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# Nutritional Requirements of Different Classes of Meat Goats

Nar Gurung
*Tuskegee University*, ngurung@tuskegee.edu

# NUTRITIONAL REQUIREMENTS OF DIFFERENT CLASSES OF MEAT GOATS

***Nar Gurung[1]**
**[1]Tuskegee University**
***Email of author*:* ngurung@tuskegee.edu**

## Abstract

Feeds provide nutrients to animals. Feeds can be grains, crop by-products or forages. Forages can form the basis of feeds for goats in the southeastern US because year-round forage production is possible. Since goats are classified as browsers, the forage program should consist of browse and pasture. Managing browse species as feed resources is challenging, and there is limited information relative to managing browse species. Hay is the main forage feed for goats in the region and average quality hay can meet nutrient requirements for maintenance. However, nutrient requirements for late-pregnancy, lactation, and growing goats cannot be met with the average quality hay alone. There is a need for supplemental feeds when hay quality and quantity are inadequate. This situation arises during winter months and in late summer. Many supplemental feeds can be fed to goats such as grains, crop byproducts, commercial feed supplements or concentrates including salts and minerals.

**Keywords**: Nutritional Requirements, Nutrition, Forages, Classes of Meat Goats, Meat Goats

## Introduction

Nutrition impacts on all aspects of animal productivity and health. Producers should provide nutrients to match the needs of animals. Animal nutrient requirements can be met from forages, crop residues, conserved and purchased feedstuffs (Court et al., 2010) but goat production should rely heavily on a good forage program. As indicated above, goats are classified as browsers, and consume browse species, forbs, and leaves. The forage program should consist of both browse and pasture. A good mix is about two acres of browse for every one acre of open grassland although there is no research evidence to support this practice. The biggest problem for maintaining this combination is that the browse will not grow back once the goats have browsed it for more than two growing seasons (Rankins, 2002). There is a need to study the optimum combination of browse and forages for meat goats. Nevertheless, the goal of feeds and nutrition is to provide the five nutrients required by animals namely, water, carbohydrate, proteins, minerals and vitamins.

Goats are natural browsers and given the opportunity, they select over 60% of their daily diets from browse (Table 1) and woody and broadleaf plants (Luginbuhl and Green, 2005; Peischel, 2014)). They are able to select the most nutritious part of the plants given the choice and can meet their nutritional needs. Besides nutritional benefits, other advantages of browsing include fewer internal parasite problems due to higher grazing heights and consumption of condensed tannin-containing browse species (Min et al., 2003; Min et al., 2004).

## Water

Water is the most important nutrient required by goats. Water comprises between 50 and 81 percent of body mass (Robbins, 1993; NRC, 2001), and plays important roles in virtually all physiological and biochemical processes (NRC, 2007). Goats can lose all their fat, up to 40% to 50% of their protein, but a water loss of only 10% can prove fatal (Rankins and Pugh, 2012). Animals receive water mainly from drinking water but water in feeds and metabolic water also

Table 1. Diet Preference Differences between Different Ruminant Species (Percentage of Diet)

| Plant | Horse | Cattle | Sheep | Goat |
|---|---|---|---|---|
| | | | | |
| Grass | 90 | 70 | 60 | 20 |
| Weeds | 4 | 20 | 30 | 20 |
| Browse | 6 | 10 | 10 | 60 |

contribute water. Water requirements are affected by the age of the animal, physiological stage, water quality, level of protein in the diet, salt intake, and dry matter intake. For example, pregnancy and lactation increase water requirements by 126% from months 1 to 5 of gestation (Rankins and Pugh, 2012). Water quality can affect water intake. Water quality depends on the quantity of dissolved substances it contains. Calcium, sodium, chloride, and bicarbonates are common contaminants (Holland and Kezar, 1995). Higher levels of these salts can cause illness and even death. Ideally, the pH of water should be between 7 and 8 and goats should have continuous access to fresh and clean water.

