Nutrient Requirements of the Beef Cow Herd

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A proper nutritional program for the cow herd is essential to the success of a cow-calf program. Expensive grasslands demand efficient utilization of forages. Supplemental feeding programs must be designed to meet the nutrient needs of the cow herd and at the same time make the most of forage supplies. Since the nutrient requirements of cattle change with age, stage of lactation, sex and environmental conditions, a knowledge of nutrient requirements is a necessary first step to matching cattle with the right size, age, sex and stage of production to the right forages and supplements at the right time. This fact sheet will discuss the protein, energy, mineral and vitamin requirements of the cow herd.

Ruminant Digestion

A simplified drawing of the digestive system in the cow is shown in Figure 1. In order to understand the nutrition of the cow, it must be realized that we are actually feeding "two" animals instead of just one. The rumen is a large fermentation vat with a bacterial population that digests most of the diet for the cow. The cow's tissues then utilize the end products of the bacterial fermentation. Since the bacteria have their own nutrient needs for optimum digestion, we must feed not only the "cow" but also her rumen.

Protein

Proteins are large chemical units made up of hundreds of amino acids. Amino acids, in turn, are organic compounds that contain nitrogen along with carbon, oxygen and sometimes sulfur. Animals consume proteins in their diets and then utilize the amino acids for synthesis of muscle, blood proteins and other body components. In swine, poultry and other nonruminants, the amino acids must be supplied in definite proportions in the diet, but in ruminants, the bacteria break down most dietary proteins and synthesize bacterial proteins which 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 to end products that can be utilized by the cow. Because of

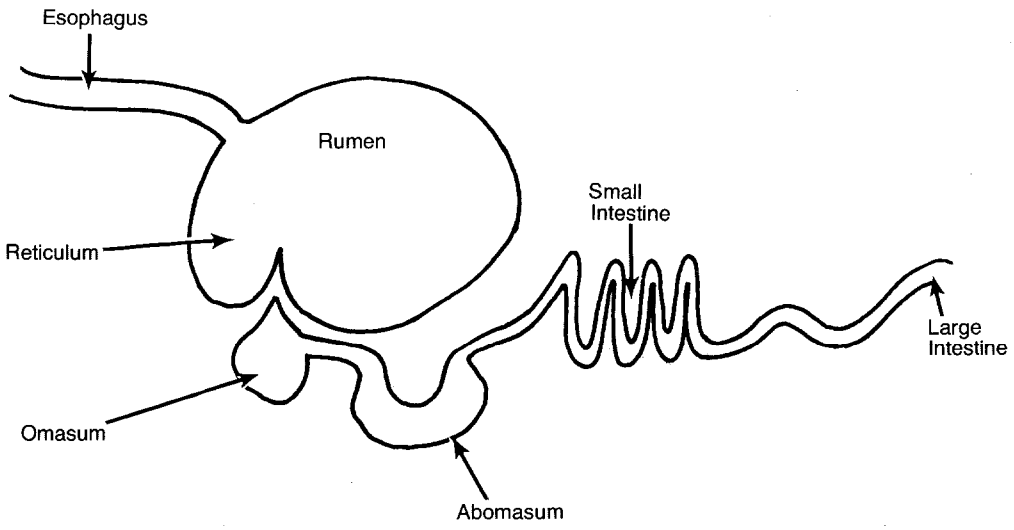

Figure 1. Primary parts of a ruminant digestive tract.

the ruminal breakdown of dietary proteins and because the amino acid make-up of bacteria is adequate for the cow, we normally do not worry about the kinds of amino acids in the protein fed to cattle. What we must be concerned about is that enough protein is fed to allow the bacteria to grow and digest roughages and to meet the requirements of the cow's body tissues.

