Effects of maternal metabolizable protein supplementation during the last 50 days of gestation on ewe performance and offspring performance from birth to weaning[1]

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The objectives of this trial were to determine the effects of maternal metabolizable protein supplementation during the last 50 days of gestation on ewe performance and offspring performance. Results indicate dam performance can be positively impacted by supplementing MP at or above requirements through maintaining dam BW and BCS, buy may have marginal effects on lamb performance from birth through weaning.

INTRODUCTION

Crude protein supplementation not only allows dams to maintain BW and BCS, but appears to improve offspring performance (Stalker et al., 2006; Larson et al., 2009). Crude protein supplementation to the dam is just one method of improving livestock performance during gestation. Metabolizable protein has been defined as the protein and amino acids that are digested and absorbed post-ruminally (Burroughs et al., 1975). Since MP is the protein directly available to the dam, it may be an indicator of how protein intake during gestation will ultimately affect offspring performance between birth and weaning. However, there has been minimal research conducted on the effects of MP intake during late gestation in sheep on offspring performance.

We hypothesized that the greater proportion of the diet that is composed of MP would yield improved offspring growth by potentially increasing nutrient transfer by the placenta or by increased nutrients within the milk. Therefore, the objectives were to evaluate isocaloric diets with increasing levels of MP during late gestation on ewe performance and offspring growth.

PROCEDURES

All procedures were approved by the NDSU Animal Care and Use Committee. This study was conducted at the Hettinger Research Extension Center in Hettinger, ND.

Ewes. On d 99 and 100 of gestation, in two consecutive years, ewes were weighed and body condition scored. On d 100 ± 8 (SD) of gestation, using the average of the initial weights (d 99 and 100 of gestation), ewes were stratified by BW, BCS, age, and expected lambing date to one of three isocaloric dietary treatments (Table 2; n = 7): **100MP1**: 100% of the MP requirements on a DM basis during the last 4 weeks of gestation of a ewe carrying twins (NRC, 2007);

60MP1: 60% of 100MP1; and **80MP1**: 80% of 100MP. Isocaloric dietary treatments (Table 2; n = 4) in year 2 were: **60MP2**: 60% of MP requirements; **100MP2**: 100% of the MP requirements; and **140MP2**: 140% of MP requirements on a DM basis of a ewe carrying twins during the last 4 weeks gestation (NRC, 2007). Once ewes had lambed, the ewes and lambs were intermingled between dietary treatments where they were maintained on a lactation ration (Table 1).

Lambs. In both years, lambs were weighed and tagged within 24 h of birth; sex, lambing assistance, and lamb vigor were also recorded. Lambs were then moved with the ewes to grouping pens and had full-access to creep pellet and water prior to weaning. At 14 days of age and at weaning all lambs were vaccinated for tetanus and *Clostridium Perfringens* types C and D (CD-T; Bar Vac CD-T, Boehringer Ingelhein, Ridgefield, CT), tails were docked, and ram lambs were castrated. Lambs were weaned at 69 ± 5 d (SD) of age in year 1 and at 61 ± 12 (SD) d of age in year 2 and weighed.

Statistical analysis. Ewe performance and lamb performance were analyzed utilizing the MIXED procedures of SAS (SAS Inst. Inc., Cary, NC). When a significant *F*-test was observed ($P \leq 0.15$), pre-planned comparisons of linear and quadratic contrasts were utilized to partition treatment effects. Significance was set at $P \leq 0.05$ and tendencies at $P \leq 0.10$.

RESULTS

Year 1

Ewes. Ewe weight change at lambing, change in BCS during gestation, gestation length, and lamb birth weight per unit initial or final ewe BW were not affected ($P \geq 0.22$; Table 3) by maternal dietary treatment. As MP increased in the diet, there was a linear ($P = 0.01$; Table 3) increase in change in BW during gestation. At lambing, ewe BW ($P = 0.02$) and BCS ($P = 0.01$) increased linearly as MP in the diet increased. There was a linear ($P < 0.001$) reduction in the percentage of BW loss from d 100 of gestation to immediately postpartum as MP increased in the diet. There was a linear increase in BCS loss as MP was reduced in the diet from d 100 ($P = 0.01$; Table 3) and 142 ($P = 0.05$) of gestation to immediately postpartum.

Lambs. There was no effect ($P = 0.30$; Table 3) of maternal dietary treatment on lamb birth weight. There tended to be a linear increase ($P \geq 0.08$) in weaning BW and ADG from birth to weaning as MP intake increased in the diet.

Year 2

Ewes. There were no significant effects ($P \geq 0.35$; Table 4) of maternal dietary treatment on ewe weight change from d 142 to lambing, change in BCS during gestation, change in BCS from d 100 and 142 to lambing, or BCS at lambing. As MP increased in the diet, there was a linear ($P = 0.01$) increase in change in BW. There was a linear ($P < 0.001$) reduction in percent BW loss from d 100 of gestation to immediately postpartum as MP increased in the diet. At lambing, ewe BW increased ($P = 0.02$) linearly as MP in the diet increased.

