

BEEF CATTLE NUTRITION IN COMMERCIAL RANCHING SYSTEMS

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Contents

1. Introduction
 2. Factors Affecting Forage Quality
 - 2.1. Seasonal Changes in Nutrient Quality of Native Range
 - 2.2. Other Factors Affecting Forage Quality
 - 2.3. Dormant Season Grazing
 3. Nutrient Requirements of Beef Cattle
 4. General Considerations for Supplementation
 5. Protein Supplementation
 - 5.1. Non-Protein Nitrogen Supplements
 - 5.2. Effects of Feeding True Protein Supplements
 - 5.3. Provision of Microbial Growth Factors
 - 5.4. Feeding to Meet the Metabolizable Protein Needs
 - 5.5. Supplementation Frequency
 - 5.6. Interaction Between Supplemental Degradable Protein and Energy
 - 5.7. Supplement Form
 6. Supplementation of Gestating Beef Cows
 7. Supplementation of the Lactating Beef Cows
 8. Mineral Supplementation
 - 8.1. Primary vs. Secondary Deficiencies
 - 8.2. Reduced Productivity
 - 8.3. Diagnostic and Laboratory Tests
 9. Behavioral Considerations for Optimizing Supplementation Programs
 10. Conclusion
- Acknowledgements
Glossary
Bibliography
Biographical Sketches

Summary

Effective supplementation decisions in commercial ranching operations require knowledge of forage quality, nutrient requirements, and practical business acumen. Rising production costs continue to present unique challenges for beef cattle producers. Feed (grazed forages, harvested feedstuffs, and supplements) constitute a majority of the production costs in almost all commercial ranching operations worldwide. Native range decreases in nutritive value as season advances, making supplementation necessary in many production systems, especially in cow-calf operations if cattle are grazing dormant forages. Adequate protein supply during gestation is essential for proper placental and fetal growth and may impact long-term offspring responses. During lactation, the need for metabolizable protein (protein from the ruminal microbes and escape protein) increases. Protein nutrition of grazing ruminants has been intensively studied for years, but the effects of feeding supplemental protein are variable. Factors which affect this variation include both environmental influences including temperature and snow cover, forage quality, and physiological status of the animal. For beef cattle receiving low-quality forage based diets, urea alone does not appear to be an effective protein supplement. Urea may effectively make up a portion of the protein supplement, but should not constitute all of the supplemental degradable intake protein. Provision of true degradable intake protein appears to stimulate rumen microbes. When true protein supplements are provided to grazing beef cattle, forage intake and/or forage digestibility are usually increased, but responses are variable. True protein supplements may provide rumen microbes with branched chain volatile fatty acids or other growth factors which are required for optimal efficiency. Provision of true protein supplements generally increases milk production and, as a consequence, calf weight gain. Degradable intake protein appears to be first limiting for cattle grazing dormant native range; however, specifically deficient components remain to be determined and likely vary regionally. Adoption of the 7th Edition of the NRC Beef Cattle Nutrient Requirements Model for protein requirements can help better define the amount and type of protein required in supplementation programs. Mineral supplementation is commonly practiced on commercial ranching operations; however, increasing mineral costs have forced commercial ranches to scrutinize these purchases carefully. Mineral content of forages varies widely and is affected by season, plant species, soil mineral content, and other factors. Cost effective decision regarding supplementation of grazing livestock ultimately requires knowledge of both the animal's nutrient requirements as well as seasonal changes in forage nutrients.

1. Introduction

The chapter on *Rangeland grazing in North American Commercial Ranching* sets the scene, with special reference to North America. Most commercial ranching depends on breeding of beef cattle on native rangeland, and, in some places introduced species such as smooth brome (*Bromus inermis*), crested wheatgrass (*Agropyron cristatum*) or crop residues (e.g. corn stover) provide additional forage. Cow calf operations are the most common arrangement for production of young cattle that are sold to either yearling/stocker cattle operations or feedlots. Yearling or stocker cattle operations typically manage growing cattle on a wide variety of forage-based grazing programs. The principles of supplementation are similar for both cow calf and yearling operations.

Knowledge of forage quality, animal requirements, and economics are essential in making supplementation decisions, regardless of whether the ranch is a cow-calf operation or a yearling operation.

