



Nutrient Requirements of Beef Cattle

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NUTRIENT REQUIREMENTS OF BEEF CATTLE

by

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OBJECTIVES

- Discuss the nutrient requirements of beef cattle.
- Provide tables that list the nutrient requirements of beef cattle at different stages of life.

- Explain how a balanced and cost-effective nutrition program is essential to the success of any beef cattle operation.

Grazing and feed expenses make up about 42% to 52% of cow/calf enterprise costs and about 60% to 70% of stocker and backgrounding operation costs. For this reason, grazing systems, supplementation programs and complete feeding programs must be designed to meet the nutrient needs of beef cattle, and at the same time, make the most of the available feed resources. Nutrient requirements of cattle change with age, stage of production, sex, breed, environmental conditions and basal diet quality and amount.

Therefore, gaining knowledge of nutrient requirements and the factors influencing these requirements is a necessary first step to designing a nutrition program that is both efficient and cost effective. Protein, energy, and macro mineral requirements will be discussed and tables of nutrient requirements are provided. Most of the nutrient requirement data is calculated from equations provided in the National Academies of Science, Engineering, and Medicine “Nutrient Requirements of Beef Cattle, Eighth Revised Edition”.

Dry Matter Intake

There really is no requirement for feed intake, although an estimate of how much forage and feed an animal will consume is essential when evaluating rations, supplements or predicting animal performance. Voluntary feed dry matter (DM) intake is influenced by a number of different factors. A few of the more important variables include animal weight, body condition, stage of production, level of milk production, forage quality, amount and type of supplement or feed provided and environmental conditions.

Cattle have a daily requirement for a certain quantity of specific nutrients such as protein, calcium and vitamin A. The necessary concentration of these nutrients in the diet is then determined by the amount of feed the animal is expected to consume given free-choice access to feed or forage. For example, steer calves gaining 2 pounds per day may require 1.6 pounds of protein per day. If they consume 15 pounds of DM daily, the protein requirement could be expressed as 10.7% of DM intake. On the other hand, if they are limit fed to consume only 10 pounds of DM daily, the protein requirement for 2 pounds of gain could be expressed as 16% of DM intake.

Intake in forage-fed cattle is generally limited by the forage capacity of the digestive tract. Values presented in Table 1 provide rule-of-thumb guidelines for variation in DM intake based on differences in forage quality and stage of production for beef cows. Forage digestibility values rarely exceed 70% of DM. Calves and yearlings frequently are fed higher quantities of concentrate feeds to improve weight

gain and feed conversion above what can be achieved with forage alone. When diet digestibility approaches 70%, feed intake is no longer regulated or limited by the capacity of the digestive tract. Rather, with diets high in digestible energy, physiological mechanisms are turned on to limit intake (Figure 1). This response can be thought of as a built-in safety mechanism so cattle are less likely to consume too much of a highly digestible diet, causing digestive upset, bloat and founder.

Forage intake is highly correlated with forage quality as shown in Figure 2 and Table 1. The more rapid rate of

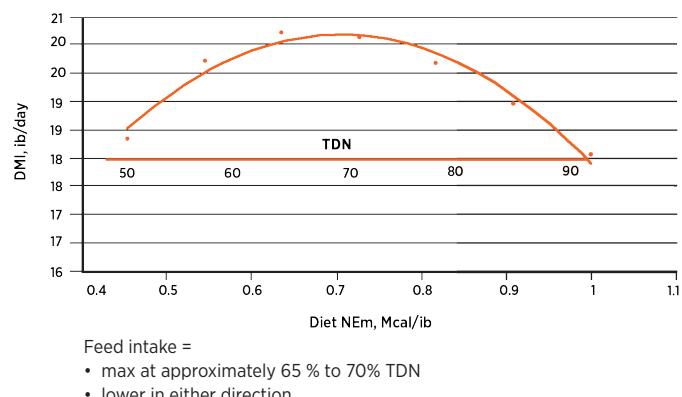


Figure 1. Influence of diet digestibility or energy concentration on voluntary feed intake of growing cattle. Source: NASEM, 2016

Table 1. Forage capacity of beef cows^a.

Forage Type and Maturity	Stage of Production	Forage Dry Matter Intake Capacity, % of Body Weight
Low quality forage (<52% total digestible nutrients) Dry Winter Forage, mature legume and grass hay, straw	Dry Lactating	1.8 2.2
Average quality forage (52-59% total digestible nutrients) Dry summer pasture, dry pasture during fall, late-bloom Legume hay, boot stage and early-bloom grass hay	Dry Lactating	2.2 2.5
High quality forage (>59% total digestible nutrients) Mid-bloom, early-bloom and prebloom legume hay, preboot stage grass hay	Dry Lactating	2.5 2.7
Lush, growing pasture	Dry Lactating	2.5 2.7
Silages	Dry Lactating	2.5 2.7

a Intake estimates assume protein requirements are met by the forage or through supplementation when forage protein is not adequate. When protein requirements are not met, forage intake will be lower than the values shown in the table.
Source: Hibbard and Thrift.

digestion and passage of higher-quality forage results in considerably higher dry matter intake compared to forage lower in digestibility.

Cattle with greater mature body weight and frame size consume more forage compared to smaller-framed cattle. Lactating cows consume considerably more of the same quality forage compared to gestating cows (Figure 3). Additionally, fleshy cattle consume 2.5% to 5% less feed or forage compared to cattle in average to thin condition. Cold stress increases dry matter intake, while heat stress reduces dry matter intake. Growth-promoting implants decrease feed intake by an average of about 6%, whereas the feed additive Rumensin® decreases feed intake by about 3%.

With this many factors influencing voluntary feed intake, accurately predicting daily feed intake can be difficult.

Estimates of dry matter intake presented in the nutrient requirement tables are determined using published prediction equations (NASEM, 2016). These equations take into account the effects of the animal's weight, level of milk production for lactating cows, energy content of the diet, stage of production and body condition in the case of the pregnant replacement heifers. It is important to note all of these equations assume adequate protein is supplied in the diet to maximize ruminal fermentation. In other words, if the diet is deficient in protein, the presented dry matter intake values are overestimated.

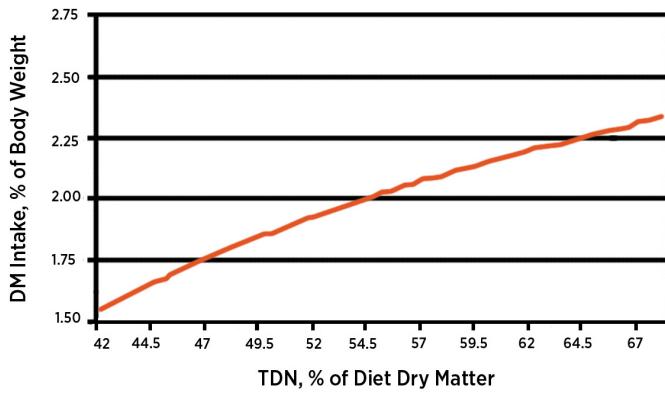


Figure 2. The relationship of forage digestibility to dry matter intake in beef cows. Source: NASEM, 2016.

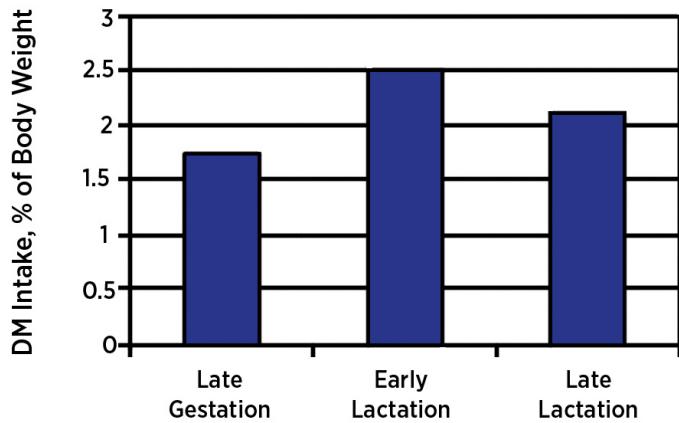


Figure 3. Dry matter intake, expressed as percent of body weight, of beef cows consuming low quality forage during three different stages of production. Source: Johnson et al., 2003.

Protein

Proteins are large chemical units made up of hundreds of amino acids. Amino acids, in turn, are organic or carbon-containing compounds that also contain nitrogen, oxygen and sometimes sulfur. Animals consume proteins in their diets, then utilize the amino acids for synthesis of muscles, blood proteins and other body components. In swine, poultry and other nonruminants, the amino acids must be supplied in definite proportions in the diet. However, in ruminants, microorganisms (bacteria and protozoa) break down most dietary proteins and incorporate the nitrogen and amino acids into their own body tissue. The microorganisms are digested in the small intestine of the ruminant animal. The bacteria themselves have a protein requirement and must have adequate protein to do their job of digesting roughages into end products that can be utilized by the cow.

Because of the ruminal breakdown of dietary proteins and because the amino acid makeup of microorganisms is adequate to meet amino acid requirements for most classes of beef cattle, feed and forage amino acid composition is generally not critical compared to nonruminant diets. On the other hand, a high priority should be placed on providing adequate ruminally available protein to allow the bacteria to grow, reproduce and digest roughages. Chemical crude protein concentration is determined by multiplying the feed nitrogen concentration by 6.25 because protein molecules contain an average of 16% nitrogen ($1/16 = 6.25$).

