

Improving Meat Goat Nutrition with Forages and Supplementation

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Introduction

Feed accounts for the highest single cost of any meat goat operation. Goats raised for meat need high quality feed in most situations and require an optimum balance of many different nutrients to achieve maximum profit potential. Because of their unique physiology, meat goats do not deposit backfat and marbling like cattle or sheep, and rates of weight gain are lower, ranging from 0.1 to 0.8 lb/day. Therefore, profitable meat goat production can only be achieved by optimizing the use of high quality forage and browse and the strategic use of the more expensive concentrate feeds. This can be achieved by developing a year-round forage program allowing for as much grazing as possible throughout the year.

Many people still believe that goats eat and do well on low quality feed. Attempting to manage and feed goats with such a belief will not lead to successful meat goat production.

Feeding Requirements

The goat is not able to digest the cell walls of plants as well as the cow because feed stays in its rumen for a shorter time period. A distinction as to what is meant by "poor quality roughage" is necessary in order to make decisions concerning which animal can best utilize a particular forage. Trees and shrubs, which often represent poor quality roughage sources for cattle, because of their high tannin content, highly lignified stems and bitter taste, may be adequate to high in quality for goats. This is because goats can manipulate their lips as they browse, and thereby avoid eating the stems, they don't mind the taste, they have the ability to detoxify tannins,

and as a result they benefit from the relatively high levels of protein and cell solubles found in the leaves and buds of these plants. On the other hand, low quality hay with high cell wall and low protein, can be used by cattle but will not provide even maintenance needs for goats because goats don't utilize the cell wall as efficiently as cattle.

In addition, goats must consume a higher quality diet than cattle because their digestive tract size is smaller with regard to their maintenance energy needs. Relative to their body weight, the amount of feed needed by meat goats is approximately twice that of cattle. When the density of high quality forage is low and the stocking rate is low, goats will still perform well because their grazing/browsing behavior allow them to select only the highest quality forage from that on offer. Thus, they are able to perform well in these situations, even though their nutrient requirements exceed those of most domesticated ruminant species.

Nutrient Requirements

Meat goats require nutrients for body maintenance, growth, reproduction, pregnancy, and production of products such as meat, milk and hair. The groups of nutrients that are essential in goat nutrition are water, energy, protein, minerals and vitamins. The nutrient requirements of bucks, young goats and does with a high production potential and at various stages of development and production are shown in Table 1. Goats should be grouped according to their nutritional needs to more effectively match feed quality and supply to animal need. Weanlings goats, does during the last month of gestation, lactating does and yearlings should be grouped

and fed separately from dry does and mature bucks which have lower nutritional needs.

When pasture is available, animals having the highest nutritional requirements should have access to lush, leafy forage or high quality browse. In a barn feeding situation such as during the winter months, these same animals should be offered the highest quality hay available. Whether grazed or barn fed, goats should be supplemented with a concentrate feed when either the pasture/browse that they are grazing or the hay that they are fed do not contain the necessary nutrients to cover their nutritional requirements. Total digestible nutrients (TDN) and protein requirements are shown in Table 1. Comparing the nutrient requirements to the chemical composition of feeds shown in Table 2 should give producers an idea of how to match needs with appropriate forages. To give producers an idea where these requirements fall, low quality forages contain 40-55% TDN, good quality forages contain from 55 to 70% TDN, and concentrate feeds contain from 70 to 90% TDN.

Water

Water is the least expensive nutrient, but production, growth and the general performance of the animals will be affected if insufficient water is available. Water needs vary with the stage of production, being highest for early lactating does, and during times when the weather is warm and forages are dry. In some instances, when consuming lush and leafy forages, or when grazing forages soaked with rain water or a heavy dew, goats can get all the water they need out of the feed. However, water is almost always needed by some members of the herd such as lactating does. Because it is difficult to predict water needs, goats should always have access to ample high quality water. Clear, flowing water from a stream or small pressurized tank is preferable to stagnant water; the latter may

contain excessive levels of blue-green algae, which may be toxic. Nitrate in drinking water should also be of concern because it is becoming the predominant water problem for livestock. Safe levels in drinking are less than 100 nitrate-nitrogen.

