# Beef nutrition 101: What a veterinarian needs to know to work with a nutritionist

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## Abstract

The disunion between veterinarians and nutritionists supporting the cattle industry is not new, albeit there are plentiful opportunities to improve. Successful operations need the perspective and technical knowledge of both professionals to optimize productivity. The need for improvement is magnified by the inability of the cattle industry to make strides in improving mortality rates that is most likely a reflection of management x health x nutrition interactions. Opportunity for veterinarians to support producers nutritionally is most prevalent among cattle segments not traditionally supported by trained nutritionists. These include cow-calf operations and confinement feeding operations with less than 500 head capacity. To facilitate nutritional conversations with the nutritionists, a basic understanding of the 6 classes of nutrients is critical. These classes include water, carbohydrates, lipids, protein, vitamins and minerals. A base level understanding of each nutrient paired with a broad idea of applied concepts associated with feeding will make for constructive two-sided conversations about nutrition between technical professionals.

**Key words:** cattle, health, nutrition

## Introduction

The cattle feeding industry has historically been segmented into 3 sections including cow-calf, growing and finishing (feedyard), each its own individual business enterprise financially independent of one another. Even with the onset of vertical integration among the poultry and swine industries, the cattle industry remains as segmented as ever. This disunion has also traditionally been active among veterinarians and nutritionists (jointly termed technical professionals) supporting the 3 segments.

Whether due to pressures to remain employed, pride, differences in interpretation of information, or a host of other reasons, often the relationship between these two technical professionals is a blame game. The blame volleys back and forth between health and nutrition as the cause of productivity losses that are the metric to which success of the technical professional is measured. In reality, successful operations need the perspective and technical knowledge of both professionals to optimize productivity. The need for improvement is magnified by the inability for the cattle industry to truly reduce mortality even with an extensive selection of antibiotics available. Morbidity also poses a risk to the system that can be both influenced by nutrient intake and can influence nutrient utilization that again justifies the need for synchrony among technical professionals to impact cattle feeding production systems.

To facilitate nutritional conversations with the nutritionists, a basic understanding of the 6 classes of nutrients is critical. These classes include water, carbohydrates, lipids, protein, vitamins, and minerals. A base level understanding of each nutrient pared with a broad idea of applied concepts associated with feeding will make for constructive two-sided conversations about nutrition between technical professionals.

## The importance of the veterinarian-nutritionist relationship

Assessing population data of feedyard animals from 1990 to 2007 indicates that mortality increased linearly even though 6 different antibiotics were introduced to the market for use in this time period (Figure 1).[1] Often, mortality is not a simple health-only problem solved with a new antibiotic or vaccine. Morbidity and mortality are typically a response to the multiple stressors associated with a change such as weaning (shipping, commingling, etc). Nutrition interacts with these stressors causing decreased feed intake or a preweaning nutritional deficiency enhancing the impact of these stressors.[4]

During a health event, immune stimulation causes an increased need for specific amino acids from protein for production of immune system cells.[3] Available amino acids in plasma otherwise used for growth are partitioned for the immune response. This is further exacerbated by reductions in nutrient intake during a health challenge resulting in even fewer nutrients taken in and available for growth. To quantify this, the immune system will use 1.0 g/glucose/hour in active tissue mass for a growing calf during immune activation[5] which may equate to nearly all the daily calories necessary for gain. The cost to productivity caused by supporting the immune response can add additional expense to a system. To reduce the impact of the caloric cost of immune activation, ensuring proper feed intake of a ration that is formulated to meet nutritional requirements is critical. Supplementing cattle during nutritional shortage (for example, forage drought or dormancy) or providing a high-quality ration can help ensure proper nutrient intake.