## Energy

Carbohydrates provide most of the energy that goats require. It is a well-established fact that energy is the first limiting nutrient under most practical feeding conditions. Many factors affect the energy requirements of goats such as age, gender, season, genotype, body composition, parasitism, physiological stage, and activity (NRC, 2007). Corn is considered the gold standard as a source of energy and other energy sources are compared to corn. Corn contains 90% TDN but is low in protein (8% to 10%). Corn can be fed as whole corn. However, corn, as well as other grains should be gradually introduced to goats to avoid acidosis. In addition to corn, various commodity feeds are available as energy supplements for goats. Soyhulls are readily available in the southeast and are very palatable to goats (Gurung, 2015). The energy value of soyhulls is equivalent to corn when fed as an energy supplement at less than 25% of forage-based diets for cattle (Anderson et al., 1988). An additional benefit of soyhulls is that they contain more protein than corn (11 to 12% protein). They can be fed in the loose or pelleted form (Rankins, 2002). They interfere with fiber digestion less than corn does. Whole cottonseed contains abundant amounts of energy and is a very good source of protein (Solaiman, 2010). Cottonseed contains about 90% TDN and 24% crude protein. The limiting factor for its use in goat diets is the fat content, which is approximately 24%. In general, mature goats can be fed 0.23 to 0.34 kg (0.5 lbs to 0.75 lbs) per day while young growing goats should be limited to less than 0.23 of a kg (0.5 lbs) per day (Rankins, 2002). The seeds can be fed on pasture on a daily or every other day basis. However, there are handling problems associated with whole cottonseed. It is very fuzzy and has a low bulk density thereby limiting its handling options. Store cottonseed in a covered shed or feed bay and not in feed bins. The fuzzy seeds do not auger or gravity-flow very well, but seeds can be easily handled with front-end loaders or by hand. Corn gluten feed is another popular byproduct with medium palatability, which is produced while making cornstarch and corn syrup from corn. It contains various amounts of corn bran, corn germ, and corn steep liquor in a dried and pelleted form. The product is consistent from a particular processing plant but maybe quite variable from one plant to another. The crude protein content will be more than 18% but may be as high as 23 to 24%. The TDN content ranges from 80 to 87% and the variation is primarily a result of the drying process. If it is heated too hot, it results in a lower feed value, palatability problems and

usually a darker color (Gurung, 2015). It can be fed up to 1% of body weight for meat goats. Many commercial supplements are available as energy sources, but their description is beyond the scope of this article.

## Protein

Generally, a minimum of 7% dietary crude protein is needed for normal rumen bacterial growth and function for goats. If dietary protein drops below 7%, forage intake and digestibility are depressed. Protein deficiency is associated with decreased fiber digestion, reduced growth, decreased immune function, anemia, reduced feed utilization, edema, and death (Rankins and Pugh, 2012). The metabolizable protein reaching the small intestine consists of bacteria, protozoa, or dietary protein that escaped ruminal digestion. The quality (amino acid proportions) of the microbial protein is excellent. Milk replacers should have protein from milk byproducts to provide an amino acid composition suitable for maximum growth. Soybean meal and cottonseed meal are excellent sources of natural protein for goats. Both contain between 40 and 45% crude protein. Soybean meal is slightly more palatable than cottonseed meal and cottonseed meal is better utilized (higher rumen undegradable protein levels) but goats readily consume both. In the southeastern US, cottonseed meal is generally cheaper than soybean meal (Gurung, 2015).

