

# BEEF CATTLE NUTRITION



## Essential Nutrients

The nutrients utilized by beef cattle are (1) protein, (2) carbohydrates, (3) fats, (4) minerals, (5) vitamins and (6) water. Producers should understand the digestive system of the ruminant animal and the nutrient requirements of the various classes of beef cattle (Table 9).

Water is one of the most important nutrients. Cattle should have access to all of the clean, fresh water that they need. Water is involved in all digestive and metabolic processes. Carbohydrates, fats and in some instances proteins provide the energy in all animal rations. Failure to provide energy represents the most serious feeding problem among Arkansas cattle producers. A large portion of feeds eaten by cattle is used to supply energy regardless of whether they are just being maintained or fed for growth, finishing or reproduction. One of the greatest causes of low fertility is inadequate energy (TDN) in beef cattle rations. This occurs during drought or because of inadequate hay TDN throughout the winter feeding period.

Protein is important in all tissue building and in cell functions of the body of beef cattle. Good quality forages will supply the protein needs of dry pregnant cows and most of the protein needs of nursing cows. Ordinarily, protein supplements cost more than any other feed and should not be fed in larger amounts than are needed to balance the ration. Protein, energy and water are discussed in the section on feeding. Only minerals and vitamins will be covered here.

## Minerals for Beef Cattle

Minerals are essential in beef cattle diets. Deficiencies in any of the required minerals will reduce production efficiency. The mineral content of the animal's body makes up approximately 5 percent of its weight. Minerals are classified into two general categories – macro and trace or micro minerals – based on their relative amounts present in the animal's body and secondly on the amounts needed in the ration. The macro minerals are calcium, phosphorus, magnesium, potassium, sodium, chlorine and sulfur. The trace minerals most often needed in the beef animal's diet are iron, manganese, copper, iodine, cobalt, zinc and selenium.

## Macro Minerals

### Calcium (Ca)

Calcium is the major element of bones; approximately 99 percent of the body's calcium supply is in bones and teeth. In addition to its role in the skeletal system, calcium is also required for many other functions in the body. A major role is in the muscle contraction process. Calcium is usually present in adequate amounts in forage, but it may be limited in feedlot rations as grains are low in calcium.

### Phosphorus (P)

Approximately 80 percent of the body's supply of phosphorus is in the skeleton and teeth. In addition to its obvious role in these areas, P has been shown to be very important in absorption and transport of various compounds within the body. It is also involved in energy transfer. Because of this, P may be viewed as the most versatile mineral element. A phosphorus deficiency is often characterized by poor reproductive performance in beef cows. Grains are considered to be moderate to high in P while forages usually contain low to moderate amounts. Supplementation of this element is often needed in a grazing situation. Certain minerals must be kept in proper ratio to one another in the ration because their roles in metabolism and body functions are interrelated. For this reason, a Ca:P ratio of 1:1 to 5:1 should normally be maintained.

### Sodium (Na) and Chlorine (Cl) (Salt)

Sodium (Na) and Chlorine (Cl), more commonly known as salt, are used in the body to regulate osmotic pressure in cells and contribute to buffering systems. Sodium is also essential in the transmission of nerve impulses. Cattle will normally consume more than their requirements if given free access to either loose salt or blocks. Since the storage of these two elements in the body is rather limited, a regular supply should be self-fed.

Salt is sometimes used as an intake limiter for a self-feeding ration. In this situation, an abundant supply of fresh water is a must to prevent salt toxicity.

## Potassium (K)

Potassium is usually found in the intracellular (within the cell) fluids. It functions primarily to maintain osmotic pressure within the cell, maintain proper pH and the transfer of nutrients across the cell wall. Forages usually contain adequate amounts of this mineral; thus, grazing cattle are not usually supplemented with K.

However, Missouri studies have shown that K will leach from the plant in a fescue pasture during winter to levels low enough to require supplementation. Thus, K supplementation may be necessary for animals grazing accumulated fescue from January through March. Potassium supplementation may also be necessary if animals are fed extremely mature, low-quality forages.