The presence of a nutritionist depends on the size of the operation and cattle segment (cow-calf, grower and feedyard). Among cow-calf operations, nutritionists are seldomly used with veterinarians serving as the primary source of nutrition information, especially as the operation size grows (Figure 2).[12] Conversely, feedyards use nutritionists most extensively, especially as the yard capacity increases. In confinement feeding operations with between 500-999 capacity, 82% use a nutritionist,[13] whereas only 28% using a nutritionist if their capacity is less than 500 head. Given that 81% of cow-calf operations have less than 99 head,[10] coupled with these low-capacity feedyards, the number of cattle potentially influenced nutritionally through the veterinarian is tremendous. In a traditional pre-veterinarian university curriculum, only about 7% of veterinary schools require a single nutrition course (Purdue University, personal communication). This demonstrates the disconnect between demand for nutritional knowledge when in practice and nutrition education in pre-vet programs. Perhaps this void can be compensated by a relationship between nutritionist and veterinarians. The inability for the industry to make sizable reductions in cattle mortality coupled with impactful health x nutrition effects demonstrates the tremendous need for technical professionals to work together to serve producers, especially when veterinarians are the primary source of nutrition information.

**Figure 1:** Calf mortality from 1990 to 2007 with arrows indicating induction of various antibiotics to the market over the same time period.[1]

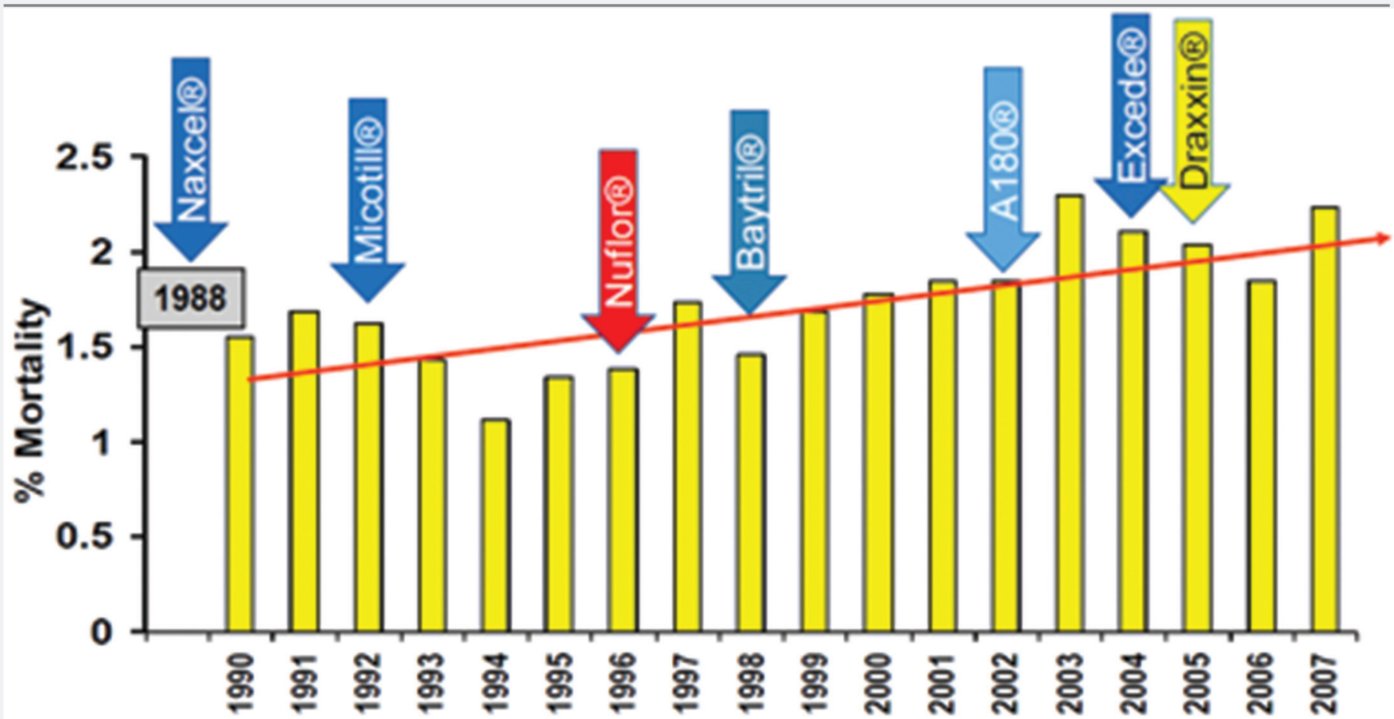
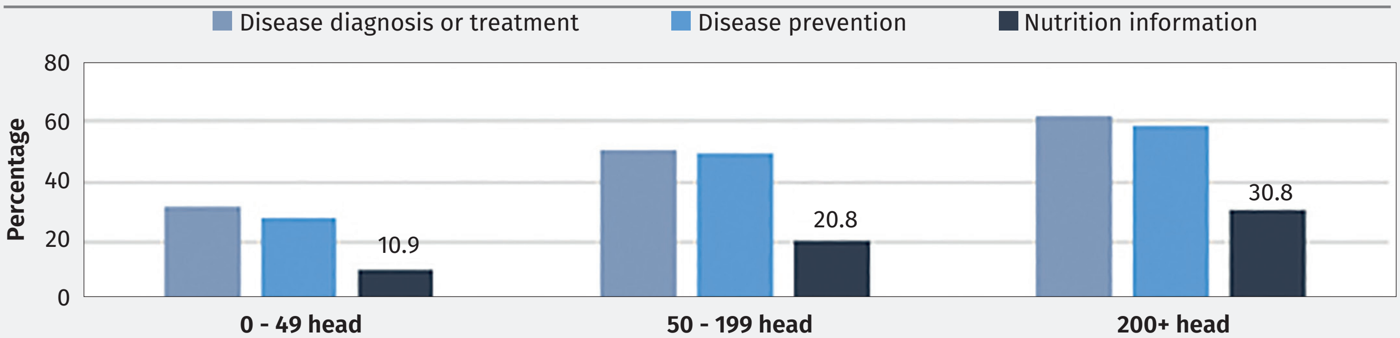