## Minerals

There are seven commonly assessed macrominerals for goats. They include calcium, phosphorus, sodium, chlorine, magnesium, potassium, and sulfur. The eight microminerals are copper, molybdenum, cobalt, iron, iodine, zinc, manganese, and selenium. The designations *macro* and *micro* do not reflect the minerals' relative importance but rather characterize the amount of each that is required as a proportion of the diet (Rankins and Pugh, 2012). Macromineral needs usually are expressed as a percentage of the diet, whereas micromineral needs generally are expressed as ppm or mg/kg. The minimum and maximum mineral requirements for goat are given in Table 2. Forages are a major source of minerals for the goat except for iodine (Hart, 2015). The major source of iodine in grazing ruminants is from soil splashed on the plant by rain (Healy et al., 1972 However, plant requirements for minerals, such as cobalt and selenium, may be much lower than the level required for animals, so animals need to be supplemented with these minerals. Soils can be deficient in some minerals which may be reflected in the plants grown on such areas. However, some plants have an ability to concentrate the minerals available in the soil (Hart, 2015). Mineral contents of plants are affected by many factors such as soil pH, environmental temperature, and season of the year. As goats eat a variety of plants, they are less likely to have mineral deficiencies than other species of animals that eat predominantly one plant species. Copper is a unique trace mineral for goats because the requirements and tolerance for copper by goats are higher than for sheep. Solaiman et al. (2001) showed that copper (100 mg/day) supplemented into a basal diet containing 13.8 mg Cu/kg DM increased average daily gain, gain efficiency and enhanced immune response in goats compared to basal diet alone. However, copper absorption in ruminants is low (<1.0 -10%) compared to values reported for nonruminants (Underwood and Suttle, 1999). However, young ruminants have higher copper absorption (70-85%) before their rumen is fully developed but decreases to <10% after weaning.

The most important consideration in choosing a mineral supplement is the level of calcium and phosphorus. Some mineral mixes are designated 12 - 8, which means they contain 12% calcium and 8% phosphorus. The levels of these two minerals should be the same that is being fed to cattle in your area (contact your county agent or livestock extension specialist). Phosphorus is expensive,

so a 12 - 12 mineral will cost more than one that is 12 - 8. However, most forages are low in phosphorus, making it the most common mineral deficiency. The mineral supplement should also contain trace minerals that are deficient in the area. Most mineral supplements are formulated to provide less than half the trace mineral requirements due to toxicity concerns and mineral interactions. A mineral supplement should be provided in the loose form to maximize consumption. The salt level in the mineral drives intake; therefore, no other sources of salt should be available. A mineral feeder should be used to protect from rain and keep the supplement clean. Replenish minerals frequently to keep them fresh (Rankins, 2002). The minimum and maximum mineral requirements for goats are given below in Table 2.

Table 2. General Macro-and Micromineral Requirements for Goats

| Mineral | Minimum | Maximum |
|---|---|---|
| Macrominerals, % of diet | | |
| Calcium (Ca) | 0.30 | 0.80 |
| Phosphorus (P) | 0.25 | 0.40 |
| Sodium (Na) | 0.20 | --- |
| Potassium (K) | 0.80 | 2.0 |
| Chloride (Cl) | 0.20 | --- |
| Sulfur (S) | 0.20 | 0.32 |
| Magnesium (Mg | 0.18 | 0.40 |
| Microminerals, ppm in diet | | |
| Iron (Fe) | 50 | 1,000 |
| Copper (Cu) | 10 | 80 |
| Cobalt (Co) | 0.10 | 10 |
| Zinc (Zn) | 40 | 500 |
| Manganese (Mn) | 40 | 1,000 |
| Selenium (Se) | 0.10 | 0.32 |
| Molybdenum (Mo) | 0.10 | 3 |
| Iodine (I) | 0.50 | 50 |

Source: Hart, 2015

## Vitamins

Vitamins are organic compounds required by goats in minute amounts but are critical in many of the body's metabolic processes. They act as co-factors in many biochemical reactions. There are two types of vitamins: fat-soluble and water-soluble. Among fat-soluble vitamins, properly functioning rumen can synthesize vitamin K. Water-soluble vitamins can be synthesized by properly functioning rumen so do not require to be supplemented to goats. Because the rumen normally synthesizes B vitamins and vitamin K in healthy goats, the only vitamins needed in the diets of nonstressed animals are the fat-soluble vitamins: A, D, and E (Table 3). If an animal has altered rumen function, is parasitized, is on a low-fiber diet, or is being given long-term antibiotic therapy, supplemental B vitamins, especially thiamine may be of value.

