MP427

Nutrition of Meat Goats

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Introduction

Feed costs account for 60 to 70 percent of the cost of raising and keeping livestock. Poor nutrition is a leading cause of poor performance in milk production, growth, and reproduction. Poor nutrition can also lead to metabolic diseases and can weaken the goat's immune system so that bacterial or viral diseases flourish. To keep costs low, it is important to manage nutrition carefully to maintain health and improve production to increase profitability.

What Are Nutrients?

Nutrients are chemicals the goat needs to maintain itself and carry out basic functions. These chemical compounds fall into five basic categories: carbohydrates, protein, lipids, minerals, and vitamins. Each one has different characteristics and meets specific needs.

Carbohydrates

Carbohydrates are the primary energy sources. Carbohydrates are sugars or chains of sugars bonded together to make more complex structures like cellulose. Goats are not able to break down cellulose. However, goats and other ruminant animals have large populations of bacteria that live in their digestive system that can break down cellulose and generate energy. Goats get their energy from the products of bacterial fermentation and from the sugars that manage to pass through the rumen into the lower digestive tract.

Proteins

Proteins are a critical part of a goat's balanced nutrition. Proteins are made up of long chains of smaller chemicals called amino acids. A special feature of amino acids, and therefore protein, is they contain nitrogen. Proteins are used to build muscle tissue, are part of the immune system, and carry out metabolic processes using special proteins called enzymes. Proteins also serve as hormones which signal the goat's body to grow and reproduce. If proteins are overfed, the goat will simply break them down and use them as another energy source.

Lipids

Fats and oils belong to a class of chemicals called lipids. Lipids do not dissolve in water like the other nutrients. Fats and oils are an especially potent energy source. They contain 2.25 times as many calories per gram as carbohydrates or proteins. Fats and oils are important for repairing cell membranes. They can act as building blocks for certain kinds of hormones, which is important for steroid hormones involved in reproduction.

Vitamins

Vitamins are a special class of nutrients required in very small amounts. They come in two basic types: those that dissolve in water and those that dissolve in lipids. The vitamins that dissolve in water are important in the metabolic processes. The ones that dissolve in lipids are important in the maintenance of the skin, teeth, hair and bones, and in reproduction.

Minerals

Minerals are different from the other nutrients. The other nutrients are chemical compounds made up of several different chemical elements, especially carbon. Minerals are individual chemical elements and do not contain carbon. They are found in the ash component and are listed on the feed tag. Minerals are used to build teeth and bones, carry oxygen in the blood, and in many metabolic processes.

Like vitamins, there are two classes of minerals: macrominerals and microminerals. Macrominerals are minerals that are needed in fairly large quantities including salt, which is made up of sodium and chloride, calcium, phosphorus, magnesium, and sulfur. Calcium and phosphorus should always be fed in a 2:1 ratio, with twice as much calcium as phosphorus in the diet.

Microminerals are also called trace minerals because they are needed in trace amounts. Copper, selenium, iodine, zinc, and manganese are examples of trace minerals. Trace minerals should be included as part of a commercial mineral supplement. It is very easy to provide too much or too little when feeding trace minerals. Over- or underfeeding trace minerals can cause metabolic disorders. Many times, the signs of a lack of a trace mineral in the diet are very similar to the signs of feeding too much trace mineral in the diet, making diagnosis difficult.

Water

Water is the most frequently overlooked nutrient in a diet. Goats need an average of one-half gallon to one gallon of fresh, clean water per day. The amount of water goats need each day varies due to many factors: temperature, humidity, wind, activity level, growing or lactating, and more. For these reasons, goats should have access to clean drinking water at all times without restriction.

Where Are Nutrients Found?

Nutrients are found in feed. But some feeds provide more of one kind of nutrient than others. Feeds can be classified as roughages, concentrates, protein supplements, and mineral supplements.

Most of a goat's needs will be met by a roughage feed. These include grasses and hay, forbs, which are broad-leaved but not woody plants, and browse, which is from woody plants. Roughages are higher in fiber than other types of feeds, usually a minimum of 18 percent crude fiber or more. Fiber is critically important to good rumen function. The rough feed particles stimulate rumen movement and improve digestion.

Roughages provide carbohydrates that are digested slowly. Many forbs and browse species, as well as young grasses, are surprisingly high in protein. They also provide many, but often not all, of the required minerals. This is especially true for mature bucks and does not producing milk nor in the last trimester of pregnancy.

Energy tends to be the most limiting nutrient in a goat's diet. Concentrates are high-energy feeds that contain less than 18 percent crude fiber, more than 70 percent total digestible nutrients (TDN) and less than 20 percent crude protein. Most concentrates are grains such as corn, oats, barley, wheat, and rye. Lipids are also concentrates because they are very high in energy, with over 70 percent TDN and 2.25 times more energy per gram than carbohydrates.

Concentrates are usually fed to rapidly growing, young kids to provide enough energy for optimum growth. Concentrates are also fed to does during the last trimester of pregnancy and during the first third of lactation to meet the needs of fetal growth and milk production, respectively. Be careful to keep the amount of concentrate feed to no more than 1 percent of the goat's body weight. Higher levels of concentrate feeding can cause digestive and urinary tract problems.

Protein supplements are feeds having more than 20 percent crude protein. Common sources of natural protein include soybeans and soybean products, cotton seeds and their byproducts, and dried brewer's or distiller's grains. Corn gluten meal is also high in protein. Alfalfa and clover hay can serve as protein supplements if they are of good quality.

Protein supplements can include nitrogen sources that are not found in a protein, like urea, as a way to boost protein in the diet. These nitrogen sources are called nonprotein nitrogen. The bacteria in the rumen are able to synthesize the nonprotein nitrogen into usable protein.

