Winter Nutrition of Spring-Calving Cows and Crude Protein Supplementation Strategies

by
David W. Bohnert, Ph.D.
Eastern Oregon Agricultural Research Center
Burns, Oregon

A nutritionally critical period in the annual cycle of beef cows is the last third of gestation (90 days). Approximately 80% of all fetal growth occurs during this time (Figure 1). The only period with a greater nutrient requirement is the first 3 to 4 months of lactation. Consequently, winter supplementation of spring-calving cows consuming low-quality (< 6% crude protein) forage is important to maintain acceptable body condition. An adequate body condition score (BCS) at calving (BCS of approximately 5) can be obtained with proper winter nutrition and will shorten the time to first estrus and improve first service and overall conception rate compared with cows consuming a diet inadequate in nutrition. This will help to maintain a yearly calving interval (Figure 2). Another benefit often noted with crude protein (CP) supplementation of low-quality forage is increased forage intake and/or nutrient digestibility. Therefore, CP supplementation normally increases the total quantity of nutrients available to the cow, thereby improving her overall nutritional status. In addition, proper winter protein nutrition will increase the likelihood of a strong, healthy calf at birth and weaning (Figure 3).

Forage availability, CP concentration, and cow nutrient requirements are the primary factors to consider in developing an effective winter nutrition program. If forage CP concentration and/or CP intake is below a cow's requirement (Table 1), supplemental CP is required to eliminate the deficiency. Also, to optimize a CP supplementation program, forage intake should not be limited by forage availability. Simply stated, providing supplemental CP to cows with a restricted intake of low-quality forage (harvested forage or pasture) is not an efficient or economical use of a CP supplementation program.

Source, Form, and Delivery of Supplemental Crude Protein

Most sources of supplemental protein can be grouped into four broad categories:

- Oilseeds and oilseed meals (cottonseed, soybean, canola, sunflower, etc.)
- Animal and grain byproducts (blood meal, fish meal, feather meal, brewers grain, distillers grain, etc.)
- Legume hays (primarily alfalfa)
- Non-protein nitrogen (urea and biuret)

Typically, most CP supplements are available in two forms:

- Dry feeds (meals, cubes, cakes, pellets, dry or pressed blocks, alfalfa hay, etc.)
- Liquid feeds (molasses-mixes, hardened molasses blocks or tubs, etc.)

These product options give cow/calf producers many choices to consider when selecting a source and form of supplemental CP. However, beef producers should consider the following factors when choosing a form of supplemental CP:

- Cost per pound of supplemental CP
- Supplement delivery method.

Calculating the cost per pound of CP allows a beef producer to determine which protein source/form is most economical to purchase for use as a protein supplement. For example, assume a beef producer has the option of purchasing alfalfa hay (19% CP; $100/ton) or soybean meal (49% CP; $215/ton) as a CP supplement and has the facilities and equipment to feed both properly. Which protein supplement is the most economical? Initially, the beef producer may assume alfalfa hay is the best choice; however, when the cost per pound of CP is calculated, it becomes clear that soybean meal (2000 lb x 49% CP = 980 lb CP; $215 ÷ 980 lb CP = **$0.22/lb CP**) is actually cheaper than alfalfa hay (2000 lb x 19% CP = 380 lb CP; $100 ÷ 380 lb CP = **$0.26/lb CP**) when expressed as per pound of CP. Therefore, soybean meal would be the most economical CP supplement

Choice of supplement delivery method will determine if a CP supplement will be hand-fed or self-fed. Hand-feeding involves regularly providing a supplement to animals in a manner that allows rapid consumption (alfalfa, soybean meal, cottonseed cake, etc.), whereas self-feeding involves periodically providing large quantities of supplement with the assumption that animals will consume the supplement in consistent, controlled amounts over an extended period of time (salt mixes, molasses mixes, blocks, tubs, etc.). Self-fed supplements normally require less labor compared to hand-fed supplements; however, they are usually more expensive per pound of CP and, depending on manufacturing expertise and formula, may have a greater variation in individual animal supplement intake. Also, intake of self-fed supplements may not always be consistent; in some cases it could be several times a day, or in other cases it could be every few days.

