Nutrition

By Francis H. Kallfelz

Some of our most nutritious foods come from cattle. Beef and dairy cattle are the source of hamburger, steak, milk and cheese, to name a few. Such foods are very important for human growth and health.

To insure a plentiful supply of these foods, it is of course necessary to provide optimal feed for both beef and dairy cattle so they will grow, reproduce, produce milk, etc., for the benefit of mankind. Much research has been and continues to be done to determine the best way to feed both beef and dairy cattle in order to produce food for humans.

Cattle as well as sheep, goats and deer belong to a group of animals known as *ruminants*. These animals have a digestive tract quite different from that of people, dogs, pigs and most other animals. A major difference is that the ruminant has four stomachs instead of one.

When a cow eats, the food swallowed enters the first stomach or *rumen* which is the largest of the four, containing in the adult cow a volume of some 30 gallons of mixed water and food.

The rumen is connected to the second stomach, the *reticulum*, and contents of the rumen can move freely into the reticulum and back again, through a large opening.

Forages (such as hay or silage) which are eaten by the cow remain in the *rumenoreticulum* for a considerable time period. During this time, the huge population of microorganisms present in the rumenoreticulum break down the fibrous portions of forages into smaller substances that

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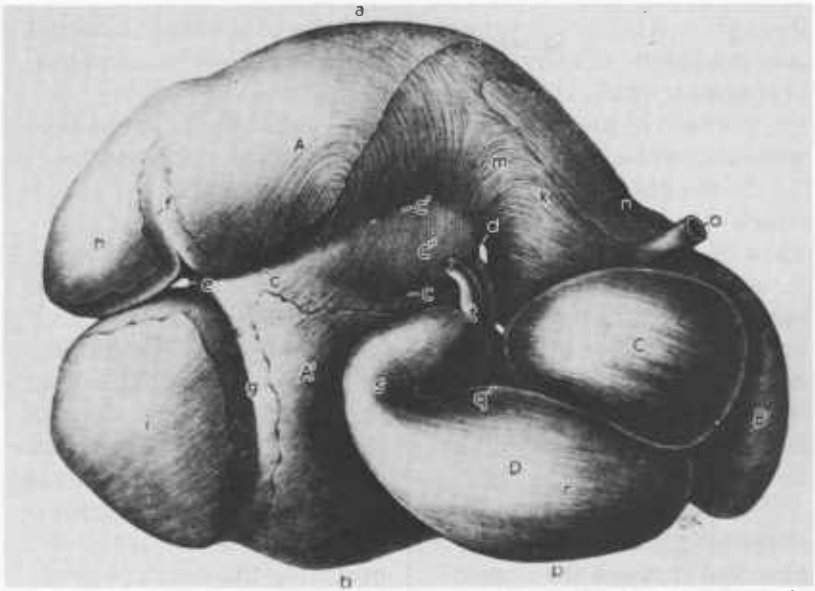

courtesy of F.H. Kallfelz

Cattle belong to a group of animals known as ruminants; the major characteristic is that they have four stomachs rather than one. a: rumen; b: reticulum; c: omasum; d: abomasum.

can be absorbed and used by the cow for growth, milk production, etc.

Besides breaking down the fiber, the micro-organisms in the rumen also synthesize (make) other substances such as protein and vitamins which subsequently can be absorbed and used by the cow.

Mixing It Up

The first two stomachs undergo periodic contractions (every minute or so) which help to mix the food particles with the micro-organisms present. Cows also chew their cuds or *ruminate*. By this is meant that small portions of the food present in the rumen are periodically brought back to the mouth for further chewing and then reswallowed. This tends to further reduce the size of food particles so that they can be more easily broken down chemically by the rumen micro-organisms.

After leaving the rumen and reticulum, the food passes through a very small tunnel into the third stomach, or omasum. This stomach is round and about the size of a volleyball. Here it is thought that water is removed from the food. The food then moves

through another small tunnel into the fourth stomach, the abomasum, which is similar to the stomach of humans and non-ruminant animals.

In the abomasum, food which was eaten but not acted upon by the micro-organisms in the rumen, substances made by the micro-organisms as well as some of the micro-organisms themselves begin to be digested and made ready for absorption in the small intestine.