## Feeding Hay to Goats

Hay is the most common feedstuff fed to goats. If hay is being fed to the goatherd, it is important to determine the quality of the hay being fed and then determine whether energy, protein, both or neither is required to supplement the hay. For mature goats that are not in late-

Table 3. General Vitamin Requirements of Goats

| Vitamin | Rates of feeding |
|---|---|
| A | 11, 000 IU/ kg of feed |
| D | 4,400 IU/ kg of feed |
| E | 176 IU/ kg of feed |
| K | Properly functioning rumen can synthesize adequate levels |

Source: NRC, 2007

pregnancy or nursing kids, hay will probably be adequate to meet nutritional needs unless it is of very poor quality. However, if the goats are in late-pregnancy or lactation, supplemental energy will likely be required and for lactation, both energy and protein will likely be needed. Many grains, byproducts including many commercial feed supplements are available to complement hay to meet the nutrient gaps. However, it is very difficult to determine the energy content of these feeds because labeling laws do not require that TDN content be part of the label. Most feed manufacturers will give an estimate of TDN if contacted. Crude protein content, fat and fiber must be listed in the feed tags. When selecting feeds for goats, it is generally better to utilize feeds that contain natural protein versus non-protein nitrogen or urea because goats are very susceptible to urea toxicity. It is important to discuss the particular feed in question with the company representative and get some estimate of energy (TDN) that the feed contains. An extremely effective way to supplement goats in the southeast is to allow them to limit graze pastures containing cool-season, annual forages that are extremely high in energy and protein content. Ideally, ryegrass, rye, wheat, oats or some combination of these forages should be planted on a prepared seedbed in September and then used after January as a high-quality supplement to hay. When used as a supplement, about two hours of grazing time per day works quite well which has been proven effective with beef cattle. The advantage of this type of system as opposed to putting out dry feed as a supplement is that the dominant goats do not control the submissive goats like they would when eating from a feed trough. However, the disadvantage is that the growth of the forage is weather dependent.

## Feeding Guidelines for Different Classes of Goats

### Feeding Young Kids

Newborn kids must receive colostrum as early as possible. It's a rich source of proteins, milk solids, globulins, fats and vitamin A. Kids have no immunity antibodies when they are born and receive passive immunity from their mothers through colostrum consumption. A newborn needs to receive 10% to 20% of its body weight in colostrum, preferably within 3 to 12 hours after birth. If it is not available from the dam, frozen colostrum supplies can be thawed and used. Colostrum absorption decreases rapidly from birth through 36 hours of age (Solaiman, 2010). Cross-species colostrum often is better than no colostrum. Rearing orphaned kids on milk replacer is quite expensive and labor-intensive. If possible, orphans should be grafted onto another doe and only rearing them on milk replacer only if this cannot be accomplished (Rankins and Pugh, 2012). Milk replacers should be fed according to manufacturers' directions. The most economical way to raise orphans is to get them onto a starter feed as soon as possible. Commercial starters are better than home mixes as has been shown in NY studies. Pellets have a higher intake. Also, few people can get the feed ingredients to make their own. Calf starter will work better. Offering 114 grams (0.25 lbs)/day of a mixture of corn, oats, alfalfa pellets, molasses, and soybean meal that provides 14%

to 16% crude protein works well (Rankins and Pugh, 2012). Top-dressing the feed with a dry milk replacer also may stimulate early intake of the dry feed. Other ingredients known to be extremely palatable to young ruminants are soybean hulls and various sources of bran, including wheat bran.

It is very important to get young goats off to a good nutritional start with creep feeding. Creep feeding is defined as allowing the young kid's access to a high-quality feed that the nannies cannot access. This is usually accomplished by placing the feed behind a gate with openings that the kids can fit through and the nannies cannot. A creep feed should contain at least 16% crude protein and should be extremely palatable. Commercial calf creep feed will work well and is widely available. Young goats will typically start consuming appreciable quantities of a creep feed at about 6 weeks of age. Creep feeds need not be complex, but they must be palatable because they are competing with milk. Pelleting or coarse grinding feeds usually increases intake. Fine grinding usually results in decreased intake as animals (particularly lambs) age. Pellets should be small enough for consumption. In goats, pellet size larger than 5 to 7 mm may decrease intake. Until the animals reach 3 to 4 weeks of age, however, palatability is the key to successful creep feeding. Low-fiber creep feeds containing 16% to 20% protein usually work best. Enhanced performance may be attained if salt (0.5% of the creep feed), ammonium chloride (0.2 kg/440 kg of feed, or 10 lb/ton), and vitamin E are added to creep feeds (Rankins, 2002). Generally, when feed costs are low and kid prices are high, creep feeding usually is profitable. It is less profitable when feed costs are high and sale prices are low. In the final analysis, the feasibility of creep feeding is determined simply as a matter of feed costs versus animal sale prices. A kid starter grain mix formulations are shown in Table 4.