Mineral supplements are mixed by feed companies to meet the needs of goats as closely as possible. Therefore, use a commercial goat mineral mix and only provide individual supplements if signs of a deficiency are observed. A trace mineralized salt supplement should be provided free choice at all times of the year to allow for adequate consumption. Loose mineral supplements are preferred because goats often do not consume enough of a block-type mineral to meet their needs.

One mineral deserves special mention: copper. Many producers want to know how much copper their goats need while at the same time avoiding copper toxicity. Unfortunately, research has not established a minimum requirement for copper in goats. Goats are able to tolerate as much or more copper in their diets than cattle. The current recommendation is a cautious one of no more than 18 milligrams per pound of dry matter feed (see page 8 for an explanation of dry matter).

If goats are not consuming enough copper, they can experience anemia. Kids from does that do not get enough copper during the last trimester of pregnancy can be born weak and unable to stand. This is because the myelin sheathing around the nerves in the brain does not grow properly. Another symptom includes staggering between one and two months of age because of a similar myelin problem which affects the spinal cord.

Copper is stored in the liver. If a goat gets too much copper over a prolonged period, or gets a very high dose quickly, the liver begins to die. More copper is released into the blood from the liver stores. The red blood cells begin to rupture and the goat dies. Copper toxicity happens so quickly that there is usually nothing you can do.

Vitamins are very rarely a concern for ruminant animals. All of the B vitamins, vitamin C, and vitamin K are produced by bacteria in the rumen. On occasion, vitamins A, D, and E may be in short supply. If goats are not consuming good quality hay or are not grazing quality forage, these vitamins may end up in short supply. Selenium and vitamin E work together and can substitute for each other to a certain extent if one or the other is in short supply.

Introduction to the Digestive System

Goats are ruminant animals, meaning they have one stomach with four compartments: rumen, reticulum, omasum, and abomasum. Bacteria and other microorganisms in the rumen and reticulum possess the cellulase enzyme that breaks down cellulose to simpler carbohydrates, which goats use as an energy source. The microbes also produce volatile fatty acids, which are absorbed in the rumen and used to make glucose, an important sugar, and fatty acids in the liver.

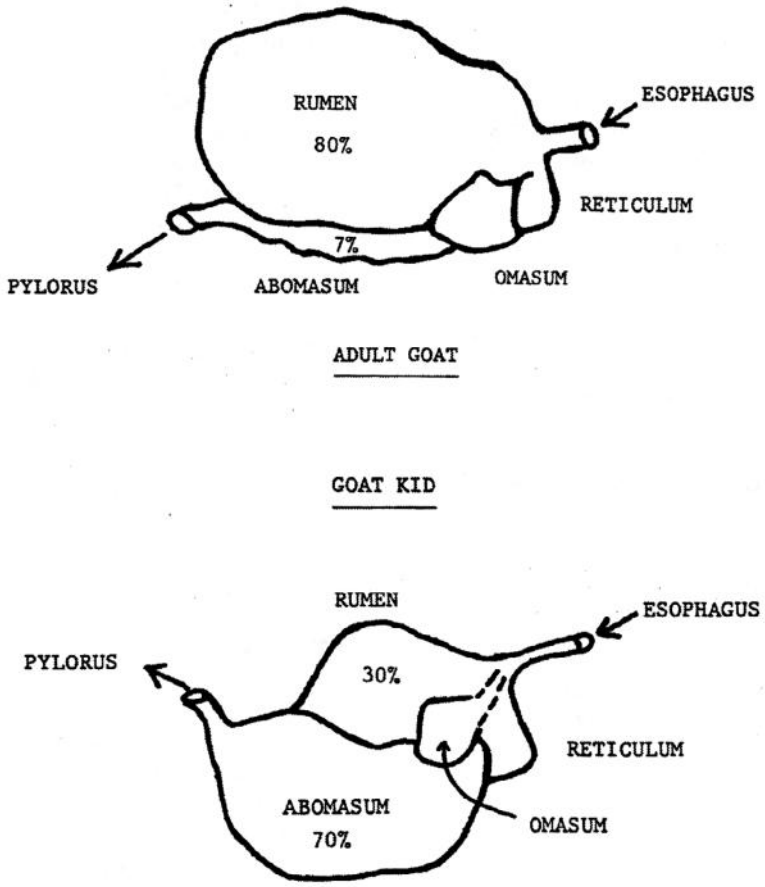
Feed is regurgitated so the goat can rechew it periodically to reduce the size of the feed particles. This is commonly referred to as chewing cud. One of the more important things about cud chewing is that it makes the goat salivate. The saliva contains bicarbonate, similar to baking soda, which helps keep the pH of the rumen near neutral. This is one of the reasons fiber in the diet is important; it causes more cud chewing and helps the rumen pH stay balanced.

Once the feed particles have become very small, they sink to the bottom of the rumen and reticulum and enter the omasum. In the omasum, much of the water in the digested material is absorbed. The feed and rumen bacteria pass into the abomasum, which functions as the true stomach. The abomasum secretes digestive juices (acids and enzymes) similarly to the simple stomach in non-ruminants such as humans and swine. Rumen bacteria are a major source of protein for grazing goats.

When a goat kid is born, the abomasum is functional, but its rumen, reticulum, and omasum are small and nonfunctional. The kid depends on low fiber milk, not forage, for its source of nutrition. When the kid swallows milk, the milk goes directly to the abomasum through the esophageal groove. Every time the kid swallows, this flap of tissue at the entrance to the reticulorumen folds over to form a groove that bypasses the reticulum and rumen. This diversion sends the milk directly to the abomasum to be digested by stomach acids.