The crude protein system has been the standard for evaluating beef cattle protein requirements and dietary supply for many years. More recently, the metabolizable protein (MP) system has been used to better characterize protein degradability as well as site and extent of digestion. To effectively use the MP system, the user must become familiar with several terms. These include ruminally degradable protein (RDP), ruminally undegradable protein (RUP) and metabolizable protein (MP). Ruminally degradable protein is the feed protein fraction degraded in the rumen. Nitrogen from RDP is used either for microorganism protein synthesis or passes through the rumen wall into the blood stream and is carried to the liver as ammonia. In the liver, this nitrogen can be converted to urea, after which it is recycled to the rumen through saliva or filtered out of the blood stream in the kidney, to be excreted in the urine. Ruminally undegradable protein is the feed protein fraction that bypasses fermentation in the rumen to be degraded and absorbed in the small intestine. The RUP value of a feed also can be calculated by subtracting the RDP value from one. Metabolizable protein is the sum of protein derived from microorganism origin plus RUP (Figure 16.4).

Perhaps one of the most practical applications of the MP system is the calculation of the animal's RDP requirement to ensure optimal rumen function. For this reason, feed RDP values are included in Fact Sheet 3018, Nutritive Value of Feeds. The requirement for RDP is thought to be closely associated with the amount of fermentable energy in the

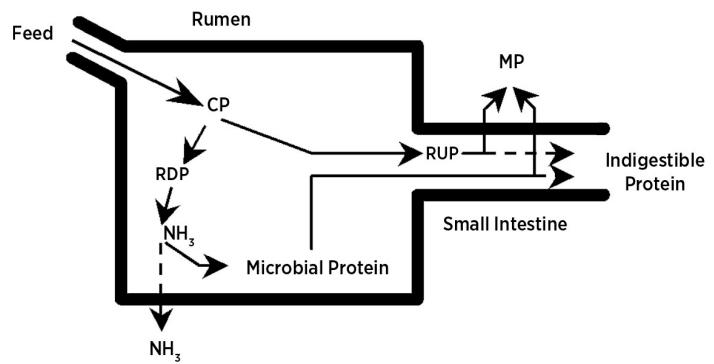


Figure 4. Illustration of protein digestion and absorption in the ruminant.
Source: Lalman.

diet. Specifically, the RDP requirement can be calculated as 10% to 13% of daily total digestible nutrients (TDN) intake. Lower values in this range are used when the cattle are receiving a low-quality diet, such as dry winter range forage or low-quality hay. Whereas higher values in the range are used when the cattle are receiving high-quality forage or a ration including at least 50% concentrate.

An example of RDP requirement follows. Assume a cow is consuming 25 pounds of hay dry matter that contains 50% TDN. The cow therefore consumes a total of 12.5 pounds of TDN per day. Therefore, the RDP requirement is 12.5 pounds \times 10%, or 1.25 pounds of RDP per day. If the hay contains 6% crude protein (DM basis), of which 65% is RDP, the forage would supply 0.98 pound of RDP each day (6% \times 65% \times 25 pounds). The requirement for supplemental RDP would be 0.27 pounds (1.25 pounds - 0.98 pound).

Nutrient requirements for beef cows and replacement heifers are shown in Tables 2 and 3. Requirements for growing calves and yearlings are shown in Tables 4 and 5. Requirements for growing and mature bulls are shown in Table 6. One exception is that the NASEM calculates the crude protein requirement for some classes of cattle to be less than 7%. Research demonstrates ruminal fermentation may be compromised with low protein diets. Therefore, 7.5% dietary crude protein was the minimum minimum crude protein requirement used for this publication. The requirements are expressed in both pounds per day of crude protein and in terms of the percentage of dry matter required in the diet. These tables illustrate the influence of age, weight, desired rate of weight gain, stage of production and genetic milking ability on nutrient requirements.

Replacement heifers need to gain about 1 pound to 1.5 pounds per day to reach 55% to 65% of their expected mature weight and puberty by 15 months of age. They also need to gain around 1 pound per day from the time they are bred until they calve to reach approximately 80% of their mature weight when they calve for the first time. The requirement of protein for muscle and organ growth is reflected in the large daily requirement for protein. Growing heifers require a high concentration of protein in the diet because of their low dry matter intake. They must have access to good-quality forage or be fed supplemental protein to achieve adequate growth prior to their first breeding season.

Gestation has little effect on the cow's protein requirement until about the seventh month of pregnancy. About two-thirds of the fetal growth occurs during the last one-third of pregnancy and the protein intake of the cow should be increased during the last one-third of pregnancy to ensure the cow will be in good condition at the time of calving. The cow is programmed to take care of the fetus at the expense of her own body and therefore loss of body condition can occur during late pregnancy if daily protein or energy are not adequate to meet the cow's requirements and the growing fetus's requirements. Adequate dietary protein during this period also is essential for the cow to produce abundant, high-quality colostrum or first milk, which will influence the newborn's immune system for the remainder of its life.

Lactation is the most nutritionally stressful activity for the cow. The modern commercial beef cow produces

around 25 pounds of milk each day during peak lactation. Milk contains a high concentration of protein. Therefore, lactating cows, particularly during early lactation, require nearly twice the daily protein of dry cows. Research shows cows in moderate condition at calving should at least maintain body weight from calving to rebreeding for good conception rates. Failure to take into account the increased protein and energy demand brought on by lactation may result in long intervals before rebreeding. Beef breeds with superior milking ability (30 pounds or more per day) and selection for high milk production within a breed result in greater protein requirements for the lactating cow.

Increasing cow size adds to the daily protein requirement but not nearly to the extent that lactation does. As mature size increases, more protein is required to maintain the heavier muscle mass and to permit faster gains that must be made by young females of larger breeds.

Energy

The cow requires energy for grazing, traveling, fetal development, milk production, temperature maintenance, reproduction, digestion and voiding of body wastes. In addition, first- and second-calf heifers require additional energy for growth until they mature at about 4 years of age. If cows are thin, additional energy will be required to restore their body condition to a moderate level. The bulk of energy for grazing cattle comes from rumen digestion of forages and roughage products. With proper amounts of protein and minerals, the rumen is capable of getting energy from a wide range of feeds that are useless to nonruminants.

Because the rumen bacteria requires protein, just as the animal's body does, it is impossible to discuss ruminant energy requirements separately from ruminant protein requirements. With too little protein in the diet, the bacteria will not efficiently digest roughages; with too much protein in the diet, the protein will be deaminated. Deamination is the process of removing nitrogen from the protein molecule. When this occurs, the nitrogen is excreted in the urine and the excess winds up serving as an expensive energy source.

Energy requirements expressed in Table 1 are in terms of TDN and net energy for maintenance (NEm) and/or net energy for gain (NEG). TDN is the sum of the digestible starch, fiber, protein and fat in a feed with a correction factor for the high energy content of fat and the amount of ash or mineral content. TDN requirements are expressed as a percent of the diet dry matter as well as in pounds per day required. Net energy requirements are expressed in terms of mega calories per pound of feed and mega calories required per day.

A close look at the nutrient requirement Table 2 shows the same factors that influence protein requirements also influence energy requirements: animal weight, rate of gain, lactation and fetal development. Lactation represents the greatest need for additional energy beyond what is used for maintenance. An average milking beef cow requires nearly 50% more TDN or net energy than when dry. It should be noted that lactating cows consume more forage

compared to gestating cows due to the increased energy demand.

Energy requirements for first-calf heifers are higher than for mature cows because energy is needed for growth in addition to body maintenance and lactation. Inadequate energy during the last third of gestation and during the critical time from calving to rebreeding can lead to poor rebreeding.

Large cows will require more energy than small cows. For example, a 1,300-pound dry pregnant cow in the middle third of pregnancy requires 32% more TDN per day than a 900-pound cow at the same stage of production. As a result, mature cow size should be considered when determining appropriate stocking rates and estimated daily hay needs.

Vitamins and Minerals

The NASEM publishes equations to determine calcium and phosphorus requirements and these estimated requirements are shown in Tables 2-6. Less is known about specific dietary requirements for the other important macro and micro minerals. Therefore, NASEM provides general dietary guidelines and maximum tolerable levels for each of these minerals (Table 7). Specific functions and sources of vitamins and minerals are discussed in greater detail in E-861, Vitamin and Mineral Requirements of Grazing Beef Cattle.

Water

Remember—water is a common, but an entirely essential nutrient. Water intake increases dramatically with increased age, weight and temperature (Table 8). Clean water is most important for young, growing calves. Dirty water can retard performance and be a breeding ground for disease in cattle of all ages.

Other Considerations

The requirements shown in the tables are designed for healthy unstressed cattle in good condition. Thin heifers or cows should be fed additional energy and protein to achieve good body condition. Some additional energy should be allowed for cows having to travel over large areas for feed or water. Cows subjected to extremely cold temperatures,

especially if combined with rain or snow, need extra energy for maintenance. The protein requirement is not increased during cold stress, however. Kansas State University research shows a 1,200-pound cow subjected to 20 F in a 14 mph wind requires about 28% more energy than at 32 F with no wind.

Conclusion

Nutrient requirements include those for protein, energy, vitamins, minerals and water. Nutrient requirements vary dramatically among animals and are influenced by age, weight, stage of production, rate of growth, environmental conditions, breed, gender and other factors. Tabular data provided in this publication should assist beef producers in determining specific nutrient requirements for their cattle.

Resources

Gadberry, S. (2002) Extension bulletin MP 391, University of Arkansas. uaex.edu/Other_Areas/publications/.

Hibbard, C.A. and T.A. Thrift (1992) Supplementation of Forage-Based Diets: Are Results Predictable? *Journal of Animal Science* 70 (Suppl. 1):181. (Abstr.)

Johnson, C.R. et al. (2003) Influence of milk production potential on forage dry matter intake of Multiparous and primiparous Brangus females. *Journal of Animal Science* 81:1837-1846.