Table 4. Example Kid Starter Grain Mix

| Ingredient | Example 1 | Example 2 |
|---|---|---|
| Cracked corn | 50% | 50% |
| Soybean hulls | 30% | ---- |
| Oats | ---- | 30% |
| Soybean meal | 15% | 15% |
| Molasses | 5% | 5% |

**Feeding Yearlings**

Most females need to gain between 0.11 and 0.23 kg (0.25 and 0.5 lb) per day from weaning until breeding depending on their weaning weights. Yearlings considered as replacements should be kept on the best available pasture. In most instances, however, this management approach will require some supplemental energy or concentrate feeding. Concentrate feeding should be fed up to 1% of bodyweight depending on breed, species, size, and so on) of a 12% to 14% crude protein should be offered in settings of poor-quality forage. Overfeeding young females, can result in excessive fat deposition in the mammary glands and decreased lifetime milk production. If females are to be bred as yearlings, a moderate growth rate is most desirable. The female should obtain 65% of her projected mature weight by the time of breeding. In reality, a range of weights probably exists within which small-framed goats may have acceptable conception rates at 55% to 60% of their projected mature weights, whereas some large-framed animals may need to be closer to 70% of their mature weights. So long as a good, well-planned forage system is available, females can achieve desired weight gains with little or no grain supplementation. Good-quality grass pasture

will need to be supplemented with additional energy and protein sources. Animals maintained on grass-legume mixtures will require less supplementation. Nevertheless, animals should be weighed, and body condition scored regularly whenever possible regardless of the breeding system. If the BCSs of the group begin to drop below 2.5, the producer should offer a source of supplemental energy; conversely, if the scores rise above 3.5, less energy supplementation is needed. A good-quality mineral mixture used for adult males as described below is appropriate for use in yearlings.

**Feeding Replacement Breeding Males**

Feeding developing males should be forage-based. They should be developed using as much forage as possible, with just enough supplemental feeding (0.5 to 1.0% of body weight) to produce desirable gains and there is no need to worry about urinary calculi. Growing males should be offered a good-quality mineral mixture, but care must be taken to include steps to prevent urinary calculi and other production-related diseases. Good quality hay and 1 to 1.5 kg of grain mix containing 14 – 16% CP is adequate. The other recommended nutrient levels are listed in Table 5.

**Feeding Dry Does**

Most medium quality forages can provide adequate levels of nutrients to dry does. The goal is to gain a small amount of body weight, so they are ready for breeding. The average quality bermudagrass hay with 50% to 54% TDN and 8% to 10% CP level can be sufficient. However, the mineral mixture should be supplemented. The least expensive mineral mix is a mixture of 50% Dicalcium Phosphate and 50% Trace-mineralized salts provided free choice with an adequate supply of clean, freshwater. The does should be maintained at a BCS at or just under 3 during the breeding season.