As the kid gets older, usually about 10 to 12 weeks of age, it starts consuming forage. The process can be sped up by providing creep feed, which is a mix of easily digested concentrate and protein supplements. Creep fed kids also grow faster. Kids often chew forage earlier than this, but they are teething, not chewing their cud or eating forage. The rumen with its microorganisms becomes active and starts to enlarge. Its population of microorganisms increases, which slowly and more efficiently allows it to digest forages. The reticulum and omasum also respond to the changes in diet by getting bigger. By the time the kid is an adult goat, forage is the main source of food, and the rumen is much larger than the abomasum.

Feed continues its passage from the abomasum to the small intestine. The small intestine is where digestive enzymes break down the complex chemicals in feed into very small, simple chemicals that can be absorbed in the small intestine. Whatever is left of the feed reaches the large intestine, water is absorbed and the digesta is processed into feces.



The four stomach compartments of young and adult goats, showing relative changes in dimensions from pre-ruminant status. *Drawing courtesy of D.L. Ace, Pennsylvania State University.*

What Are My Goat's Needs?

A goat's nutritional needs change throughout the year because different demands are placed on its body as it grows, matures, mates, kids, and raises kids. These changes in the demands placed on the goat are parts of the production cycle. By following the production cycle through a typical year, the goat's nutritional needs can be examined.

Birth

A newborn kid should be up and sucking within 30 minutes of birth. Some kids will take a little longer than others, so don't become overly concerned unless the weather is very cold. Kids should consume colostrum, the first milk produced by the doe, preferably within the first 6 hours of its life and certainly within the first 12 hours. Colostrum is rich in antibodies and higher in fat and protein than normal milk. Antibodies are proteins which help the body fight diseases. The amount of antibodies and the kid's ability to absorb antibodies in the colostrum decrease rapidly after birth.

The kid's ability to resist disease is greatly affected by the quality, quantity, and timing of colostrum intake. It's a good idea to freeze good quality colostrum from an older, healthy doe in small amounts (4 to 6 ounces) for later use in case a doe dies or a kid cannot nurse. Frozen colostrum should be thawed at approximately 100° to 120°F and fed at about 100°F. Boiling will destroy the proteins that make up the antibodies.

Most meat goat kids will nurse their doe until they are weaned at 2 to 6 months of age. However, some does may not produce enough milk for their young throughout lactation, especially if they are raising more than one kid. If milk replacer is necessary, it should contain at least 5 percent fat and 20 percent crude protein.

Growing kids need roughly the same amount of energy and protein as their dams, yet they are only half the size. After the first 8 weeks of life, more of this energy needs to come from a feed source other than milk. Does' milk production drops quickly after the first 4 weeks. If the pastures are lush and growing rapidly, the pastures should be able to meet the kids' growing needs. If not, provide what is called a starter ration.

Starter rations are special concentrate rations designed to be very easily digested. Grains in starter rations are usually finely ground, easily digested protein supplements, and often molasses is mixed in to reduce dust and improve palatability. Keep the starter ration fresh by replacing it regularly. Do not be concerned if the kids seem disinterested or do not eat much at first. Kids will begin experimenting with it at first then begin eating it frequently. Put the starter ration somewhere does cannot access it, such as a creep feeder.

Growing and Weaning

If the kids are raised on a starter ration, they can be weaned as early as 8 to 10 weeks of age. Weaning at 12 to 16 weeks of age is more common, especially for kids not creep fed. Some producers do not actively wean their kids. Instead, they let the does wean the kids naturally. When you choose to wean depends upon your management goals and your farm system.

Once they are weaned, continue feeding the kids a grain-based growing ration or raise them on pasture. Grain fed kids grow faster and are ready for sale sooner, but too often the improved growth does not offset the higher price of the feed. Calculate the cost and the selling price expected to see if grain feeding will be profitable.

Breeding

As goats approach the breeding season, they should be in good body condition, neither too thin nor too fat. Underweight and overweight goats have difficulty breeding and becoming pregnant. They should have a body condition score of three on a scale of one to five, with five being obese and one being emaciated. See FSA9610, *Body Condition Scoring*

Creep feeders allow you to provide extra energy and protein to growing kids without competition from their dams. *(Image courtesy of Sydell, Inc., www.sydell.com)*

of Sheep (http://www.uaex.edu/publications/PDF/FSA-9610.pdf), for more details on how to body condition score goats. The process is the same for sheep and goats.

If goats are underweight, improve breeding season success by flushing goats. Flushing is the practice of providing supplemental feed from concentrates to boost energy intake. Provide one-half to three-quarters of a pound of concentrate per head per day to flush underweight does. Flush for 10 to 14 days before the breeding season begins. Once the breeding season begins, stop flushing. There is some evidence that the high energy intake creates a uterine environment that is hostile to the developing embryo, reducing pregnancy rates.

Remember to increase the bucks' feed, too. Bucks are often forgotten in supplemental feeding programs. Breeding requires plenty of energy. Bucks often do not eat as much as they need during the breeding season because they are distracted by seeking and mating does. Do not overfeed breeding bucks. Obese bucks can have trouble mating, and they can be less fertile than normal-weight bucks. It is a good idea to have a breeding soundness exam conducted on the buck by a veterinarian 30 to 60 days prior to breeding.

Dry Period

The dry period refers to the period of time when does are not nursing kids or lactating. This period usually begins in early summer when kids are weaned and proceeds until just before the breeding season. It picks up again after flushing is over and continues until the last trimester of pregnancy. During the dry period, the adult goats' nutritional needs are at their lowest. There are few demands on their bodies and they are regaining any weight lost from nursing kids (see Lactation, page 8). Good quality pasture, especially if it has preferred browse species, will adequately meet the goats' needs during this time. A salt and mineral supplement should always be available.

