Beef Cow Nutrition Guide

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A good cowherd nutrition program not only meets the cow's needs, but does so at minimal cost. This emphasis on cost is essential since cost/return analyses of cowherds in Kansas indicate that feed costs represent approximately 50 to 70 percent of total costs; and, feed costs are one of the few areas in which producers can make significant changes, quickly.

Feed is not only the major cost item, but it also is the major factor influencing reproductive performance—the second most important factor in cowherd profitability. This relationship establishes what should be the primary goal of cowherd nutrition programs—maintaining a high reproductive rate. Specifically, the emphasis should be on maintaining an optimal reproductive rate, which may be somewhat below the maximum rate attainable. In other words, it may cost more in feed to move the calf crop from 92 to 94 percent than the additional calves are worth. Attaining the most profitable balance between feed costs and reproductive rate is obviously difficult, but it is the key to a profitable cowherd enterprise.

The Biological Priority for Nutrients

A key concept that producers must keep in mind when planning a cowherd nutrition program is the biological priority for nutrients as shown in Table 1. The most important concept is that before a beef female will reproduce, the other requirements (i.e., maintenance, growth and milk production) must first be met.

Meeting the nutritional requirements of beef cows at minimal cost is complicated by the fact that many variables influence cow requirements and the nutritional composition of feedstuffs. The following is a review of the factors that influence nutritional requirements of beef cows.

Factors Influencing Nutritional Requirements

1. Stage of Production

One of the most difficult aspects of feeding beef cows is that their nutritional requirements change dramatically during the year based on pregnancy and lactation status. While requirements change gradually during the year, a useful way of considering these changes is to divide the beef cow reproductive year into four periods as shown in Table 2.

Period 1. This is the most crucial period in the beef cow year in terms of production and reproduction. Not only must the cow nurse a calf, but she must rebreed within 80 to 85 days to calve at the same time next year. Consequently, her nutrient requirements are greatest during this period, with inadequate nutrition resulting in lower milk production and calf weaning weight, and poorer rebreeding performance.

Period 2. During Period 2, the cow is pregnant and lactating; however, the requirements of pregnancy during this period are relatively small. Furthermore, in a spring-calving program, high-quality forage is normally available. Consequently, Period 2 isn't considered a crucial reproductive period.

Period 3. During this post-weaning period, referred to as mid-gestation, the cow isn't nursing a calf and the requirements for the developing fetus are still relatively low. Therefore, the cow's nutritional requirements are low, so Period 3 isn't considered a crucial reproductive period—it is a time to maximize the use of crop residues and other low-cost roughages. For spring-calving cows, timing the breeding season so that cows are in the middle trimester of gestation when crop residue use can be maximized will reduce annual cow cost. If cow body condition scores are low, Period 3 is an excellent time to increase the cows' weight.

Period 4. The period from approximately 60 to 90 days prior to calving is another crucial reproductive period. During this time, fetal growth is at its maximum. Additionally, the cow is laying on fat stores to assist in lactation. The consequences of inadequate nutrition during this period include:

1. Lighter calf birth weights (although calving difficulty won't be reduced).
2. Lower calf survival.
3. Lower milk production and calf growth.
4. Delayed estrus—this means a later calf next year and subsequent reduced weaning weights.

Table 3 shows the nutritional requirements for an 1,100-pound beef cow by period.

2. Weather

As any producer knows, cold weather greatly increases nutritional requirements. Thus, typical

Table 1. Biological Priority for Nutrients by Beef Cows

Priority	Function
1	Maintenance
2	Growth
3	Milk production
4	Reproduction

Table 2. The 365-Day Beef Cow Year by Periods

Period	1	2	3	4
Days	82	123	70	90
	post-calving	pregnant & lactating	mid-gestation	pre-calving

Table 3. NRC* Requirements For an 1,100-Pound Beef Cow Producing 15 pounds of Milk Per Day

	Nutritional Periods			
	1	2	3	4
TDN (lbs/day)	14.5	11.5	9.5	11.2
NEm (Mcal/day)	14.9	12.2	9.2	10.3
Protein (lbs/day)	2.3	1.9	1.4	1.6
Calcium (grams/day)	33	27	17	25
Phosphorus (grams/day)	25	22	17	20
Vitamin A (I.U./day)	39,000	36,000	25,000	
27,000				

Table 4. Windchill Factors for Cattle with Winter Coat

wind speed (mph)	Temperature (°F)												
	-10	15	0	5	10	15	20	25	30	35	40	45	50
Calm	-10	-5	0	5	10	15	20	25	30	35	40	45	50
5	-16	-11	-6	-1	3	8	13	18	23	28	33	38	43
10	-21	-16	-11	-6	-1	3	8	13	18	23	28	33	38
15	-25	-20	-15	-10	-5	0	4	9	14	19	24	29	34
20	-30	-25	-20	-15	-10	-5	0	4	9	14	19	24	29
25	-38	-32	-27	-22	-17	-12	-7	-2	2	7	12	17	22
30	-46	-41	-36	-31	-27	-21	-16	-11	-6	-1	3	8	13
35	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
40	-78	-73	-68	-63	-58	-53	-48	-43	-38	-33	-28	-23	-18

Table 5. Estimated Lower Critical Temperatures for Beef Cattle

Coat Description	Critical Temp.
Wet or summer coat	59°F
Dry fall coat	45°F
Dry winter coat	32°F
Dry heavy winter coat	18°F

rations may be low in energy during extremely cold weather and allowances should be made for the additional requirement.