Winter supplementation is expensive, consisting of the costs of the supplement, labor, and equipment associated with supplement delivery. Other than determining the type and quantity of a CP supplement to purchase, a beef producer has little control over supplement cost. However, a beef producer does have significant control over labor and associated supplement delivery costs. Therefore, recent research has attempted to develop CP supplementation strategies that decrease the costs associated with supplement delivery.

Infrequent Supplementation of Crude Protein

Recent research has indicated infrequent supplementation of CP to ruminants consuming low-quality forage is an economical management practice. This is because it reduces the costs associated with supplement delivery without compromising cow performance. Oregon research has evaluated the influence of CP source and supplementation frequency on intake, nutrient utilization, and cow performance.

Table 1. Crude protein (CP) requirements of beef cows during the last third of gestation (adapted from NRC, 1984)

	CP (DM basis)	
Cow Wt. (lb)	lb	%
800	1.4	8.2
900	1.5	8.0
1,000	1.6	7.9
1,100	1.6	7.8
1,200	1.7	7.8
1,300	1.8	7.7
1,400	1.9	7.6

Experiment 1

The first experiment consisted of three studies comparing low rumen degradable (60% CP; 40% rumen degradable) and high rumen degradable (54% CP; 80% rumen degradable) supplements provided daily, once every three days (three times the daily amount), or once every six days (six times the daily amount) to ruminants consuming low-quality forage (5% CP). All supplemented treatments received the same quantity of supplemental CP over a six-day period. Briefly, CP supplementation of wethers and steers increased ($P < 0.05$) organic matter intake by 16 and 15% and organic matter digestibility by 15 and 11%, respectively (Table 2). Also, organic matter intake by steers and organic matter digestibility by wethers and steers was not affected by CP degradability or supplementation frequency; however, organic matter intake by wethers decreased linearly ($P < 0.01$) as supplementation frequency decreased.

Rumen bacterial nitrogen production and bacterial efficiency (g bacterial N/kg OM truly digested in the rumen) increased ($P < 0.05$) by approximately 63 and 38%, respectively, with supplementation compared to unsupplemented controls. Also, high rumen degradable treatments had greater ($P = 0.04$) bacterial nitrogen production than low rumen degradable treatments. No difference was noted because of supplementation frequency. Similarly, nitrogen balance and digested nitrogen retained increased ($P < 0.01$) with CP supplementation, indicating improved use of dietary CP. Digested nitrogen retained and nitrogen balance was not affected by CP degradability and digested nitrogen retained was not affected by supplementation frequency; however, nitrogen balance decreased linearly ($P = 0.04$) as supplementation frequency decreased. Nevertheless, nitrogen balance with the least frequently supplemented treatments was increased compared with the unsupplemented control. This coincides with results obtained in a cow performance study in which cows were provided CP supplements during the last third of gestation. Body condition score change at calving was improved ($P < 0.05$) with CP supplementation and not affected by CP degradability or supplementation frequency. The results of Experiment 1 indicate that more frequent

FIGURE 1

Fetus growth during gestation. Approximately 80% of all fetal growth occurs during the last third of gestation (adapted from Anthony et al., 1986).

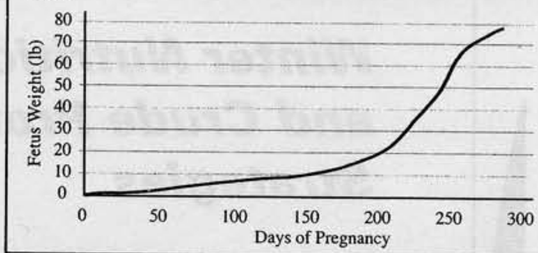

FIGURE 2

The relationship between cow body condition score at breeding and calving interval. The dotted line is provided to depict 365 days, while the curved line indicates how long a cow's calving interval can be expected to be if her body condition score at breeding ranges from 2 to 8 (adapted from Herd and Sprott, 1986).

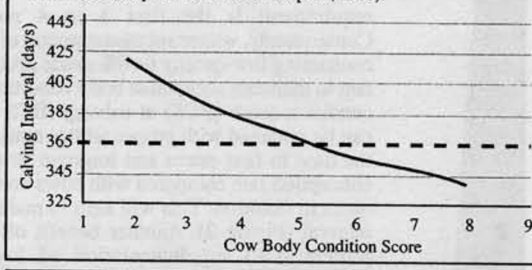

FIGURE 3

Incidence of weak calf syndrome in cattle herds consuming differing amounts of crude protein (adapted from Bull et al., 1974).