Late Pregnancy

During the last 50 days of pregnancy, the last trimester, the does' nutritional needs grow dramatically. Between 70 and 80 percent of fetal growth happens during this period. That means an 8-pound kid at birth grows from 1.6 to 8 pounds in that 50 days, an increase of 6.4 pounds, or four times its size! All of the building blocks for this growth, plus the energy it takes

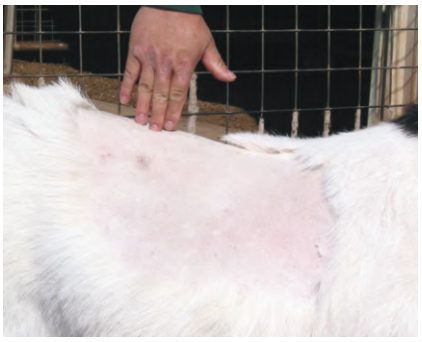
Body Condition Scores (BCS) of Goats

BCS 1. Weak and bony. You can fit your fingers between the bones of the backbones and rib bones. No fat and little muscle.

BCS 2. Slight fat cover on the ribs, but you can still see and feel the backbone and spaces between the ribs.

BCS 3. The backbone is visible, but does not stand out. You must press firmly to get your fingers between the ribs and they have a moderate covering of fat.

BCS 4. The backbone and ribs cannot be seen. The ribs are sleek and the bones can barely be felt under a layer of fat.



BCS 5. The backbone and ribs are so deeply covered in fat as to not be seen or felt.

Images courtesy of Dr. Roger Merkel, Langston University

for a fetus to grow and maintain itself, must come from the doe. Her energy needs will be nearly double, and her protein requirement will increase by almost 250 percent, but she will not be able to eat more than she did during early pregnancy. Why? The increased size of the fetuses, fetal membranes, and uterus takes up much space in the abdomen. Therefore, there is not enough space for more feed in the rumen.

Does are typically in late pregnancy during the winter, meaning high quality hay is required. Average quality hay will not contain enough nutrients to sustain the doe and fetal growth. If the doe is fed average or low quality hay, the doe will begin to lose body condition. Avoid this problem by supplementing concentrates. Add concentrates to their diet slowly to prevent acidosis and grain bloat. It may be necessary to provide up to a pound of concentrate per head per day to meet the needs of late pregnancy and a protein supplement as well, depending upon the protein content of the hay. Forage test the hay to determine the protein and TDN content so a cost-effective supplementation feeding program can be determined. For more information on forage testing, contact your local county extension agent (http://www.uaex.edu/counties/default.aspx).

Lactation

Once the kid(s) are born and the doe is producing milk, her nutritional needs make another dramatic jump. In fact, milk production in the first 6 to 8 weeks is such a nutritional drain on does they generally will lose weight no matter the feeding program. This is normal, and they will regain the weight as their milk production drops later in the season and after the kids are weaned. Not only do her energy and protein demands go up, but her calcium requirement will be nearly six times as high as her maintenance requirement, and her phosphorus needs will increase by more than four times.

Fortunately, as lactation progresses and milk production falls, requirements fall as well. As the kids get an increasing proportion of their nutrition from plant sources, does will regain condition and fill back out.

How Do I Meet My Goat's Needs/How Do I Balance a Ration?

Goats tend to eat 2.5 to 3 percent of their body weight in dry matter (DM) each day. So a 100-pound doe will eat about 2.5 to 3 pounds of DM per day, and a 150-pound doe will eat about 3 to 4.5 pounds of DM per day.

Dry Matter

Dry matter (DM) is what is left in a feed after the water is removed. Dry matter includes the portion of the feed that is made up of carbohydrates (energy source), protein, lipids (more energy), vitamins, and minerals. Dry matter is used to compare the nutrient quality of feeds that have different water content. Once the feed comparisons are made, convert the DM feed back to "as fed" basis, which involves calculating the feed needed with the water in the feed included.

Total Digestible Nutrients

Total digestible nutrients (TDN) is a measure of the amount of energy in a feed. It is measured as a percent of the DM in the feed. TDN is calculated using the energy value of the carbohydrates, proteins, and fats in the feed. Digestible energy (DE) is a more accurate method of measuring the energy in a feed and is becoming more common. Digestible energy is calculated by subtracting the energy left in the manure from the total energy in the feed. Digestible energy is usually measured in megacalories per kilogram (Mcal/kg) or per pound (Mcal/lb).

Crude Protein

Crude protein (CP) really measures the amount of nitrogen in a feed. Nitrogen is the chemical element that makes a protein different from carbohydrates. Because nitrogen is much easier to measure, it is used as a substitute for actual protein. The bacteria in the rumen of goats can add nitrogen to carbohydrates to make protein. Some manufacturers take advantage of this ability by including cheap, nonprotein nitrogen (NPN) sources, like urea, in the feed to boost protein content without greatly increasing the cost of the feed. Feed labels in Arkansas are required by law to report both CP and nonprotein nitrogen levels in the feed.

To balance a ration, it is usually least expensive to start with pasture or hay. Calculate how much TDN and CP is available in the amount of feed they are consuming from the pasture or hay. Compare that to the amount of each nutrient the goat needs. Sometimes substituting a concentrate for some of the roughage will be necessary and, in some cases, adding a high oil or fat supplement to the diet to raise their energy intake. But high-fat diets can cause digestive problems in ruminants. The current recommendation is to keep added fats below 5 percent of the diet to avoid problems. Because concentrates are often

low in CP (corn is only 9 percent CP), adding a protein supplement may be necessary.

Finally, make sure the goats' calcium and phosphorus needs are met. The ratio of calcium to phosphorus should be at least 2:1. Most concentrates have very high phosphorus levels and very low calcium, the exact opposite of what you want. Calcium supplements, like feed-grade lime and dicalcium phosphate, can be topdressed on feed or mixed in thoroughly.

The goat's nutritional requirements based on its stage of the production cycle and its productivity are listed in the National Research Council's (NRC) book, *Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids and New World Camelids*. Some of the more common requirements are provided at the end of this publication. The nutritional values of many feeds are also listed in the NRC's book. For a step-by-step guide to ration balancing see FSA9613, *Balancing Rations for Sheep and Goats* (http://www.uaex.edu/publications/pdf/FSA-9613.pdf).