Cattle perform optimally in the thermoneutral zone where temperatures are neither too cold nor too hot. When the effective ambient temperature, an index of the heating or cooling power of the environment, is outside of the thermoneutral zone, cattle performance is depressed. The effective ambient temperature considers wind, humidity and solar radiation in addition to the actual air temperature. The most common situation that producers face is an effective ambient temperature (wind chill index) below the lower critical temperature—the lower range of the thermoneutral zone. Table 4 shows the windchill index for varying combinations of wind and temperature. If cows have shelter from the wind, the effective ambient temperature is the same as the air temperature.

In addition to actual weather conditions, the amount of insulation on the animal influences the lower critical temperature (the temperature at which the animal's performance is adversely influenced by the environment). Table 5 shows the estimated lower critical temperatures for cattle with varying hair coats.

The only adjustment in cow rations necessitated by weather is to increase maintenance energy. Protein, mineral and vitamin requirements are not changed by weather stress. Table 6 shows the percentage increase in energy required per degree (F) that the wind chill is below the lower critical temperature.

The general rule of thumb is to increase winter ration energy 1 percent for each degree (F) below the lower critical temperature.

As anyone who has lived in Kansas knows, there is no such thing as a typical weather pattern; however, the information in Table 7 gives monthly averages for temperature and wind speed at several locations in Kansas for the months with typical windchill indexes below the lower critical temperature. This information is provided to allow producers to consider the average wind chill or effective ambient temperature for use in adjusting rations for weather stress.

Table 8 gives examples of the amount of specific feedstuffs, i.e. grain or hay, needed to meet the additional energy requirements incurred by weather stress. In some cases simply feeding more of a low-quality feedstuff

Table 6. Increased Maintenance Energy Costs for Cattle Per Degree (F) Coldness				
	Cow Weight (lbs)			
	1000	1,100	1,200	1,300
Coat Description	Percentage increase per degree coldness			
Summer coat or wet	2.0	2.0	1.9	1.9
Fall coat	1.4	1.3	1.3	1.3
Winter coat	1.1	1.0	1.0	1.0
Heavy winter coat	.7	.7	.6	.6

Ames, Kansas State University.

Table 7. Average Windspeed and Temperature at Several Kansas Locations					
Month/City	Concordia	Dodge City	Goodland	Topeka	Wichita
Average monthly wind speed, mph					
Jan.	12.0	13.6	12.4	10.3	12.3
Feb.	12.4	14.1	12.6	10.8	12.9
Mar.	13.8	15.8	14.2	12.6	14.4
Nov.	11.5	13.7	11.8	10.2	12.3
Dec.	11.9	13.5	12.0	10.2	12.2
Average monthly temperature					
Jan.	24.9	29.5	27.2	26.1	29.6
Feb.	30.9	35.0	31.9	32.5	35.1
Mar.	39.9	42.1	37.2	41.8	44.1
Nov.	41.1	42.5	38.1	42.7	44.3
Dec.	30.8	33.7	30.3	31.8	34.4

[1] Comparative climatic data for the United States through 1978.
[2] Monthly normals of temperature, precipitation, and HDD and CDD for 1951–1980 for Kansas. Sept. 1982 edition #81.

Table 8. Affect of Temperature on Energy Needs[a]				
Effective Temp.	Increase % in Energy	Amount of Extra Hay Needed	or	Extra Grain Needed
50°F	0	0		0
30°F	0	0		0
10°F	20	3½–4 lbs/cow		2–2½ lbs/cow
-10°F	40	7–8 lbs/cow		4–5 lbs/cow

[a] Assumes a dry winter coat.

Table 9. Relationship Between Cow Weight and Nutrient Requirements—(dry, mature cows—middle third of pregnancy)			
	Requirements (lbs)		
Cow Weight (lbs/day)	TDN (lbs/day)	NEm (Mcal/day)	Protein
1000	8.8	7.57	1.3
1100	9.5	8.13	1.4
1200	10.1	8.68	1.5

Nutrient Requirements of Beef Cattle, NRC, 1984.

will not meet these additional requirements, in which case the energy density of the diet must be increased by either feeding a high-quality forage or by adding a high-energy feedstuff such as grain.

3. Cow Weight

As cow weight increases, the nutritional requirement for energy and protein increases. Table 9 shows the energy and protein requirements for cows of differing weights at moderate body conditioning scores. As a general rule, each 100-pound change in weight changes the Net Energy of Maintenance (NEm) requirement by about .57 Mcal. Correspondingly, the crude protein requirement changes by about .1 pound for each 100-pound change in body weight.

4. Cow Body Condition Score

While the concept of using body condition as a tool in feeding cattle is certainly not new, it has gained considerable favor with producers and nutritionists since numerous research trials have shown that reproduction in beef cows is greatly influenced by body fatness. For example, Table 10 shows the relationship between body condition at calving, pre- and post-calving gains, and cycling activity 60 days post-calving. From a practical standpoint, the goal should be to have cows calve in good body condition and avoid significant loss in condition between calving and the start of the breeding season.

To assist producers in eval-uating body condition, a nine-point cow condition scoring system has been developed with "1" being a very thin cow and "9" a very fat cow. Readers interested in more information regarding the use of this system are referred to the bulletin, C-842, *Feeding Your Cows by Body Condition Score*, available from K-State Research and Extension.