NRC. (2000) *Nutrient Requirements of Beef Cattle* (7th Edition). National Academy Press, Washington, D.C.

Table 2. Nutrient requirements of beef cows.

Gestating cow, middle 1/3 of pregnancy

Weight (lbs)	Expected calf birth weight (lbs)	DM intake (lbs/day)	DM intake % of BW	Diet nutrient density					Daily nutrients per animal				
				TDN (% DM)	NEm (Mcal/lb)	CP (% DM)	Ca (%DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	CP (lbs)	Ca (g)	P (g)
900	64	16.6	1.8	50	0.44	7.5	0.28	0.17	8.3	7.1	1.35	21	13
1,000	70	18.0	1.8	50	0.44	7.5	0.28	0.17	9.0	7.7	1.35	23	14
1,100	75	19.3	1.8	50	0.44	7.5	0.29	0.18	9.7	8.2	1.45	25	16
1,200	83	21.4	1.7	50	0.44	7.5	0.29	0.18	10.7	9.1	1.6	28	18
1,300	85	21.9	1.7	50	0.44	7.5	0.29	0.18	11.0	9.3	1.64	29	18
1,400	90	23.1	1.7	50	0.44	7.5	0.30	0.18	11.6	9.9	1.73	31	19
1,500	95	24.4	1.6	50	0.44	7.5	0.30	0.19	12.2	10.4	1.83	33	21

Gestating cow, last 1/3 of pregnancy

900	64	18.6	2.1	54	0.51	7.5	0.25	0.16	10.1	9.4	1.4	21	14
1,000	70	20.1	2.0	54	0.51	7.5	0.25	0.17	10.9	10.2	1.51	23	15
1,100	75	21.6	2.0	54	0.51	7.5	0.26	0.17	11.7	10.9	1.62	25	17
1,200	83	23.9	1.9	54	0.51	7.5	0.26	0.17	13.0	12.1	1.8	28	19
1,300	85	24.5	1.9	54	0.51	7.5	0.26	0.18	13.3	12.4	1.84	29	20
1,400	90	25.9	1.8	54	0.51	7.5	0.27	0.18	14.1	13.1	1.94	31	21
1,500	95	27.3	1.8	54	0.51	7.5	0.27	0.18	14.8	13.8	2.20	33	22

Lactating cow, first 90 days after calving

Weight (lbs)	Peak milk lb/day	DM intake lb/day	DM Int % of BW	TDN % DM	NEm Mcal/lb	CP % of DM	Ca Req % of DM		TDN lb/day	NEm Mcal/day	CP lb/day	Ca g/day	Phos g/day
							Req	% of DM					
900	10	21.3	2.4	56	0.53	8.8	0.24	0.16	12.0	11.4	1.9	23	16
	15	23.3	2.6	58	0.56	9.8	0.27	0.18	13.4	13.0	2.3	29	19
	20	25.1	2.8	59	0.58	10.6	0.30	0.19	14.9	14.7	2.7	34	22
1,000	15	24.7	2.5	58	0.55	9.6	0.27	0.18	14.2	13.7	2.4	30	20
	20	26.6	2.7	59	0.58	10.4	0.30	0.19	15.7	15.3	2.8	36	23
	25	28.4	2.8	60	0.60	11.1	0.32	0.20	17.1	17.0	3.1	41	26
1,100	20	28.0	2.5	59	0.57	10.1	0.29	0.19	16.4	16.0	2.8	37	24
	25	29.9	2.7	60	0.59	10.8	0.31	0.20	17.9	17.6	3.2	43	27
	30	31.7	2.9	61	0.61	11.4	0.34	0.21	19.3	19.2	3.6	48	30
1,200	17.7	29.6	2.3	57	0.55	9.5	0.27	0.18	16.9	16.3	2.8	37	24
	25	31.3	2.6	59	0.58	10.6	0.31	0.20	18.5	18.3	3.3	44	28
	30	33.1	2.8	61	0.60	11.2	0.33	0.21	20.0	19.9	3.7	50	31
1,300	25	32.6	2.5	59	0.58	10.4	0.31	0.20	19.3	18.9	3.4	45	29
	30	34.4	2.6	60	0.60	11.0	0.33	0.21	20.7	20.5	3.8	51	32
	35	36.3	2.8	61	0.61	11.5	0.34	0.22	22.2	22.1	4.2	57	36
1,400	25	33.9	2.4	59	0.57	10.3	0.30	0.20	20.0	19.5	3.5	47	30
	30	35.8	2.6	60	0.59	10.8	0.32	0.21	21.4	21.1	3.9	52	33
	35	37.6	2.7	61	0.60	11.3	0.34	0.21	22.9	22.7	4.3	58	37
1,500	25	35.2	2.3	59	0.57	10.1	0.30	0.20	20.6	20.1	3.6	48	31
	30	37.1	2.5	60	0.59	10.7	0.32	0.20	22.1	21.7	4.0	54	34
	35	38.9	2.6	61	0.60	11.2	0.34	0.21	23.5	23.4	4.3	59	38

Table 3. Pregnant yearling replacement heifer, middle 1/3 of pregnancy.

Pregnant yearling replacement heifer, middle 1/3 of pregnancy

Current weight (lbs)	Current BCS (1-9)	Mature Wt @ BCS=5	Calf birth weight	Maternal tissue ADG, lb	Gravid uterus ADG, lb	Diet nutrient density											
						DM intake		lb/day	% DM	Nem, Mcal per day		Crude Protein		Calcium			
						lb/day	% of BW			lb/day	per day	per lb	lb/day	% of DM	g/day	% of DM	
600	5	1000	75	1.0	0.29	16.4	2.7	9.1	55.5	8.6	0.52	1.4	8.3	29	0.39	12	0.16
600	5	1000	75	1.5	0.29	16.6	2.8	10.0	60.0	9.9	0.59	1.6	9.5	34	0.45	14	0.19
600	5	1000	75	2.0	0.29	16.6	2.8	TDN 10.9	66.0	11.3	0.68	1.8	11.0	39	0.52	17	0.22
700	6	1000	75	1.0	0.29	18.4	2.6	10.3	56.0	9.9	0.53	1.4	7.7	30	0.36	13	0.15
700	6	1000	75	1.5	0.29	18.7	2.7	11.4	61.0	11.4	0.61	1.6	8.7	34	0.40	15	0.18
700	6	1000	75	2.0	0.29	18.6	2.7	12.3	66.0	12.7	0.68	1.8	9.7	38	0.45	17	0.20
800	7	1000	75	1.0	0.29	20.5	2.6	11.7	57.0	11.2	0.55	1.5	7.5	31	0.33	14	0.15
800	7	1000	75	1.5	0.29	20.7	2.6	12.8	62.0	12.9	0.62	1.7	8.1	35	0.37	16	0.17
800	7	1000	75	2.0	0.29	20.5	2.6	13.7	67.0	14.3	0.70	1.8	8.9	38	0.41	17	0.18
750	5	1200	80	1.0	0.31	19.2	2.6	10.4	54.0	9.6	0.50	1.5	7.8	31	0.36	14	0.16
750	5	1200	80	1.5	0.31	19.6	2.6	11.5	58.5	11.2	0.57	1.7	8.8	37	0.41	16	0.18
750	5	1200	80	2.0	0.31	19.7	2.6	12.4	63.0	12.5	0.64	1.9	9.9	41	0.46	18	0.20
850	6	1200	80	1.0	0.31	21.2	2.5	11.7	55.0	11.0	0.52	1.6	7.5	33	0.34	15	0.15
850	6	1200	80	1.5	0.31	21.6	2.5	12.7	59.0	12.5	0.58	1.8	8.2	37	0.38	17	0.17
850	6	1200	80	2.0	0.31	21.6	2.5	13.8	64.0	14.1	0.65	2.0	9.2	41	0.42	19	0.19
950	7	1200	80	1.0	0.31	22.0	2.5	12.2	55.5	11.5	0.52	1.6	7.5	33	0.33	15	0.15
950	7	1200	80	1.5	0.31	23.5	2.5	14.1	60.0	13.9	0.59	1.8	7.8	37	0.35	17	0.16
950	7	1200	80	2.0	0.31	23.5	2.5	15.0	64.0	15.3	0.65	2.0	8.4	41	0.38	19	0.18
900	5	1400	85	1.0	0.33	21.9	2.4	11.7	53.5	10.8	0.49	1.6	7.5	35	0.35	15	0.15
900	5	1400	85	1.5	0.33	22.4	2.5	12.8	57.0	12.2	0.55	1.9	8.3	39	0.38	18	0.17
900	5	1400	85	2.0	0.33	22.6	2.5	13.8	61.0	13.7	0.61	2.1	9.2	43	0.42	20	0.19
1,000	6	1400	85	1.0	0.33	23.8	2.4	12.9	54.0	11.9	0.50	1.8	7.5	35	0.33	16	0.15
1,000	6	1400	85	1.5	0.33	24.3	2.4	14.1	58.0	13.7	0.56	1.9	7.9	40	0.36	18	0.17
1,000	6	1400	85	2.0	0.33	24.4	2.4	15.1	62.0	15.2	0.62	2.1	8.7	44	0.40	20	0.18
1,100	7	1400	85	1.0	0.33	25.7	2.3	14.0	54.5	13.1	0.51	1.9	7.5	36	0.31	17	0.15
1,100	7	1400	85	1.5	0.33	26.1	2.4	15.3	58.5	14.9	0.57	2.0	7.5	40	0.34	19	0.16
1,100	7	1400	85	2.0	0.33	26.2	2.4	16.4	62.5	16.5	0.63	2.1	8.1	44	0.37	21	0.17

Table 3. Nutrient requirements of pregnant replacement heifers (continued).