The protein requirements for cattle of various ages, sizes, and stages of productivity are shown in Table 1. The requirements are shown in pounds per day of crude protein and digestible protein or in terms of the percentage required in the diet dry matter. Digestible protein is useful when determining the amount of protein actually available to the cow from forages that vary in maturity. As forages become more mature, the percentage of protein in the plant and the digestibility both tend to decrease, but digestible protein may decrease at a faster rate.

Table 1 dramatically illustrates the influence of age, weight and function on protein requirements. Replacement heifers need to gain about 1.0 - 1.5 lbs/day in order to reach puberty by 15 months of age. The requirement of protein for muscle growth is reflected in the large daily requirement for protein. Note that growing heifers require a high concentration of protein in the diet because of the low dry matter intake of the heifers. Growing heifers must have access to good quality forage or be fed supplemental protein to make adequate gains.

Gestation has little effect on the cow's protein requirement until about the 7th month of pregnancy. About 2/3 of the fetal growth occurs during the last 1/3 of pregnancy and the protein intake of the cow should be increased during the last 1/3 of pregnancy to insure that 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 losses of body condition frequently occur in late pregnancy when daily protein or energy are not increased to match the needs of the pregnant cow. The protein requirement for pregnant yearling heifers is 50-100% greater than for pregnant mature cows. Cattle reach mature size at about four years of age, and until maturity is reached, additional protein for growth must be added to the amount required for pregnancy and lactation. It is critical that good cow condition be maintained to calving. Research is showing that the condition of the cow at calving is one of the most important factors in achieving fast return to estrus following calving.

Lactation is the most nutritionally stressful activity for the cow. Average milking beef cows (10-12 lbs/day) require more than twice the daily protein of dry cows. Research shows that 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 demand brought on by lactation may result in long intervals to rebreeding and poor conception rates. Beef breeds with superior milking ability (20-22 lbs/day) or beef cows with dairy breeding have an even higher protein requirement.

Particular attention should be paid to lactating first- and second-calf heifers. These heifers must continue to grow in addition to meeting requirements for maintenance and lactation. Lactating first-calf heifers with average milking ability should be fed more protein than mature cows to be sure that needs for growth and lactation are met.

Increasing cow size adds to the daily protein requirement but not nearly to the extent as does lactation. As the mature size gets larger, 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. The primary impact of cow size is on energy requirements, which will be discussed later.

Nutrition of the breeding bull is often overlooked, and many cattlemen are surprised to learn that breeding bulls require about the same daily protein as do lactating cows. As with heifers, young bulls require additional protein to allow for growth, in addition to normal maintenance and breeding activity.

Energy

Just as an automobile engine requires fuel to function, the cow requires energy for grazing, milk production, growth, temperature maintenance, reproduction, digestion and voiding of body wastes. The bulk of energy for 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 themselves require protein, just as the animal 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, while with too much protein in the diet, the protein will be deaminated (the nitrogen removed) and used as a very expensive energy source.

The standard measure for energy in diets for grazing beef cattle is total digestible nutrients (TDN). Systems using net energy are excellent for feedlot and dairy cattle, but the lack of net energy values for forages severely limits the usefulness of net energy for most cow-calf situations. 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.

A close look at Table 1 shows that the same factors that influenced protein requirements also influence energy requirements: animal weight, rate of gain, lactation and fetal development. Lactation imposes the greatest strain on the cow's energy intake. An average milking beef cow requires about 40% more TDN than she does when dry. If the cow is milking about 20 lbs per day, the TDN requirement is increased by about 70% over when she is dry.