**Feeding Pregnant Does**

The does in the early gestation period can be maintained on average quality hay with mineral supplementation similar to dry does. The goal is to economically feed does while maintaining proper body condition. A BCS of 2.5 to 3 is adequate during early gestation. The most important consideration is to gain partial fetal and placental growth during this period. However, the doe nutrition is very critical during the last six weeks of pregnancy because approximately 70% of fetal growth occurs during this period. If does are not properly fed, the consequences can be low kid birth weights, lower energy reserves on the newborn kids, and increased death losses at the time of kidding. On the other hand, if does are overfed, this can result in obesity and contribute to dystocia and pregnancy toxemia (Rankins and Pugh, 2012). The pregnant does should be supplemented to between 150 to 454 grams (1/3 to 1 lbs) of grains per day. This will help prevent pregnancy toxemia which is the accumulation of ketones in the blood due to accelerated fat catabolism, although pregnancy toxemia in goats is less common compared to sheep. Do not feed alfalfa hay as a sole source of forage to pregnant does in the last trimester of their pregnancy because alfalfa hay is imbalanced with respect to its calcium to phosphorus ratio, and generally contain higher levels of potassium.

**Feeding the Lactating Doe**

The milk production peaks within 2 to 3 weeks after kidding and then declines 8 to 10 weeks after parturition. This is the most critical period for does because they need high amounts of nutrients to produce milk. The nutrient needs depend on litter size also. Lactating does can consume up to 4% to 5% of their body weight in dry matter. Energy is the most important nutrient. Does should be fed to meet their nutrient needs. High-quality forages such as spring pasture or moderate quality alfalfa hay can provide adequate levels of nutrients but if bermudagrass is the forage source, a 16% dairy ration, 1.18 kg (2.6 lbs) of hay and 910 grams (2.0 lbs) of ration should be fed to meet the nutrient needs for a 50 kg (110 lbs) Boer doe (Hart, 2015). The nutrient recommendation levels are listed in Table 5.

Table 5. Daily Nutrient Requirements for Meat Producing Goats[1,2]

| Nutrient | Young Goats[3] | | Does (50 kg or 110 lbs) | | | | Bucks (36.4 – 54.5 kg or 80 – 120 lbs) |
|---|---|---|---|---|---|---|---|
| | Weanling 13.6 kg or 30 (lbs) | Yearling (27.3 kg 60 lbs) | Early Pregnant | Late Pregnant | Average Milk | High Milk | |
| DM, kg or lbs | 908 g (2.0 lbs) | 3.0 | 1.46 or 4.5 | 2.05 kg or 4.5 | 2.05 kg or 4.5 | 2.27 kg or 5.0 | 2.27 kg or 5.0 |
| TDN, % | 68 | 65 | 55 | 60 | 60 | 65 | 60 |
| Protein, % | 14 | 12 | 10 | 11 | 11 | 14 | 11 |
| Calcium, % | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 | 0.4 |
| Phosphorus, % | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 |

[1]NRC, 2007; [2]Pinkerton, 1989; [3]Expected weight gain >200 g (0.44 lbs)/day.

**Feeding Herd Sires**

Breeding bucks should be maintained on a medium quality forage diet because they can obtain most of the nutrients from it. However, if bucks are still growing, they need to be provided with additional supplements. Replacement bucks should be gaining faster than doelings. Whole shelled corn at the rate of 206 grams (0.5 lbs) to 454 grams (1 lb) would be adequate. The BCS for breeding buck should be maintained at three or higher before, they enter the breeding season. Feeding higher amounts of grains can lead to urinary calculi. If it is necessary to feed higher levels of grain, producers should use a commercial concentrate with urine acidifiers to prevent urinary calculi.

Breeding bucks can lose up to 10% to 20% of their body weight during the breeding season and so they be fed supplements 4 to 6 weeks before the breeding season (Solaiman, 2010). Although the feeding rates vary according to BCS, a daily ration of 2.7 kg (6 lbs) to 3.64 kg (8 lbs) of forage and 454 grams (1 lb) to 91008 grams (2 lbs) of 12% to 14% protein supplement is adequate. The dicalcium phosphate and trace mineralized salt mixture (50:50 ratio) should be provided free choice. Trace mineral salt supplementation should be based on local soil types. The nutrient recommendations are given in Table 5.

## Conclusion

Meat goat production should be forage-based in the southeastern US where year-round forage production is possible. Forage-based goat production is not only profitable, but it is environmentally sustainable, and meat is of higher quality. Moreover, goats prefer less grains compared to other ruminant species. The additional supplementation including minerals and vitamins should only complement forages.

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