Metabolic Disorders Caused by Poor Nutrition

Poor nutrition will not only slow the rate of gain of growing kids, decrease milk production, and make pregnancy and twinning less likely, but can also cause metabolic disorders that threaten the lives of goats. While the disorders listed below are not a complete list of potential nutrition-related problems in goats, they are among the more common ones.

Likewise, goats that are fed a high-concentrate diet or that get into the feed bin and gorge on high-energy feeds can suffer from metabolic diseases.

For additional information regarding these nutrition-related problems, treatment, or other information, contact your local veterinarian.

Acidosis

Acidosis results because starch in the feed is rapidly converted to lactic acid by rumen microorganisms. Lactic acid causes the pH of the rumen to drop rapidly. In mild cases, goats will simply stop eating for a brief period, no more than a day. In fact, goats may exhibit an on-again, off-again feeding pattern. They will eat one day and not the next because of chronic mild acidosis. Reducing the amount of grain and increasing the roughage in their diet will likely end the problem.

In the case of a sudden grain overload, such as a goat that gets into the feed bin and gorges itself on feed, acute acidosis may cause a severe reaction. Goats will go off feed and have difficulty standing or walking. The rumen will become less active and may stop moving altogether. The affected goat will feel cool and have a lowered body temperature. Many times, the goat will die before a problem is realized.

Enterotoxemia

Enterotoxemia, also called overeating disease, is caused by a sudden bloom of bacteria in the small intestine. *Clostridium perfringins* Type C and D are bacteria that occur naturally in the intestine of goats. But a sudden increase in concentrates causes them to reproduce rapidly and release a toxin into the intestine. Goats suffering from enterotoxemia may be excitable and have diarrhea. Animals affected often die quickly, so no other signs of a problem than a dead goat are observed. Vaccinate the herd against enterotoxemia. Remember to increase concentrates in your goats' diets gradually.

Bloat

Bloat can be caused by grain overload or by certain types of high-protein diets. Bloat is a serious condition that can kill goats in as little as an hour. Often, the only sign of bloat is a dead animal.

Methane and hydrogen gasses are normal byproducts of fermentation in the rumen. Normally, the gas accumulates above the feed and fluids in the rumen and exits when your goat burps. Under certain conditions, proteins from plants can form tiny bubbles around these gasses, trapping them in the rumen. Oftentimes swelling on the left side of the animal is noticeable. If you firmly tap on the swelling, it will sound like a drum.

Grain bloat, as it is often called, is caused by sudden, rapid grain consumption. The pH of the rumen drops and rumen motility falls. This causes gas to build up in the rumen because regurgitation does not occur. As the gas builds up, the increasing pressure on the rumen reduces its motility further.

Pasture bloat is a common form of bloat. Goats grazing pastures with high-protein forages, such as legumes, are more likely to suffer from bloat. Some common legumes in Arkansas that are more apt to cause bloat include alfalfa, white clover, and Persian clover. Here are a few management practices to help prevent bloat:

- Ensure pastures with high legume content are mixed well with grasses.

- Do not graze when pastures are wet from dew or rain.
- Do not turn hungry goats out on pastures with high legume content.

The worst-case scenario is turning out goats on a high-legume pasture when they are hungry, the pasture is wet from dew or rain, and the goats are not acclimated to the forage. It is important to slowly introduce the goats to high-protein forages. This can be accomplished by turning the goats out on the pasture after they are full from hay or another pasture to prevent them from gorging and by only allowing them to graze the legume pasture for short periods of time for a few days before leaving them on the legume pasture. Other legumes that have been noted to cause bloat but are less likely to cause bloat include brassicas and vegetative wheat.

Condensed tannins can reduce the potential for bloat by binding other proteins and slowing the rate of digestion. Some legumes that are high in condensed tannins include forage types of lespedeza – annual (Korean and Kobe) and sericia. For more information, refer to FSA3050, *Forage Lespedeza* (https://www.uaex.edu/publications/pdf/FSA-3050.pdf).

Grass Tetany

Grass tetany is a common problem usually seen in the early spring grazing season. It is caused by low levels of magnesium. Sheep and cattle are more susceptible to grass tetany than goats. Goats with grass tetany exhibit a staggering gait, followed by paddling or swimming, convulsions, and death. Often the only sign is a dead animal.

Magnesium is critical to nerve signaling and muscle contraction. If magnesium levels in the blood fall below normal levels, neurological and muscular signs can result. Potassium interferes with magnesium absorption in the digestive tract of livestock. Rapidly growing grasses, especially small grain pastures like wheat or rye and ryegrass, tend to be high in potassium. Pastures that have been fertilized with potash will also have higher potassium levels in the plants. Early lactation and late pregnancy drain magnesium and other minerals from goats.

Grass tetany can be prevented by limiting the amount of time the goats graze fresh pasture. Allow them to eat their fill of hay before turning them out on fresh green pasture. Providing special high-magnesium loose mineral for 2 weeks, so their magnesium levels are adequate at turnout, will help prevent grass tetany. A high-magnesium mineral is not very palatable to livestock; therefore, remove all other salt blocks from the pasture so they consume enough of the high-magnesium mineral. Another suggestion is to mix loose magnesium mineral with molasses or ground corn to aid palatability and consumption.

Other ways to help prevent grass tetany include improving the legume content in pastures and maintaining optimum soil phosphorus levels. If the soil is deficient in phosphorus, the plants cannot pick up as much magnesium.

Ketosis

Ketosis, which is also called pregnancy toxemia, usually happens during the last trimester of pregnancy. Pregnant does often cannot consume enough energy to meet the needs of their own bodies and their growing fetuses. Their abdomens are filled with a pregnant uterus that is expanding rapidly, and feed quality is usually lower in the winter when most does are pregnant. Does begin to mobilize their fat stores to meet their energy needs.