Energy requirements for first-calf heifers are higher than for mature cows because energy is needed for growth,

Table 1. Nutrient Requirements of the Cow Herd

Body Wt, lb.	Daily Gain lb.	Min.dry Matter Consumption, lb.	Crude Protein lb/day	% in DM	Dig. Protein lb/day	% in DM	TDN lb/day	% in DM	Calcium gm/day	Phosphorus gm/day	Vit A IU/day
Replacement											
400	1.5	12.0	1.3	10.8	.8	6.6	7.5	62	18	16	12,000
550	1.2	14.0	1.4	10.0	.85	6.0	9.0	64	17	15	14,000
700	1.0	17.5	1.5	8.6	.9	5.2	11.0	63	15	15	18,000
Pregnant yearling heifers - last 3/4 months of pregnancy.											
775	.9	15.2	1.35	8.9	.77	5.1	8.1	53	15	15	19,000
825	.9	15.9	1.4	8.8	.80	5.1	8.4	53	15	15	20,000
940	.9	17.2	1.5	8.7	.88	5.1	9.0	52	16	16	22,000
Dry pregnant, mature cows - middle third of pregnancy.											
900	—	13.7	.8	6.0	.38	2.8	7.3	53	11	11	17,000
1100	—	15.9	.9	5.8	.44	2.8	8.6	54	13	13	20,000
1300	—	18.0	1.1	6.1	.50	2.8	9.6	54	15	15	23,000
Dry pregnant, mature cows - last third of pregnancy.											
900	.9	15.7	.97	6.2	.47	3.0	9.0	58	14	14	21,000
1100	.9	17.9	1.12	6.3	.53	3.0	9.9	55	15	15	24,000
1300	.9	20.0	1.2	6.2	.58	3.0	11.0	55	17	17	27,000
Cows nursing calves - average milking ability, first 3-4 months postpartum.											
900	—	19.8	1.8	9.2	1.1	5.3	10.4	53	25	25	21,000
1100	—	21.6	2.0	9.2	1.2	5.4	11.7	54	27	27	24,000
1300	—	23.8	2.25	9.2	1.25	5.3	13.0	55	28	28	27,000
Cows nursing calves - superior milking ability, first 3-4 months postpartum.											
900	—	24.2	2.6	10.8	1.5	6.0	13.5	56	45	41	34,000
1100	—	26.0	2.85	11.0	1.7	6.4	14.8	57	46	43	38,000
1300	—	28.0	3.10	11.1	1.8	6.4	16.1	58	46	44	43,000
Bulls, growth and maintenance (moderate activity).											
1325	1.1	26.4	2.25	8.8	1.3	5.0	16.1	61	22	22	48,000
1550	.7	28.4	2.41	8.5	1.4	5.0	16.5	58	23	23	50,000
2000	—	25.1	2.13	8.5	1.2	5.0	13.9	55	21	21	44,000
2 year old heifers producing 11 lbs milk, first 3-4 months of postpartum.											
775	.5	20.6	2.16	10.5	1.25	6.1	12.0	58	30	26	37,000
1000	.5	23.7	2.49	10.5	1.44	6.1	13.7	58	32	29	42,000
1100	.5	25.1	2.64	10.5	1.53	6.1	14.6	58	34	30	45,000
2 year old heifers producing 18 lbs milk, first 3-4 months postpartum.											
775	.5	21.3	2.73	12.8	1.58	7.4	13.6	64	39	33	38,000
1000	.5	23.9	3.06	12.8	1.77	7.4	15.3	64	41	35	42,000
1100	.5	25.0	3.20	12.8	1.86	7.4	16.0	64	42	36	45,000

[1]Adapted from *Nutrient Requirements of Beef Cattle,* National Research Council and from *Nutrient Requirements of Breeding Beef Cattle.* Paul Guyer and Jim Gosey. 1978. University of Nebraska.
[2]Average milking ability = 10-12 lbs/day.
[3]Superior milking ability = 19.5 - 24 lbs/day.

in addition to body maintenance and lactation. For a 2-year-old, first-calf heifer giving 11 lbs of milk per day and consuming 20.6 lbs of dry matter per day, the diet needs to contain 58% TDN. Replacement heifers weighing 550 lbs and gaining 1.2 lbs per day require at least 14 lbs of diet containing 64% TDN. The dry matter intake figures listed in Table 1 represent minimum expected dry matter intakes. Larger cattle, particularly mature cattle, can be expected to consume more dry matter than shown in the table, and as a result can utilize diets with a lower TDN percent than listed by consuming more of the diet to meet the daily requirement. However, replacement heifers with small rumen capacities, lactating heifers and high milking cows often require either good quality forage or heavy supplementation to meet daily energy requirements. Inadequate energy during the last third of lactation and during the critical time from calving to rebreeding can lead to poor rebreeding.