**Figure 2:** Reasons for calling a veterinarian among cow-calf producers by herd size.[12]




## Nutrients 101

A baseline knowledge of the 6 classes of nutrients is important to providing accurate information on nutrition, diet formulation and feed delivery in the field. The 6 classes of nutrients include water, carbohydrates (CHO), lipids, protein, vitamins, and minerals. This discussion will focus on nutrient definitions and practical feeding applications within each class of nutrients.

## Carbohydrates

Carbohydrates provide energy and physical fiber fill for the rumen. Multiple chemical forms encompass CHOs including non-fiber CHOs (organic acids, starch, water soluble CHO and soluble fiber) and fiber CHOs (hemicellulose, cellulose and lignin). Glucose is an intermediate product of fermentation and is the ultimate form of energy because it is hydrolyzed to volatile fatty acids. The primary volatile fatty acids are propionate, acetate and butyrate that provide over 80% of the daily energy requirement of the animal. Starch is a form of CHO that is concentrated in feed grains and typically fed in larger quantities as the animal ages approaching harvest. Starch consists of amylopectin and amylose that is unavailable to the animal. Grain processing is used to physically disrupt starch, so particle size is reduced resulting in increased availability of starch to rumen microbes to maximize total tract digestibility. Grain processing methods include steam flaking, steam rolling, dry rolling or cracking corn. As compared to whole corn, steam processing corn has the largest positive impact on total tract digestibility.[6] Total starch content in the ration is a concern for digestive health as excessive starch can lead to digestive disorders such as acidosis.

The energy requirement of cattle is met through carbohydrates (and fat) that are present in all feedstuffs to some degree. In pasture-based systems, cattle will derive their energy from grazed or harvested forages and this is typically measured by total digestive nutrients (TDN) for beef cows with neutral detergent fiber (NDF) being an indicator of feed intake potential.

For growing calves on pasture or in confinement and feedyard cattle, energy in the ration is indicated by net energy for gain (NEg). The most common use of grains (concentrate rations) is in the feedyard or dairy sectors.

