Chapter One

# GOAT MARKETING

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## Introduction

Oftentimes, producers raise their goats and think about marketing when the goats are ready to sell. Farmers may take their goats to the local auction barn, call someone who may be interested in purchasing meat goats or advertise in the newspaper that they have meat goats for sale. In these situations, the producer is merely selling his goats or goat meat and acting as a ***price-taker***. Selling may be described as the transaction where the goat or goat meat is transferred from the producer to the consumer for a price. While this transaction is important, selling is only one component of a complete marketing scheme.

In contrast, marketing is a proactive approach to producing and selling meat goats, allowing the producer to behave more like a ***price-maker***. Marketing is the process of planning and executing the idea of a product, its price and the promotion and distribution of that product to satisfy the needs of the customer (Community Futures Development Corporation, 2005). Marketing of meat goats encompasses all of the operations and decisions made by the producer, which should be based on the needs and expectations of the end customer, from the breeding program and production methods to selling the live animal or meat to the consumer. This means marketing should not be an afterthought of production but should be planned well before production takes place and considered throughout the activities of the supply chain.

This chapter will discuss fundamental meat goat marketing concepts including:
- The history of meat goat marketing in Tennessee
- Supply and demand of meat goats and goat meat
- Marketing mix considerations (product, price, place and promotion)
- Regulatory considerations for direct marketing of goat meat and on-farm harvest

## History of Meat Goat Marketing in Tennessee

Meat goats and goat meat marketing are a relatively new industry in Tennessee as it is in most of the United States with, perhaps, the exception of Texas. The organized marketing of goats began in Tennessee during the early 1990s when the University of Tennessee Extension encouraged producers in Bedford County to pool their goats together to create a larger sale base to meet buyers' demands (Ailshie, 2005). Shortly thereafter, in the mid-1990s, the Tennessee Livestock Producers[1] became involved with goat marketing

[1] The Tennessee Livestock Producers is a livestock marketing cooperative and service company of the Tennessee Farm Bureau Federation.

through goat auctions, which were held in conjunction with sheep auctions. Prior to organized marketing encouraged by Extension and the collective sheep and goat auctions, producers typically sold their goats at local sale barns or directly off the farm to consumers and other producers.

Soon after the United States Department of Agriculture, Agricultural Marketing Service (USDA-AMS) adopted grading standards for live goats and institutional meat purchase specifications for fresh goat meat in October 2001[2], some goat auctions in Tennessee began to implement the live animal grading standards by hosting graded goat sales. Tennessee hosted its first graded goat sale in August 2002 at Thompson Station. As of September 2005, there are two graded goat sales in Tennessee with one at Thompson Station and the other in Somerville. Both graded goat sales are organized and run by the Tennessee Livestock Producers. The auction at Thompson Station has graded goat sales every second and fourth Friday of each month and typically sells a higher volume of goats than the auction in Somerville. The Somerville auction sells goats at noon every Tuesday.[3] Both graded goats sales are still held in conjunction with the sale of sheep.

Even with the graded goat sales, it is estimated that many goats are marketed directly off the farm. Producers often sell their goats through a production sale, private treaty or individual sale directly to the consumer. As of September 2005, however, limited data is available on the number of head sold directly off the farm throughout the state.

## Supply and Demand of Meat Goats and Goat Meat

Markets for every product and service, including goats and goat meat, are a function of supply and demand. The U.S. supply of goat meat is made up of domestic production and imports less exports. Because of the relationship between supply and demand, these measures of supply are also indirect measures of demand.

Domestic production can be explored through the evaluation of live animal inventory and federally-inspected slaughter data. Trade data can be used to evaluate the amount of chilled and frozen goat meat imported to and exported from the U.S.

### *Geographic Areas of Meat Goat Inventory*

The USDA National Agricultural Statistics Service estimated the U.S. inventory of meat and other goats as of January 1, 2005 to be more than 1.9 million head, an increase of only 1 percent from the 2002 Census of Agriculture (Table 1). Texas led the nation in numbers with over 1 million head in 2005, a 7 percent increase from 2002. Tennessee ranked a distant second with 98,000 head in 2005, a 9 percent decline from the 2002 Census.

[2] The USDA-AMS specifications are discussed in more detail later in the chapter.
[3] Sale information listed as of September 2005. Dates, time and locations are subject to change.

Several other southern states also ranked high in the inventory. Georgia, Kentucky, North Carolina, South Carolina and Alabama were all in the top ten for meat and other goat inventory as of January 1, 2005. Florida, Missouri and Virginia joined in the top fifteen.

**Table 1. Meat and Other Goat Inventory: Number by State and United States December 31, 2002, January 1, 2005 and Percent Change**

| *State* | *2002 (1)* | *2005* | *Percent Change (2002-2005)* |
|---|---|---|---|
| AL | 47,270 | 37,800 | -20% |
| AZ | 4,272 | 4,000 | -6% |
| AR | 26,578 | 27,000 | 2% |
| CA | 61,241 | 50,000 | -18% |
| CO | 11,976 | 16,000 | 34% |
| FL | 36,020 | 36,000 | 0% |
| GA | 66,018 | 77,000 | 17% |
| ID | 6,683 | 5,200 | -22% |
| IL | 12,142 | 11,000 | -9% |
| IN | 20,045 | 15,800 | -21% |
| IA | 9,666 | 13,000 | 34% |
| KS | 19,797 | 27,000 | 36% |
| KY | 61,618 | 63,500 | 3% |
| LA | 13,641 | 12,500 | -8% |
| MI | 10,785 | 8,500 | -21% |
| MN | 11,084 | 8,000 | -28% |
| MS | 24,788 | 14,100 | -43% |
| MO | 37,515 | 34,800 | -7% |
| NE | 8,204 | 13,000 | 58% |
| N ENG (2) | 9,783 | 10,000 | 2% |
| NM | 10,095 | 7,300 | -28% |
| NY | 19,539 | 18,100 | -7% |
| NC | 58,993 | 52,200 | -12% |
| OH | 28,439 | 34,000 | 20% |
| OK | 73,302 | 65,000 | -11% |
| OR | 19,222 | 21,700 | 13% |
| PA | 26,257 | 22,000 | -16% |
| SC | 37,985 | 41,000 | 8% |
| TN | 107,211 | 98,000 | -9% |
| TX | 941,783 | 1,010,000 | 7% |
| VA | 35,710 | 34,400 | -4% |
| WA | 14,265 | 14,000 | -2% |
| WV | 14,326 | 11,700 | -18% |
| WI | 8,634 | 6,400 | -26% |
| Other States (3) | 44,037 | 45,000 | 2% |
| **U.S.** | **1,938,924** | **1,965,000** | **1%** |