## Magnesium (Mg)

Magnesium is closely associated with calcium and phosphorus in its distribution and metabolism in the animal's body. Under normal conditions, Mg is not a problem; however, the condition "grass tetany" is related to Mg deficiency. The gestating beef cow needs about 9 grams of Mg daily, while the lactating cow may need up to 20 grams. Under high risk grass tetany situations, the cow needs to be fed an average of 2 ounces of magnesium oxide per day. This amount of magnesium oxide will supply 31 grams of magnesium which should assure that each animal's needs are met. Magnesium needs to be supplied daily in high tetany risk situations because it leaves the blood in 20 to 30 hours after consumption.

When the risk of tetany is slight to medium, a mineral mixture containing equal parts cottonseed meal, trace mineral salt, magnesium oxide and dicalcium phosphate can be fed on a free-choice basis. If the risk of tetany is high, mix 7 pounds of magnesium oxide, 10 pounds of dicalcium phosphate, 20 pounds of cottonseed meal, 20 pounds of salt, 3 pounds of trace mineral salt and 40 pounds of grain. Feed this mixture on a free-choice basis. Monitor intake and adjust the mixture, if needed, to maintain an intake of 2 pounds per head per day.

## Trace Minerals

The level of trace minerals in the basic diet is ignored many times in ration formulations and 100 percent of the animal's requirements are added. This is done because of the tremendous variability that exists in the trace mineral composition of feeds and the minimal cost involved in adding these elements to the ration. Iodine, copper and selenium

are all deficient in many soils of the United States. Cobalt may need to be supplied because of its role in the formation of vitamin B<sub>12</sub> by rumen microorganisms. Copper has been shown to be deficient in the coastal plains region where heavy stocking rates and high nitrogen fertilization have occurred. Selenium deficiencies have been found in fescue pastures in north Arkansas. Iron levels are usually adequate in most grazing situations. In recent years, copper, selenium and zinc deficiencies have been the most prevalent in Arkansas cow herds.

## Vitamins for Beef Cattle

Pasture and average to excellent quality roughages usually contain sufficient quantities of the vitamins needed by beef cattle to support body maintenance, production and reproduction. Beef cattle may need vitamins A, D and E supplementation where the forage supply consists of crop residue, over-mature or weather-damaged hay or dry winter forage.

Vitamins are classified as fat soluble or water soluble. The water soluble vitamins include vitamin C and the B vitamins. B vitamins are produced by the cow during rumen fermentation and are seldom deficient. Vitamin C is only needed in the diets of humans, monkeys and guinea pigs.

The fat soluble vitamins include vitamins A, D, E and K. Vitamin K is synthesized in the rumen under most feeding conditions. Thus, the animal has little need for supplemental K. Vitamins A, D and E are routinely included in mineral mixes.

## Vitamin A

Vitamin A is strictly a product of animal metabolism. Its counterpart in plants is known as carotene. The beef animal transforms carotene into vitamin A. Cattle store vitamin A and carotene in the liver and body fat during periods of abundant intake. These periods occur when animals are grazing green forage. The stored reserves may be adequate to meet the animal's needs for two to four months. Vitamin A deficiencies may cause night blindness, watery eyes, and in pregnant animals, abortions. Weak calves, retained placentas and rebreeding problems may also occur. If animals are on a prolonged diet of bleached or weathered roughage, vitamin A stores may be depleted from the body. This vitamin may be provided to the cow herd by intramuscular injection, added to the mineral mix or in their regular ration. Pregnant cows that are being fed low-carotene feeds should receive the equivalent of 30,000 international units (IUs) of vitamin A daily while lactating cows should receive 45,000 IUs.

## Vitamin D

Beef cattle usually receive adequate amounts of this vitamin by exposure to direct sunlight or through consuming sun-cured forages. Vitamins D and E are usually included with vitamin A supplements or injection solutions administered to cattle. Only cattle kept indoors and not fed sun-cured hay are likely to show symptoms of vitamin D deficiency.