Energy

Energy comes primarily from carbohydrates (sugars, starch and fiber) and fats in the diet. Lush leafy forage and browse, and tree leaves contain sufficient energy to cover the nutrient requirements of every goat on the farm. Feeds that are high in energy are corn and other feed grains, whole cottonseed, wheat middlings, soybean hulls, and corn gluten feed. Bacteria that are present in the rumen of goats ferment sugars, starches, fats and fibrous carbohydrates into volatile fatty acids. These acids are absorbed and used for energy. Fat is efficiently used for energy, but the amount that can be included in the diet is limited. Usually added fat should not represent more than 5% of a diet because it depresses ruminal fermentation. For example, if whole cottonseed (perhaps with as much as 25% fat) is used as a supplement, it should not be more than 20% of the diet. Whole cottonseed also contains a good level of protein and phosphorous, and fed at 0.5 to 1.0 lb per day makes an excellent supplement to low quality forage. If the diet consumed by goats contains an excess of energy, that extra energy will be stored in the body as fat, mainly around the internal organs.

Protein

Protein is usually the most expensive component of the goat diet. As for energy, lush leafy forage and browse, and tree leaves contain sufficient protein to cover the nutrient requirements of every goat on the farm (Tables 1 & 2). Concentrates that are high enough in protein to serve as supplements are whole cottonseed, soybean meal, wheat middlings and corn gluten feed. Protein is required both as a

source of nitrogen for the ruminal bacteria and to supply amino acids for protein synthesis in the animal's body. When the level of protein is low in the diet, digestion of carbohydrates in the rumen will slow and intake of feed will decrease. Inadequate levels of protein in the diet can negatively affect growth rate, milk production, reproduction and disease resistance because insufficient amino acids are getting to the intestines to be absorbed by the body. Unlike energy, excess of protein is not stored in the body of the goat; it is excreted in the urine as urea. Therefore, it is important for animals to have access to enough protein to cover their nutritional requirements. Protein requirements vary with developmental and physiological stages and level of production (Table 1).

Minerals

Goats require many minerals for basic body function and optimal production. Providing free choice a complete goat mineral is advisable under most situations. Major minerals likely to be deficient in the diet are salt (sodium chloride), calcium, phosphorous and magnesium. Trace minerals likely to be low in the diet are selenium, copper, and zinc.

Most forages are adequate or nearly adequate in calcium, so supplemental calcium is usually needed only if grain or a low calcium byproduct (like wheat middlings) is fed. Low quality, mature or weathered forages may be deficient in phosphorous, especially for lactating does. The ratio of calcium to phosphorous in the diet is important and should be kept 2:1, which should be a consideration when using feeds that are high in phosphorus and low in calcium (like wheat middlings, corn, or corn gluten feed). Grass tetany can occur when goats in early lactation are grazing lush, leafy small grain, annual ryegrass or grass/legume pastures. Under those conditions, it is advisable to provide a mineral mix that contains 5 to 10% magnesium.

Selenium is marginal to deficient in all areas of the US, and most common "red" trace mineralized salts do not contain Se. Trace mineralized salt or a salt mineral mix that includes selenium should be provided to the goat herd at all times. In case selenium is absent, producers should encourage their local feed store to include it in commercial mixes or to order trace mineralized salts that contain selenium. The legal limit to selenium in salt is 120 ppm.

Copper requirements for goats have not been definitively established. Growing and adult goats are less susceptible to copper toxicity than sheep, but their tolerance level is not well known. Young, nursing kids are generally more sensitive to copper toxicity than mature goats, and cattle milk replacers should not be fed to nursing kids. Mineral mixes and sweet feed should contain copper carbonate or copper sulfate because these forms of copper are better utilized by the goat than copper oxide. Grains are generally lower in copper than forages. However, copper levels are of limited value in assessing adequacy unless forage concentrations of copper antagonists such as molybdenum, sulfur, and iron are also considered.

In practice, many more cases of copper deficiency are encountered in the field than copper toxicity. This is because "sheep and goat minerals" were originally formulated copper-sensitive sheep and contain little if any supplemental copper. We have conducted research on copper tolerance of growing Boer-cross goats for several years. Minerals were formulated without added copper, with the typical level found in high-quality cattle mineral (1000 ppm), or at a level well in excess of most cattle minerals (3000 ppm). Supplemental copper came from copper sulfate in those studies. Liver copper levels in the goats increased during the experimental period, but did

not approach toxic levels on either level. This work is continuing with long-term supplementation of does and kids to determine if the high level might eventually be a problem.

Forages, especially low quality forages, often contain concentrations of zinc that are thought to be below recommended levels for ruminants. However, zinc requirements of goats have not been defined, and little is known regarding factors that affect zinc availability in forages.

We currently recommend that producers either use a mineral supplement formulated specifically for goats, or use a supplement made for cattle with around 1000 ppm copper. Intake of the complete mineral should be about 0.5 to 1 oz/day for each goat.