2. Factors Affecting Forage Quality

2.1. Seasonal Changes in Nutrient Quality of Native Range

Numerous research stations have investigated seasonal changes in nutrient quality of native range over the growing season. Year to year variation in forage quality occurs. Much of this variation is related to environmental conditions such as amount and timing of precipitation, date of frost at the beginning and end of the growing season, and other conditions which affect plant growth. Table 1 and Table 2 give the seasonal changes in nutritive value and protein fractions, respectively, of grazed native range (mixed-grass prairie) in southwestern North Dakota. Principal vegetation in these study areas include western wheatgrass (*Pascopyrum smithii*), prairie Junegrass (*Koeleria macrantha*), needle-and thread (*Hesperostipa comata*), and green needlegrass (*Nassella viridula*). Associated with these species are several shorter grasses and sedges, in particular blue grama (*Bouteloua gracilis*), threadleaf sedge (*Carex filifolia*), and sun sedge (*Carex inops*). Three major range sites dominate the study area and include sandy, shallow, and silty. Crude protein and digestibility of native mixed-grass prairie decrease as the growing season advances. In addition, DIP (expressed as a percentage of CP) declines as do total dietary concentrations of CP, DIP, and UIP. Likewise, the microbial CP supply to the small intestine also declines with advancing season (for more information see Section 5.3). Depending on desired productivity levels for grazing livestock, these circumstances likely make supplementation necessary for a portion of the grazing season.

Item	Mid-June	Late July	Early September	Early October	Mid-November	Mid-December
NDF	59.5	51.0	58.7	59.6	67.9	72.1
ADF	35.7	34.8	40.3	38.5	40.9	41.8
CP	13.6	14.9	10.2	9.7	6.6	6.2
IVOMD	68.1	60.5	55.6	54.3	57.3	53.3

¹Data adapted from Johnson et al. (1998). Major forage species include western wheatgrass (*Pascopyrum smithii*), prairie Junegrass (*Koeleria macrantha*), needle-and thread (*Hesperostipa comata*), and green needlegrass (*Nassella viridula*).

Table 1. Effect of advancing season on nutrient composition of native range in southwestern North Dakota (Latitude: 46° 52' 45" N; Longitude: 102° 47' 21" W)¹

Item	Grazing period ¹				
	Late-June	Late-July	Late-August	Mid-September	Mid-November
Forage CP, % of OM	12.19	8.81	9.75	8.38	7.19
DIP, % of forage OM	8.06	5.91	4.63	3.42	2.30
UIP, % of forage OM	4.12	2.92	5.11	4.93	4.90
DIP, % CP	66.1	66.9	48.8	41.1	31.9

UIP, % CP	33.9	33.1	51.2	58.9	68.1
Intake CP, g/d	1,110.0	763.8	585.6	498.8	310.0
DIP, g/d	735.5	507.8	302.7	210.0	99.5
UIP, g/d	374.4	256.4	282.7	282.4	215.9
Microbial CP supply, g/d	469.8	470.2	346.6	326.8	257.8
¹ Adapted from Cline et al. (2009).					

Table 2. Effect of advancing season on CP supply in steers grazing native mixed-grass prairie in western North Dakota (Latitude: 46° 52' 45" N; Longitude: 102° 47' 21" W).

Native grasslands dominated by western wheatgrass (*Pascopyrum smithii*), prairie Junegrass (*Koeleria macrantha*), needle-and thread (*Hesperostipa comata*), and green needlegrass (*Nassella viridula*)

Table 3 and Table 4 provide the seasonal changes in nutritive value of subirrigated meadow and native range, respectively, in the Nebraska Sandhills. The nutrient analysis from these forage samples clearly demonstrate the importance of understanding the type of forage and nutrient characteristics of each plant mix throughout the grazing season. The subirrigated meadow is predominantly cool season species, while the upland range is predominantly warm season. Dominant grass species on the native upland range sites were as follows: little bluestem (*Schizachyrium scoparium*), prairie sandreed (*Calamovilfa longifolia*), sand bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), sand lovegrass (*Eragrostis trichodes*), Indiangrass (*Sorghastrum nutans*), and blue grama (*Bouteloua gracilis*). Common forbs and shrubs include western ragweed (*Ambrosia psilostachya*) and leadplant (*Amorpha canescens*). Dominant vegetation on the subirrigated meadows consisted of smooth brome grass (*Bromus inermis*), redtop (*Agrostis gigantea*), timothy (*Phleum pratense*), slender wheatgrass (*Elymus trachycaulus*), quackgrass (*Elytrigia repens*), Kentucky bluegrass (*Poa pratensis*), prairie cordgrass (*Spartina pectinata*), and several species of sedges (*Carex* spp.) and rushes (*Juncus* spp.). Less-abundant grass species were big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). Abundant legumes included red clover (*Trifolium pretense*).

