W30	W50	W70	W100	W30	W50	W70	W100
No. of ewes/treatment	10	10	10	12	12	12	11*	12
No. lambing to induced oestrus	10	8	7	7	11	10	4	4
No. lambing to repeat oestrus	—	1	2	2	0	0	3	3
No showing 2nd repeat oestrus	—	0	0	2	1	1	1	2
No. failing to return to oestrus at 14–21 days and failing to lamb	—	1	1	1	0	1	1†	2†
No. of lambs born/ewe lambing								
Mean	2.6	2.8	1.7	3.3	2.3	2.2	2.0	2.5
Range	2–3	1–4	1–3	2–5	1–4	1–3	1–3	2–3
Mean no. of lambs born/ewe put to ram	2.6	2.2	1.2	1.9	2.1	1.8	0.7	0.8

* One ewe failed to show oestrus after pessary withdrawal.

† One ewe in each group (not in table) had an abnormally long interval between periods of oestrus.

Of the ewes that failed to lamb to the induced oestrus, 7 (26%) failed to show oestrus 14–21 days after mating. The progesterone levels (Text-fig. 3) in 5 of these ewes (Category A) were elevated for at least 20 days and in some ewes for more than 60 days after mating. Another ewe (Category B) initially had elevated progesterone concentrations but these declined to <1 ng/ml at Day 18 and then rose, suggesting a 'silent heat'. The remaining ewe (Category C) had progesterone concentrations of 1.0–1.5 ng/ml during the first few days after mating and <1 ng/ml at Day 10 after mating. Progesterone levels then rose to normal values for several days and declined again to <1 ng/ml at Day 27.

Text-fig. 3. Examples of the patterns of progesterone concentrations in three categories of ewes that failed to show a repeat oestrus and did not lamb: ○, Category A; □, Category B; ●, Category C.

Pattern of LH production. Basal plasma LH concentrations were generally <2 ng/ml in ewes of both flocks.

The highest concentration of LH recorded in the plasma samples collected during oestrus was arbitrarily designated as the preovulatory peak height. The precise areas under the peaks

were not assessed but an indication of their relative sizes was obtained by summation of the values recorded during the period when plasma LH levels were elevated. Of the variables measured, only the mean interval from oestrus onset to the start of the LH peak differed ($P < 0.05$) between ewes which conceived to the induced oestrus and those that did not, the interval being greater for ewes which failed to lamb to the induced oestrus (8.6 compared with 5.1 h). As the difference was small and probably of no biological significance, all the data were pooled for further analysis (see Table 4). No significant differences were found between weaning times for any of the variables investigated, but there was a small seasonal difference in the timing of the LH peak.

Table 4. Mean times to onset of LH peaks, and mean peak heights and 'areas' for ewes in relation to month of mating and time of weaning (Exp. 1)

	Month of mating and group						r.s.d.*	Significance of seasonal differences
	December (Flock D)			March (Flock M)				
	W30	W50	W70/100	W30	W50	W70/100		
Interval from pessary removal to start of LH peak (h)	42.0	42.9	45.1	40.5	36.8	39.7	7.42	$P < 0.01$
Interval from onset of oestrus to start of LH peak (h)	6.0	2.8	5.7	8.5	6.8	8.8	5.00	$P < 0.01$
Peak height (ng/ml)								
Mean	90.0	97.4	84.6	73.9	88.7	94.1	42.40	N.S.
Range	25–141	40–154	18–174	38–121	34–143	15–276		
Mean peak 'area' (ng/ml)	181.9	193.4	173.5	145.0	187.5	173.4	66.66	N.S.

* Residual standard deviation.

Experiment 2

Oestrous activity between parturition and pessary insertion. Oestrus was not recorded in any Flock J ewes before pessary insertion but 26% (11 ewes) of Flock O showed oestrus at a mean interval of 42.9 ± 1.30 (range: 35–48) days after lambing.

Oestrous activity and ovulation rate following pessary withdrawal. One ewe in Flock J was discarded because the pessary could not be removed. Another 6 (14.6%) ewes in Flock J and 1 ewe in Flock O failed to show an overt oestrus within 70 h of pessary withdrawal (see Table 5).