Vitamins

Vitamins are needed by the body in very small quantities. The vitamins most likely to be deficient in the diet are A, D and E. All other vitamins are either formed by bacteria found in the rumen or are synthesized in the body tissues in adequate quantities to meet needs.

Vitamin A is not contained in forages, but carotene found in green, leafy forages is converted into vitamin A in the body. In addition, vitamin A is stored in the liver and fat of goats during times when intake exceeds requirements. Goats consuming weathered forages or forages that have undergone long-term storage should be fed a mineral mix containing vitamin A, or should receive vitamin A injections.

Vitamin D may become deficient in animals raised in confinement barns, especially during the wintertime. Animals should have frequent access to sunlight because it causes vitamin D to be synthesized in their skin, or they should receive supplemental vitamin D. A

deficiency in vitamin D results in poor calcium absorption, leading to rickets, a condition where the bones and joints of young animals grow abnormally.

Vitamin E is found in adequate levels in fresh high quality forages, but in some cases might be low in weathered or stored forages. Supplemental vitamin E has been shown to improve reproduction and immunity in some cases, and it works synergistically with selenium to detoxify toxins in the body. Generally, providing some vitamin A, D and E either by periodic injection or preferably in the mineral mix is a good idea.

Factors Influencing Animal Requirements

A mature dry, non-pregnant doe or a mature buck in good body condition are examples of animals having maintenance requirements only. Additional requirements above those needed for body maintenance are required for growth, pregnancy, lactation and hair production. As the productivity of meat goats is increased through selection and crossbreeding with goats having a higher production potential, such as the Boer goat, nutritional requirements will also increase. Therefore, the more productive goats should be fed high quality feed, especially weaned kids being prepared for market, young replacement doelings and does in late gestation and early lactation. Does nursing twins or triplets have greater nutritional requirements than does nursing a single kid.

Goats grazing very hilly pastures will have higher nutritional requirements than goats on level pastures of the same quality because they will expend more energy to gather feed. In some situations where brush control in rough areas is the primary purpose of keeping goats, less productive animals or maintenance animals (especially mature wethers) can be forced to consume lower quality feed. If their body

condition deteriorates, these animals can then be grazed on better quality pastures or brushy areas. Once desirable body condition is achieved, the same animals can again be grazed to control brush.

Nutritional Management of Meat Goats

Nutrition of Newborn Kids

Colostrum is the first milk produced after birth. Colostrum contains a high content of immunoglobulins (antibodies), vitamin A, minerals, fat and other sources of energy. Antibodies are proteins which help the kid fight diseases. The ability of kids to resist diseases is greatly affected by the timing of colostrum intake and the quantity and quality of the colostrum fed. Colostrum should be ingested or bottle-fed (in case of weak kids) as soon as kids have a suckling reflex. Extremely weak kids that are unable to suckle should be fed with a tube feeder.

The producer must be certain that all newborn kids get colostrum soon after birth (within the first hour after birth, and certainly within the first 6 hours) because the percentage of antibodies found in colostrum decreases rapidly after birth. It is crucial that the antibodies in colostrum be consumed before the kids suck on dirty, pathogen-loaded parts of its mother or stall. In addition, the ability of the newborn kid to absorb antibodies also decreases rapidly after birth. Newborn kids should ingest 10% of their body weight in colostrum during the first 12 to 24 hours of life for optimum immunity. A goat kid weighing 5 lb at birth should ingest ½ lb of colostrum (approximately ½ pint) during the first 12 to 24 hours of life.

Any extra colostrum produced by high producing does during the first 24 hours following kidding can be frozen for later use when needed. Only first milking from healthy animals should be frozen for later feeding, and the colostrum from

older animals that have been on the premises for several years is typically higher in antibody content against endemic pathogens than is colostrum from first fresheners. Revaccination against enterotoxemia (over-eating disease) and tetanus 2 to 4 weeks before the kidding date is commonly used to improve the protective value of the colostrum against these conditions.

Ice trays are ideal containers for freezing colostrum. Once frozen, cubed colostrum can be stored in larger containers and the trays used for another batch. Frozen colostrum cubes are ideal for portioning, reducing waste to a minimum, and are quick to thaw. It is recommended to thaw colostrum either at room temperature or at a fairly low temperature. Colostrum should never be cooked during the thawing process.

Nutritional Management of Replacement Does

Doe kids needed for replacement should be grazed with their mothers during as much of the milking period as possible and not weaned early. Following weaning, doe kids should be separated from the main herd and have access to high quality forage and receive good nutrition through first kidding at 1-2 years of age, depending on the nutritional plane. Leaving doe kids with the main herd will result in undernourished does that are bred too young and too small; these animals will never reach their production potential. A yearly supply of replacement does that are healthy, of good size, and free of internal and external parasites, is essential to the success of any meat goat enterprise.