Table 10. Relationship of Body Condition and Percentage of Cows Cycling 60 Days After Calving			
Condition at calving	Weight change pre-calving	Weight change post-calving	% cycling 60 days post-calving
Good	Lost	Lost	90%+
Moderate	Gained	Lost	74%
Moderate	Lost	Lost	48%
Thin	Lost	Gained	46%
Thin	Lost	Lost	25%

* Source: Whitman, Colorado State University, 1975.

Table 11. Relationship Between Milk Production and Nutrient Requirements—1,100-pound cow

	Requirement (lbs.)		
Lbs. of milk per day (lbs/day)	TDN (lbs/day)	NEm (Mcal/day)	Protein
10	12.1	11.54	2.0
15	13.3	13.24	2.3
20	14.5	14.94	2.6

Nutrient Requirements of Beef Cattle, NRC, 1984.

Table 12. Peak and Average Milk Production for Common Beef Breeds

Breed	Peak milk production lbs/day	Average milk production lbs/day
Angus	20.7	14.9
Charolais	21.6	15.1
Gelbvieh	25.3	17.8
Hereford	18.7	12.5
Limousin	20.9	14.1
Simmental	24.1	16.8

Meat Animal Research Center.

5. Milk Production

Milk production places tremendous demands for nutrients on beef cows. For example, an increase in milk production of 5 pounds per day requires about 1.7 Mcal of NEm, .3 pounds of crude protein, .012 pounds of calcium, and .006 pounds of phosphorus. Table 11 illustrates the influence of increasing milk production on cow nutrient requirements.

Not only does milk production put tremendous nutritional stress on beef cows, but peak lactation usually occurs by 60 to 80 days postpartum, which unfortunately precedes the start of the breeding season. Also, it is important to keep in mind that milk production has a higher biological priority for nutrients than reproduction. Consequently, attempting to feed a thin cow more just prior to the breeding season to increase condition may only result in more milk production. Table 12 shows the average peak production and average total production over a 205-day lactation for the most common beef breeds. Studies of lactation curves in beef cows indicate that milk production increases rather rapidly from birth of the calf to a peak at 60–80 days and then declines slowly until weaning.

6. Age

The age of the animal influences nutritional requirements because a young cow is still growing. Again, a review of the biological priority for nutrients (Table 1) is useful since it indicates that growth is the second highest priority. The importance of this factor is clear when one considers that Kansas producers routinely indicate that most of their "open" cows are 2- and 3-year-olds. The failure of these females to rebreed means that nutrition was inadequate to meet maintenance + growth + milk production and allow for reproduction.

Table 19 shows the nutrient requirements of 2-year-old heifers during early lactation. Included in these requirements is a growth rate of .5 pounds per day. The actual growth rate may be higher for large-framed heifers or heifers that are compensating for previous restrictions in energy intake. Consequently, producers should increase the levels of energy and protein above those shown in Table 19, if these situations exist.

If possible, young females, along with old or thin cows, should be fed separately from the mature cows during the winter so that their additional nutritional requirements for growth and/or condition can be met. In short, the loss of 2- and 3-year-old cows due to reproductive failure represents a significant economic loss because the expense of heifer development has already been incurred with very limited returns.

7. Physical Activity

The maintenance requirement of beef cows is increased by activity. As a general guideline, the NEm requirement is increased by about .9 Mcal/day in cows grazing compared to cows fed in a drylot. Consequently, if cows are required to graze over wide areas, adjustments should be made to the requirements shown in Table 19.

Practical Considerations

1. Forage Intake

The beef cow, by the very fact that she has a ruminant digestive system, is designed to consume and digest forages. However, a key issue is how much she will consume when allowed free-choice access to forages either on pasture or in a drylot situation. The major factors influencing intake are:

Quality of forage available. Intake is probably most influenced by the quality of forage with intake decreasing dramatically as quality decreases.

Quantity of forage available. Since beef cattle selectively graze, eating the better-quality forage first, as the quantity of forage available declines, the intake also tends to decline.

Protein content of the diet. Since protein is required by ruminal microorganisms to digest forages, if it is inadequate, voluntary intake will be substantially reduced.

Environment. Weather conditions also can impact forage intake by disrupting grazing patterns. While cold weather generally increases intake, windy or wet weather will reduce grazing time and intake.

Table 13 illustrates the relationship between forage intake, forage quality, and supplementation with energy or protein.

One of the most important concepts illustrated in this table is that, when forage quality is low or average, forage intake is increased with protein supplementation but not with energy supplementation. This increase in intake caused by adequate protein supplementation, coupled with maintenance of forage digestibility, means that the total daily energy status of the cow is increased. Also, note that the quantity of supplement is a factor in intake since the animals may substitute the supplement for forage. This is especially true with large quantities of an energy-based supplement, such as grain. Thus, the intake guidelines for forage intake with an energy supplement shown in Table 13 may be too high when a large amount of supplement is fed.