Table 5. Oestrous activity and ovulation rates of ewes after pessary withdrawal in relation to month of mating, time of weaning and level of feeding (Exp. 2)

	Month of mating and group							
	July (Flock J)				October (Flock O)			
	W50H	W50L	W70H	W70L	W50H	W50L	W70H	W70L
No. of ewes/treatment	8	10	8	15	8	10	8	16
No. showing oestrus	6	10	6	13	8	9	8	16
Mean interval from pessary removal to first oestrus (h)*	30.3	36.6	33.9	33.2	31.6	33.2	41.4	35.0
No. of ewes examined by laparoscopy	2	5	1	6	5	5	5	6
No. of CL								
Mean	2.0	2.4	2.0	2.7	3.2	2.4	2.4	3.0
Range	1–2	2–3	—	2–3	2–4	2–3	1–4	2–5

* The residual standard deviation was 0.56.

For those ewes that exhibited oestrus the mean interval from pessary withdrawal to onset of oestrus was not significantly affected by time of weaning, plane of nutrition or season. The same was true for ovulation rate (Table 5) although the overall mean value was slightly lower for Flock J ewes (2.3 ± 0.14) than for Flock O ewes (2.8 ± 0.21). The variation in ovulation rates did not differ significantly with treatment.

Lambing rates and litter sizes. In Flock J the lambing rates of ewes which had had their lactations terminated before the time of mating were higher than those of ewes lactating at the time of mating and this was true for both nutritional treatments (see Table 6). In contrast, there was no evidence of such an effect for ewes in Flock O in which conception rates were higher ($P < 0.01$). For the ewes lambing to the induced oestrus litter size was not significantly affected by time of weaning or plane of nutrition but was slightly lower for those mated in July (2.2 ± 0.12) than in October (2.4 ± 0.17).

Table 6. Ewes lambing to the induced and repeat oestrus, oestrous activity after mating and mean litter sizes of ewes lambing to the induced oestrus, in relation to month of mating, time of weaning and level of feeding (Exp. 2)

	Month of mating and group							
	July (Flock J)				October (Flock O)			
	W50H	W50L	W70H	W70L	W50H	W50L	W70H	W70L
No. of ewes/treatment	8	10	8	15	8	10	8	16
No. failing to show overt oestrus	2	0	2	2	0	1	0	0
No. lambing to induced oestrus	3	7	1	7	5	8	6	13
No. lambing to repeat oestrus	0	1	3	3	0	0	2	1
No. showing a 2nd repeat oestrus	1	1	0	1	2	0	0	1
No. failing to return to oestrus 14–21 days and failing to lamb	2	1	2	2	1	1	0	1
No. of lambs born/ewe lambing								
Mean	2.3	2.0	1.0	2.4	2.0	2.0	2.7	2.7
Range	2–3	—	—	2–3	1–3	1–3	2–4	2–4
Mean no. of lambs born/ewe put to ram	0.9	1.4	0.1	1.1	1.3	1.6	2.0	2.2

Table 7. Mean times to onset of LH peaks, and mean peak heights and 'areas' for ewes in relation to month of mating, time of weaning and level of feeding (Exp. 2)

	Month of flock and group								r.s.d.*	Significance of seasonal differences
	July (Flock J)				October (Flock O)					
	W50H	W50L	W70H	W70L	W50H	W50L	W70H	W70L		
No. of ewes/treatment	8	10	6	14	8	9	8	16		
Interval from pessary removal to start of LH peak (h)	35.3	41.1	39.5	45.5	40.5	39.3	49.1	45.2	10.5	N.S.
Interval from oestrus onset to start of LH peak (h)	5.2	4.5	5.6	7.6	8.9	6.2	7.7	10.2	5.0	$P < 0.05$
Peak height (ng/ml)										
Mean	72.0	71.7	48.3	60.2	80.5	56.1	57.1	70.0	28.4	N.S.
Range	45–128	50–96	37–70	13–118	42–143	12–125	32–92	18–123		
Mean peak area (ng/ml)	138.1	130.9	97.3	111.4	144.3	116.7	108.5	135.6	43.9	N.S.

* Residual standard deviation.

Of the ewes that were mated at the induced oestrus and failed to lamb, 10 (38.5%) also failed to show an overt oestrus between 14 and 21 days after mating. Examination of the progesterone profiles of these animals showed that in 9 delayed luteal regression indicative of embryonic death had occurred while the remaining ewe had an unusually short luteal phase and an early return to basal plasma progesterone concentrations (<1.0 ng/ml).

