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Effects of mid-pregnancy nutrition and shearing on ewe body reserves and foetal growth

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ABSTRACT

In an experiment replicated over three years, ewes were individually fed concentrate diets containing two levels of protein (12 and 18%) at either maintenance or 1.5 x maintenance from days 35 to 74 of pregnancy, and then at an allowance of approximately 2.0 kgDM/head/day on pasture until parturition. Half of the ewes within each treatment were shorn on day 74. Ewes were CT scanned to measure body composition at days 35, 74, 115 and 140 of pregnancy. Neither protein nor energy level fed during mid-pregnancy had any significant effects on conceptus growth, birth weight or lamb skeletal measurements. Shearing resulted in changes in ewe body composition as well as an increase of 0.36 kg ($P<0.01$) in lamb birth weights. Lambs from the shorn ewes were 14 mm longer in length ($P<0.05$) but 8 mm shorter in height ($P<0.05$) than those from unshorn ewes. Shorn ewes lost 1.3 kg more body fat ($P<0.001$) than their unshorn contemporaries over the second half of pregnancy. Unshorn ewes lost 0.74 kg of carcass lean over this period, while the shorn ewes gained 0.22 kg ($P<0.001$). The results show that ewes can be fed maintenance during mid-pregnancy if this allows good quality feed reserves to be built up in front of them for the third trimester. Mid-pregnancy shearing is likely to increase lamb survival in multiple born lambs through higher birth weights.

Keywords: sheep; energy; protein; birth weight; CT scanning.

INTRODUCTION

There has been considerable industry push to lift lambing percentages in New Zealand. Increases in litter size are normally negatively related to birth weight, and reduced birth weight associated with poor neo-natal survival. Management practices that increase the viability of multiple born lambs can make a significant impact on farm profitability, and ensure that investment in increased prolificacy is not wasted.

A variety of management practices and nutritional regimes have an influence on birth weight., However, relatively little is known about the influence of management practices during the second trimester. Nutrition during mid-pregnancy has been shown to influence foetal size and therefore lamb viability and survival (Alexander, 1984). Low energy levels in the diet during the middle stages of pregnancy can reduce both placental growth and foetal size (Mellor, 1983). It has also been suggested that protein deficiencies can reduce conceptus growth in the second trimester (Robinson, 1987). Supplementation levels of bypass protein as low as 80g/head/day from day 50 to parturition in ewes fed on pasture have been reported to produce small but significant increases in birth weight (Hinch *et al*., 1996), although large individual variation in ewe protein intake was suspected.

Shearing ewes during mid pregnancy is a management practice shown to increase lamb birth weights in a number of studies (Austin & Young, 1977; Maund, 1980; Kirk *et al*., 1984; Morris & McCutcheon, 1997). Responses have been variable in these studies, with increases in birth weight in twins ranging from 0.3 to 1.1 kg for ewes shorn at various stages of pregnancy (days 50 to 130). Morris and McCutcheon (1997) compared birth weight responses to shearing at days 70, 100 and 130 days and found the greatest response (0.7 kg) following shearing at day 70. In a review of studies on mid- to late-pregnancy shearing, Kenyon *et al*. (1999) concluded that the response to shearing was greatest when conditions were likely to result in poor birth weights, i.e. when birth weight is maternally constrained.

The main objective of this experiment was to examine the effects of nutrition and shearing during mid-pregnancy on ewe body reserves and foetal growth. Specifically, the first goal was to define the effects of protein and energy content in the diet during mid-pregnancy on energy partitioning between the ewe and foetus. The second objective was to characterise the interaction of the above with mid-pregnancy shearing on ewe energy reserves and foetal growth and birth weight.