Pregnant yearling replacement heifer, last 1/3 of pregnancy

Current weight (lbs)	Current BCS (7-9)	Mature Wt @ BCS=5	Calf birth weight	Maternal tissue ADG, lb	Gravid uterus ADG, lb	Diet nutrient density									
						DM intake		Nem, Mcal per day		Crude Protein		Calcium		Phosphorous	
lb/day	% of BW	lb/day	% DM	per day	per lb	lb/day	% of DM	g/day	% of DM	g/day	% of DM				
700	5	1000	75	0.5	0.96	18.4	2.6	10.3	56.0	9.8	0.53	1.5	8.2	25	0.30
700	5	1000	75	1.0	0.96	18.7	2.7	11.4	61.0	11.4	0.61	1.7	9.2	29	0.35
700	5	1000	75	1.5	0.96	18.6	2.7	TDN 12.4	67.0	12.9	0.70	1.9	10.3	34	0.40
800	6	1000	75	0.5	0.96	20.4	2.5	11.4	56.0	10.8	0.53	1.6	7.8	26	0.28
800	6	1000	75	1.0	0.96	20.7	2.6	12.6	61.0	12.6	0.61	1.8	8.6	30	0.32
800	6	1000	75	1.5	0.96	20.5	2.6	13.7	67.0	14.3	0.70	2.0	9.5	34	0.36
900	7	1000	75	0.5	0.96	22.3	2.5	12.5	56.0	11.8	0.53	1.7	7.5	27	0.27
900	7	1000	75	1.0	0.96	22.6	2.5	14.0	62.0	14.1	0.62	1.8	8.2	31	0.30
900	7	1000	75	1.5	0.96	22.3	2.5	15.2	68.0	15.9	0.71	2.0	9.0	35	0.34
850	5	1200	80	0.5	1.02	21.2	2.5	11.7	55.0	11.0	0.52	1.7	7.9	28	0.29
850	5	1200	80	1.0	1.02	21.6	2.5	12.7	59.0	12.5	0.58	1.9	8.7	32	0.33
850	5	1200	80	1.5	1.02	21.6	2.5	13.8	64.0	14.1	0.65	2.1	9.6	36	0.37
950	6	1200	80	0.5	1.02	23.1	2.4	12.7	55.0	11.9	0.52	1.8	7.6	29	0.28
950	6	1200	80	1.0	1.02	23.5	2.5	14.1	60.0	13.9	0.59	2.0	8.3	33	0.31
950	6	1200	80	1.5	1.02	23.4	2.5	15.2	65.0	15.6	0.67	2.1	9.1	37	0.35
1,050	7	1200	80	0.5	1.02	24.9	2.4	13.7	55.0	12.8	0.52	1.9	7.5	30	0.26
1,050	7	1200	80	1.0	1.02	25.3	2.4	15.2	60.0	15.0	0.59	2.0	7.9	34	0.30
1,050	7	1200	80	1.5	1.02	25.3	2.4	16.4	65.0	16.9	0.67	2.2	8.6	37	0.33
1,020	5	1400	85	0.5	1.09	24.2	2.4	13.0	54.0	12.1	0.50	1.9	7.7	31	0.28
1,020	5	1400	85	1.0	1.09	24.7	2.4	14.3	58.0	13.9	0.56	2.1	8.4	35	0.32
1,020	5	1400	85	1.5	1.09	24.8	2.4	15.4	62.0	15.4	0.62	2.2	9.1	39	0.35
1,120	6	1400	85	0.5	1.09	25.9	2.3	14.0	54.0	13.0	0.50	1.9	7.5	32	0.27
1,120	6	1400	85	1.0	1.09	26.4	2.4	15.3	58.0	14.9	0.56	2.1	8.0	36	0.30
1,120	6	1400	85	1.5	1.09	26.6	2.4	16.7	63.0	16.9	0.64	2.3	8.7	40	0.33
1,220	7	1400	85	0.5	1.09	27.8	2.3	15.3	55.0	14.4	0.52	2.1	7.5	34	0.27
1,220	7	1400	85	1.0	1.09	28.3	2.3	16.7	59.0	16.3	0.58	2.2	7.7	37	0.29
1,220	7	1400	85	1.5	1.09	28.3	2.3	18.0	63.5	18.3	0.64	2.4	8.3	41	0.32

Table 3. Nutrient requirements of pregnant replacement heifers (continued).

Lactating first-calf heifer, first 90 days after calving

Current weight (lbs)	Current BCS (7-9)	Mature Wt @ BCS=5	Peak milk lbs/day	Maternal tissue ADG, lb	Gravid uterus ADG, lb	Diet nutrient density									
						lb/day	% of BW	lb/day	% DM	per day	Nem, Mcal per lb	Crude Protein lb/day	% of DM	g/day	% of DM
700	5	1000	8	0.5		18.4	2.6	11.0	60.0	8.3	0.45	1.8	9.7	24	0.29
700	5	1000	12	0.5		19.8	2.8	12.0	61.0	8.1	0.41	2.1	10.5	28	0.31
700	5	1000	16	0.5		21.2	3.0	TDN 13.3	62.5	8.2	0.38	2.4	11.3	33	0.34
800	6	1000	10	0.5		20.9	2.6	12.7	61.0	9.4	0.45	2.0	9.6	27	0.28
800	6	1000	15	0.5		22.7	2.8	14.2	62.5	9.4	0.41	2.4	10.6	32	0.32
800	6	1000	20	0.5		24.5	3.1	15.7	64.0	9.4	0.39	2.8	11.4	38	0.34
900	7	1000	10	0.0		20.9	2.3	12.4	59.0	8.8	0.42	1.9	9.0	24	0.25
900	7	1000	15	0.0		22.8	2.5	13.9	61.0	9.0	0.39	2.3	10.0	29	0.28
900	7	1000	20	0.0		24.4	2.7	15.2	62.0	8.7	0.36	2.7	10.9	35	0.31
850	5	1200	10	0.5		21.5	2.5	12.9	60.0	9.5	0.44	2.1	9.7	28	0.29
850	5	1200	15	0.5		23.2	2.7	14.1	61.0	9.2	0.40	2.4	10.6	33	0.32
850	5	1200	20	0.5		25.0	2.9	15.6	62.5	9.2	0.37	2.8	11.4	39	0.34
950	6	1200	12	0.5		23.9	2.5	14.6	61.0	10.6	0.44	2.3	9.7	32	0.29
950	6	1200	17	0.5		25.8	2.7	16.1	62.5	10.7	0.42	2.7	10.5	37	0.32
950	6	1200	22	0.5		27.5	2.9	17.5	63.5	10.6	0.38	3.1	11.3	43	0.34
1,050	7	1200	12	0.0		23.7	2.3	14.0	59.0	9.8	0.41	2.2	9.2	28	0.26
1,050	7	1200	17	0.0		25.4	2.4	15.2	60.0	9.5	0.37	2.6	10.1	34	0.29
1,050	7	1200	22	0.0		27.1	2.6	16.5	61.0	9.3	0.34	3.0	10.9	39	0.32
1,020	5	1400	12	0.5		24.6	2.4	14.7	59.5	10.5	0.43	2.4	9.6	33	0.29
1,020	5	1400	17	0.5		26.5	2.6	16.2	61.0	10.6	0.40	2.8	10.5	38	0.32
1,020	5	1400	22	0.5		28.3	2.8	17.5	62.0	10.4	0.37	3.2	11.2	44	0.34
1,120	6	1400	15	0.5		27.5	2.5	16.8	61.0	11.8	0.43	2.7	9.8	37	0.30
1,120	6	1400	20	0.5		29.2	2.6	18.1	62.0	11.7	0.40	3.1	10.5	43	0.32
1,120	6	1400	25	0.5		31.0	2.8	19.5	63.0	11.6	0.37	3.5	11.2	48	0.34
1,220	7	1400	15	0.0		27.0	2.2	15.9	59.0	10.7	0.40	2.6	9.5	34	0.28
1,220	7	1400	20	0.0		28.7	2.4	17.2	60.0	10.5	0.37	2.9	10.3	39	0.30
1,220	7	1400	25	0.0		30.4	2.5	18.5	61.0	10.3	0.34	3.3	11.0	45	0.33

Table 4. Nutrient requirements of growing steer and heifer calves.