Table 13. Expected Intake Levels of Forage Varying in Quality With and Without Supplementation

Roughage Type	Forage Intake (% Body Weight, DM Basis) of Beef Cows: Dry, bred cow	Lactating Cow
Low quality roughages:		
Unsupplemented	1.5	2.0
With protein supplement	1.8	2.2
With energy supplement	1.5	2.0
(above 4 pounds supplement, each pound supplement will decrease forage consumption by about 0.6 pound.)		
Average Quality Roughages:		
Unsupplemented	2.0	2.3
With protein supplement	2.2	2.5
With energy supplement	2.0	2.3
(above 4 pounds supplement, each pound supplement will decrease forage consumption by about 0.6 pound.)		
High Quality Roughages:		
Unsupplemented	2.5	2.7
With protein supplement	2.5	2.7
With energy supplement	2.5	2.7
(pound for pound substitution of supplement for forage)		

C. A. Hibbard and T.A. Thrift, Oklahoma.
Presented at 1992 National Meeting of ASAS.

Calculating Forage Intake Under Grazing Situations. How much crop residue or dry, winter grass will a beef cow consume? To answer this question, using the information in Table 13, let's assume that an 1,150-pound cow is grazing a low-quality crop residue. Assuming that adequate protein supplementation is supplied, the cow will consume about 1.8 percent of her body weight in forage dry matter (DM). Taking 0.018 times 1,150 pounds, we get an intake of 20.7 pounds of dry matter. If the crop residue is assumed to be 90 percent DM, the "as-fed" intake is 20.7/.9 = 23 pounds of residue per day plus the protein supplement. The guidelines in Table 13 can be used in this manner to estimate the intake of any forage available free-choice.

Differences in Nutrient Content Between Clipped Forage Samples and Actual Intake by Grazing Beef Cows. It would seem logical to collect forage samples from a standing forage, such as dry-range grass in the winter, and have it analyzed. While this process will give an accurate picture of the feed value of the forage on average in the pasture, clipped samples are not representative of what cattle consume. Beef cattle, given adequate forage availability, will select the highest quality material, resulting in a diet 2 to 3 percentage points higher in protein, for instance, than clipped samples. As a general rule, the differences in nutrient composition will be greatest when forage quality is low. From a practical standpoint, it is recommended that producers add approximately 2 percentage points to the laboratory protein analysis of clipped samples before formulating rations.

2. Protein Supplementation

While energy is the most commonly deficient nutrient in beef-cow diets, protein often represents the largest "out-of-pocket" expense for cow-calf producers. Proper protein supplementation of poor quality forages will increase forage intake. Increased forage intake meets the cow additional energy intake. Thus, to maximize profitability, it is essential to optimize protein supplementation. Inadequate dietary protein results in low forage intake and digestibility, resulting in much poorer performance. This reduction in performance may be expressed as weight loss, a decline in body condition, lower milk production, lower antibody transfer to calves through colostrum, or numerous health problems resulting from lowered resistance to disease.

Meeting the protein requirements of beef cattle is complicated by the fact that the microorganisms in the ruminant digestive system can utilize many sources of nitrogen to make protein. Additionally, the digestive characteristics of plant and animal proteins are variable. The following section is an attempt to define some of the terms used in describing types of protein and give guidelines for practical application of these concepts.

Degradable and Undegradable Intake Protein. The protein fraction of the diet can be divided into two components, degradable intake protein (DIP) and undegradable intake protein (UIP). The DIP fraction is available to the rumen microflora and, thus, can be used for their growth and digestion of dietary fiber. Supplementing low-quality forages with DIP has been shown to increase forage digestion and intake, thus increasing energy intake. The UIP is not available to the rumen microflora and, therefore, has essentially no effect on forage utilization. The UIP fraction can be a direct supply of amino acids to the host animal or it can go undigested and be expelled from the gastrointestinal tract. Oil seed byproducts (soybean meal, cottonseed meal, sunflower meal) contain a high percentage of DIP while proteins derived from animal sources contain mostly UIP. From these general statements, producers should realize that for most forage-based diets, supplementation programs should focus on the inclusion rates of DIP in the diet. K-State research has indicated that the amount of DIP required to maximize forage use appears to be about 10 to 11 percent of the digestible organic matter (which is roughly the same as TDN content). Therefore, to correctly supply the proper amount of supplement, producers need to know the source of the supplemental protein as well as an estimate of forage intake, digestibility and nutrient composition.

Non-Protein Nitrogen (NPN). From a practical viewpoint, cattle have the ability to use either "natural" protein such as that contained in feedstuffs or various other nitrogen sources. Sources other than natural protein are generally referred to as nonprotein nitrogen (NPN) sources. Common NPN sources used in protein supplements include urea, biuret and ammonia hydroxide.

Usefulness of NPN in Beef Cow Rations—The use of NPN in cow rations has been discouraged in the past because for the rumen microflora to convert NPN into protein they must also be supplied with adequate energy and carbon skeletons. Forage-based diets usually do not supply excessive amounts of either, thus, limiting the quantity of NPN that can be fully utilized. Most NPN sources are considered to be 100 percent DIP in nature. Recent research results have indicated limited amounts of the DIP in supplements can be replaced by NPN.

At present, an inclusion level of 15 percent of the total crude protein (or 20 percent of the DIP) as NPN can be used without significantly jeopardizing livestock performance. Because of the severe energy limitations of low-quality forage diets, NPN is less potent as an energy source than say with high-quality-forage diets or high-concentrate diets. Previous research where supplement containing significant amounts of NPN indicates that, at best, 50 percent of the protein coming from NPN can be utilized by cows consuming low- to medium-quality roughages. And, as NPN inclusion rates increase, the NPN utilization can steadily fall from 50 percent to as low as 20 to 25 percent. Therefore, cattlemen need to carefully analyze their protein supplementation programs and only include those amounts of NPN that will be optimum to their operations.