To generate energy from her fat stores, a doe still needs a certain amount of blood sugar. If she does not get enough energy from her feed, ketones created during fat metabolism build up to toxic levels. The doe stops eating, which only makes matters worse. She will become lethargic, have difficulty walking, grind her teeth, and eventually go down. Her breath will smell sweetish or foul because of the ketones in her blood. Finally, she will lapse into a coma and die. Once she goes down, the likelihood she will recover drops dramatically.

Prevention is the key to pregnancy toxemia. Does most likely to suffer from the condition are fat and carrying twins or triplets. Usually, the older females are more susceptible to pregnancy toxemia than the younger ones. Very thin females are also at risk, but because they often have less fat to mobilize, they are less likely to suffer from the condition. Make sure does are in good condition (3.5 on a scale of 1 to 5) but not overconditioned.

Hypocalcemia

Hypocalcemia, or milk fever, is caused by a sudden drop in calcium levels in the blood. Calcium is critical for muscle and nerve activity. Without enough calcium in her blood, a doe will become lethargic, have muscle tremors and difficulty walking, or go down. In the past, based on research in dairy cows, producers were told to reduce calcium intake shortly before kidding to maximize calcium uptake from the digestive system when their does kidded. More recent research debunks this recommendation. Always provide adequate calcium in the goat's ration.

Urinary Calculi

Calcium deficiency or imbalance in the ration is also involved in urinary calculi. Calcium in the diet should be twice as high as phosphorus. But grains can have 40 times more phosphorus than calcium. When the phosphorus level in the total diet exceeds the calcium level, the phosphorus can combine with magnesium in the bladder to form stonelike crystals. The crystals get stuck in the urethra, which is the passage from the bladder to the outside world. The problem is more common in males, especially wethers, because the urethra is much longer and narrower than in the doe. It also makes three s-shaped bends where the stones get stuck.

Urinary calculi is a critical problem. If the blockage becomes severe and the goat cannot urinate, the bladder may rupture and death is unavoidable. Proper calcium-to-phosphorus ratio is critical to prevention.

White Muscle Disease

White muscle disease is caused by too little selenium in the diet. Goats are much more susceptible to white muscle disease than cattle or sheep. Selenium, acting together with vitamin E, acts as an antioxidant in the muscles. When selenium in the diet is low, the free oxidative radicals in the muscle damage the muscle tissue, leaving white streaks, especially in the heart. Kids are the usual victims. Kids are born weak and have trouble standing and nursing.

Selenium is usually a component of a complete trace mineral mix or trace mineralized salt. It can also be provided in an injectable form along with vitamin E. Be careful when providing selenium supplements to your goats. Little research is available on the effects of selenium overdose on goats, but selenium is toxic at high doses in other livestock species. Selenium overdose causes hair loss, hoof sloughing, staggering, vomiting, muscle tremors, difficulty breathing, and death in cattle and sheep.

Polioencephalomalacia

Polioencephalomalacia, also called goat polio, is caused by a deficiency of thiamine (vitamin B1). The rumen usually produces plenty of thiamine. But under some circumstances, thiamine production can be blocked. A common example is treatment for coccidiosis with Corid®. Corid® blocks thiamine production to kill the coccidia parasites, but it also blocks thiamine production in your goat's rumen.

Polioencephalomalacia causes tissues in the brain to die. The classic sign of polioencephalomalacia is a goat lying on its side with its head thrown back and its legs stiffly extended. If the problem is caught early enough, thiamine injections can save the infected goat. If the brain damage becomes too severe, the goat is unlikely to survive.

Prussic Acid Poisoning

One of the more common concerns after storms or in the fall is fallen leaves and branches and whether or not they are safe for goats to eat. In the case of members of the *Prunus* family of trees, the answer is no. *Prunus* family members include cherries, plums, peaches, apricots, and almonds. These plants contain prussic acid in their tissues. Sorghum, johnsongrass, and sudangrasses also contain prussic acid. When the tissues become damaged, especially when the leaves wilt from frost or drought or on downed branches, the prussic acid is converted into deadly hydrogen cyanide. These kinds of plants are called cyanogenic. Hydrogen cyanide prevents the red blood cells from releasing oxygen by binding to the hemoglobin in oxygen's place. The result is rapid death. Sorghum, johnsongrass, and sudangrass pastures can be used safely until a frost occurs. Once the plants have been damaged by frost or drought, keep your goats out of those pastures.

Nitrate Poisoning

Nitrate poisoning and prussic acid poisoning are often confused. Nitrate poisoning can be a problem with sorghum and sudangrasses, especially after they have been fertilized with nitrogen followed by a lack of rain. The grasses pull nitrogen from the soil to use in building plant tissues. But without sufficient moisture, the nitrogen accumulates as nitrates in the nodes of the plants. Nitrates can sometimes reach toxic levels in water. For example, runoff after a heavy rain from recently fertilized fields can raise nitrate levels in ponds and streams.

Nitrates alter the iron in the hemoglobin molecule in blood so it is less capable of carrying oxygen. The result is brown, almost chocolatey blood and rapid death. Infected goats will appear weak and may stagger. Their pulse will be weak and their temperature will be lower than normal.

How to Use the NRC Nutrient Requirements Tables

The NRC tables are the best guidelines for meeting the nutritional needs of your goats. However, keep in mind that they are just that – guidelines. Many different factors combine to subtly alter the actual needs of the animals on your farm.

For example, mineral interactions can interfere with or improve mineral absorption from the diet. Minerals in the soil, forages, feed, mineral or salt mix, or water are different on every farm.