Pattern of LH production. The patterns of LH production in ewes which lambed to the induced oestrus and in those which did not were not significantly different. The data for the two categories were therefore pooled. Three of the ewes in Flock J which failed to show oestrus after hormonal treatment had LH surges which did not differ significantly from those of other ewes. These data were therefore included in the statistical analysis and the results are given in Table 7. The only significant effect was that of season on the interval from onset of oestrus to the start of the LH surge, the overall mean values being 5.9 and 8.6 h ($P < 0.05$) for ewes mated in July and October respectively.

Discussion

The results of Exp. 1 show that even in the well nourished Finn $\times$ Dorset Horn ewe spontaneous oestrus tends to be inhibited by lactation and that the size of the effect is dependent on the season. Despite this natural inhibition, oestrus was readily induced by hormone treatment but fertility was depressed by lactation and this was particularly true for ewes mated in March. These effects on fertility were not due to differences in ovulation rates between lactating and non-lactating ewes or between those mated in December and those in March.

There are many reports which suggest that the reduced fertility of ewes mated at an induced oestrus during lactation or outwith the breeding season may be due to failure of fertilization because of abnormal timing of LH release or onset of oestrus (Cumming *et al.*, 1970; Mauer *et al.*, 1972; Lintin, Lamming & Butt, 1973; Shevah, Black, Carr & Land, 1974). There was no evidence of such abnormalities in the present study. Furthermore, contrary to the findings of Pelletier & Thimonier (1973), Lewis, Bolt & Inskeep (1974) and Cognie & Pelletier (1976), the mean size of the LH surges was similar in non-lactating and lactating ewes, being consistent in both groups with the levels reported by others for non-lactating ewes (Geschwind & Dewey, 1968; Scaramuzzi, Caldwell & Moor, 1970; Kann, 1971). While there was considerable variation in the interval between onset of oestrus and the start of the LH peak, both within and between seasons, this period was not correlated with fertility.

Cognie & Pelletier (1976) showed that in lactating ewes, a proportion of eggs are shed abnormally late in relation to the LH surge and may not be fertilized. The timing of ovulations was not investigated in the present work but in view of the fact that differences in lamb production between lactating and non-lactating ewes arose from differences in the incidence of barrenness and not from differences in litter size, it seems unlikely that our results were influenced by this phenomenon. In contrast, the results suggest that lactation interferes primarily with pregnancy establishment before implantation. This may be deduced by comparing the lambing rates of ewes of Groups W70 and W100; delaying weaning until after implantation (Group W100) resulted in little additional barrenness. It would appear that most wastage of eggs or embryos occurred during the first 12 days of pregnancy when the ewes were either still lactating (Group W100) or when influenced by possible residual effects of lactation (Group W70). The fact that most ewes which failed to lamb to the induced oestrus returned to the ram 14–21 days later is also indicative of complete failure of fertilization or early embryonic death, i.e. before Day 12 (Moor & Rowson, 1964).

The observation, for 5 ewes which failed to lamb, of a prolonged elevation of plasma progesterone in early pregnancy suggests that embryo death also occurred after Day 12, because it seems unlikely that the elevated progesterone levels could result from the pessary and PMSG

treatment or from the presence of progesterone residues in the vagina after pessary withdrawal. Combining data for early and late embryo loss showed that the total incidence was greatest in ewes which were lactating at the time of mating. This may be a function of abnormal ova or embryos in the lactating animals (Cognie *et al.*, 1975) but it is also possible that luteal regression preceded embryonic death and was the cause of it. The occurrence of premature luteal regression in one ewe at about 7–10 days after mating supports this view. Short oestrous cycles have been recorded previously in lactating Finn $\times$ Dorset ewes (Land, 1971) and in hormonally treated non-lactating ewes of the same breed (J. J. Robinson, unpublished observations). They may be due to failure of the normal luteotrophic mechanisms or to abnormally early luteolytic activity.

The results of Exp. 2 illustrate the difficulties in controlling milk production and body tissue mobilization by altering only the plane of nutrition. The data suggest that the effects of nutrition on fertility were mediated through changes in milk production. For example, the higher conception rate for the ewes on a low (Group W70L) compared with a high (Group W70H) plane of nutrition was associated with a lamb growth rate which was 20% lower. As there was no effect of the plane of nutrition of the ewes on the intake of creep feed by the lambs, this reduction in lamb growth rate must have been associated with a reduction in daily milk yield. The evidence of similar differences in milk production within Flock O which were not associated with differences in fertility requires further validation but may suggest a season $\times$ milk yield interaction on fertility.

The results of this experiment are consistent with the suggestion made above that part of the reduction in fertility of ewes at some times of year is the result of early embryonic death.

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