Pregnancy Disease (Ketosis)

During late pregnancy, nutritional requirements are as high as they are during lactation, especially if the pregnant doe is carrying more than one fetus. Not only are extra nutrients needed by the developing fetuses, but they also

crowd the abdominal cavity and reduce ruminal volume. As a result, adequate amounts of low to moderate quality forage cannot be consumed. Because of this, does fed a such diets (especially if they are fat) can develop ketosis and die due to inadequate energy intake.

Inadequate nutrition during late pregnancy will also result in small, weak kids at birth, and high early death losses, especially with twin or triplets. When forage or browse is low in quality, (<55% TDN; <10% protein), does in late pregnancy and early lactation should be provided with about 1 lb/day of a 16% protein concentrate.

Urinary Calculi (Urinary Stones)

In goats, clinical obstruction of the urinary tract is most frequently seen in young, castrated males and the calculi are usually comprised of calcium phosphate salts. Castrated goats kept as pets and overfed bucks are at high risk for developing the condition due primarily to the feeding of excessive grain in the diet. If the diet contains too much phosphorous relative to calcium, supplemental calcium from feed grade limestone is one way to maintain the calcium:phosphorous ratio between 2:1 to 4:1.

Body Condition Scoring

The term body condition refers to the level of fat reserve an animal has. Producers should be concerned with the body condition of their animals. Does should not be allowed to become too thin or too fat (Refer to ANS00-605MG: Monitoring the body condition of meat goats: A key to successful management, available at http://www.cals.ncsu.edu/an_sci/extension/animal/meatgoat/ahgoats_index.html). Reproductive failure can result if does are under or over conditioned at the time of breeding. Clinical symptoms of over or under conditioned does may include: low twinning and low weaning

rates, pregnancy toxemia and dystocia.

Simply looking at an animal to determine its body condition and assigning it a body condition score (BCS) can easily be misleading. Rather, animals should be touched and evaluated in a chute. The easiest area to feel and touch to determine the body condition of an animal are the rib areas, on either side of the spine, by running a hand over those areas and pressing down with a few fingers. In doing so, one is able to determine the amount of fat covering the ribs. Other areas to monitor are the shoulders, the tail heads, the pins, the hooks, the edge of the loins and the backbone. Producers should develop an eye and a touch for the condition of their animals and strive to maintain a moderate amount of condition on their goats. If you can easily see the backbone and ribs, the goats are most probably undernourished. When body condition starts to decrease, it is a sign that feed supply or quality is limiting. Waiting until goats become thin to start improving their feeding regime may lead to large production losses.

One should also be concerned with the body condition of the breeding bucks. Bucks will have reduced fertility if they are too thin (BCS = 4 or lower) at the start of the breeding season. On the other hand, if bucks are overfed and become too fat (BCS = 7 or higher), they may have no desire to breed does.

Flushing

Flushing means increasing the level or quality of feed offered to breeding does starting about one month prior to breeding, to increase body weight, ovulation rate and litter size. Increasing the level of energy offered to does should continue throughout the breeding season and for approximately 30 to 40 days after removing the bucks, for adequate implantation of the fetuses in the uterus. Body condition is used to determine whether flushing will be of benefit to

breeding does. Does in extremely good body condition will tend not to respond to flushing. On the other hand, does that are in relatively poor condition as a result of poor feed quality and supply, high worm loads, late kidding of twins or triplets, will respond favorably to flushing by improving their body condition.

Flushing can be accomplished by moving breeding does to a lush nutritious pasture 3 to 4 weeks prior to the introduction of the bucks. This cost-effective flushing method is underutilized in the Southeast where forage is abundant. Another method is feeding ½ lb/day of a high energy supplement. Corn is the grain of choice for flushing; whole cottonseed is another low cost, high energy and also high protein supplement. The goal being to increase the intake and body weight, breeding does should be grouped according to their body condition.

Byproduct Feeds

Byproduct feeds offer opportunities for producers to reduce supplemental feed costs while maintaining performance. Recent research shows that soybean hulls, wheat middlings, corn gluten feed and whole cottonseed have potential as goat supplements. Compared to corn and other starchy grains, these byproducts have energy from digestible fiber, or in the case of whole cottonseed both digestible fiber and fat. Soybean hulls, wheat middlings and corn gluten feed are comparable to a mix of corn and soybean meal of 16% protein when fed at moderate levels (1% of bodyweight). For wheat middlings and corn gluten feed there are potential problems with feeding higher levels because wheat midds contain some very rapidly digested starch, because corn gluten feed contains a high level of sulfur, and because both have a severe imbalance of calcium and phosphorus. Because of its fat content and the fact that palatability may be a problem, cottonseed should be limited to 0.5% of body weight or 20% of the diet. In all

cases the Ca:P ratio should be evaluated as most of these byproducts are high in phosphorus and low in calcium.