The tables are a great place to *begin*. Be sure to measure the progress of your animals to make sure the nutrition program is actually meeting your goals and adjust it accordingly if it is not.

To convert kilograms (kg) to pounds (lb) simply multiply the kg by 2.2. To convert pounds to kilograms, divide the pounds by 2.2.

Example 1

40 kg x 2.2 = 88 lb
88 lb ÷ 2.2 = 40 kg

To convert grams (g) to ounces (oz), multiply grams by 0.035. To convert ounces to grams, divide the ounces by 0.035.

Example 2

20 g x 0.035 = 0.7 oz
0.7 oz ÷ 0.035 = 20 g

To convert ounces (oz) to pounds (lb), simply divide the number of ounces by 16. To convert pounds to ounces, multiply the number of pounds by 16.

Example 3

36 oz ÷ 16 = 2.25 lb
2.25 lb x 16 = 36 oz

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Appendix

The following goat nutrient requirement tables were adapted from the National Research Council's *Nutrient Requirements of Small Ruminants, Sheep, Goats, Cervids and New World Camelids, Third Edition* (2007).

Carefully read the units in which the requirements are listed. For example, selenium is listed in micrograms per day, whereas copper is listed in milligrams per day, and calcium and phosphorus are listed in grams per day. A mistake could cause a serious overdose of selenium or copper. Crude protein is listed as ounces per day, but TDN in listed in pounds per day.

Also, be sure to notice that the average daily gain for an early lactation doe with twins is negative. This means she will lose weight. This is normal.

Animal	Weight (lbs.)	ADG (lbs.)	Energy in the feed (Kcal/lbs.)	DM Intake (lbs.)	Daily Nutrients Per Animal							Daily Nutrient Density			
					TDN (lbs.)	CP (oz.)	Ca (g)	P (g)	Mg (mg)	Cu (mg)	Se (mcg)	TDN (% DM)	CP (% DM)	Ca (% DM)	P (% DM)
Growing kid	20	0.00	0.87	0.8	0.4	0.8	1.0	0.6	164	8	264	50.0	6.3	0.28	0.17
		0.06	1.09	0.7	0.5	1.2	1.5	0.7	209	7	300	71.4	10.7	0.47	0.22
		0.22	1.30	0.8	0.7	2.2	2.0	1.0	345	9	418	87.5	17.2	0.55	0.28
		0.33	1.30	0.9	0.8	2.9	4.4	1.9				88.9	20.1	1.08	0.47
		0.44	1.30	1.0	0.9	3.6	5.5	2.5				90.0	22.5	1.21	0.55
	30	0.00	0.87	1.1	0.5	1.1	1.1	0.8	236	12	273	45.5	6.3	0.22	0.16
		0.06	0.87	0.9	0.6	1.5	1.5	0.9	282	11	309	66.7	10.4	0.37	0.22
		0.22	1.09	1.2	0.8	2.5	3.5	1.7	418	12	427	66.7	13.0	0.64	0.31
		0.33	1.30	1.1	0.9	3.2	4.5	2.0				81.8	18.2	0.90	0.40
		0.44	1.30	1.2	1.1	3.9	5.6	2.5				91.7	20.3	1.03	0.46
	45	0.00	0.87	1.5	0.7	1.5	1.4	1.0	358	16	317	46.7	6.3	0.21	0.15
		0.06	0.87	1.7	0.8	1.9	2.1	1.4	409	17	358	47.1	7.0	0.27	0.18
		0.22	1.09	1.6	1.0	3.1	4.0	2.0	563	17	491	62.5	12.1	0.55	0.28
		0.33	1.09	1.8	1.2	3.9	5.4	2.7	665	18	573	66.7	13.5	0.66	0.33
		0.44	1.30	1.5	1.3	4.7	6.4	3.0				86.7	19.6	0.94	0.44
		0.55	1.30	1.7	1.5	5.4	7.8	3.5				88.2	19.9	1.01	0.45
	55	0.00	0.87	1.7	0.9	1.8	1.6	1.2	440	19	320	52.9	6.6	0.21	0.16
		0.06	0.87	1.9	0.9	2.2	2.3	1.5	490	20	360	47.4	7.2	0.27	0.17
		0.22	0.87	1.7	1.1	3.3	4.0	2.1	640	21	490	64.7	12.1	0.52	0.27
		0.33	1.09	1.9	1.3	4.1	5.4	2.7	740	22	570	68.4	13.5	0.63	0.31
		0.44	1.09	2.2	1.4	4.8	6.7	3.3				63.6	13.6	0.67	0.33
		0.55	1.09	1.8	1.6	5.6	7.7	3.5				88.9	19.4	0.94	0.43
	65	0.00	0.87	2.0	1.0	2.0	1.8	1.3	522	22	315	50.0	6.3	0.20	0.14
		0.06	0.87	2.1	1.0	2.4	2.5	1.7	571	24	463	47.6	7.1	0.26	0.18
		0.22	0.87	2.6	1.3	3.5	4.5	2.7	719	26	483	50.0	8.4	0.38	0.23
		0.33	1.09	2.1	1.4	4.3	5.4	2.8	817	25	571	66.7	12.8	0.57	0.29
		0.44	1.09	2.3	1.5	5.0	6.8	3.3	916	26	650	65.2	13.6	0.65	0.32
		0.55	1.09	2.5	1.7	5.8	8.1	3.9				68.0	14.5	0.71	0.34
		0.66	1.09	2.1	1.8	6.5	9.1	4.1				85.7	19.3	0.96	0.43

(Continued)