Interpreting the NPN content of feedstuffs—Feed tags must show the NPN content of commercial-protein supplements. Commonly, this is done by showing the total protein concentration followed by the amount of protein coming from NPN. For example, a tag on a range cube might show the figures "20–10" for protein. This means that the total protein content of the cube is 20 percent with the equivalent of 10 percentage units or 50 percent of the protein coming from NPN.

Calculating the Protein Value of a Supplement with NPN—For use with beef cows grazing dormant range or crop residues in late winter, the 20–10 supplement should be considered, at best, a 15 percent supplement (10 percent from natural sources plus 50 percent of the 10 percent from NPN). Again, this is allowing for 50 percent utilization of the NPN which is a "best case" scenario.

If the actual rate of utilization is only 20 percent, as could be the case with crop residues in late winter, this supplement may only give performance equal to a 12 percent all natural (10 percent natural + 20 percent of the 10 percent from NPN = 12 percent). Note that the 12 or 15 percent figure for protein content should be used both for meeting protein requirements and

Table 14. Mineral Requirements and Maximum Tolerable Levels in Beef Cattle[a]

Mineral	Unit	Requirement[b]: Gestating	Early Lactating	Maximum Tolerable Concentration
Calcium	%	See Table 19		
Chlorine	%	—	—	1,000.00
Cobalt	ppm	0.10	0.10	10.00
Copper	ppm	10.00	10.00	100.00
Iodine	ppm	0.50	0.50	50.000
Iron	ppm	50.00	50.00	1,000.00
Magnesium	%	0.10	0.20	0.40
Manganese	ppm	20.00	40.00	1,000.00
Molybdenum	ppm	—	—	5.00
Phosphorus	%	See Table 19		
Potassium	%	0.60	0.70	3.00
Selenium	ppm	0.10	0.10	2.00
Sodium	%	0.06–0.08	0.10	—
Sulfur	%	0.15	0.15	0.40
Zinc	ppm	30.00	30.00	500.00

[a] Taken from National Research Council publication Nutrient Requirements of Beef Cattle, Seventh Revised Edition, 1996.

[b] Requirements for most minerals are affected by a variety of dietary and animal factors. Thus, it may be better to evaluate rations based on a range of mineral requirements and for content of interfering substances than to meet a specific dietary value.

for pricing the supplement compared to a 20 percent "all natural supplement" or other protein source.

Biuret—While urea is the most commonly used form of NPN, many supplements contain biuret which is essentially two urea molecules chemically bound together. Biuret is somewhat safer, but a review of research comparing urea and biuret indicates that the performance of cattle has been similar.

Ammonia Hydroxide—During the past 10 years, ammoniation of roughages has gained wide acceptance by beef producers in Kansas, especially as a way of making a quality feedstuff out of wheat straw and other crop residues in drought years. Feed analyses routinely show an increase in the crude protein content of wheat straw by 4 to 6 percentage points by ammoniation. Thus, a straw at 4 percent CP prior to ammoniation often tests 9 percent CP after ammoniation. However, this protein is in the form of ammonia hydroxide—an NPN source. Research has shown that beef cows make some use of this NPN source, but respond very well to additional supplementation with "natural" protein. This clearly points out that the primary reason for ammoniating forages is to increase fiber and energy intake and digestibility, and not to meet all of the protein needs of the cows.

By-Pass Protein. In recent years, considerable research has focused on the concept that not all types of "natural" proteins are digested by rumen microorganisms—some of it "bypasses" or escapes the rumen to be digested directly in the intestine. Examples of high-escape protein sources include dehydrated alfalfa, blood meal, corn gluten meal, distillers grains and feather meal. There is merit in having a percentage of protein bypass ruminal digestion, and protein sources differ greatly in the proportion of protein that bypasses.

A review of the literature on bypass protein utilization by beef cows indicates that high-bypass sources rarely show any benefit compared to other "all natural" sources such as soybean meal (SBM) or cottonseed meal (CSM). However, supplements containing high bypass protein sources are better utilized in combination with NPN than are lower bypass sources such as SBM. In general, producers can price high bypass compared to low-bypass protein sources on a pound-for-pound basis for use with beef cows. It should be pointed out, however, that high-bypass sources plus NPN have shown some benefit in growing programs and may have some economic advantage.

3. Mineral Supplementation

In general, mineral requirements of beef cows can be grouped into the major minerals (calcium, phosphorus and salt) and the trace minerals which are required at much lower levels. Table 14 shows a list of the minerals for which a suggested nutrient allowance has been established.

Calcium (Ca), Phosphorus (P), and Salt. These minerals are required at significant levels by beef cows, and, thus, are major considerations in diet formulation. Since calcium is usually found in fairly high levels in forages, it is rarely deficient in diets typically fed to beef cows. Conversely, forages are relatively poor sources of phosphorus which means that it should be the first mineral considered in a supplementation program. Unfortunately, phosphorus is relatively expensive, and producers are advised to meet animal requirements but avoid over supplementation.

Cattle have a definite requirement and appetite for sodium (Na). Since most feedstuffs are deficient in this nutrient, cattle should be offered supplements containing salt (sodium chloride) at all times.