Soybean hulls are a unique feed because they are primarily digestible fiber, have moderate protein (12-16%) and have a good mineral balance. When fed at above 1% of body weight, they will have a value higher than corn for energy because the starch in corn starts to interfere with the digestion of the forage component of the diet. Soybean hulls have been successfully been hand-fed at over 2% of body weight, and have also successfully been fed free-choice from a self-feeder.

Soybean hulls, corn gluten feed and wheat middlings are available either pelletized or in the loose form, and because some goats are very picky eaters the pellets will generally work better.

Suggested Supplemental Feeding Program for Goats

As a general recommendation a complete goat mineral should be offered free choice year-around. When goats are raised on browse, abundant supply should be made available to allow goats to be very selective and to ingest a high quality diet that will meet their nutritional requirements. When forage or browse is limited or of low quality (< 10% protein), lactating does (and does in the last 30 days of gestation) and developing/breeding bucks should be fed 1.0 lb/day of a 16% protein commercial feed or homemade mixture (77:20:2.5:0.5 ground corn : soybean meal :goat mineral : limestone). Alternatively, whole cottonseed, wheat middlings, soybean hulls or corn gluten feed can be substituted for the conventional commercial or homemade feed.

Low to medium quality forage (> 10% protein) will meet requirements of dry does and non-

breeding bucks. When forage or browse is limited or of low quality (< 10% protein), weanlings and yearlings should be fed 1.0 lb/day of the standard feeds or one of the byproducts. In general, whole cottonseed is not of much use for growing kid because it can't be fed at a high enough level to have much impact on growth rates. Goats can be forced to eat very low quality feed including twigs, tree bark, etc., but producers should be aware this practice will hurt the productivity of superior meat and fiber goats.

Table 1. Daily Nutrient Requirements for Meat Producing Goats^{1,2}

NUTRIENT	YOUNG GOATS		DOES (80 lb)			BUCK (80-120 lb)
	Weanling ³ (30 lb)	Yearling ⁴ (60 lb)	Dry (Pregnant)	Lactating Avg Milk High Milk		
Dry matter, lb	2.0	3.0	4.5	4.5	5.0	5.0
TDN, %	68	65	60	60	65	60
Protein, %	14	12	10	11	14	11
Calcium, %	.6	.4	.4	.4	.6	.4
Phosphorus, %	.3	.2	.2	.2	.3	.2

¹ Nutrient Requirements of Goats in Temperate and Tropical Countries. 1981. National Research Council.

² Pinkerton, F. 1989. Feeding Programs for Angora Goats. Bulletin 605. Langston University

³ Expected weight gain 0.44 lb/day.

⁴ Expected weight gain 0.22 lb/day.

Table 2. Estimated Nutrient Composition of Various Feeds

PLANT TYPE	TDN, %	CRUDE PROTEIN, %
Acorns, fresh	47	5
Alfalfa hay	50-63	13-20
Annual ryegrass, vegetative	72-84	17-27
Bermuda hay, 7 weeks growth	54-58	9-11
Bermuda hay, 12 weeks growth	47-50	7-9
Blackberry, leaves	70	17
Cereal rye, vegetative	73-84	18-27
Chicory	65	15
Corn	86	9
Cowpea leaves, vegetative	75-80	19
Curled dock	74	13
Fescue hay, 9 weeks growth	50-58	8-10
Fescue hay, 6 weeks growth	58-62	10-16
Hackberry, mature	40	14
Honeysuckle, mature	68	10
Honeysuckle, leaves+buds	70	16
Juniper leaves	64	6
Kudzu, early hay	55	14
Mimosa leaves	72	21
Mulberry leaves	72	17
Multiflora rose, leaves	72	18
Oak, buds and young leaves	64	18
Pasture, vegetative	60-76	12-24
Pasture, dead leaves	35-45	5-7
Pasture, mature	50-60	8-10
Pearl millet leaves, vegetative	73-81	17
Persimmon leaves	54	12
Soybean leaves, vegetative	72-77	18
Soybean meal (48%)	87	54
Soybean hulls	80	14
Sumac, early vegetative	77	14
Triticale, vegetative	74-83	18-28
Wheat middlings	80	17
Whole cottonseed	88	22