## Lipids

Lipids refer to fat most commonly in the form of fatty acids and are the most efficient way of delivering energy in the diet. In general, forages contain a low lipid content and grains a higher content. Fatty acids are categorized by the number of double bonds and unlike dairy nutrition, fatty acids are not considered in ration formulation of beef diets. During lipid metabolism (lipolysis), lipids are metabolized by rumen microorganisms to fatty acids, glycerol or other minute products.[2] Biohydrogenation of fats takes place in the rumen to saturate unsaturated fatty acids resulting in microbes disposing of a hydrogen bond.[2] Because fat is not absorbed in the rumen, it leaves the rumen either attached to feed particles and microbes, as microbial phospholipids, or is never digested.[7] The extent of lipolysis is influenced by CHO source (forage or concentrate) and lipid source (plant or fish oil). For example, high grain consumption results in an increase in branched-chain fatty acids and high forage results in an increase in saturated fatty acids.[2]

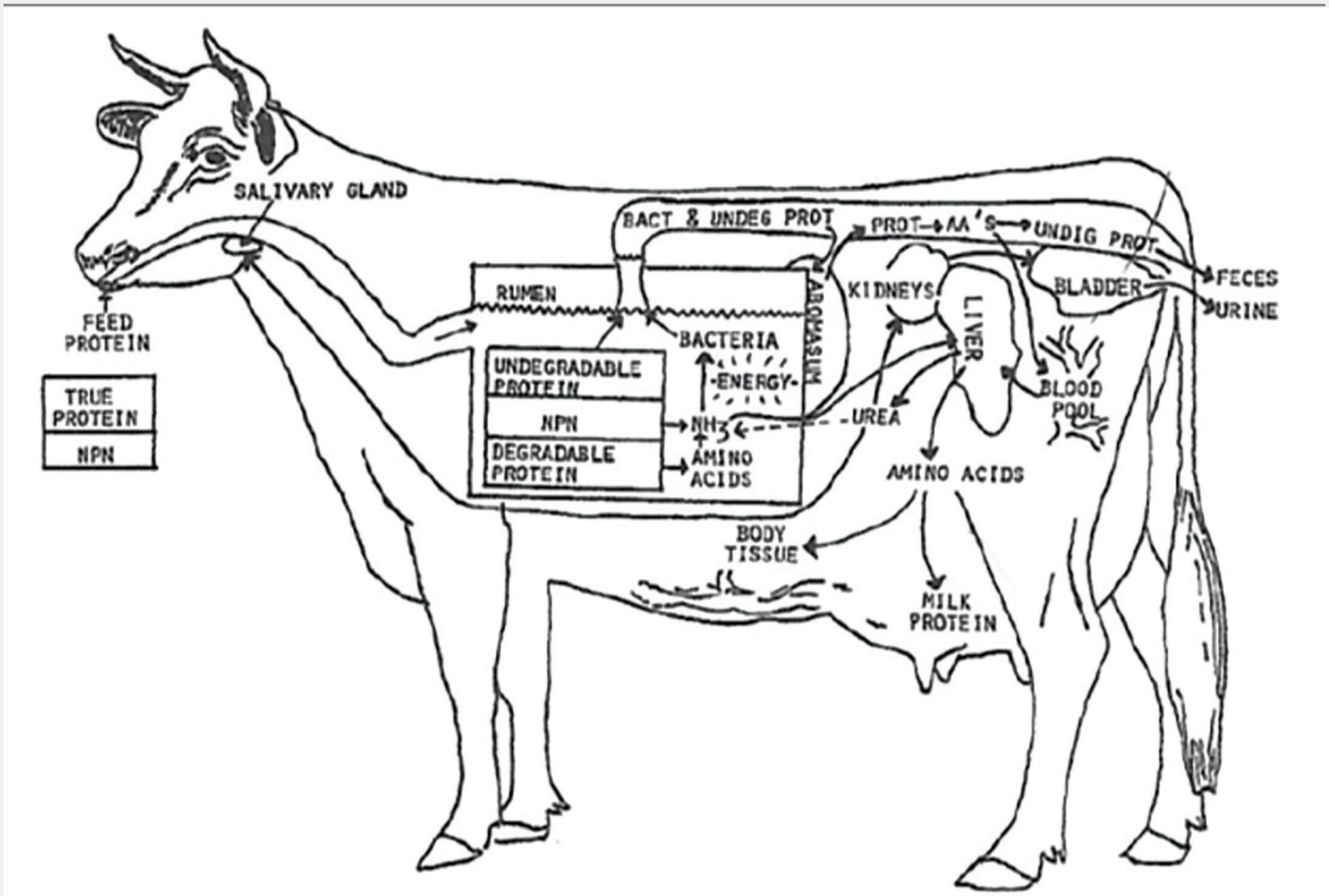
Adding fat in the form of animal fat is a common method of increasing palatability and energy content of a ration, but also for feed lubrication (flowability) and dust control. Maximum added fat is utilized in feedyard rations at 6% or less, around 2-4% for growing cattle, and minimally for reproducing animals in an effort to avoid declines in milk quality. Excessive added fat to a ration may reduce performance because of interference with energy metabolism and microbial attachment of feed particles in the rumen.[7] Although supplementing fat in rations is economical and efficient, it is less than ideal biologically compared to relying on fat from feedstuffs in the ration.