MATERIALS AND METHODS

Animals

The experimental ewes were mixed-age (four tooth or older) Romney ewes. For each of three years, ewes were synchronised with CIDRs and single-sire mated. Mating marks were recorded twice daily for two days, with the first day being defined as day 1 of gestation. Ewes were laparoscoped on day 17 to identify those with twin ovulations. On day 22, 75 ewes with twin ovulations that had not returned to service were selected for the initial experimental flock. This group was reduced to 64 ewes at day 35 following introduction to the experimental concentrate diet. The group was further reduced to its final level of 48 ewes following pregnancy detection with ultrasound at day 60 and selection of twin-bearing ewes. Any shortfall in twin-bearing ewes was made up from single -bearers. There were 32 sets of twins in 1997 and 1998, and 36 sets of twins in 1999.

Treatments

The critical period of foetal growth targeted in this experiment was between days 35 and 74 of gestation. During this period, individually penned ewes were randomly allocated to four experimental groups (*n*=16 per group at day 35) and fed one of two experimental

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diets of differing protein concentration (12 or 18% w/w) at either a maintenance feeding level or 1.5 times maintenance (0.55 or 0.82 MJME/kgLW$^{0.75}$, respectively). Feeding levels were designed to generate a 5 kg difference in ewe live weight between the maintenance and 1.5 x maintenance treatment groups at day 70.

Twelve ewes per treatment remained at the end of the individual feeding period. Half of each of the four nutrition groups (balanced for litter size) were shorn on day 74. Following shearing, the ewes were turned out onto pasture and run as a single mob. Daily feed allowance was set at approximately 2.0 kgDM/head. Live weights were recorded at three weekly intervals from day 74 until day 140.

Ewes were lambed in pens to ensure accurate pedigrees were recorded. Lambs were tagged, sexed and weighed at birth. Crown- to- rump length (CR) and hind-leg length (hip to foot; HF) were also measured at birth.

CT scanning was used to measure body composition in the ewes and growth of the conceptus. Body composition was measured on four occasions, namely days 35 (*n*=64), 74 (*n*=48), 115 and 140, with the exception of the final year in which the day 115 scan was omitted. Data analysed included total fat (TF), carcass lean (CL), non-fat visceral components (excluding the conceptus; VC), and carcass weight (CW) in the ewe. The weight of fat, lean and bone was measured in the conceptus (CPF, CPL and CPB, respectively). Ewes were condition scored at each CT scanning (Russel, 1984).

Statistical analysis

Ewe and lamb body composition and growth traits throughout the indoor and outdoor feeding periods in ewes and lambs were analysed using general linear models (SAS Institute Inc., 1992). For the analysis of both the indoor and outdoor periods, the change in ewe and conceptus component weights were analysed in a model that included terms for the fixed effects of year, protein level, energy level, birth rank and indoor site nested within year. First order interactions were fitted, and non-significant interactions were removed from the analysis. Carcass weight as at day 35 was fitted as a covariate. For the outdoor feeding period, the fixed effect of shearing was added to the analysis. Liveweight gain (LWG), gestation length, birth weight, crown-to-rump length and hip-to-foot length were analysed in a model that included the fixed effects of protein and energy levels, shearing treatment (where appropriate) and birth rank.

RESULTS

The ewe live weight and condition score, and data recorded at birth for the lambs are presented in Table 1. Detailed compositional information is presented in Table 2. The data have been analysed over two periods, namely the change over the indoor-feeding period (days 35 to 74), and the outdoor-feeding period (days 75 to parturition). During the indoor-feeding period, protein content in the diet had a significant effect on LWG (+1.1 kg [P<0.01] on the high protein diet; Table 1), but not ewe condition score. Protein level had no significant effect on body composition during this period (Table 2). The ewes from both protein groups gained body fat and carcass lean, but had small losses of visceral components. The effect of energy content on live weight and condition score was highly significant with ewes on the high energy allowance having 4.3 kg (P<0.001) and 0.35 (P<0.001) more (LWG) and condition score gain, respectively, than ewes on the low energy diet. The number of lambs born did not have a significant effect on either LWG or change in condition score.