## Vitamin E

Under most conditions, natural feedstuffs supply the requirements of vitamin E. Cereal grains, grain forages and good quality hay are all excellent sources of this vitamin. Vitamin E is usually added to mineral-vitamin supplements because of its antioxidant properties which facilitate the uptake and storage of Vitamin A.

## Balancing Rations

Several terms used in balancing beef cattle rations are:

**Ration** – The feed an animal receives in a 24-hour period.

**Balanced Ration** – A ration that furnishes the nutrients needed in the proper amounts to allow the individual to perform a certain function such as maintenance, growth, gestation or lactation.

**Dry Matter (DM)** – The feed remaining after all water is removed. Dry matter averages about 35 percent in silages, 90 percent in No. 2 corn and 90 percent in hay.

**Supplement** – A concentrate feed added to a ration to provide one or more nutrients not adequately supplied by the usual feed.

**Nutrient** – Any feed component or group of feed components of similar chemical composition that aid in the support of animal life. Protein, carbohydrates, fat, minerals and vitamins are examples. Carbohydrate, fat and excess protein are all used in the animal body as energy.

**Total Digestible Nutrients (TDN)** – A term used as a measure of energy (caloric content of feedstuffs). On an as-fed basis, grains usually contain 65 to 80 percent TDN, hays usually 50 percent and less, and silages about 20 percent.

**Crude Protein or Total Protein** – The crude protein content of a feed is determined by analyzing the feed for nitrogen. Protein in a feed contains approximately 16 percent nitrogen; therefore, multiplying N by 6.25 gives the total protein content of the feed.

Since purchased feeds are usually expensive, home-raised forages should supply the major source of feeds used by beef cattle. Purchased supplements, whether for energy or protein, should be fed only to supply those nutrients not furnished by homegrown forages.

To formulate a balanced ration, you should know (1) the nutrient requirements of the beef cattle to be fed and (2) the nutritive value of feedstuffs available. Table 9 gives a partial listing of the National Research Council's (NRC) nutrient requirements of beef cattle.

Average composition values of Arkansas produced feeds are presented in Table 10. While the average nutritive content of many feedstuffs is known, the nutritive content of roughages is highly variable. Therefore, it is very important to have an analysis conducted on these feeds to determine their exact nutrient content so that rations may be balanced accurately. An analysis is inexpensive and often prevents expensive mistakes in underfeeding or overfeeding. DON'T GUESS – FORAGE TEST.

To formulate a ration for a 1,100-pound mature, lactating beef cow (2 months since calving, 20 pounds peak milk), first list (as shown in Table 7) the nutrient requirements of this class of cattle from Table 9. Next, assume that grass hay is available for feeding with the following analysis on a dry matter basis: 10 percent protein, 58 percent TDN, 0.35 percent calcium and 0.18 percent phosphorus. Assume daily intake of grass hay will be 26.4 pounds. Calculate the daily intake of each nutrient by multiplying the daily intake by the hay analysis (for protein,  $26.4 \times 0.10 = 2.64$  pounds).

|                           | Pounds |         |      |         |            |
|---------------------------|--------|---------|------|---------|------------|
|                           | DM     | Protein | TDN  | Calcium | Phosphorus |
| Requirements              | 26.4   | 2.88    | 15.9 | 0.084   | 0.055      |
| Grass hay                 | 26.4   | 2.64    | 15.3 | 0.092   | 0.048      |
| Deficiency (-)/Excess (+) |        | -0.24   | -0.6 | +0.008  | -0.007     |

Grass hay alone supplies inadequate amounts of protein, TDN and phosphorus. From Table 10, corn and cottonseed meal are chosen as good sources of TDN and protein, respectively. Next, the net gain by feeding supplemental corn and cottonseed meal is determined.

One pound of grass hay dry matter contains 0.58 pounds of TDN, while one pound of corn dry matter contains 0.90 pound of TDN. The net effect of replacing one pound of grass hay with one pound

of corn dry matter is a net gain of 0.32 pound of TDN ( $0.90 - 0.58 = 0.32$ ).