Date	Type ²	CP (%)	NDIN (%)	ADIN (%)	UIP (%)	DIP (%)	NDF (%)	ADF (%)	IVOMD (%)
JAN	Regrowth	12.1	0.76	0.12	1.4	10.7	77.2	50.2	53.4
MAR	Primary	16.6	0.91	0.22	1.2	15.4	66.8	42.4	60.2
APR	Primary	29.4	0.92	0.03	4.2	25.3	49.3	27.3	68.3
MAY	Primary	17.6	1.09	0.17	3.1	14.5	73.0	42.3	68.3
JUN	Primary	17.3	0.75	0.13	2.3	15.0	68.6	39.2	70.8
JUL	Primary	12.4	0.67	0.13	2.0	10.4	72.0	41.7	66.0
AUG	Regrowth	17.2	0.63	0.08	2.3	14.8	63.2	44.4	64.4
SEPT	Regrowth	15.6	0.67	0.14	1.8	13.9	70.52	43.7	63.4
OCT	Regrowth	14.9	0.68	0.14	1.3	13.6	63.8	44.1	67.7
NOV	Regrowth	9.1	0.48	0.23	1.2	7.9	78.6	53.8	47.5
DEC	Regrowth	8.1	0.47	0.19	1.0	7.0	83.1	55.8	54.2
<p>¹Each observation represents 4 to 7 diets collected by esophageal fistulated cows or ruminally cannulated steers; CP, crude protein; NDIN, neutral detergent insoluble nitrogen; ADIN, acid detergent insoluble nitrogen; UIP, undegraded intake protein; DIP, degraded intake protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; IVOMD, in vitro organic matter disappearance. Dominant forage species included smooth brome grass (<i>Bromus inermis</i>), redtop (<i>Agrostis gigantea</i>), timothy (<i>Phleum pratense</i>), slender wheatgrass (<i>Elymus trachycaulus</i>), quackgrass (<i>Elytrigia repens</i>), Kentucky bluegrass (<i>Poa pratensis</i>), prairie cordgrass (<i>Spartina pectinata</i>), and several species of sedges (<i>Carex</i> spp.) and rushes (<i>Juncus</i> spp.).</p> <p>²Sample type: Regrowth - growth following July haying; Primary - growth before July haying.</p>									

Table 3. Means and standard deviations of laboratory analysis of meadow diet samples collected at Gudmundsen Sandhills Laboratory, Whitman, Nebraska (Latitude: 41:55:05 N Longitude: 101:32:08 W), in 1992 and 1994 (OM Basis).¹

Sample Date	CP (%)	NDIN (%)	ADIN (%)	UIP (%)	DIP (%)	NDF (%)	ADF (%)	IVOMD (%)
JAN	6.3	0.45	0.15	0.8	5.5	83.6	52.5	58.0
MAR	6.0	0.48	0.09	1.0	5.0	82.5	53.3	54.8
APR	11.4	0.79	0.11	1.2	10.2	77.5	43.2	67.6
JUN	13.8	0.85	0.12	2.5	11.3	72.4	40.6	67.6
JUL	12.3	0.90	0.14	2.2	10.1	79.8	43.6	67.5
AUG	11.3	0.79	0.16	1.8	9.5	77.9	46.4	63.7
SEPT	7.4	0.51	0.12	1.1	6.4	79.7	48.8	60.7
NOV	5.9	0.37	0.27	0.7	5.2	84.4	56.1	48.3
DEC	6.5	0.39	0.13	1.2	5.4	86.0	54.5	53.9

¹Each observation represents 4 to 7 diets collected by esophageal fistulated cows or ruminally cannulated steers; CP, crude protein; NDIN, neutral detergent insoluble nitrogen; ADIN, acid detergent insoluble nitrogen; UIP, undegraded intake protein; DIP, degraded intake protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; IVOMD, in vitro organic matter disappearance. Dominant grass species included little bluestem (*Schizachyrium scoparium*), prairie sandreed (*Calamovilfa longifolia*), sand bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), sand lovegrass (*Eragrostis trichodes*), Indiangrass (*Sorghastrum nutans*), and blue grama (*Bouteloua gracilis*). Common forbs and shrubs include western ragweed (*Ambrosia psilostachya*) and leadplant (*Amorpha canescens*).

Table 4. Means and standard deviations of laboratory analysis of upland range diet samples collected at Gudmundsen Sandhills Laboratory in 1992 and 1994 (OM Basis).¹

2.2. Other Factors Affecting Forage Quality

In addition to species composition, stage of growth also affects nutrient composition of grazed diets. Grass species are typically highest in nutrient content during vegetative stages of growth. Once the plant flowers and enters the reproductive stage, CP and digestibility of the forage typically decline.