## Protein

Protein is comprised of amino acids containing nitrogen, oxygen, hydrogen and sometimes sulfur. Amino acids are referred to as the building blocks of the body as the main component of muscle, soft tissue, antibodies and many hormones and enzymes. Protein is supplied through feed protein (measured by crude protein) or non-protein nitrogen, such as urea. Protein needs are based upon the metabolizable protein (MP) system that includes protein absorbed in small intestine from microbial crude protein, undegradable intake protein, and endogenous protein.

Protein metabolism of ruminants is a complex and dynamic biological process. Unfortunately, nutritionists have also assigned the process numerous acronyms, many of which can be difficult to understand. Metabolizable protein is a term used to describe site and extent of protein digestion that is not characterized by crude protein. Two types of protein make up MP and those include degradable intake protein (DIP, also referred to as Rumen Degradable Protein [RDP]) and undegradable intake

**Figure :** Protein digestion pictorial indicating the pathway of various types of protein in a ruminant.[9]



protein (UIP, also referred to as Rumen Undegradable Protein [RDP]). Figure 3 is a pictorial of protein digestion in cattle to visually understand this process.[9] Degradable intake protein refers to protein degraded in the rumen and the subsequent nitrogen used for microbial protein synthesis. Rumen function is measured by DIP which is particularly important in cattle consuming low-quality feedstuffs where DIP will represent approximately 10-13% of daily total digestible nutrients.[8] Alternatively, UIP is protein that is not degraded by microbes in the rumen, instead degraded and absorbed in the small intestine and is available to the animal. Ruminants also have the ability to recycle urea from DIP through the liver and saliva and this can contribute to meeting the protein requirement. A balance of DIP and UIP is critical to maximizing protein metabolism, especially when cattle are receiving low-quality forage compromising ruminal fermentation.

For cattle grazing low-quality forages, protein requirement of both the animal and rumen microorganisms must be met to optimize productivity. Supplementation programs are used to close the gap in nutritional deficiency from what the forage is offering alone, and this deficiency can be protein, energy, minerals or all three. Positive associative effect is a term describing using nutrient supplementation to enhance intake of low-quality forage that is deficient in that particular nutrient. For example, if cows in mid-gestation are grazing a forage containing 5% crude protein, the cow and rumen microorganisms are likely deficient in protein. Supplementing cows with a protein source will help meet protein requirement of the microorganisms, enhancing digestibility and feed passage rate resulting in increased forage intake. Any time intake is increased, the animal is receiving more daily nutrients, also helping to meet nutrient requirements. Protein requirements of growing calves will decline with age. Typical receiving rations post-weaning will contain 16-17% crude protein and decline to around 12% in late finishing.