While some very small chemical substances can be absorbed through the rumen wall, most absorption of broken down food occurs in the small intestine of the cow as is the case in other animals. The absorbed food is then used for such things as energy, growth, and milk production.

Because cows have rumens containing micro-organisms capable of breaking down fiber (the woody parts of plants), they can digest inexpensive feedstuffs like grass, hay and cornstalks—which cannot be digested by other animals—and convert them into foods (meat, milk) which can be used by humans. The goal of cattle farmers is to obtain inexpensive feedstuffs which provide a complete and balanced diet for their cattle in order to produce meat and milk which can be sold for a profit.

Feedstuffs for cattle include forages, concentrates, and supplements.

Forages consist of grasses, legumes, hay, corn silage, and other substances which have relatively high levels of fiber. While historically these were sufficient to supply all the needs of cattle in the wild, modern day cattle have been genetically selected for high production. Forages alone are often incapable of providing the nutrient needs of these super-efficient "food factories" since the digestibility of forages frequently is quite low.

Thus more concentrated types of feeds must also be fed in most contemporary cattle operations. The term *concentrate* really means a feed which contains more available energy per pound than is found in forages. Grains such as corn, wheat, and oats are used as concentrates.

Rations of high-producing cattle often must be supplemented as well with protein, minerals, and vitamins. Feeds such as soybeans, cottonseed, and corn gluten can be used to provide extra protein and often are included in the concentrate portion of cattle ra-

tions. Supplements containing minerals and vitamins also are frequently added to concentrates when additional amounts of these substances are needed.

The specific nutrients of ruminants, including cattle, are similar to those of other animals. Since the rumen micro-organisms can manufacture many of these nutrients, however, the rations fed depend upon the nutrient requirements of the rumen micro-organisms as well as those of the cow. Also, nutrient requirements differ with age (young as compared to adult animals), product (milk as compared to meat), level of production (high producing as compared to average dairy cows), pregnancy, and so forth.

The nutrient requirements of adult beef cattle are not too high. Good quality grass pasture or grass hay in sufficient quantity is sufficient to supply adequate levels of protein, energy, fiber, and most minerals for both pregnant and lactating beef cows.

Water, Salt

It is essential that clean water be available at all times. This sometimes can be a problem with cows on pasture during the winter when water sources may freeze. Also, trace mineralized salt should be available. If pasture or hay quality is poor, then supplementation with protein, energy, minerals, and vitamins may be needed.

Nutrient requirements of non-producing and pregnant dairy cows are similar to those of beef cattle. These animals can obtain all nutrient needs from a good quality hay, trace mineralized salt, and water.

The high producing milking dairy cow, however, has greatly increased nutrient needs. A cow producing 90 to 100 pounds of milk per day may require over five times as much protein and several times as much energy and minerals as a non-producing cow. While the lactating cow will eat more, it also is necessary to increase the concentration of protein, energy and minerals in the ration of these animals in order to provide adequate nutrient intake.

Concentrates play an important role in supplying the significant additional nutrient needs of the lactating dairy cow. A constant availability of salt and clean water also is essential. Lactating cows can require over 40 gallons of water a day.

Harry W. Oneth, USDA-SCS

Erwin W. Cole, USDA-SCS

Good grass, well-balanced feed and plenty of clean water—key ingredients for maximum growth.

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Growth Factors

The age of cattle also affects nutrient requirements. Higher amounts of all nutrients are needed during growth as compared to adult maintenance needs. Another fact is that the rumen does not begin to function until a calf is about 6 to 8 weeks old. Before this time, therefore, the calf requires a diet similar to that of non-ruminant animals, one which contains all the energy, protein, vitamins, etc., in a readily digestible form.

Whole milk, of course, is the best food for the young calf, but many milk replacer products are also available for this purpose.

After the rumen begins to function, dairy calves must be fed rations that contain all nutrients at levels high enough to support growth. With beef cattle, however, the growth period is most important since this is the time during which the meat (muscle) is formed. Therefore, the diet must be designed to promote rapid growth and formation of the right combination of muscle and fat to produce quality meat.

Growing and finishing (being readied for market) beef cattle require slightly higher protein and considerably higher energy levels than do growing dairy cattle. High levels of concentrate feeding are most often used with just enough forage included to keep the rumen functioning normally.

