EFFECTS OF EARLY- TO MID-PREGNANCY NUTRITION OF EWES ON EWE AND LAMB LIVEWEIGHT AND BODY COMPOSITION, AND ON MILK INTAKE BY LAMBS

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SUMMARY

Three groups of grazing ewes were managed so that over the period from 30 days before mating until day 100 after the start of mating, they would either gain (H), maintain (M) or lose (L) maternal weight. By day 100, the nutritional treatments had resulted in a range (H v. L) of 8-9 kg in ewe liveweights (including conceptus), but a much larger relative range in body energy reserves. The groups grazed together for the last 50 days of pregnancy, with *ad libitum* access to pasture. After lambing in early August, ewe and lamb liveweights and body compositions, and milk intakes by lambs were measured commencing on days 9, 23, 44, 69 and 86 of lactation. The H ewes produced more milk than L ewes during lactation, but mobilised more body fat and protein, so that ewe liveweights were similar by the end of the study. Lamb liveweight gains in the L treatment were significantly lower than in the H and M treatments (H 223, M 214, L 188 g/day). Changes in lamb body composition reflected their liveweight responses. The results are discussed in relation to the nutrition of the breeding ewe.

Keywords: grazing ewes, pregnancy, lactation, milk intake.

INTRODUCTION

In the sheep, 85% of the growth of the foetus and almost all of the growth of the mammary tissues occurs during the last 50 days of pregnancy. It is therefore not surprising that studies of the influence of nutrition on foetal development and lactation performance have focussed on the level of feeding during late pregnancy and lactation (Robinson 1983; Treacher 1983). Moreover, management recommendations for the breeding ewe (eg., Meat and Livestock Commission 1981) have suggested that because of the low nutritional demands of the conceptus before day 100 of pregnancy, nutrients can be conserved for late pregnancy/lactation by moderately restricting ewes in early- to mid-pregnancy. This has become a relatively common practice under Australian conditions, in which lambs are frequently born before the onset of rapid pasture growth in spring. However, the extent to which ewes can safely be underfed in the first 100 days of pregnancy is not well defined.

Concerns about undernutrition in the first two-thirds of pregnancy are usually related to the possible reductions in placental size, with resultant effects on lamb birthweights and survival. However, it is also possible for undernutrition prior to day 100 to influence lactation, because of the involvement of the placenta in mammogenesis (Mellor 1987). For example, Mavrogenis *et al.* (1980) observed reduced milk production in ewes which were underfed before day 100 of pregnancy, despite *ad Zibitum* feeding over the last 6 weeks of pregnancy.

The present study was conducted under grazing conditions in southern Australia, to investigate the effects of varying levels of feeding prior to day 100 of pregnancy on the subsequent performance of ewes and their lambs.

MATERIALS AND METHODS

The results described in this paper were obtained at Ginninderra Experiment Station near Canberra, A.C.T., in Border Leicester x Merino ewes grazing pastures dominated by *Phalaris aquatica* and *Trifolium subterraneum.*

Animals and management during pregnancy .

In 3 groups, each comprising 40 ewes, grazing pressures were manipulated in an attempt to achieve either gain (II), maintenance (M) or loss (L) of maternal weight from 30 days before mating until day 100 after the start of mating to Dorset Horn rams. The rams were with the ewes from 3 March until 9 April. The mean date of mating for all ewes was 13 March (standard deviation 5.7 days), while that for the 24 ewes ultimately studied in lactation was 15 March (standard deviation 3.4 days). Over the last trimester of pregnancy, the ewes grazed pasture *ad Zibitum* until lambing commenced in early August. Within each of these groups, *in vivo* body composition was determined in a subset of 6 ewes from the dilution of injected tritiated water (TOH), using the procedures described by Donnelly and Freer (1974). Estimates were made when ewes were allocated to the treatments (late December), at mating and at days 21, 63, 111 and 140 after the start of mating.

Management during Lactation

At lambing, 3 groups of 8 ewes which had not received TOH during pregnancy, were selected from the H, M and L treatments, for inclusion in the present study of milk production and body composition during lactation. These 24 ewes grazed as a single group, together with their lambs. Due to inadequate late winter rains, pasture supply was sparse until the onset of spring rains near day 35 of lactation. Lambs were aged from 4 to 14 days (mean 9 ± 0.7 days) at the start of measurements. They were weighed near birth and then, starting on days 9, 23, 44, 69 and 86 of lactation, milk intakes were determined over 4-day periods using a double-isotope (TOH/D_2O) dilution procedure, as described in detail by Dove (1988). This also provided estimates of body composition in the ewes and lambs.