Trace Minerals. Table 14 indicates both the minimum required levels and maximum tolerable levels for trace minerals. Requirements for these minerals may be met by using trace mineralized (TM) Salt in a free-choice supplement; however, there are a few areas in Kansas where deficiencies of specific trace minerals are common. In these locations, producers must increase the concentration of specific trace minerals in the supplement to avoid deficiency symptoms. A mineral consumed at .22 pounds/day would have to contain 0.0005 percent Cobalt, 0.05 percent Copper, 0.0025 percent Iodine, 0.25 percent Iron, .25 percent Manganese, 0.0005 percent Selenium, and .2 percent Zinc to meet 50 percent of a beef cow's total daily requirement.

General Considerations in Mineral Supplementation

Do Beef Cows Have the Ability to Balance Their Mineral Requirements? Many producers believe that beef cows have the ability to consume specific minerals when a deficiency exists. However, research has shown that cows do not have the "nutritional wisdom" to balance their diets, which means that producers must do the "balancing" for their cows. However, as previously mentioned, one of the minerals that cattle do crave is salt. Thus, other minerals should be mixed with salt or other feed ingredients to promote intake. The desire for salt means that a free-choice mineral, high in TM Salt and phosphorus, will usually provide adequate mineral supplementation. Since cows don't crave minerals other than salt, it is recommended that producers avoid using a salt block separate from a free-choice mineral supplement.

Producers often comment that their cows go through periods of extremely high mineral intake and periods of little or no intake. Again, these fluctuations are probably driven by an appetite for salt. Consequently, producers should increase the salt content of their free-choice mineral when the cows consume over .2 pounds daily.

Free-Choice Mineral Supplements. Average mineral consumption per cow should range from .1 to .2 pounds daily. Intake can be adjusted by altering the salt level (higher levels reduce intake) or adding flavoring agents, such as SBM or molasses, to increase intake. Phosphorus intake and the cost of mineral supplementation can best be altered by changing the salt level in the mineral.

"Home Mineral Mixes." In periods of high requirements, such as early lactation and the breeding season, a mixture of 50 percent Dicalcium phosphate + 50 percent TM Salt is recommended. During these periods, 3 to 5 percent SBM or molasses may be added to increase intake and prevent caking. During periods of reduced mineral requirements, a mixture of 30 percent Dicalcium phosphate + 70 percent TM Salt should be adequate.

Special Mineral Considerations.

Magnesium—Many producers must supplement with magnesium (Mg) in the early spring to prevent

Table 15. Estimated Daily Water Intake of Cattle

Month	Mean Temp. °F	Cows Nursing Calves[1] Gal	Bred Dry Cows & Heifers Gal	Bulls Gal
January	36	11.0	6.0	7.0
March	50	12.5	6.5	8.6
May	73	17.0	9.0	12.0
July	90	16.5	14.5	19.0
Sept.	78	17.5	10.0	13.0
Nov.	52	13.0	6.5	9.0

Source: Paul Q. Guyer, University of Nebraska.

[1] Cows nursing calves during first three to four months after parturition—peak milk production period.

Table 16. Rations for the Middle Trimester of Pregnancy (October through November)

Ration	Feedstuff	Amount Per Head Per Day Lbs.		Feedstuff	Lbs.	Mineral Req.
1	Wheat Straw	17	+	Alfalfa Hay	6.5	P + TM Salt
2	Corn Stover[a]	24		—		P + TM Salt
3	Milo Stover[a]	24		—		P + TM Salt
4	Brome Hay	18[b]		—		TM Salt
5	Prairie Hay	22[c]		—		P + TM Salt
6	Prairie Hay	22	+	Commercial Cubes	.5[d]	TM Salt

[a] Both the corn and milo stovers were assumed to be 6.6 percent crude protein during this period.

[b] This level of intake is only 72 percent of expected free choice consumption, which means that all cows must have access during feeding to avoid over consumption by "boss" cows.

[c] Slightly low in CP

[d] 20 percent CP. A practical way of delivering these cubes would be to feed 2 pounds/head every four days, or even 3 pounds/head every six days.

Note: If a high urea cube is utilized, they should be fed daily instead of periodically.

Table 17. Rations for the Last Trimester of Pregnancy (December through February)						
			Amount Per Head Per Day (lbs)			
Ration	Feedstuff	Lbs.		Feedstuff	Lbs.	Mineral Req.
1[a]	Corn Stover	18	+	Alfalfa Hay	8	P + TM Salt
2	Corn Stover	20	+	Wheat Midds	7	TM Salt
3	Milo Stover	18	+	Alfalfa Hay	7	P + TM Salt
4	Milo Stover	19	+	Wheat Midds	7	TM Salt
5[b]	Dry Winter Grass	16	+	Alfalfa Hay	7	P + TM Salt
6[b]	Dry Winter Grass	20	+	Commercial Cubes[c]	4	P + TM Salt
7	Dry Winter Grass	16	+	Wheat Midds	9	TM Salt
8	Brome Hay	26				TM Salt
9	Prairie Hay	16	+	Alfalfa Hay	9	TM Salt
10	Prairie Hay	20	+	Wheat Midds	5	TM Salt
11	Wheat Straw	15	+	Alfalfa Hay	10	TM Salt
12	Wheat Straw	17	+	Wheat Midds	8	Ca + TM Salt
13	Forage Sorghum Hay	25				TM Salt

[a] Under the conditions described, cows consuming this ration would lose approximately ⅓ body condition score. Consequently, if this loss is unacceptable, this ration should be adjusted.
[b] Under the conditions described, cows consuming these rations would lose approximately ½ body condition score from December 1st to March 1st. Thus, additional supplementation may be necessary.
[c] 20% CP.