Lambs. There were no effects ($P \geq 0.25$; Table 4) of maternal dietary treatment on lamb birth BW, weaning BW, age at weaning, percent BW growth from birth to weaning, and ADG from birth to weaning.

DISCUSSION

Previous research has indicated that supplementation of protein during late gestation improves dam BW gain and BCS and restriction of protein results in reductions of dam BW and BCS (Stalker et al., 2006). Along with the current study, these studies suggest that increasing CP intake during late gestation enhances dam performance and minimizes the mobilization of dam body reserves to maintain fetal growth.

Similar to our results, Anthony et al. (1986) did not observe any effects on calf birth weight when dams were either fed low (81%) or high (141%) protein diets during late gestation (89 days prior to parturition). Amanlou et al. (2011) also observed no effects of maternal MP supplementation on lamb birth weight. Overall, our results suggest that birth weight may not be negatively impacted by maternal MP restriction.

Average daily gain of lambs from birth to weaning has also been positively affected by maternal nutrition during late gestation. Calves born to cows supplemented with CP during late gestation had increased ADG from birth to weaning compared with those calves born to unsupplemented cows (Stalker et al., 2006). In year 1, weaning BW tended to increase as MP increased in the diet, but weaning BW was not altered by maternal MP intake in year 2. The current results suggest that weaning weights may be reduced in lambs born to dams fed less than required MP, but feeding above MP requirements during late gestation may not improve weaning weights of lambs.

IMPLICATIONS

These results suggest that dam performance can be positively impacted by supplementing MP at or above requirements through maintaining dam BW and BCS. Restricting MP during late gestation may not negatively impact lamb birth weights, but may reduce weaning weights especially when ewes are below a BCS of 3. However, supplementing above MP requirements during late gestation will likely improve weaning weights. The results of the current study suggest that supplementing MP during late gestation may be a key asset to be utilized to improve dam performance from late gestation to weaning, but may have marginal effects on lamb growth from lambing to weaning.

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Table 1. Nutrient composition of fescue straw and lactation ration in years 1 and 2

	Fescue Straw[1]		
Item	Year 1	Year 2	Lactation Ration[2]
Diet, % DM	64.51	56.51	100.00
DM, %	83.05	77.61	64.37
NEm, Mcal/kg	2.22	2.12	—
CP, % of DM	3.04	3.07	11.52
MP, % of DM	1.95	1.97	—
NDF, % of DM	79.85	81.13	48.05
ADF, % of DM	48.97	51.10	27.16
Ash, % of DM	9.49	7.78	8.59

[1]Ewes were fed fescue straw in each year to limit metabolizable protein intake.
[2]Ewes were fed a common ration during lactation across all dietary treatments; 28.5% oats, 28.5% haylage, 42.9% chopped hay.

Table 2. Ingredient and nutrient composition of dietary supplements fed to ewes in year 1 and 2

Item	Year 1[1]			Year 2[2]		
	60MP1	80MP1	100MP1	60MP2	100MP2	140MP2
Ingredient, % DM						
Corn	18.50	15.00	5.00	30.00	19.00	—
DDGS[3]	7.00	20.00	30.00	4.00	24.00	43.00
Soyhulls	9.50	—	—	9.00	—	—
Trace mineral[4]	0.49	0.49	0.49	0.49	0.49	0.49
Nutrient composition						
DM, %	88.75	89.34	89.68	88.64	90.19	92.16
NEm, Mcal/kg	2.00	2.22	2.14	2.05	2.19	2.06
CP, % of DM	13.16	20.21	25.13	10.21	18.67	28.68
MP, % of DM	8.41	13.01	16.31	6.54	11.96	18.37
NDF, % of DM	31.03	30.73	39.79	29.64	31.40	45.34
ADF, % of DM	15.69	7.45	10.49	13.87	8.68	13.34
Ash, % of DM	3.22	3.48	4.55	3.53	3.80	5.13

[1]Maternal diets (DM basis) were balanced for mature ewes baring twins during the last 4 weeks of gestation according to NRC (2007). Treatments: 60MP1: 60% of metabolizable protein of 100MP1; 80MP1: 80% of the metabolizable protein 100MP1; and 100MP1: 100% of the metabolizable protein requirement.

[2]Maternal diets (DM basis) were balanced for mature ewes baring twins during the last 4 weeks of gestation according to NRC (2007). Treatments: 60MP2: 60% of metabolizable protein of 100MP2; 140MP2: 140% of the metabolizable protein of 100MP2; 100MP2: 100% of the metabolizable protein requirement.

[3]Dried distillers grains with solubles

[4]Trace mineral content: 16.0-17.0% Ca; 8.0% P; 21.0-23.0% Salt; 2.75% Mg; 3 ppm Co; 5 ppm Cu; 100 ppm I; 1,400 ppm Mn; 20 ppm Se; 3,000 ppm Zn; 113,500 IU/kg Vitamin A; 11,350 IU/kg Vitamin D; and 227 IU/kg Vitamin E.