Chemical analyses

Procedures for the vacuum sublimation and liquid scintillation counting of blood samples required to determine the dilution of TOH in body water were as described by Donnelly and Freer (1974), while D_2O was assayed as described by Dove (1988).

Calculations and statistical analyses

Milk intake was estimated from the proportion of the lambs' total body water turnover derived from milk (Dove 1988). The *in vivo* body composition of ewes and lambs was estimated from their D_2O dilution spaces using the prediction equations of Donnelly and Freer (1974), supplemented with data for pregnant animals (Freer, unpublished data). Although these equations are based on a large number of animals, they do not include lactating ewes. However, comparison with the equations of Foot *et al.* (1979), which were based on 10 lactating Scottish Blackface ewes, showed no systematic differences in predicted body composition. The equations based on a larger number of animals were therefore preferred. The effects of plane of nutrition on liveweight, body composition and milk intake were examined by analysis of variance, using covariance to adjust for the spread in stage of lactation.

RESULTS

Changes in liveweight and body composition during pregnancy

At the time of their allocation to treatment groups, the ewes had a mean liveweight (± sem) of 41.5 ± 4.22 kg, a mean fat content of 5.7 ± 0.32 kg (13.5% of liveweight) and a mean energy content of 339 ± 11.8 MJ. The aim of the nutritional treatments was to generate gain, maintenance or loss of maternal tissue from the period from 30 days before mating until day 100 after the start of mating. This aim was only partly achieved. In the ewes ultimately studied during lactation, the observed weight changes (including conceptus) over this 130-day period were: H 13.5 ± 1.31 kg; M 10.1 ± 1.37 kg; and L 6.1 ± 1.07 kg. By day 100, ewes in treatment H were 10.8% (5.2 kg) heavier than ewes in treatment M and 18.1% (8.2 kg) heavier than ewes in treatment L. In their cohort groups in which body composition was measured during pregnancy, the difference in liveweight between H and L ewes was similar (22.8% or 9.0 kg); most of this difference of 9 kg was attributable to body fat (7.0 kg). Ewes on treatment L only maintained body energy content between allocation and day 100 (348 ± 11.7 MJ), while H ewes gained significantly (650 ± 12.9 MJ), so that the relative difference in body energy reserves between H and L ewes was much greater (86.8%) than the difference in liveweight. Ewe weights (including conceptus) immediately before lambing were 56.3 ± 1.08 kg (H), 52.1 ± 1.14 kg (M) and 50.1 ± 2.09 kg (L). These correspond to approximate maternal liveweights of 50, 46 and 44 kg respectively, on the assumption that at term, a lamb of birthweight 4.5 kg (see below) represents a conceptus weight of 6 kg (Agricultural Research Council 1980).

Responses of ewes during lactation

At day 9 of lactation, ewes from treatment L were significantly lighter ($P < 0.01$) than those from the other 2 treatments (Table 1). Thereafter, they lost significantly less weight ($P < 0.01$) so that by the end of lactation, ewe liveweights were not significantly different (H 44.5 ± 1.6 kg; M 44.8 ± 1.4 kg; L 43.4 ± 1.8 kg). Almost all of the difference in liveweight at day 9 was attributable to differences in body fat, which differed significantly between all treatments ($P < 0.025$). Over the course of lactation, ewes from treatment H lost significantly more fat ($P < 0.05$) than ewes in treatments M and L. Treatment differences in body protein content, while statistically significant, were small. The energy content (MJ) of the ewes and the way in which this changed during lactation were thus very similar to the observed changes in body fat content.

Milk intake and responses in lambs

Lamb birthweight was unaffected by the nutritional treatments imposed during pregnancy (Table 2), nor was there any significant difference in lamb liveweights at day 9 of lactation. Thereafter, lambs from

Table 1. Effects of the nutritional treatment of ewes in early- to mid-pregnancy on their liveweight and body composition on day 9 of lactation (kg, MJ) and on the daily changes from day 9 to day 86 of lactation (g/day, MJ/day)

Variate	Treatment			LSD[A]
	H	M	L	
Liveweight	50.8	49.1	44.4	4.6
Liveweight change	-79	-56	-2	49.9
Body fat	12.5	10.2	6.8	2.3
Change in body fat	-52	-19	7	34.9
Body protein	6.6	6.4	6.0	0.41
Change in body protein	-7	-5	0	4.8
Body energy content	645	551	408	98.8
Change in energy content	-2.2	-0.9	0.3	1.5