Body weight (lbs)	ADG (lbs)	DM intake (lbs/day)	Diet nutrient density						Daily nutrients per animal					
			TDN (% DM)	NEm (Mcal/lb)	NEg (Mcal/lb)	CP (% DM)	Ca (% DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	NEg (Mcal)	CP (lbs)	Ca (grams)	P (grams)
1,200 pounds at finishing														
300	0.5	7.9	54	0.50	0.24	9.2	0.30	0.16	4.3	3.1	0.42	0.73	9	5
	1.0	8.4	59	0.57	0.31	11.4	0.46	0.23	5.0	3.1	0.90	0.95	18	9
	1.5	8.6	64	0.64	0.37	13.6	0.62	0.29	5.5	3.1	1.40	1.17	22	14
	2.0	8.6	69	0.72	0.44	16.2	0.79	0.36	5.9	3.1	1.92	1.39	32	14
	2.5	8.5	75	0.81	0.52	18.9	0.96	0.40	6.4	3.1	2.46	1.61	36	18
	3.0	8.2	83	0.92	0.62	22.2	1.17	0.51	6.8	3.1	3.00	1.83	45	18
400	0.5	9.8	54	0.50	0.24	8.7	0.27	0.15	5.3	3.8	0.52	0.85	14	9
	1.0	10.4	59	0.57	0.31	10.4	0.39	0.20	6.1	3.8	1.12	1.08	18	9
	1.5	10.7	64	0.64	0.37	12.1	0.50	0.24	6.8	3.8	1.74	1.30	23	14
	2.0	10.7	69	0.72	0.44	14.1	0.62	0.29	7.4	3.8	2.39	1.51	32	14
	2.5	10.6	75	0.81	0.52	16.3	0.75	0.34	8.0	3.8	3.50	1.72	36	18
	3.0	10.2	83	0.92	0.62	19.0	0.90	0.41	8.5	3.8	3.72	1.94	41	18
500	0.5	11.6	54	0.50	0.24	8.4	0.25	0.15	6.3	4.5	0.62	0.97	14	9
	1.0	12.2	59	0.57	0.31	9.8	0.34	0.18	7.2	4.5	1.32	1.19	18	9
	1.5	12.6	64	0.64	0.37	11.2	0.42	0.22	8.1	4.5	2.06	1.41	23	14
	2.0	12.7	69	0.72	0.44	12.8	0.52	0.25	8.8	4.5	2.82	1.63	32	14
	2.5	12.5	75	0.81	0.52	14.7	0.62	0.30	9.4	4.5	3.60	1.84	36	18
	3.0	12.1	83	0.92	0.62	16.9	0.74	0.35	10.0	4.5	4.40	2.05	41	18
600	0.5	13.2	54	0.50	0.24	8.2	0.23	0.14	7.1	5.2	0.71	1.08	14	9
	1.0	14.0	59	0.57	0.31	9.4	0.30	0.17	8.3	5.2	1.51	1.31	18	9
	1.5	14.4	64	0.64	0.37	10.6	0.38	0.20	9.2	5.2	2.36	1.53	23	14
	2.0	14.6	69	0.72	0.44	11.9	0.44	0.22	10.1	5.2	3.23	1.74	32	14
	2.5	14.4	75	0.81	0.52	13.6	0.52	0.26	10.8	5.2	4.13	1.95	36	18
	3.0	13.8	83	0.92	0.62	15.7	0.62	0.30	11.5	5.2	5.04	2.17	41	18
700	0.5	14.9	54	0.50	0.24	8.0	0.22	0.14	8.0	5.8	0.79	1.19	14	9
	1.0	15.8	59	0.57	0.31	9.0	0.28	0.16	9.3	5.8	1.70	1.42	18	14
	1.5	16.2	64	0.64	0.37	10.1	0.33	0.19	10.4	5.8	2.65	1.64	23	14
	2.0	16.3	69	0.72	0.44	11.4	0.39	0.21	11.2	5.8	3.63	1.85	27	14
	2.5	16.1	75	0.81	0.52	12.8	0.46	0.24	12.1	5.8	4.64	2.06	32	18
	3.0	15.5	83	0.92	0.62	14.6	0.54	0.27	12.9	5.8	5.66	2.27	36	18

Table 4. Nutrient requirements of growing steer and heifer calves (continued).

Body weight (lbs)	ADG (lbs)	DM intake (lbs/day)	Diet nutrient density					Daily nutrients per animal					
			TDN (% DM)	NEm (Mcal/lb)	NEG (Mcal/lb)	CP (% DM)	Ca (%DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	NEG (Mcal)	CP (lbs)	Ca (grams)
<i>1,400 pounds at finishing</i>													
300	0.5	7.8	54	0.49	0.24	9.4	0.31	0.17	4.2	3.1	0.39	0.73	14
	1.0	8.3	58	0.56	0.30	11.5	0.48	0.23	4.8	3.1	0.84	0.95	18
	1.5	8.6	63	0.63	0.36	13.7	0.63	0.29	5.4	3.1	1.31	1.17	23
	2.0	8.6	68	0.70	0.42	16.2	0.80	0.36	5.8	3.1	1.80	1.40	32
	2.5	8.6	73	0.78	0.50	18.7	0.96	0.43	6.3	3.1	2.30	1.61	36
	3.0	8.3	80	0.88	0.58	22.0	1.18	0.52	6.6	3.1	2.81	1.83	45
400	0.5	9.7	54	0.49	0.24	8.8	0.28	0.16	5.2	3.8	0.49	0.85	14
	1.0	10.3	58	0.56	0.30	10.4	0.39	0.20	6.0	3.8	1.04	1.07	18
	1.5	10.6	63	0.63	0.36	12.2	0.51	0.25	6.7	3.8	1.63	1.30	23
	2.0	10.7	68	0.70	0.42	14.1	0.63	0.30	7.3	3.8	2.23	1.51	32
	2.5	10.7	73	0.78	0.50	16.1	0.76	0.35	7.8	3.8	2.85	1.72	36
	3.0	10.4	80	0.88	0.58	18.7	0.90	0.41	8.3	3.8	3.49	1.94	41
500	0.5	11.5	54	0.49	0.24	8.4	0.25	0.15	6.2	4.5	0.58	0.97	14
	1.0	12.2	58	0.56	0.30	9.8	0.34	0.18	7.1	4.5	1.23	1.19	18
	1.5	12.6	63	0.63	0.36	11.2	0.43	0.22	7.9	4.5	1.93	1.41	27
	2.0	12.6	68	0.70	0.42	12.9	0.53	0.26	8.6	4.5	2.64	1.63	32
	2.5	12.6	73	0.78	0.50	14.6	0.63	0.30	9.2	4.5	3.37	1.84	36
	3.0	12.2	80	0.88	0.58	16.8	0.75	0.35	9.8	4.5	4.12	2.05	41
600	0.5	13.2	54	0.49	0.24	8.2	0.24	0.15	7.1	5.2	0.66	1.08	14
	1.0	14.0	58	0.56	0.30	9.3	0.31	0.17	8.1	5.2	1.42	1.31	18
	1.5	14.4	63	0.63	0.36	10.6	0.38	0.20	9.1	5.2	2.21	1.52	27
	2.0	14.4	68	0.70	0.42	12.1	0.46	0.23	9.8	5.2	3.03	1.74	32
	2.5	14.4	73	0.78	0.50	13.5	0.54	0.26	10.5	5.2	3.87	1.95	36
	3.0	14.0	80	0.88	0.58	15.4	0.64	0.31	11.2	5.2	4.73	2.16	41
700	0.5	14.8	54	0.49	0.24	8.0	0.23	0.14	8.0	5.8	0.74	1.18	14
	1.0	15.7	58	0.56	0.30	9.0	0.29	0.17	9.1	5.8	1.59	1.42	23
	1.5	16.2	63	0.63	0.36	10.1	0.34	0.19	10.2	5.8	2.48	1.64	27
	2.0	16.3	68	0.70	0.42	11.3	0.41	0.21	11.1	5.8	3.40	1.85	32
	2.5	16.2	73	0.78	0.50	12.7	0.47	0.24	11.8	5.8	4.34	2.05	36
	3.0	15.8	80	0.88	0.58	14.4	0.55	0.27	12.6	5.8	5.30	2.27	41

Table 5. Nutrient requirements of growing yearlings.

Body weight (lbs)	Diet nutrient density								Daily nutrients per animal					
	ADG (lbs)	DM intake (lbs/day)	TDN (% DM)	NEm (Mcal/lb)	NEg (Mcal/lb)	CP (% DM)	Ca (% DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	NEg (Mcal)	CP (lbs)	Ca (grams)	P (grams)
1,100 pounds at finishing														
605	0.7	16.3	50	0.45	0.20	7.5	0.22	0.13	8.2	5.2	1.0	1.2	18	9
	1.9	17.3	60	0.61	0.35	10.0	0.36	0.19	10.4	5.2	3.0	1.7	27	14
	2.9	16.9	70	0.76	0.48	12.7	0.49	0.24	11.8	5.2	4.8	2.2	36	18
	3.6	15.9	80	0.90	0.61	15.3	0.61	0.29	12.7	5.2	6.1	2.4	45	23
	4.0	14.7	90	1.04	0.72	17.8	0.72	0.34	13.2	5.2	7.0	2.6	50	23
660	0.7	17.5	50	0.45	0.20	7.5	0.21	0.13	8.8	5.5	1.1	1.3	18	9
	1.9	18.4	60	0.61	0.35	9.7	0.34	0.18	11.0	5.5	3.2	1.8	27	14
	2.9	18.0	70	0.76	0.48	12.3	0.45	0.23	12.6	5.5	5.1	2.2	36	18
	3.6	17.0	80	0.90	0.61	14.7	0.56	0.27	13.6	5.5	6.5	2.5	45	23
	4.0	15.7	90	1.04	0.72	17.1	0.66	0.32	14.1	5.5	7.4	2.7	45	23
715	0.7	18.5	50	0.45	0.20	7.5	0.20	0.13	9.3	5.9	1.1	1.4	18	9
	1.9	19.6	60	0.61	0.35	9.2	0.32	0.17	11.8	5.9	3.5	1.8	27	14
	2.9	19.1	70	0.76	0.48	11.5	0.42	0.21	13.4	5.9	5.5	2.2	36	18
	3.6	18.1	80	0.90	0.61	13.7	0.52	0.26	14.5	5.9	6.9	2.5	41	23
	4.0	16.7	90	1.04	0.72	15.9	0.61	0.30	15.0	5.9	7.9	2.7	45	23
770	0.7	19.6	50	0.45	0.20	7.5	0.20	0.12	9.8	6.2	1.2	1.5	18	9
	1.9	20.7	60	0.61	0.35	8.8	0.30	0.16	12.4	6.2	3.6	1.8	27	14
	2.9	20.2	70	0.76	0.48	10.9	0.39	0.20	14.1	6.2	5.8	2.2	36	18
	3.6	19.1	80	0.90	0.61	12.9	0.48	0.24	15.3	6.2	7.3	2.5	41	23
	4.0	17.6	90	1.04	0.72	14.8	0.56	0.28	15.8	6.2	8.3	2.6	45	23
825	0.7	20.6	50	0.45	0.20	7.5	0.19	0.12	0.3	6.6	1.3	1.6	18	14
	1.9	21.8	60	0.61	0.35	8.4	0.28	0.16	13.1	6.6	3.8	1.8	27	18
	2.9	21.3	70	0.76	0.48	10.3	0.37	0.19	14.9	6.6	6.1	2.2	36	18
	3.6	20.1	80	0.90	0.61	12.1	0.44	0.23	16.1	6.6	7.7	2.4	41	23
	4.0	18.6	90	1.04	0.72	13.9	0.52	0.26	16.7	6.6	8.8	2.6	45	23
880	0.7	21.7	50	0.45	0.20	7.5	0.19	0.12	10.9	6.9	1.3	1.6	18	14
	1.9	22.9	60	0.61	0.35	8.1	0.27	0.15	13.7	6.9	4.0	1.9	27	14
	2.9	22.4	70	0.76	0.48	9.8	0.34	0.18	15.7	6.9	6.4	2.2	36	18
	3.6	21.1	80	0.90	0.61	11.4	0.42	0.22	16.9	6.9	8.1	2.4	41	23
	4.0	19.5	90	1.04	0.72	13.1	0.48	0.25	17.6	6.9	9.2	2.6	41	23