Table 3. Effects of maternal metabolizable protein supplementation during the last 50 d of gestation on ewe and offspring performance from birth to weaning for year 1

	Dietary Treatment[1]					Orthogonal Contrasts[4]	
Item	60MP1	80MP1	100MP1	SEM[2]	*P* – value[3]	Linear	Quadratic
Initial BW, lb	139.8	142.0	142.4	2.36	0.71	0.43	0.79
BW at lambing,[5] lb	130.5	137.3	138.7	2.51	0.04	0.02	0.36
Weight change, lb							
Gestation	14.3	19.6	20.1	1.30	0.01	0.01	0.15
Lambing	-27.7	-24.8	-26.4	1.30	0.33	0.50	0.16
Percent BW change,[6] %	-10.65	-4.98	-4.98	1.02	<0.001	<0.001	0.02
Initial BCS	2.9	2.9	2.9	0.03	0.51	0.53	0.33
BCS at lambing[5]	2.7	2.7	2.9	0.06	0.02	0.01	0.45
BCS change							
Gestation	-0.02	0.02	0.02	0.04	0.68	0.44	0.65
Lambing							
d 100 to lambing[7]	-0.20	-0.17	0.02	0.05	0.02	0.01	0.24
d 142 to lambing[8]	-0.18	-0.20	-0.02	0.05	0.06	0.05	0.14
Lamb birth weight, lb	10.0	9.9	10.4	0.24	0.30	0.22	0.33
Lamb weaning BW, lb	38.7	43.0	42.2	1.46	0.07	0.08	0.14
Lamb ADG,[9] lb/d	0.40	0.46	0.44	0.01	0.07	0.10	0.10

[1]Maternal diets (DM basis) were balanced for mature ewes baring twins during the last 4 weeks of gestation according to NRC (2007). Treatments: 60MP1: 60% of metabolizable protein of 100MP1; 80MP1: 80% of the metabolizable protein 100MP1; and 100MP1: 100% of the metabolizable protein requirement.
[2]Greatest SEM presented (n = 7).
[3]*P* -value for the F test of the mean.
[4]*P*-value for linear and quadratic effects of increasing metabolizable protein concentrations.
[5]Ewe BW and BCS measured within 24 h after parturition.
[6]Percent BW change from initial BW (d 100 of gestation) to BW immediately postpartum.
[7]Change in ewe BCS from the initial BCS (d 100 of gestation) to the BCS immediately postpartum.
[8]Change in ewe BCS from the final BCS (d 142 of gestation) to the BCS immediately postpartum.
[9]ADG calculated: (weight at birth, kg – weight at weaning)/age at weaning.

Table 4. Effects of maternal metabolizable protein supplementation during the last 50 d of gestation on ewe performance and offspring performance from birth to weaning for year 2

	Dietary Treatment[1]					Orthogonal Contrasts[4]	
Item	60MP2	100MP2	140MP2	SEM[2]	*P* – value[3]	Linear	Quadratic
Initial BW, lb	148.7	148.6	148.4	3.55	1.00	0.95	0.97
BW at lambing,[5] lb	134.0	142.0	144.1	3.17	0.06	0.02	0.48
Weight change, lb							
Gestation	11.4	17.6	19.2	1.72	0.02	0.01	0.28
Lambing	-27.8	-25.0	-24.8	1.90	0.35	0.26	0.60
Percent BW change,[6] %	-11.62	-5.09	-4.04	1.44	<0.001	<0.001	0.12
Initial BCS	3.0	3.0	3.0	0.01	0.40	0.22	0.40
BCS at lambing[5]	2.9	3.0	3.0	0.04	0.93	0.74	0.88
BCS change							
Gestation	0.00	0.00	-0.02	0.01	0.40	0.22	0.49
Lambing							
d 100 to lambing[7]	-0.06	-0.04	-0.04	0.04	0.94	0.74	0.88
d 142 to lambing[8]	-0.06	-0.04	-0.02	0.04	0.81	0.51	0.96
Lamb birth weight, lb	10.2	10.6	10.2	0.24	0.45	0.92	0.22
Lamb weaning BW, lb	33.6	36.8	35.4	1.87	0.49	0.51	0.33
Lamb ADG,[9] lb/d	0.40	0.44	0.40	0.02	0.25	0.78	0.11

[1]Maternal diets (DM basis) were balanced for mature ewes baring twins during the last 4 weeks of gestation according to NRC (2007). Treatments: 60MP2: 60% of metabolizable protein of 100MP2; 140MP1: 140% of the metabolizable protein 100MP2; and 100MP2: 100% of the metabolizable protein requirement.
[2]Greatest SEM presented (n = 4).
[3]*P* -value for the F test of the mean.
[4]*P*-value for linear and quadratic effects of increasing metabolizable protein concentrations.
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[8]Change in ewe BCS from the final BCS (d 142 of gestation) to the BCS immediately postpartum.
[9]ADG calculated: (weight at birth, kg – weight at weaning)/age at weaning.