Table 18. Rations for Lactation (March through April)						
			Amount Per Head Per Day (lbs)			
Ration	Feedstuff	Lbs.		Feedstuff	Lbs.	Mineral Req.
1	Brome Hay	28		—		TM Salt
2	Corn Stover	15	+	Alfalfa Hay	14	P + TM Salt
3	Corn Stover	22	+	Commercial Cubes[a]	8	TM Salt
4	Milo Stover	14	+	Alfalfa Hay	14	P + TM Salt
5	Milo Stover	21	+	Commercial Cubes[a]	8	TM Salt
6	Wheat Straw	15	+	Alfalfa Hay	14	P + TM Salt
7	Prairie Hay	16	+	Alfalfa Hay	11	P + TM Salt
8	Forage Sorghum Hay	20	+	Alfalfa Hay	8	TM Salt
9	Winter Native Grass	19	+	Commercial Cubes[a]	8	TM Salt
10	Winter Native Grass	14	+	Alfalfa Hay	13	TM Salt

[a] 20% CP.

grass tetany, especially on cool-season forages such as brome, fescue and wheat pasture. Supplementation should be started about three weeks prior to initiation of grazing for best results. The recommended intake of magnesium oxide (MgO) is at least .03 pounds per day which means that it must make up 15 to 20 percent of a free-choice mineral supplement. A good "home mix" for this period would be 15 percent MgO, 50 percent dicalcium phosphate, 25 percent salt, and 10 percent molasses or SBM. Since MgO is unpalatable, a flavoring agent, such as molasses or SBM, should be added to increase intake. Commercial mineral mixtures utilized during early spring should be at least 10 percent Mg. In some situations, it may be necessary to increase Mg above the normal requirement. A suggested mix for these situations, is 25 percent MgO, 25 percent dicalcium phosphate, 25 percent salt, and 25 percent molasses or SBM.

Chelated Minerals—Chelated minerals are trace minerals that are attached to an organic molecule, i.e. an amino acid or protein. Most research has shown that chelated minerals have greater bioavailability (higher absorption potential) than some organic forms, especially oxides, used in common mineral supplements.

However, inorganic forms are much less expensive. Currently, the question of whether chelates are beneficial or not is one of the most controversial areas in beef cattle nutrition. This controversy results from the fact that even though absorption is greater, there is little, if any, research demonstrating improved cattle performance. Until further research demonstrates an economic advantage, producers are advised to use highly available inorganic forms of trace minerals to minimize costs while assuring nutritional adequacy.

4. Troubleshooting Cow Herd Nutrition Programs

It seems to be human nature to want to blame poor reproduction or performance in a herd of cattle on exotic causes rather than the most logical causes. In troubleshooting cow herd nutrition programs, keep in mind that a very high percentage of problems, including poor reproduction or low weaning weights, can be directly attributed to inadequate energy and/or protein intake and not to a trace mineral or unknown growth factor. Only after the adequacy of energy and protein has been established should the focus turn to mineral and vitamin nutrition.

5. Vitamin Requirements

While beef cattle have requirements for several vitamins, most are produced by rumen microorganisms and, thus, are not required in the diet. However, vitamin A must be supplied in some form. Requirements for vitamin A are shown in Table 19. Research has shown that cattle are capable of storing large quantities of vitamin A in the liver during periods of high intake. This commonly occurs during the grazing season on lush, green forage, with these storage supplies being depleted during the winter months. Supplementing vitamin A is very inexpensive and can be accomplished by:

1. Feeding forages high in vitamin A such as high-quality alfalfa hay less than six to eight months old.
2. Including vitamin A in mineral mixes or in other supplements.
3. Injecting vitamin A in periods where feedstuffs are low in vitamin A content and/or requirements are high. Injecting 2 million I.U. should provide sufficient vitamin A for 80 to 100 days.

6. Water Requirements

Normally, water is easily supplied to cattle and little thought is given to this requirement. But, drought conditions are common in Kansas and hauling water an all too frequent necessity. Generally, as temperature increases water consumption increases. If water intake is limited, feed intake also will be depressed, resulting in subpar performance. Since water requirements are influenced by a number of physiological and environmental factors, Table 15 is included to provide a guideline for animal requirements.

Guidelines to Manage Beef Cow Diets

1. Feeding cattle is dynamic. Producers must consider animal, environment and diet factors to correctly feed beef cows.
2. A cow's nutrient requirements (energy, protein, minerals) will increase about 30 to 40 percent with calving. Forage intake will generally increase about 30 percent with calving.
3. Positive response to providing a supplement with high-protein concentrations is most likely when forage crude protein is less than 7 percent. The first-limiting nutrient in low-quality forages is protein. Therefore, the best approach for increasing total protein and energy supply is to supplement with DIP.
4. The NPN inclusion rate in supplements for forage-based diets must be monitored closely, as only up to 15 percent of the total dietary crude protein should be NPN in nature. Including NPN at too high of levels may result in refusal to consume supplements.
5. Starch can negatively impact forage intake and fiber digestion. Supplementing winter cow diets with corn, grain sorghum and other cereal grains can actually decrease energy intake. The key is to meet protein requirements of the rumen so that forage utilization is maximized.
6. When fed at levels exceeding 0.5 percent of body weight (e.g. 5.5 pounds of daily supplement for 1,100-pound cows) intake of low-quality forage will be reduced by 0.5 pounds for each 1 pound of alfalfa hay or low-protein concentrate fed above the 0.5 percent threshold.
7. Only minor differences in performance are evident for cattle supplemented every-other-day or three-times-weekly compared with daily.