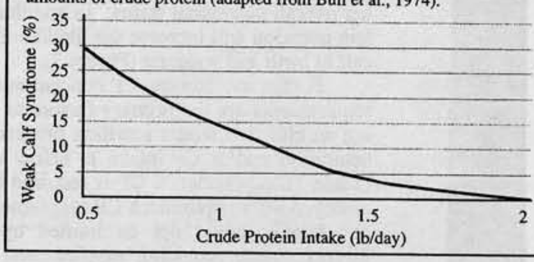

Table 2. **Effect of protein degradability and supplementation frequency on ruminants consuming low-quality forage**

	Treatment [a]							P-Value[b]			
ITEM	CON	HD	H3D	H6D	LD	L3D	L6D	Con vs Supp	H vs L	L SF	Q SF
Lambs (36 kg)											
OM Intake, g/kg BW	20.2	24.0	22.7	22.3	25.6	24.5	21.3	0.005	0.29	0.004	0.69
Total Tract OM Dig., %	54.0	62.4	61.9	60.4	60.9	63.2	63.2	<0.001	0.28	0.87	0.34
N balance, g/kg BW	-0.009	0.101	0.088	0.094	0.098	0.094	0.068	<0.001	0.25	0.04	0.94
Digested N retained, %[c]	-16.3	35.3	27.7	29.6	31.2	25.8	24.0	<0.001	0.54	0.41	0.63
Steers (264 kg)											
OM intake, g/kg BW	20.7	24.1	25.6	22.7	23.1	24.4	22.8	0.007	0.33	0.34	0.03
Total Tract OM Dig., %	53.3	61.3	58.1	58.0	59.3	59.0	58.7	0.001	0.87	0.11	0.46
Bacterial N Production, g/kg BW	0.237	0.410	0.441	0.419	0.309	0.413	0.328	0.004	0.04	0.73	0.09
Bacterial Efficiency[d]	20.0	28.9	29.0	32.0	23.2	28.8	24.0	0.04	0.09	0.52	0.48
Cows											
Initial body condition score	5.06	5.00	4.98	4.96	4.91	4.91	4.90				
BCS change	0.12	0.65	0.56	0.50	0.63	0.59	0.65	<0.001	0.48	0.50	0.68

[a] CON = control; HD = high rumen degradable protein every day; H3D = high rumen degradable protein every third day; H6D = high rumen degradable protein every sixth day; LD = low rumen degradable intake protein every day; L3D = low rumen degradable protein every third day; L6D = low rumen degradable protein every sixth day.

[b] Con vs Supp = control vs supplemented treatments; H vs L = high rumen degradable protein vs low rumen degradable protein; L SF = linear effect of supplementation frequency (SF); Q SF = quadratic effect of SF.

[c] Calculated as (Daily N retention, g/kg BW / Daily N digested, g/kg BW) x 100.

[d] Calculated as g bacterial nitrogen/kg of OM truly digested in the rumen.

Table 3. **Effect of non-protein nitrogen source and supplementation frequency on ruminants consuming low-quality forage**

Item	Treatment [a]					P-Value[b]		
	CON	UD	U2D	BD	B2D	Con vs Supp	Urea vs Biuret	D vs 2D
Lambs (39 kg)								
OM intake, g/kg BW	24.8	29.5	27.5	29.5	27.5	0.01	0.96	0.08
Total tract digestibility OM, %	42.8	51.4	51.2	51.0	48.7	0.009	0.49	0.56
N balance, g/kg BW	-0.012	0.042	0.013	0.041	0.041	0.02	0.36	0.34
Digested N retained, %[c]	-54.4	16.3	6.5	28.6	19.4	0.003	0.45	0.56
Steers (491 kg)								
OM intake, g/kg BW	16.1	17.7	17.3	18.1	17.4	0.009	0.29	0.08
Total Tract OM Dig., %	53.7	53.8	54.6	55.5	53.7	0.31	0.52	0.38
Bacterial N Production, g/kg BW	0.213	0.208	0.229	0.271	0.251	0.04	0.002	0.92
Bacterial Efficiency[d]	24.1	20.8	24.2	26.2	26.9	0.84	0.05	0.28
Cows								
Initial body condition score	4.85	4.85	4.86	4.87	4.89			
BCS change	-0.55	0.20	0.21	0.18	0.02	<0.001	0.40	0.51

[a] CON = control; UD = urea supplement every day; U2D = urea supplement every-other-day; BD = biuret supplement every day; B2D = biuret supplement every-other-day.