Table 5. Nutrient requirements of growing yearlings (continued).

Body weight (lbs)	Diet nutrient density								Daily nutrients per animal					
	ADG (lbs)	DM intake (lbs/day)	TDN (% DM)	NEm (Mcal/lb)	NEg (Mcal/lb)	CP (% DM)	Ca (% DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	NEg (Mcal)	CP (lbs)	Ca (grams)	P (grams)
1,200 pounds at finishing														
660	0.7	17.5	50	0.45	0.20	7.5	0.22	0.13	8.8	5.5	1.1	1.3	18	9
	2.0	18.4	60	0.61	0.35	10.2	0.36	0.19	11.0	5.5	3.3	1.9	32	18
	3.0	18.0	70	0.76	0.48	13.0	0.49	0.24	12.6	5.5	5.2	2.3	41	18
	3.8	17.0	80	0.90	0.61	15.8	0.61	0.29	13.6	5.5	6.5	2.7	45	23
	4.2	15.7	90	1.04	0.72	18.4	0.72	0.34	14.1	5.5	7.4	2.9	50	23
720	0.7	18.6	50	0.45	0.20	7.5	0.21	0.13	9.3	5.9	1.1	1.4	18	9
	2.0	19.7	60	0.61	0.35	9.7	0.34	0.18	11.8	5.9	3.5	1.9	32	18
	3.0	19.2	70	0.76	0.48	12.2	0.45	0.23	13.4	5.9	5.5	2.3	41	18
	3.8	18.2	80	0.90	0.61	14.6	0.56	0.27	14.6	5.9	7.0	2.7	45	23
	4.2	16.8	90	1.04	0.72	17.0	0.66	0.32	15.1	5.9	7.9	2.9	50	23
780	0.7	19.8	50	0.45	0.20	7.5	0.20	0.13	9.9	6.3	1.2	1.5	18	14
	2.0	20.9	60	0.61	0.35	9.2	0.32	0.17	12.5	6.3	3.7	1.9	32	18
	3.0	20.4	70	0.76	0.48	11.4	0.42	0.21	14.3	6.3	5.8	2.3	41	18
	3.8	19.3	80	0.90	0.61	13.6	0.52	0.26	15.4	6.3	7.4	2.6	45	23
	4.2	17.8	90	1.04	0.72	15.8	0.61	0.30	16.0	6.3	8.4	2.8	50	23
840	0.7	20.9	50	0.45	0.20	7.5	0.20	0.13	10.5	6.6	1.3	1.6	18	14
	2.0	22.1	60	0.61	0.35	8.8	0.30	0.16	13.3	6.6	3.9	1.9	32	18
	3.0	21.6	70	0.76	0.48	10.8	0.39	0.20	15.1	6.6	6.2	2.3	41	18
	3.8	20.4	80	0.90	0.61	12.8	0.48	0.24	16.3	6.6	7.8	2.6	45	23
	4.2	18.8	90	1.04	0.72	14.7	0.56	0.28	16.9	6.6	8.9	2.8	54	23
900	0.7	22.0	50	0.45	0.20	7.5	0.19	0.12	11.0	7.0	1.3	1.7	18	14
	2.0	23.3	60	0.61	0.35	8.4	0.28	0.16	14.0	7.0	4.1	2.0	27	18
	3.0	22.7	70	0.76	0.48	10.2	0.37	0.19	15.9	7.0	6.5	2.3	36	18
	3.8	21.5	80	0.90	0.61	12.0	0.44	0.23	17.2	7.0	8.3	2.6	45	23
	4.2	19.8	90	1.04	0.72	13.8	0.52	0.26	17.8	7.0	9.4	2.7	45	23
960	0.7	23.1	50	0.45	0.20	7.5	0.19	0.12	11.6	7.3	1.4	1.7	18	14
	2.0	24.4	60	0.61	0.35	8.1	0.27	0.15	14.6	7.3	4.3	2.0	32	18
	3.0	23.9	70	0.76	0.48	9.7	0.34	0.19	16.7	7.3	6.8	2.3	36	23
	3.8	22.5	80	0.90	0.61	11.3	0.41	0.22	18.0	7.3	8.7	2.5	41	23
	4.2	20.8	90	1.04	0.72	13.0	0.48	0.25	18.7	7.3	9.9	2.7	45	23

Table 5. Nutrient requirements of growing yearlings (continued).

Body weight (lbs)	Diet nutrient density								Daily nutrients per animal					
	ADG (lbs)	DM intake (lbs/day)	TDN (% DM)	NEm (Mcal/lb)	NEg (Mcal/lb)	CP (% DM)	Ca (% DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	NEg (Mcal)	CP (lbs)	Ca (grams)	P (grams)
1,300 pounds at finishing														
715	0.8	18.5	50	0.45	0.20	7.5	0.22	0.13	9.3	5.9	1.1	1.4	18	9
	2.1	19.6	60	0.61	0.35	10.2	0.36	0.19	11.8	5.9	3.5	2.0	33	18
	3.2	19.1	70	0.76	0.48	13.0	0.49	0.24	13.4	5.9	5.5	2.5	42	23
	4.0	18.1	80	0.90	0.61	15.7	0.61	0.29	14.5	5.9	6.9	2.8	50	23
	4.5	16.7	90	1.04	0.72	18.3	0.72	0.34	15.0	5.9	7.9	3.1	54	27
780	0.8	19.8	50	0.45	0.20	7.5	0.21	0.13	9.9	6.3	1.2	1.5	18	14
	2.1	20.9	60	0.61	0.35	9.6	0.34	0.18	12.5	6.3	3.7	2.0	32	18
	3.2	20.4	70	0.76	0.48	12.1	0.45	0.23	14.3	6.3	5.8	2.5	41	23
	4.0	19.3	80	0.90	0.61	14.5	0.56	0.27	15.4	6.3	7.4	2.8	50	23
	4.5	17.8	90	1.04	0.72	16.9	0.66	0.32	16.0	6.3	8.4	3.0	54	27
845	0.8	21.0	50	0.45	0.20	7.5	0.21	0.13	10.5	6.7	1.3	1.6	18	14
	2.1	22.2	60	0.61	0.35	9.1	0.32	0.17	13.3	6.7	3.9	2.0	32	18
	3.2	21.7	70	0.76	0.48	11.4	0.42	0.22	15.2	6.7	6.2	2.5	41	23
	4.0	20.5	80	0.90	0.61	13.6	0.51	0.26	16.4	6.7	7.9	2.8	50	23
	4.5	18.9	90	1.04	0.72	15.7	0.60	0.30	17.0	6.7	8.9	3.0	50	27
910	0.8	22.2	50	0.45	0.20	7.5	0.20	0.13	11.1	7.1	1.4	1.7	18	14
	2.1	23.5	60	0.61	0.35	8.7	0.30	0.17	14.1	7.1	4.1	2.0	32	18
	3.2	22.9	70	0.76	0.48	10.7	0.39	0.20	16.0	7.1	6.6	2.5	41	23
	4.0	21.6	80	0.90	0.61	12.7	0.48	0.24	17.3	7.1	8.3	2.7	45	23
	4.5	20.0	90	1.04	0.72	14.6	0.56	0.28	18.0	7.1	9.4	3.0	50	27
975	0.8	23.4	50	0.45	0.20	7.5	0.20	0.13	11.7	7.4	1.4	1.7	23	14
	2.1	24.7	60	0.61	0.35	8.3	0.28	0.16	14.8	7.4	4.4	2.1	32	18
	3.2	24.1	70	0.76	0.48	10.2	0.37	0.19	16.9	7.4	6.9	2.5	50	23
	4.0	22.8	80	0.90	0.61	11.9	0.44	0.23	18.2	7.4	8.8	2.7	45	23
	4.5	21.0	90	1.04	0.72	13.7	0.52	0.26	18.9	7.4	9.9	2.9	50	27
1,040	0.8	24.5	50	0.45	0.20	7.5	0.19	0.13	12.3	7.8	1.5	1.8	23	14
	2.1	25.9	60	0.61	0.35	8.0	0.27	0.15	15.5	7.8	4.6	2.1	32	18
	3.2	25.3	70	0.76	0.48	9.6	0.34	0.19	17.7	7.8	7.2	2.4	41	23
	4.0	23.9	80	0.90	0.61	11.3	0.41	0.22	19.1	7.8	9.2	2.7	45	23
	4.5	22.1	90	1.04	0.72	12.9	0.48	0.25	19.9	7.8	10.4	2.9	50	27

Table 5. Nutrient requirements of growing yearlings (continued).