Breaking the LWG down into its body composition components showed that ewes on the high energy diet gained 2.1kg (P<0.001) and 1.21 kg (P<0.001) more TF and CL, respectively, than ewes on the low energy diet. Also, the low energy diet resulted in a 0.55 kg loss of VC over the indoor feeding period, while the high energy diet resulted in a 0.20 kg gain (P<0.01).

The sustained effects of protein and energy over the outdoor-feeding period show that the only significant effect was that of energy on LWG (-2.77 kg [P<0.001] for ewes previously given the high- compared to the low-energy treatment). The difference comprised 0.92 kg (P<0.01) less TF loss, 0.89 kg (P<0.001) more VC gain, and a 0.23 kg gain in CL as opposed to a 0.75 kg loss for the low-energy diet ewes compared to the high- energy diet. Protein and energy treatments had no significant effects on gestation length, birth weight, CR and HF, or on the gain in conceptus fat, lean or bone.

Shearing on day 74 had pronounced effects on a number of traits. Ewes that were shorn had 2.1 kg (P<0.001) more LWG than their unshorn contemporaries over the outdoor feeding period (Table 1), mostly due to a 1.68 kg difference in the weight of the conceptus (1.58 and 0.10 kg heavier conceptus lean and bone, respectively in shorn compared to unshorn ewes; Table 2.). Each lamb from a shorn ewe had an average 0.36 kg (P<0.01) birth-weight advantage, and were skeletally longer but not as tall (14 mm [P<0.05] greater CR and 8 mm [P<0.05] shorter HF) than lambs from unshorn ewes. Shorn ewes mobilised approximately 1.3 kg (P<0.001) more TF than unshorn ewes, but interestingly gained 0.22 kg CL over the outdoor-feeding period compared with the unshorn ewes, which lost 0.74 kg CL over the same period (P<0.001).

DISCUSSION

The effect of energy in the diet was pronounced during the indoor-feeding period, with ewes fed the low energy level gaining less live weight during mid-pregnancy than ewes fed the high-energy allowance. This was due to reduced gain in fat and carcass lean, and a loss of visceral components. There was no significant difference in any of the fat, lean or bone components in the conceptus.

Ewes were able to compensate in the mid- to late-pregnancy period for differences in body composition generated in mid-pregnancy. Ewes that were fed the low energy rations between day 35 and 74 gained more live weight on pasture between day 74 and parturition, with the result that they regained 2.8 kg of the 4.3 kg difference generated over the indoor-feeding period. This difference was comprised of reduced losses of body fat, and gains in both carcass lean and visceral components. There was

TABLE 1: Effects of dietary protein and energy, and shearing, on ewe live weight gains and condition scores, and lamb birth traits

Trait	Protein			Energy			Shearing		
	12%	18%	P	1M	1.5M	P	Shorn	Wool	P
Indoor period – day 34 to 74 on concentrates									
LWT[1] (kg)	56.6	57.1	NS	55.9	57.8	NS			
LWG[2] (kg)	7.09	8.18	**	5.49	9.79	***			
CS[5]	0.16	0.32	NS	0.07	0.42	***			
Outdoor period – day 74 to 140 on pasture									
LWT[1] (kg)	65.3	66.7	NS	63.6	68.4	***	66.1	65.9	NS
LWG[2] (kg)	7.67	7.13	NS	8.78	6.01	***	8.44	6.34	***
CS	-0.25	-0.34	NS	0.22	-0.37	NS	-0.18	-0.42	*
Gest. length (d)	148.2	147.4	NS	148.2	147.3	NS	147.8	147.7	NS
Birth wt (kg)	4.64	4.49	NS	4.52	4.61	NS	4.74	4.38	**
CR[3] length (m)	0.471	0.462	NS	0.465	0.467	NS	0.473	0.459	*
HF[4] length (m)	0.282	0.280	NS	0.281	0.281	NS	0.277	0.285	*