[b] Con vs Supp = control vs supplemented treatments; Urea vs Biuret = urea vs biuret treatments; D vs 2D = daily vs alternate day supplementation.

[c] Calculated as (Daily N retention, g/kg BW / Daily N digested, g/kg BW) x 100.

[d] Calculated as g bacterial nitrogen/kg of OM truly digested in the rumen.

Table 4. Economics of infrequent supplementation over a 30-day period

Item	Supplementation Interval			
	Daily	2 days	3 days	6 days
Fuel Cost ($)[a]	135.00	67.50	45.00	22.50
Labor Cost ($)[b]	517.50	258.75	172.50	86.25
Total Costs	652.50	326.50	217.50	108.75
Benefit (hours)	**0**	**37.50**	**50.00**	**62.50**
Benefit ($)	**0**	**326.25**	**435.00**	**543.75**

[a] Fuel cost calculated as 3 gallons/supplementation day at $1.50/gallon

[b] Labor cost calculated as 2.5 hours/supplementation day at $6.90/hour

supplemental CP intake increased organic matter intake and increased nitrogen balance.

Experiment 2

The second experiment compared daily and alternate day supplementation of biuret- or urea-based supplements (29% CP) to ruminants consuming low-quality forage (4% CP). All supplemented treatments received the same quantity of supplemental CP over a two-day period. Organic matter intake by steers and wethers increased ($P < 0.01$) with CP supplementation and was not affected by non-protein nitrogen source or supplementation frequency (Table 3). Rumen bacterial nitrogen production increased ($P = 0.04$) with supplementation and was not affected by supplementation frequency; however, biuret supplemented steers had 19% greater bacterial nitrogen production than those receiving supplemental urea. This suggests that the slower hydrolysis of biuret to ammonia within the rumen may have provided the ruminal microflora with a more consistent supply of nitrogen, thereby improving bacterial growth compared with urea. This coincided with an 18% greater ($P = 0.05$) bacterial efficiency for biuret- compared with urea-supplemented steers.

Nitrogen balance and digested nitrogen retained by wethers was improved ($P < 0.03$) with CP supplementation and not altered by non-protein nitrogen source or supplementation frequency. However, it is of interest to note that, though not statistically different, nitrogen balance and digested nitrogen retained were 49 and 110% greater, respectively, with biuret supplementation compared with urea. Also, BCS change of cows consuming low-quality forage during the last third of gestation was improved ($P < 0.01$) with CP supplementation but not affected by non-protein nitrogen source or supplementation frequency.

The results of Experiment 2 indicate that supplements containing biuret as an NPN source resulted in greater and more efficient bacterial protein production than supplements containing urea. Although not statistical, nitrogen balance was also greater for biuret than for urea containing supplements.

Summary

Infrequent supplementation of CP to ruminants consuming low-quality forage resulted in improved nitrogen utilization and animal performance compared to no nitrogen supplementation. Performance for animals supplemented every six days was superior to animals not receiving supplementation. Animal performance and nitrogen utilization were not greatly different between daily and infrequent supplementation schedules. However, there were suggestions that more frequent CP intake may increase forage intake and improve nitrogen utilization efficiency. Consequently, decreasing the frequency of CP supplementation is a management practice that can decrease the labor and associated costs of a winter supplementation program while maintaining animal performance. Self-fed supplements are an option that can reduce labor and delivery costs and provide the opportunity for frequent supplement intake. Table 4 provides a potential scenario illustrating the economical benefit of infrequent supplementation compared with daily supplementation.

However, infrequent supplementation of urea should be conducted with extreme caution to minimize the potential for urea toxicity; consequently, consultation with a ruminant nutritionist is strongly recommended when considering infrequent supplementation of urea. In contrast, biuret does not pose the toxicity concerns associated with urea and should be safe to supplement infrequently. ❑