Animal	Weight (lbs.)	ADG (lbs.)	Energy in the feed (Kcal/lbs.)	DM Intake (lbs.)	Daily Nutrients Per Animal							Daily Nutrient Density			
					TDN (lbs.)	CP (oz.)	Ca (g)	P (g)	Mg (mg)	Cu (mg)	Se (mcg)	TDN (% DM)	CP (% DM)	Ca (% DM)	P (% DM)
Growing kid (cont.)	80	0.00	0.87	2.3	1.1	2.4	2.0	1.6	634	26	343	47.8	6.5	0.19	0.15
		0.06	0.87	2.5	1.2	2.8	2.7	1.9	686	28	384	48.0	7.0	0.24	0.17
		0.22	0.87	3.0	1.4	4.0	4.9	2.9	842	32	530	46.7	8.3	0.36	0.21
		0.33	1.09	2.4	1.6	4.8	5.8	3.0	945	31	613	66.7	12.5	0.53	0.28
		0.44	1.09	2.6	1.8	5.6	7.3	3.6	1049	30	696	69.2	13.5	0.62	0.31
		0.55	1.09	2.8	1.9	6.4	8.6	4.3	1153	32	779	67.9	14.3	0.68	0.34
		0.66	1.09	3.1	2.1	7.1	10.1	4.9				67.7	14.3	0.72	0.35
	90	0.00	0.87	2.5	1.3	2.6	2.1	1.6	716	29	338	52.0	6.5	0.19	0.14
		0.06	0.87	2.7	1.3	3.0	2.9	2.0	767	31	389	48.1	6.9	0.24	0.16
		0.22	0.87	3.2	1.6	4.2	5.0	3.0	920	35	522	50.0	8.2	0.34	0.21
		0.33	0.87	3.5	1.7	4.9	6.4	3.7	1023	35	603	48.6	8.8	0.40	0.23
		0.44	0.87	2.7	1.8	5.7	7.3	3.7	1125	34	695	66.7	13.2	0.60	0.30
		0.55	1.09	3.0	2.0	6.5	8.6	4.3	1227	35	777	66.7	13.5	0.63	0.32
		0.66	1.09	3.2	2.1	7.3	10.0	4.9	1330	36	869	65.6	14.3	0.69	0.34
Mature doe maintenance	45		0.87	1.1	0.6	1.3	1.2	0.8	358	11	153	54.5	7.4	0.24	0.16
	65		0.87	1.5	0.8	1.7	1.4	1.0	522	15	158	53.3	7.1	0.21	0.15
	90		0.87	1.9	1.0	2.2	1.7	1.3	716	18	164	52.6	7.2	0.20	0.15
	110		0.87	2.2	1.2	2.5	1.9	1.5	880	22	170	54.5	7.1	0.19	0.15
	130		0.87	2.5	1.3	2.8	2.1	1.7	1034	25	167	52.0	7.0	0.19	0.15
	155		0.87	2.8	1.5	3.3	2.3	1.9	1238	28	171	53.6	7.4	0.18	0.15
	175		0.87	3.1	1.6	3.5	2.5	2.0	1392	31	179	51.6	7.1	0.18	0.14
	200		0.87	3.4	1.8	3.9	2.6	2.2	1596	34	182	52.9	7.2	0.17	0.14
Late gestation mature doe carrying twins	45	0.15	1.3	1.4	1.1	3.7	5.0	2.4	624	12	235	78.6	16.5	0.79	0.38
	65	0.19	1.3	1.7	1.4	4.5	5.0	2.5	837	16	246	82.4	16.5	0.65	0.32
	90	0.23	1.3	2.6	1.7	5.8	5.7	3.1	1115	24	297	65.4	13.9	0.48	0.26
	110	0.28	1.3	2.9	2.0	6.4	5.9	3.3	1330	27	310	69.0	13.8	0.45	0.25
	130	0.31	1.3	3.3	2.2	7.1	6.0	3.4	1536	30	325	66.7	13.4	0.40	0.23
	155	0.35	1.3	3.7	2.5	8.0	6.3	3.7	1802	34	362	67.6	13.5	0.38	0.22
	175	0.39	1.3	5.1	2.7	9.3	7.2	4.6	2018	41	388	52.9	11.4	0.31	0.20
	200	0.43	1.3	5.6	3.0	10.2	7.6	4.9	2273	51	424	53.6	11.4	0.30	0.19
Early lactation mature doe nursing twins	45	-0.07	1.09	1.5	1.0	3.9	7.8	4.2	1156	15	358	66.7	16.3	1.15	0.62
	65	-0.08	0.87	2.4	1.3	5.1	8.1	4.6	1477	25	404	54.2	13.3	0.74	0.42
	90	-0.10	0.87	3.0	1.6	6.3	8.8	5.1	1882	31	460	53.3	13.1	0.65	0.37
	110	-0.11	0.87	3.4	1.8	7.1	8.9	5.3	2170	35	500	52.9	13.1	0.58	0.34
	130	-0.12	0.87	3.8	2.0	7.2	9.1	5.5	2442	38	532	52.6	11.8	0.53	0.32
	155	-0.13	0.87	4.3	2.3	8.8	9.5	5.8	2798	44	574	53.5	12.8	0.49	0.30
	175	-0.14	0.87	4.6	2.5	9.5	9.6	6.1	3053	47	607	54.3	12.9	0.46	0.29
	200	-0.15	0.87	5.1	2.7	10.3	10.0	6.4	3394	52	646	52.9	12.6	0.43	0.28
Mature buck maintenance	125		0.87	2.9	1.5	3.1	2.4	1.9	1000	30	193	51.7	6.7	0.18	0.14
	150		0.87	3.1	1.6	3.4	2.5	2.0	1191	33	164	51.6	6.9	0.18	0.14
	200		0.87	3.8	2.0	4.2	2.9	2.5	1591	40	173	52.6	6.9	0.17	0.15
	275		0.87	5.0	2.6	5.4	3.7	3.2	2190	52	200	52.0	6.8	0.16	0.14
	325		0.87	5.6	3.0	6.1	4.0	3.6	2590	59	207	53.6	6.8	0.16	0.14

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