Body weight (lbs)	ADG (lbs)	DM intake (lbs/day)	Diet nutrient density						Daily nutrients per animal					
			TDN (% DM)	NEm (Mcal/lb)	NEg (Mcal/lb)	CP (% DM)	Ca (% DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	NEg (Mcal)	CP (lbs)	Ca (grams)	P (grams)
1,400 pounds at finishing														
770	0.8	19.6	50	0.45	0.20	7.5	0.22	0.13	9.8	6.2	1.2	1.5	18.	14
	2.2	20.7	60	0.61	0.35	10.1	0.36	0.19	12.4	6.2	3.7	2.1	36	18
	3.4	20.2	70	0.76	0.48	12.9	0.49	0.24	14.1	6.2	5.8	2.6	41	23
	4.2	19.1	80	0.90	0.61	15.6	0.61	0.29	15.3	6.2	7.3	3.0	54	27
	4.7	17.6	90	1.04	0.72	18.1	0.72	0.34	15.8	6.2	8.3	3.2	59	27
840	0.8	20.9	50	0.45	0.20	7.5	0.21	0.13	10.5	6.6	1.3	1.6	18	14
	2.2	22.1	60	0.61	0.35	9.6	0.34	0.18	13.3	6.6	3.9	2.1	36	18
	3.4	21.6	70	0.76	0.48	12.1	0.45	0.23	15.1	6.6	6.2	2.6	41	23
	4.2	20.4	80	0.90	0.61	14.5	0.56	0.27	16.3	6.6	7.8	3.0	50	27
	4.7	18.8	90	1.04	0.72	16.8	0.65	0.32	16.9	6.6	8.9	3.2	54	27
910	0.8	22.2	50	0.45	0.20	7.5	0.21	0.13	11.1	7.1	1.4	1.7	23	14
	2.2	23.5	60	0.61	0.35	9.1	0.32	0.17	14.1	7.1	4.1	2.1	36	18
	3.4	22.9	70	0.76	0.48	11.3	0.42	0.22	16.0	7.1	6.6	2.6	41	23
	4.2	21.6	80	0.90	0.61	13.5	0.51	0.26	17.3	7.1	8.3	2.9	50	27
	4.7	20.0	90	1.04	0.72	15.6	0.60	0.3	18.0	7.1	9.5	3.1	54	27
980	0.8	23.5	50	0.45	0.20	7.5	0.20	0.13	11.8	7.5	1.4	1.8	23	14
	2.2	24.8	60	0.61	0.35	8.7	0.30	0.17	14.9	7.5	4.4	2.2	32	18
	3.4	24.2	70	0.76	0.48	10.7	0.39	0.20	16.9	7.5	6.9	2.6	41	23
	4.2	22.9	80	0.90	0.61	12.6	0.47	0.24	18.3	7.5	8.8	2.9	50	27
	4.7	21.1	90	1.04	0.72	14.5	0.56	0.28	19.0	7.5	10.0	3.1	54	27
1,050	0.8	24.7	50	0.45	0.20	7.5	0.20	0.13	12.4	7.9	1.5	1.9	23	14
	2.2	26.1	60	0.61	0.35	8.3	0.28	0.16	5.7	7.9	4.6	2.2	32	18
	3.4	25.5	70	0.76	0.48	10.1	0.37	0.20	17.9	7.9	7.3	2.6	41	23
	4.2	24.1	80	0.90	0.61	11.9	0.44	0.23	19.3	7.9	9.3	2.9	50	27
	4.7	22.2	90	1.04	0.72	13.6	0.51	0.26	20.0	7.9	10.5	3.0	50	27
1,120	0.8	25.9	50	0.45	0.20	7.5	0.19	0.13	13.0	8.2	1.6	1.9	23	14
	2.2	27.4	60	0.61	0.35	8.0	0.27	0.16	16.4	8.2	4.8	2.2	32	18
	3.4	26.8	70	0.76	0.48	9.6	0.34	0.19	18.8	8.2	7.7	2.6	41	23
	4.2	25.3	80	0.90	0.61	11.2	0.41	0.22	20.2	8.2	9.7	2.8	45	27
	4.7	23.3	90	1.04	0.72	12.8	0.48	0.25	21.0	8.2	11.1	3.0	50	27

Table 6. Nutrient requirements of growing and mature bulls.

Body weight (lbs)	Diet nutrient density								Daily nutrients per animal					
	ADG (lbs)	DM intake (lbs/day)	TDN (% DM)	NEm (Mcal/lb)	NEg (Mcal/lb)	CP (% DM)	Ca (% DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	NEg (Mcal)	CP (lbs)	Ca (grams)	P (grams)
1,700-pound mature weight														
900	0.4	22	50	0.45	0.20	7.5	0.16	0.11	11.0	8.0	0.9	1.7	18	14
	1.6	23	60	0.61	0.35	7.5	0.23	0.14	14.0	8.0	3.5	1.7	23	14
	2.5	23	70	0.76	0.48	8.8	0.30	0.16	15.9	8.0	5.8	2.0	32	18
	3.1	22	80	0.90	0.61	10.2	0.36	0.19	17.2	8.0	7.6	2.2	36	18
1,000	0.4	24	50	0.45	0.20	7.5	0.16	0.11	11.9	8.7	1.0	1.8	18	14
	1.6	25	60	0.61	0.35	7.5	0.22	0.13	15.1	8.7	3.8	1.9	27	14
	2.5	25	70	0.76	0.48	8.1	0.27	0.15	17.2	8.7	6.3	2.0	32	18
	3.1	23	80	0.90	0.61	9.3	0.32	0.18	18.6	8.7	8.2	2.2	32	18
1,100	0.4	26	50	0.45	0.20	7.5	0.16	0.11	2.8	9.4	1.0	1.9	18	14
	1.6	27	60	0.61	0.35	7.5	0.20	0.13	16.2	9.4	4.1	2.0	27	14
	2.5	26	70	0.76	0.48	7.5	0.25	0.14	18.5	9.4	6.8	2.0	32	18
	3.1	25	80	0.90	0.61	8.6	0.29	0.16	19.9	9.4	8.8	2.1	32	18
1,200	0.4	27	50	0.45	0.20	7.5	0.16	0.11	13.7	10.0	1.1	2.0	18	14
	1.6	29	60	0.61	0.35	7.5	0.19	0.12	17.3	10.0	4.4	2.2	27	18
	2.5	28	70	0.76	0.48	7.5	0.23	0.14	19.7	10.0	7.2	2.1	27	18
	3.1	27	80	0.90	0.61	7.9	0.26	0.15	21.3	10.0	9.4	2.1	32	18
1,300	0.4	29	50	0.45	0.20	7.5	0.16	0.11	14.5	10.6	1.2	2.2	23	14
	1.6	31	60	0.61	0.35	7.5	0.19	0.12	18.4	10.6	4.6	2.3	27	18
1,400	0.4	31	50	0.45	0.20	7.5	0.16	0.11	15.4	11.2	1.2	2.3	23	18
	1.6	32	60	0.61	0.35	7.5	0.18	0.12	19.4	11.2	4.9	2.4	27	18
1,500	0.4	32	50	0.45	0.20	7.5	0.16	0.11	16.2	11.8	1.3	2.4	23	18
	1.6	34	60	0.61	0.35	7.5	0.17	0.12	20.5	11.8	5.1	2.6	27	18
1,600	0.4	34	50	0.45	0.20	7.5	0.16	0.12	17.0	12.4	1.4	2.6	23	18
	1.6	36	60	0.61	0.35	7.5	0.16	0.11	21.5	12.4	5.4	2.7	27	18
1,700	0.0	33	46	0.39	0.00	7.5	0.16	0.12	15.1	13.0	0.0	2.5	23	18
	0.4	36	50	0.45	0.20	7.5	0.16	0.12	17.8	13.0	1.4	2.7	27	18

Table 6. Nutrient requirements of growing and mature bulls (continued).