## Minerals

Due to the complexity of mineral interactions and antagonisms, and the plentiful published information about toxicity and deficiency, discussing each mineral in detail is outside the scope of these proceedings. From a practical feeding and management standpoint, minerals and vitamins are often quickly blamed for morbidity or mortality challenges in cattle. They certainly can be the culprit, but it's not a simple assessment. Mineral status is often influenced by other minerals and vitamins and is not as simple as measuring a single mineral in serum. Consideration should be paid to how performance or physiological status of the animal affects mineral requirements and biological mineral storage reserves.

Assessing the mineral status of a herd or individual animal should include mineral analysis of each source of nutrients (forage, complete feed, tub, block, cube, loose mineral, injectable mineral, etc.) and water. There are numerous different product options for providing mineral to cattle and they often vary in mineral quality based on mineral bioavailability. Bioavailability refers to the amount of mineral consumed that is available for use by the animal. Minerals generally come in inorganic (sulfate, chloride, oxide) or organic forms with inorganic minerals being less bioavailable and less expensive. Organic minerals are a complex, chelate, proteinate or hydroxy, and are higher quality mineral sources that are more bioavailable to the animal.[11] These may have enhanced benefits to the animal considering some forms are bound to an amino acid or other beneficial nutrients. Providing mineral in complete feed or as a supplement to meet animal requirement is critical to maximize health and productivity.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## References


1. Benchmark data.

2. Byers, FM, Schelling, GT. Lipids in ruminant nutrition. Church, DC, ed. *The Ruminant Animal, Digestive Physiology and Nutrition*. Waveland Press, Long Grove, IL. 1988; 298-311.

3. Colditz, IG. Effects of the immune system on metabolism: implications for production and disease resistance in livestock. *Livest Prod Sci* 2001; 75:257-268.

4. Galyean ML, Perino, LJ, Duff, GC. Interaction of cattle health/immunity and nutrition. *J Anim Sci* 1999; 77:1120-1134.

5. Kvidera SK, Horst EA, Al-Qaisi M, Dickson MJ, Rhoads RP. Leaky gut's contribution to inefficient nutrient utilization. *Proceedings,* Western Canadian Dairy Seminar Advances in Dairy Technology 2017; 29:137-143.

6. NRC. Carbohydrates. Nutrient Requirements of Beef Cattle. 7th ed. *National Academies Press,* Washington, DC. 1996. 68.

7. NRC. Lipids. Nutrient Requirements of Beef Cattle. 7th ed. *National Academies Press,* Washington, DC. 1996. 84-89.

8. Oklahoma State University. *Beef Cattle Manual*. 7th ed. Oklahoma Cooperative Extension Service. 2015. 135.

9. Owens, FN, Zinn, R. Protein metabolism of ruminant animals. Church, DC, ed. *The Ruminant Animal, Digestive Physiology and Nutrition*. Waveland Press, Long Grove, IL. 1988; 227.

10. Progressive Cattle. 2021 beef statistics. 2021. **https://www.progressivecattle.com/site/stats/us-beef-stats.** Accessed October 29, 2021.

11. University of Georgia Cooperative Extension. Mineral supplements for beef cattle, 2017. **https://extension.uga.edu/publications/detail.html?number=B895&title=Mineral%20Supplements%20for%20Beef%20Cattle**. Accessed June 21, 2021.

12. USDA National Animal Health Monitoring System. Beef 2017 Beef Cow-calf Management Practices in the United States, 2017. **https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/monitoring-and-surveillance/nahms/NAHMS_Beef_CowCalf_Studies**. Accessed July 21, 2021.

13. USDA National Animal Health. Feedlot 2011 Part I: Management Practices on U.S. Feedlots with a Capacity of 1,000 or More Head, 2011. **https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/monitoring-and-surveillance/nahms/nahms_feedlot_studies.** Accessed July 21, 2021.