A deficiency of 0.6 pound of TDN exists. Dividing the pounds of nutrient deficiency by the pounds of nutrient gain gives the pounds of dry matter to substitute. For example:

$$\frac{0.6 \text{ pound TDN needed}}{0.32 \text{ pound TDN net gain}} = \frac{1.9 \text{ pounds of corn dry matter}}{\text{substituted for 1.9 pounds of grass hay dry matter}}$$

The protein deficit of 0.24 pound does not change because corn and the grass hay contain the same amount of crude protein.

Next, determine how much cottonseed meal is needed to meet the protein deficit. One pound of cottonseed meal substituted for one pound of grass hay gives a net gain of 0.36 pound ( $0.46 - 0.10 = 0.36$ ) of protein when 1 pound of cottonseed meal is substituted for 1 pound of hay.

$$\frac{0.24 \text{ pound protein needed}}{0.36 \text{ pound protein net gain}} = 0.67 \text{ pound of cottonseed meal}$$

The amount of grass hay in the ration is reduced to 23.8 pounds due to the substitution of 1.9 pounds of corn and 0.7 pound of cottonseed meal. The balanced ration is as follows:

|                 | Pounds   |                     |               |           |          |         |
|-----------------|----------|---------------------|---------------|-----------|----------|---------|
|                 | DM (lbs) | Total Feed (as-fed) | Protein (lbs) | TDN (lbs) | Ca (lbs) | P (lbs) |
| Requirements    | 26.4     | ---                 | 2.88          | 15.9      | 0.084    | 0.055   |
| Ration:         |          |                     |               |           |          |         |
| Grass hay       | 23.8     | 26.4                | 2.38          | 13.8      | 0.083    | 0.043   |
| Corn            | 1.9      | 2.1                 | 0.19          | 1.7       | ---      | 0.006   |
| Cottonseed Meal | 0.7      | 0.8                 | 0.32          | 0.5       | 0.001    | 0.008   |
| Total           | 26.4     | 29.3                | 2.89          | 16.0      | 0.084    | 0.057   |

The total feed (as-fed) is determined by dividing the pounds of feed (dry matter basis) by the percent dry matter in the feed (for grass hay with 90% dry matter,  $23.8$  divided by  $0.90 = 26.4$ ).

Grass hay fed alone was deficient in phosphorus, but supplemental corn and cottonseed meal eliminated the phosphorus deficiency. If phosphorus deficiency was a problem, dicalcium phosphate or another feed with a high phosphorus level could be used to meet the animal's requirement. If only calcium was deficient, limestone could be used. The same procedure used to determine protein and TDN needs would be used to determine calcium or phosphorus needs.

A mineral-vitamin supplement should be provided with the ration above to supply adequate amounts of all required minerals, including salt, trace minerals and also vitamin A.

When purchasing nutrients to balance a ration, always purchase the feed that provides the least cost per pound of nutrient needed. For example, if energy is a limiting factor in your ration, then supplement the ration with a high-energy feed such as corn, milo, barley, oats or wheat. Refer to Table 10 (Composition of Feeds) for the TDN level of various feeds and calculate what each unit of TDN costs by using the following formula:

$$\text{Cost/cwt of TDN} = \frac{\text{Cost of feed/cwt}}{\text{Lbs of TDN/cwt (as-fed basis)}} \times 100$$

To convert TDN value of corn on a dry matter basis to an as-fed basis, multiply the TDN value of corn on a dry matter basis (90 percent) by percent dry matter for corn (90 percent).

$$90\% \text{ (TDN)} \times 0.90 \text{ (DM)} = 81\% \text{ TDN As-fed}$$

$$\text{Corn} \quad \frac{\$6/\text{cwt}}{81 \text{ lbs of TDN/cwt}} \times 100 = \$7.40/\text{cwt TDN}$$

To calculate the cost of a protein supplement:

$$\text{Cost/cwt of total protein} = \frac{\text{Cost of feed/cwt}}{\text{Lbs of protein/cwt}} \times 100$$

A computer is often used to calculate beef cattle rations. Several ration formulation programs are available for public use. Contact the county Extension office to help plan feeding programs for individual farms.