Body weight (lbs)	Diet nutrient density							Daily nutrients per animal						
	ADG (lbs)	DM intake (lbs/day)	TDN (% DM)	NEm (Mcal/lb)	NEG (Mcal/lb)	CP (% DM)	Ca (% DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	NEG (Mcal)	CP (lbs)	Ca (grams)	P (grams)
2,000-pound mature weight														
1,000	0.5	24	50	0.45	0.20	7.5	0.17	0.12	11.9	8.7	1.0	1.8	18	14
	1.7	25	60	0.61	0.35	7.5	0.25	0.14	15.1	8.7	3.8	1.9	27	18
	2.8	25	70	0.76	0.48	9.1	0.32	0.17	17.2	8.7	6.3	2.2	36	18
	3.5	23	80	0.90	0.61	10.5	0.38	0.20	18.6	8.7	8.2	2.4	41	22.7
1,100	0.5	26	50	0.45	0.20	7.5	0.17	0.12	12.8	9.4	1.0	1.9	18	14
	1.7	27	60	0.61	0.35	7.5	0.23	0.14	16.2	9.4	4.1	2.0	27	18
	2.8	26	70	0.76	0.48	8.4	0.29	0.16	18.5	9.4	6.8	2.2	36	18
	3.5	25	80	0.90	0.61	9.8	0.35	0.19	19.9	9.4	8.8	2.4	41	23
1,200	0.5	27	50	0.45	0.20	7.5	0.17	0.12	13.7	10.0	1.1	2.0	23	14
	1.7	29	60	0.61	0.35	7.5	0.22	0.13	17.3	10.0	4.3	2.2	27	18
	2.8	28	70	0.76	0.48	7.9	0.27	0.16	19.7	10.0	7.2	2.2	36	18
	3.5	27	80	0.90	0.61	9.0	0.32	0.18	21.3	10.0	9.4	2.4	36	23
1,300	0.5	29	50	0.45	0.20	7.5	0.17	0.12	14.5	10.6	1.2	2.2	23	14
	1.7	31	60	0.61	0.35	7.5	0.21	0.13	18.4	10.6	4.6	2.3	27	18
	2.8	30	70	0.76	0.48	7.5	0.25	0.15	21.0	10.6	7.7	2.3	32	18
	3.5	28	80	0.90	0.61	8.4	0.29	0.17	22.6	10.6	10.0	2.4	36	23
1,400	0.5	31	50	0.45	0.20	7.5	0.16	0.12	15.4	11.2	1.2	2.3	23	18
	1.7	32	60	0.61	0.35	7.5	0.20	0.13	19.4	11.2	4.9	2.4	27	18
1,500	0.5	32	50	0.45	0.20	7.5	0.16	0.12	16.2	11.8	1.3	2.4	23	18
	1.7	34	60	0.61	0.35	7.5	0.19	0.13	20.5	11.8	5.1	2.6	32	18
1,600	0.5	34	50	0.45	0.20	7.5	0.17	0.12	17.0	12.4	1.4	2.6	27	18
	1.7	36	60	0.61	0.35	7.5	0.18	0.12	21.5	12.4	5.4	2.7	32	18
1,700	0.5	36	50	0.45	0.20	7.5	0.16	0.12	17.8	13.0	1.4	2.7	27	18
	1.7	38	60	0.61	0.35	7.5	0.18	0.12	22.5	13.0	5.6	2.9	32	23
1,800	0.5	37	50	0.45	0.20	7.5	0.16	0.12	18.5	13.5	1.5	2.9	27	18
	1.7	39	60	0.61	0.35	7.5	0.17	0.12	23.5	13.5	5.9	2.8	32	23
1,900	0.5	39	50	0.45	0.20	7.5	0.16	0.12	19.3	14.1	1.5	2.9	27	23
	1.7	41	60	0.61	0.35	7.5	0.17	0.12	24.5	14.1	6.1	3.1	32	23
2,000	0.0	37	46	0.39	0.00	7.5	0.17	0.13	17.1	14.6	0.0	2.8	27	23
	0.5	40	50	0.45	0.20	7.5	0.16	0.12	20.1	14.6	1.6	3.0	32	23

Table 6. Nutrient requirements of growing and mature bulls (continued).

Body weight (lbs)	Diet nutrient density								Daily nutrients per animal					
	ADG (lbs)	DM intake (lbs/day)	TDN (% DM)	NEm (Mcal/lb)	NEG (Mcal/lb)	CP (% DM)	Ca (% DM)	P (% DM)	TDN (lbs)	NEm (Mcal)	NEG (Mcal)	CP (lbs)	Ca (grams)	P (grams)
2,300-pound mature weight														
1,200	0.5	27	50	0.45	0.20	7.5	0.18	0.12	13.7	10.0	1.1	2.0	23	14
	1.9	29	60	0.61	0.35	7.5	0.24	0.14	17.3	10.0	4.4	2.2	32	18
	3.0	28	70	0.76	0.48	8.7	0.30	0.17	19.7	10.0	7.2	2.5	41	23
	3.8	27	80	0.90	0.61	10.1	0.36	0.20	21.3	10.0	9.4	2.7	45	23
1,300	0.5	29	50	0.45	0.20	7.5	0.17	0.12	14.5	10.6	1.2	2.2	23	18
	1.9	31	60	0.61	0.35	7.5	0.23	0.14	18.4	10.6	4.6	2.3	32	18
	3.0	30	70	0.76	0.48	8.2	0.28	0.16	21.0	10.6	7.7	2.5	41	23
	3.8	28	80	0.90	0.61	9.4	0.34	0.19	22.6	10.6	10.0	2.7	45	23
1,400	0.5	31	50	0.45	0.20	7.5	0.17	0.12	15.4	11.2	1.2	2.3	23	18
	1.9	32	60	0.61	0.35	7.5	0.22	0.14	19.4	11.2	4.9	2.4	32	18
	3.0	32	70	0.76	0.48	7.7	0.26	0.15	22.2	11.2	8.1	2.4	36	23
	3.8	30	80	0.90	0.61	8.8	0.31	0.18	23.9	11.2	12.5	2.6	41	23
1,500	0.5	32	50	0.45	0.20	7.5	0.17	0.12	16.2	11.8	1.3	2.4	27	18
	1.9	34	60	0.61	0.35	7.5	0.21	0.13	20.5	11.8	5.2	2.6	32	23
1,600	0.5	34	50	0.45	0.20	7.5	0.17	0.12	17.0	12.4	1.4	2.6	27	18
	1.9	36	60	0.61	0.35	7.5	0.20	0.13	21.5	12.4	5.4	2.7	32	23
1,700	0.5	36	50	0.45	0.20	7.5	0.17	0.12	17.8	13.0	1.4	2.7	27	18
	1.9	38	60	0.61	0.35	7.5	0.19	0.13	22.5	13.0	5.7	2.9	32	23
1,800	0.5	37	50	0.45	0.20	7.5	0.17	0.12	18.5	13.5	1.5	2.8	27	23
	1.9	39	60	0.61	0.35	7.5	0.19	0.13	23.5	13.5	5.9	2.9	32	23
1,900	0.5	39	50	0.45	0.20	7.5	0.17	0.12	19.3	14.1	1.5	2.9	32	23
	1.9	41	60	0.61	0.35	7.5	0.18	0.13	24.5	14.1	6.2	3.1	36	23
2,000	0.5	40	50	0.45	0.20	7.5	0.17	0.12	20.1	14.6	1.6	3.0	32	23
	1.9	42	60	0.61	0.35	7.5	0.18	0.13	25.4	14.6	6.4	3.2	36	23
2,100	0.5	42	50	0.45	0.20	7.5	0.17	0.13	20.8	15.2	1.7	3.3	32	23
	1.9	44	60	0.61	0.35	7.5	0.17	0.12	26.3	15.2	6.6	3.3	36	23
2,200	0.5	43	50	0.45	0.20	7.5	0.17	0.13	21.6	15.7	1.7	3.2	32	23
	1.9	46	60	0.61	0.35	7.5	0.17	0.12	27.3	15.7	6.9	3.5	36	27
2,300	0.0	45	46	0.39	0.00	7.5	0.16	0.12	20.5	16.3	0.0	3.4	32	23
	0.5	47	50	0.45	0.20	7.5	0.16	0.12	23.5	16.3	1.8	3.5	36	27

Table 7. Mineral requirements and maximum tolerable concentration and vitamin requirements, dry matter basis.

Mineral/vitamin	Unit	Growing and finishing ^a	Cows		
			Gestation	Early lactation	Maximum tolerable level
Magnesium	%	0.10	0.12	0.20	0.40
Potassium	%	0.60	0.60	0.70	3.00
Sodium	%	0.06-0.08	0.06-0.08	0.10	--
Sulfur	%	0.15	0.15	0.15	0.35 or 0.5 ^b
Cobalt	ppm	0.15	0.15	0.15	25.00
Copper	ppm	10.00	10.00	10.00	40.00
Iodine	ppm	0.50	0.50	0.50	50.00
Iron	ppm	50.00	50.00	50.00	500.00
Manganese	ppm	20.00	40.00	40.00	1,000.00
Selenium	ppm	0.10	0.10	0.10	5.00
Zinc	ppm	30.00	30.00	30.00	500.00
Vitamin A	IU/lb	1,000.00	1,270.00	1,770.00	--
Vitamin D	IU/lb	125.00	125.00	125.00	--
Vitamin E ^c	IU/lb	16.00	16.00	16.00	--

a Also for breeding bulls.

b Maximum tolerable level recommended by NRC (205) = 0.5% of diet dry matter for cattle consuming diets with >40% forage and 0.35% of diet dry matter for cattle consuming diets with <1% forage.

c 108 to 225 for high-stress receiving cattle.

Source: NASEM, 2016.

Table 8. Approximate total daily water intake of beef cattle (gallons)^a.

Weight (lbs)	Temperature (F) ^b					
	40	50	60	70	80	90
Water intake (gallons/day)						
Growing heifers, steers and bulls						
400	4.0	4.3	5.0	5.8	6.7	9.5
600	5.3	5.8	6.6	7.8	8.9	12.7
800	6.1	6.8	7.9	9.2	10.6	15.0
Finishing cattle						
600	6.0	6.5	7.4	8.7	10.0	14.3
800	7.3	7.9	9.1	10.7	12.3	17.4
1,000	8.7	9.4	10.8	12.6	14.5	20.6
Wintering pregnant and lactating cows						
Milk						
Cow Body Weight (lb)	Production (lb/day)	40	65	90	*Gallons of Water/ Day	
1,100	0	8.2	10.8	13.4		
1,100	10	10.5	13.1	15.7		
1,100	25	12.8	15.4	17.9		
1,300	0	9.2	11.8	14.3		
1,300	15	12.2	14.8	17.4		
1,300	30	14.5	17.1	19.7		
1,500	0	10.2	12.7	15.3		
1,500	20	14.0	16.5	19.1		
1,500	35	16.3	18.8	21.4		

*1 gallon is equivalent to 8.35 pounds.

a Adapted from NASEM, 2016.

b Water intake of a given class of cattle in a specific management regime is a function of dry matter intake and ambient temperature. Water intake is quite constant up to 40 F.

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