Large cows will require more energy than will small cows. For example a 1300 lb, dry, pregnant cow in the middle third of pregnancy requires 32% more TDN per day than a 900 lb cow at the same state of production. Producers who are increasing the mature size of their cows should recognize the greater energy requirements of the larger cows and reduce their stocking rates to compensate.

Minerals

The minerals needed are divided into the macro or major minerals and the trace minerals.

Phosphorus is the single most commonly deficient mineral in Oklahoma. It is adequate in most immature growing forages but deficient from later summer to spring in range areas. Eastern Oklahoma ranges tend to be more deficient than western ranges. Lactation and growth are the primary functions that increase the phosphorus requirement. Since phosphorus, which is stored in the bone, has a multitude of functions in the body and in the rumen, deficiencies are serious. They include poor growth, reduced appetite, poor digestibility, bone deformities, and possibly poor reproduction.

Lack of calcium is usually not a problem, because most forages are high in calcium and most supplemental phosphorus sources also contain calcium. The two most

common possibilities for low calcium diets are (1) cows fed high grain rations with little roughage and (2) cows grazing small grain pastures in winter, which tend to be low in calcium.

Magnesium deficiency is normally not a problem in range areas. It can be a serious problem, however, if cows are grazed on small grains pastures and can occasionally be a problem on fescue and bermuda pastures. Magnesium deficiency causes a condition called grass tetany and is most prevalent in old cows in late pregnancy or lactation.

Potassium, until recently, was not thought to be deficient in range or pasture cattle. Dormant, winter range forage has been shown to be almost devoid of potassium because of leaching, and gain responses to potassium supplementation have been seen in some cases. Although precise potassium requirements have not been established, Nebraska research suggests that the equivalent of 2% potassium in a 2 lb supplement is needed. Since cottonseed meal and soybean meal both contain about 2% potassium, the requirement should be met if these two protein sources are used.

Salt is deficient in all forage diets. Although California research demonstrates that the salt requirement is probably small, salt is cheap and usually fed free choice.

The trace minerals include cobalt, iron, iodine, copper, manganese, zinc and selenium. No deficiencies of these have been reported in Oklahoma.

Vitamins

The vitamins are divided into the fat soluble (A,D,E and K) and the water soluble vitamins (the B vitamins and vitamin C). The rumen and intestinal bacteria effectively synthesize the necessary water soluble vitamins as well as vitamin K. Vitamin E is found in most feeds and vitamin D is synthesized in the skin when exposed to sunlight.

True vitamin A is found only in animal tissue but is readily synthesized from carotene that occurs in growing plants. Carotene is practically devoid in mature, weathered forages, grains and many crop residues, and deficiencies can exist during winter, droughts or under drylot conditions. Fortunately, the liver is capable of storing vitamin A for long periods and frequent supplementation even during winter is not needed. A single intramuscular injection of one million International Units of vitamin A provides sufficient vitamin A for two to four months in growing or breeding beef cattle. Vitamin A requirements in thousands of International Units per day are shown in Table 1. Deficiencies of vitamin A usually show up first with weak, blind or stillborn calves. Other signs are scours, respiratory problems, poor gains and poor reproduction.

Other Comments

The requirements shown in Table 1 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 range 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, for example, shows that a 1200 lb cow subjected to 20°F. in a 15 MPH wind requires about 28% more energy than at 32°F. with no wind.

Do not forget that water is a common but entirely essential nutrient. Clean water is most important for young growing calves, but filthy water can retard performance and be a breeding ground for disease in all ages of cattle.

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