Nutrient content also varies by plant part as well. Leaves are the highest quality portion of the plant while stems are typically the lowest in both CP and digestibility. As the plant enters dormancy, loss of leaf tissue leads to further reductions in nutrient content and availability.

Grazing selectivity also has an impact on nutrient content of the diet in grazing animals. On native rangelands with a wide variety of forage species to select from, grazing animals are able to select a diet which consists of a wide variety of plants of varying nutrient content. When grazing improved pastures or monocultures, the ability to select is reduced as all plants are typically in a similar phenological state. Diet composition also varies by livestock species as cattle tend to select more grasses while sheep and goats tend to select more forbs, browse, and shrubs.

2.3. Dormant Season Grazing

Cow-calf producers in many areas of the world have access to dormant grasses during fall and winter months when lack of snow or ice cover permits grazing. Stockpiled forages (native range) represent a low-cost forage resource for these producers since it requires no haying or feeding operation for delivery as cattle do the harvesting themselves. To make any extensive dormant grazing program successful, strategic, accurate supplementation is necessary. Degradable intake protein (DIP), which is protein available to the rumen microbes, is the first limiting nutrient in dormant native range. Strategic supplementation will improve cattle performance on dormant grasses and improve forage utilization. This chapter will focus mainly on protein supplementation of grazing beef cattle, predominantly breeding cows in cow-calf operations in North America.

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Biographical Sketches

Dr. Greg P. Lardy was born in Dickinson, North Dakota in 1969. He received his B.S. degree in Animal and Range Sciences from North Dakota State University in 1991, his M.S. from the University of Missouri in Animal Sciences in 1993, and his Ph.D. in Animal Sciences from the University of Nebraska in 1997.

In 1997, he accepted a position of assistant professor and extension beef cattle specialist at North Dakota State University (NDSU) where he progressed to his current rank of Professor in the Animal Sciences Department at NDSU in 2009. He is currently Co-Director of the Beef Systems Center of Excellence for

Nutrition and Pregnancy at NDSU. During the past 12 years at NDSU, Dr. Lardy has authored numerous extension bulletins, peer-reviewed manuscripts, and popular press articles on beef cattle nutrition and management. In addition, he has trained numerous graduate students in the area of beef cattle nutrition.

Dr. Lardy was awarded the NDSU College of Agriculture's 'Extension Excellence Early Career Award in 2000 and the Larson/Yaggie Excellence in Early Career Research Award in 2004. In addition, he has received numerous Program Excellence Awards for his extension programming efforts. He also served as Associate Editor for the *Journal of Animal Science* and is an ad hoc reviewer for numerous journals. Dr. Lardy resides in West Fargo, North Dakota with his wife, Lynae and their three children, Jacob, Jarrett, and JaeLyn. In his free time, he enjoys outdoor activities such as hunting, fishing, and running.

Dr. Joel Caton was born in Missouri in 1959. He received his B.S. (1982) and M.S. (1983) degrees in Animal Science from New Mexico State University, Las Cruces and University of Missouri, Columbia, respectively. His Ph.D. in Animal Science (Ruminant Nutrition) was awarded from New Mexico State University, Las Cruces in 1987. He completed a Post Doctoral Fellowship at the University of Missouri, Columbia in 1988.

In 1988, he accepted a position of assistant professor at North Dakota State University (NDSU) and has progressed to his current rank; Professor of Animal Science at NDSU. He is also currently Co-Director of the Center for Nutrition and Pregnancy. In 1999 he completed a sabbatical in the United Kingdom in the area of protein and amino acid metabolism. He is also currently on sabbatical as Research Fellow at the Rowett Institute of Nutrition and Health, University of Aberdeen, UK. During the past 21 years at NDSU, his research program has resulted in numerous publications and grants. In addition, he has advised or co-advised numerous undergraduate and graduate students and several post doctoral fellows. His teaching efforts include both undergraduate and graduate courses in nutrition.

Dr. Caton was awarded the NDSU College of Agriculture's Research Award in 2003. In 2004 he received the National AFIA Ruminant Nutrition Award presented by the American Society of Animal Science. He has served as Associate Editor for the *Journal of Animal Science* and held many positions of service in both his institution and professional society. He has served as ad hoc reviewer for numerous journals and granting agencies including the USDA and the NIH. Dr. Caton lives in Fargo with his wife, Kristina and their youngest daughter, Lorna. In his spare time he enjoys hunting, fishing, other outdoor activities, and spending time with family.