[1] live weight at start of period; [2]live weight gain during period; [3] crown to rump length at birth; [4] hip to foot length at birth; [5]change in condition score during period

TABLE 2: Effects of dietary protein and energy, and shearing, on ewe and conceptus composition changes (kg) during indoor feeding during mid-pregnancy, and outdoor feeding until parturition

Trait[1]	Protein			Energy			Shearing		
	12%	18%	P	1M	1.5M	P	Shorn	Wool	P
Indoor period – day 35 to 74 on concentrates									
TF gain	1.65	1.79	NS	0.69	2.76	***			
CL gain	0.84	1.18	NS	0.41	1.62	***			
VC gain	-0.31	-0.05	NS	-0.55	0.20	**			
CW gain	2.03	2.40	NS	1.00	3.43	***			
CPF gain	0.032	0.043	NS	0.041	0.035	NS			
CPL gain	2.83	2.78	NS	2.89	2.72	NS			
CPB gain	0.008	0.008	NS	0.008	0.008	NS			
Outdoor period – day 74 to 140 on pasture									
TF gain	-2.26	-2.42	NS	-1.88	-2.80	**	-2.97	-1.71	***
CL gain	-0.24	-0.28	NS	0.23	-0.75	***	0.22	-0.74	***
VC gain	2.31	2.10	NS	2.65	1.76	***	2.27	2.14	NS
CW gain	-0.86	-1.08	NS	-0.26	-1.68	***	-0.85	-1.09	NS
CPF gain	0.100	0.118	NS	0.101	0.117	NS	0.112	0.106	NS
CPL gain	8.17	8.13	NS	8.06	8.24	NS	8.94	7.36	***
CPB gain	0.967	0.967	NS	0.971	0.962	NS	1.02	0.92	*

[1] TF = total body fat; CL = carcass lean; VC = non-fat visceral components; CW = carcass weight; CPF = conceptus fat; CPL = conceptus lean; CPB = conceptus bone.

no significant difference between the energy groups in conceptus growth rate.

The results have clearly demonstrated that while differences in ewe energy reserves could be generated by feeding differing energy levels during mid-pregnancy, ewes were able to mostly compensate for those differences before parturition if subsequently given an adequate food allowance. The feed allowance during the outdoor feeding period (from day 75 to parturition) was adequate, but it is not known how much the food intake can be restricted in the third trimester before effects are observed on foetal and conceptus growth. To practically apply these results, ewes can be fed at maintenance during mid-pregnancy if this allows good quality feed reserves to be built up in front of the ewes for the third trimester. If winter stock numbers and pasture growth allow for above maintenance feeding during mid-pregnancy, then it may be possible to restrict feeding a little in mid- to late-pregnancy in order to build up pasture reserves for early lactation. However, caution should be used in this approach as is not known how much of a restriction can be tolerated before adverse birth-weight effects occur.

The lack of a protein effect indicates that 12% protein is adequate for maintenance of the ewe and normal foetal growth. The effect of protected protein supplementation on lamb survival reported by Hinch *et al.* (1996) was not observed in the present experiment and would suggest that their pasture was not of sufficient quality to allow normal foetal growth.

The results indicate that mid-pregnancy shearing had pronounced and repeatable effects on lamb birth weights. It was the only treatment to have a significant effect on the either lamb birth weight or size. The birth-weight advantage of mid-pregnancy shearing was 0.36 kg, with a corresponding increase in the lambs' skeletons. This effect is beneficial to the commercial farmer for two reasons. Firstly, increased birth weight should result in improved survival in multiple-born lambs, as twin and triplets are often born at sub-optimal birth weights for survival. Secondly, mid-pregnancy shearing minimises the effects of wool break during pregnancy. Wool quality can be improved because any break that occurs is close to the end of the staple rather than in the middle. These two results are compelling reasons for the use of mid-pregnancy shearing on commercial farms

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