Growth Stimulants

Another technique that promotes weight gain in beef cattle is the use of growth stimulants. These are substances that increase the efficiency of conversion of food to muscle (meat).

For example, some antibiotics when mixed in small amounts with the feed will alter the microbial population of the rumen and intestine, resulting in improved growth and feed efficiency. Also, certain chemicals and hormones stimulate growth by altering chemical reactions in the body. These substances can be formed into pellets and placed under the skin (implanted) in growing beef cattle. The active chemicals then are slowly dissolved into the blood over several months, resulting in long term stimulation of growth.

When formulating rations (deciding upon the mixture of various feeds) of dairy or beef cattle for various functions such as growth and production, be sure the ration is balanced—that is, contains all

the necessary nutrients at appropriate concentrations. This requires a knowledge of those requirements. Such information is available in several textbooks and government publications.

One must also know what basic feeds and supplements are available for use and at what cost. Availability and cost of ingredients differ in various parts of the United States.

On dairy farms, the roughages such as corn silage or hay often are grown on the farm and hence are used as the basis of the ration. Many farmers have these forages analyzed in order to be sure of the nutrient content. The amounts to be fed daily to each animal will depend upon the number of animals, the total amount of feed available, and the number of days during which the feed will be used.

Ration Balancing

Information on nutrient content of the forages as well as how much will be fed per animal each day can then be combined to determine how much of each essential nutrient (protein, energy, minerals) is supplied by the forages to be used.

Comparing this information with the nutrient requirements allows a calculation of how much of each essential nutrient must be provided by the concentrate, protein and mineral supplements, etc. This procedure is known as ration balancing. This can be done by hand; however, today many computer programs can also be used for this purpose.

Frequently, in feedlot situations where finishing cattle are fed, purchase of all feeds is necessary. In this case a "least cost" approach often is used in balancing rations. That requires considering costs of the available feeds as well as their nutrient content.

While least cost ration balancing is complex, computer programs are available which can be used to formulate a balanced ration by using the most economical combination of the feeds and supplements available. The least cost technique also can be used to balance rations for dairy cattle and other animals.

When, for any number of reasons, balanced rations in adequate amounts are not fed, nutritional disease results. Both underfeeding and overfeeding of any or all essential nutrients can result in disease problems.

Starvation Syndrome

Failure to provide adequate amounts of nutrients in general results in various degrees of starvation syndrome. In animals that are mildly underfed, a slightly decreased growth rate may be the only sign in growing cattle, with decreased production seen in adults.

Moderate underfeeding will result in a significant decrease in size compared to age in young animals, and decreased production and weight loss in adults. Severe underfeeding results in weight loss and eventual death in both young and adult animals.

Overfeeding of a balanced ration results in overconditioned cattle which can also result in disease problems, particularly at and shortly after calving.

Individual nutrient deficiencies can result in specific diseases in both beef and dairy cattle. For example, a frequent problem in beef cattle on pasture in the winter is *hypomagnesemic tetany* or *winter tetany*.

This disease is the result of low blood magnesium levels caused by too little magnesium in the diet, and is most common in beef cows with nursing calves. Signs of the disease include nervousness and a stiff gait progressing to falling down, paddling, and convulsions. Death occurs within a few hours of the onset of convulsions. Sometimes cows are just found dead in the pasture.

Treatment of affected animals must be accomplished quickly by intravenous administration of magnesium and calcium.

A similar disease known as *grass tetany* can occur in beef or dairy cattle on lush grass pastures in the spring. The disease can be prevented by insuring adequate intake of magnesium.

Grain Overload

Overfeeding of specific dietary ingredients can cause serious disease problems. Grain overload is a common disease of this type in feedlot beef cattle. Micro-organisms of the rumen in cattle fed forage are adapted to breaking down fiber. Feedlot cattle must be slowly changed to a high concentrate ration which contains high levels of starch and sugar. When too much grain is fed to unadapted cattle, the starch and sugar is broken down to acids.