Table 19. Nutrient Requirements of Breeding Cattle

						Energy in Diet DM		Total Protein		Calcium	Phos.	Vit. A[d]
Wt[a] (lbs)	Gain[b] (lbs)	Daily DM[c] (lbs)	Daily TDN (lbs)	NEm (Mcal)	TDN (%)	NEm (Mcal/lbs)	NEg (Mcal/lbs)	Daily (lbs)	in Diet DM (%)	in Diet DM (%)	in Diet DM (%)	Daily (1000's IU)
Pregnant yearling heifers—Last third of pregnancy												
700	0.9	15.3	8.5	7.95	55.4	0.52	NA[e]	1.3	8.4	0.27	0.20	19
700	1.4	15.8	9.6	7.95	60.3	0.60	0.34	1.4	9.0	0.33	0.21	20
700	1.9	15.8	10.6	7.95	67.0	0.70	0.43	1.5	9.8	0.33	0.21	20
800	0.9	16.8	9.2	8.56	54.8	0.51	NA	1.4	8.2	0.28	0.20	21
800	1.4	17.4	10.4	8.56	59.6	0.59	0.33	1.5	8.8	0.33	0.21	22
800	1.9	17.5	11.6	8.56	66.1	0.69	0.42	1.6	9.3	0.35	0.21	22
900	0.9	18.3	9.9	9.15	54.3	0.51	NA	1.5	8.1	0.26	0.20	23
900	1.4	19.0	11.3	9.15	59.1	0.58	0.32	1.6	8.5	0.30	0.21	24
900	1.9	19.2	12.5	9.15	65.4	0.68	0.41	1.7	9.0	0.32	0.21	24
Dry pregnant mature cows—Middle third of pregnancy												
900	0.0	16.7	8.2	7.00	48.8	0.42	NA	1.2	7.0	0.18	0.18	21
1100	0.0	19.5	9.5	8.13	48.8	0.42	NA	1.4	7.0	0.19	0.19	25
1300	0.0	22.0	10.8	9.22	48.8	0.42	NA	1.5	6.9	0.20	0.20	28
Dry pregnant mature cows—Last third of pregnancy												
900	0.9	18.2	9.8	9.15	54.0	0.50	NA	1.5	8.0	0.27	0.21	23
1000	0.9	19.6	10.5	9.72	53.6	0.50	NA	1.6	7.9	0.26	0.20	25
1200	0.9	22.3	11.8	10.83	52.9	0.49	NA	1.7	7.8	0.26	0.21	28
1400	0.9	24.9	13.1	11.90	52.5	0.48	NA	1.9	7.6	0.26	0.21	32
Two-year-old heifers nursing calves—First 3–4 months postpartum—10 lbs milk/day												
700	0.5	15.9	10.3	9.20[f]	65.1	0.67	0.40	1.8[g]	11.3	0.36	0.24	28
800	0.5	17.6	11.2	9.81[f]	63.8	0.66	0.39	1.9[g]	10.8	0.34	0.24	31
900	0.5	19.2	12.0	10.40[f]	62.7	0.64	0.37	2.0[g]	10.4	0.32	0.23	34
1000	0.5	20.8	12.9	10.98[f]	61.9	0.62	0.36	2.1[g]	10.0	0.31	0.23	37
Cows nursing calves—Average milking ability—First 3–4 months postpartum—10 lbs milk/day												
900	0.0	18.8	10.8	10.40[f]	57.3	0.55	NA	1.9[g]	9.9	0.28	0.22	33
1100	0.0	21.6	12.1	11.54[f]	56.0	0.54	NA	2.0[g]	9.4	0.27	0.22	38
1300	0.0	24.3	13.4	12.63[f]	55.1	0.52	NA	2.2[g]	9.1	0.27	0.22	43
Cows nursing calves—superior milking ability—First 3–4 months postpartum—20 lb milk/day												
900	0.0	18.7	13.1	13.81[f]	69.8	0.74	NA	2.4[g]	12.9	0.41	0.28	33
1100	0.0	22.3	14.5	14.94[f]	65.2	0.67	NA	2.6[g]	11.9	0.38	0.27	40
1300	0.0	25.3	15.9	16.03[f]	62.6	0.64	NA	2.8[g]	11.2	0.36	0.26	45

[a] Average weight for a feeding period.
[b] Approximately 0.9 + 0.2 pound of weight gain/day over the last third of pregnancy is accounted for by the products of conception. Daily 2.15 Mcal of NEm and 0.1 pound of protein are provided for this requirement for a calf with a birth weight of 80 pounds.
[c] Dry matter consumption should vary depending on the energy concentration of the diet and environmental conditions. These intakes are based on the energy concentration shown in the table and assuming a thermoneutral environment without snow or mud conditions. If the energy concentrations of the diet to be fed exceeds the tabular value, limit feeding may be required.
[d] Vitamin A requirements per pound of diet are 1,273 IU for pregnant heifers and cows and 1,773 for lactating cows and breeding bulls.
[e] Not applicable.
[f] Includes 0.34 Mcal NEm/pound of milk produced.
[g] Includes 0.03 pound protein/pound of milk produced.

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