[A]Least Significant Difference ($P < 0.05$).

treatment L consumed significantly less milk ($P < 0.001$) throughout lactation, compared with lambs from the other treatment groups. Treatment differences in milk dry matter intake were similar, since no significant differences in milk dry matter content were noted (mean 18.2 ± 0.20%). Between days 9 and 86 of lactation, lambs from treatment L gained significantly less liveweight ($P < 0.025$), fat ($P < 0.005$) and protein ($P < 0.05$) than lambs from treatments H and M. Compared with lambs from treatment H, lambs from treatment L were 3.0 kg lighter and contained 1.7 kg less fat and 0.3 kg less protein by day 86 of lactation.

Table 2. Effects of the nutritional treatment of ewes in early- to mid-pregnancy on the birthweight (kg), milk intake (mL/day), liveweight and body composition (kg) of their lambs (at day 9 ± 0.7 of lactation) and on the daily gains from day 9 to day 86 of lactation (g/day)

Variate	Treatment			LSD[A]
	H	M	L	
Birth weight	4.6	4.4	4.6	0.23
Milk intake, days 9-13	1958	1771	1724	257.5
days 23-27	1280	1015	916	
days 44-48	913	910	761	
days 69-73	868	780	578	
days 86-90	602	701	462	
Liveweight	6.5	5.9	6.0	1.75
Liveweight gain	223	214	188	23.7
Body fat content	0.9	0.7	0.8	0.96
Gain in body fat	60	62	41	11.2
Body protein content	1.0	1.0	1.0	0.19
Gain in body protein	28	27	25	0.45

[A]Least Significant Difference ($P < 0.05$).

DISCUSSION

As a consequence of the restricted amounts of pasture available to the ewes during lactation, milk production did not rise to a peak but fell throughout the study (Dove 1988). Nevertheless, there was a marked effect of pregnancy treatment on milk production. Mean milk production to day 90 by the H ewes (1114 mL/day) was 7.5% higher than that of M ewes (1036 mL/day) and over 25% higher than that of L ewes (888 mL/day). Gains in lamb liveweight and body composition were correspondingly affected

(Table 2) so that L lambs were 3 kg lighter than H lambs by the end of the study.

Gibb and Treacher (1980) noted that, particularly when pasture intake in lactation was restricted, differences in ewe body composition established before day 90 of pregnancy could result in reduced milk production. Mavrogenis *et al.* (1980) manipulated feeding levels before day 100 of pregnancy to establish differences between their H and M ewes of 3.6 kg and between H and L ewes of 7.6 kg. Despite *ad Zibitum* feeding in late pregnancy, these differences resulted in differences in milk production of 8.5% (H v. M) and 24% (H v. L) respectively. Our results are remarkably similar.

Nutrition in the first 100 days of pregnancy can influence milk production in 2 ways. The first appears to operate via the process of mammogenesis. While almost all of the growth of the mammary tissue occurs late in pregnancy, the process is strongly influenced by secretions from the placenta, the concentrations of which are in turn affected by placental size (see Treacher 1983; Mellor 1987). By directly affecting placental development, ewe nutrition before day 100 can thus influence udder size and the capacity for milk production in the subsequent lactation (Davis *et al.* 1980; Robinson 1983; Mellor 1987).

However, milk production can also be influenced by the level of body reserves in the ewe at parturition, especially if nutrition during lactation is sub-optimal (Mavrogenis *et al.* 1980; Treacher 1983). Although all groups in the present study were fed *ad Zibitum* for the last 50 days of pregnancy, just as in previous studies (eg., Mavrogenis *et al.* 1980), this only partly compensated, for the earlier under-nutrition so that H ewes entered lactation with considerably greater body energy reserves than L ewes (Table 1). This "carry-over" effect of earlier nutrition, coupled with the poor pasture growth in early lactation, is likely also to have contributed to the reduced milk production by the L ewes.

The results discussed by the Meat and Livestock Commission (1981) indicate that ewes in good condition at mating (condition score 3+) appear to tolerate the loss of up to 0.5 units of condition score during the first 100 days of pregnancy, without detrimental effects on foetal growth or subsequent milk production. By contrast, ewes in treatment L of the present study essentially maintained condition over the first 100 days of pregnancy, but had significantly reduced milk production after lambing. This apparent contradiction is probably related to the fact that our ewes were in relatively poor condition at the start of the experiment (condition score 2), so that those in treatment L entered lactation with little by way of body energy reserves.

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