The consequences of this are many, including overdistention of the rumen with fluid, dehydration of the ani-

mal, death of the rumen wall, founder, severe metabolic changes, and death of the animal. A similar problem can occur in dairy cattle if they suddenly consume large amounts of grain. This disease can be prevented by slowly increasing the concentrate intake so that micro-organisms in the rumen can adapt to breaking down starch and sugar rather than fiber.

Salt Deficiency

Disease problems as a result of improper nutrition also occur frequently in dairy cattle. One problem related to undernutrition is salt deficiency.

Dairy cows producing large amounts of milk can require a quarter of a pound or more of salt per day. Forages and grain contain very low levels of salt, so it is essential to add it as a supplement.

When balancing rations, farmers and feed dealers sometimes fail to consider the salt requirement and this results in salt deficiency. Symptoms include a severe drop in milk production, loss of body weight, and a significant increase in water consumption and urine production.

This condition can be treated and prevented by being sure sufficient salt is added to the ration. Also, since cattle needing salt will develop a hunger for it, having salt available free choice is a good management practice. However, this does not hold for other minerals; cattle deficient in calcium, for example, will not necessarily consume a calcium supplement made available free choice.

Overfeeding of calcium can be a problem in dairy cattle. While calcium is required at high levels during lactation, much lower levels are needed during late pregnancy after milk production has ceased (the dry period). During this time, dairy cows are fed mainly forages but some of these can contain high levels of calcium—resulting in overfeeding of this nutrient.

Milk Fever

When the cow gives birth, milk production begins again and large amounts of calcium are needed for this. During early lactation, much of the calcium is obtained by removal from bone. Overfeeding of calcium in late pregnancy causes the bone to become resistant to calcium removal. Thus when milk production begins, blood calcium levels quickly fall, resulting in a disease called parturient hypocalcemia or milk fever.

The cow becomes very

Murray Lemmon, USDA

Salt that is readily available will eliminate the risk of undernutrition due to salt deficiency.

weak and usually is found lying down with the head turned into the flank. Her body temperature is low and skin cold. The pulse is rapid but weak.

Cows with milk fever are treated by intravenous and subcutaneous administration of calcium which often results in rapid and complete recovery. To prevent the disease, carefully control calcium level of the diet of cows in late pregnancy to avoid overfeeding.

Most nutritional disorders are classified as metabolic diseases. Such problems are the result of abnormal metabolism (the term *metabolism* meaning the chemical reactions occurring in the body) rather than being caused by bacterial or viral infections.

Ketosis

Metabolic diseases can cause serious losses in both beef and dairy cattle. In addition to winter tetany, grain overload and milk fever, which have

just been described, another very common metabolic disease is ketosis.

After calving, milk production in the dairy cow increases rapidly. Feed intake also increases but, frequently during the first few weeks of lactation, not rapidly enough to provide all the nutrients needed for milk production. In such cases, the cow can become energy deficient.

The blood sugar level falls and the cow begins to break down body fat to meet the energy demands of milk production. If the fat is not efficiently utilized, small breakdown products of fat called *ketones* are formed and the blood level of these ketones can become quite high. The ketones affect the cow in such a way that she reduces her feed intake, and milk production falls.

Treatment of this disease (ketosis) involves intravenous administration of sugar and other techniques to improve feed intake and thus provide the extra energy needed for milk production.

Of course if the cow becomes sick for some reason and stops eating as much as she should, ketosis may be a result. Another metabolic disease in which ketosis frequently is a problem is *displaced abomasum.*

The abomasum is located on the right side of the cow and sits on the floor of the abdomen (the space containing the stomachs, intestines, etc.). It is attached at the front end to the omasum and at the back end to the small intestine. The mid-portion of the abomasum is not held rigidly in place by other structures; however, the weight of material within it usually keeps it in place on the floor of the abdomen.

Sometimes, however, when metabolism of the stomach is abnormal, the abomasum slides under the rumen, becomes partially filled with gas, and rises on the left side between the rumen and the body wall. This causes the cow to feel sick and stop eating, and she develops ketosis. In this condition, if one thumps the left side of the cow (behind the ribs) while listening with a stethoscope, a high-pitched ping (from the gas-filled abomasum) can be heard.

Treatment for this condition involves rolling the cow onto her back to get the abomasum back into its normal position or performing surgery to fasten the abomasum in such a way that it is no longer free to move.