(1) 2002 Census of Agriculture. (2) N ENG includes CT, ME, MA, NH, RI, and VT.
(3) Other States include AK, DE, HI, MD, MT, NJ, NV, ND, SD, UT, and WY.

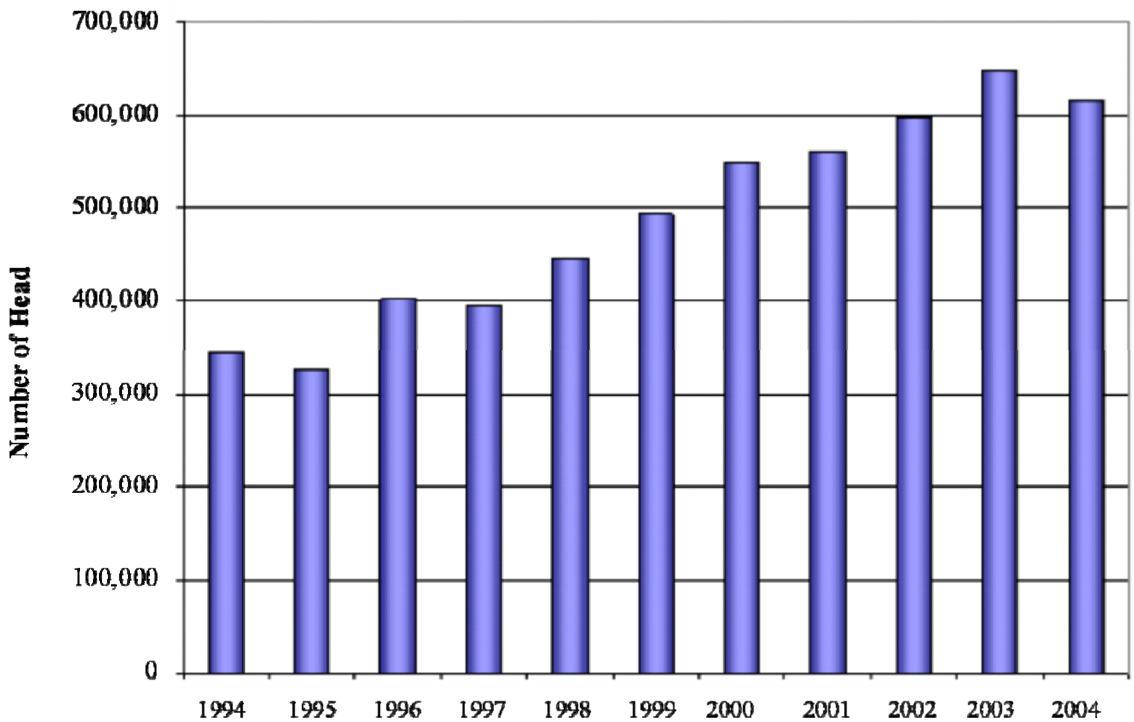
Source: USDA National Agricultural Statistics Service. *Sheep and Goats*. January 28, 2005.

According to a USDA Animal and Plant Health Inspection Service (APHIS) (2005) report, many industry experts believe the 2002 Census of Agriculture numbers underestimated the goat population by as much as 35 to 45 percent in the nation. If this is indeed the case, inventory numbers would have been between 2.6 million and 2.7 million head of meat and other goats in the U.S. in 2002.

***Federally-Inspected Slaughter***

Domestic production of goat meat can be evaluated through USDA National Agricultural Statistics Service (NASS) slaughter and inventory data. The NASS began collecting data on goats slaughtered at federally-inspected plants in 1977, when approximately 35,000 goats were slaughtered under this inspection system (Gipson). By 1997, over 390,000 goats were slaughtered in the U.S. annually (Figure 1), an increase of greater than 1,000 percent from 1977. In 2004, more than 615,000 goats were slaughtered in the nation, another 57 percent increase from 1997 in federally-inspected slaughter numbers.

**Figure 1. Goats Slaughtered in United States: Federally Inspected**




Source: USDA National Agricultural Statistics Service. Livestock Summary Annual Report.

At the state level, a few states dominate federally-inspected slaughter. For fiscal year 2004, New Jersey reported almost 35 percent of total federally-inspected goat slaughter with 231,171 head as total federally-inspected slaughter numbers totaled 666,203 for fiscal year 2004. Texas accounted for an additional 18 percent with 119,280 head. Pennsylvania and New York followed with 9 and 5 percent respectively. Tennessee rounded out the top five with 33,073 goats slaughtered in federally-inspected plants during fiscal year 2004. In addition, California, Illinois, Maryland and Indiana all had over 20,000 head slaughtered under federal inspection (USDA-APHIS, 2005).

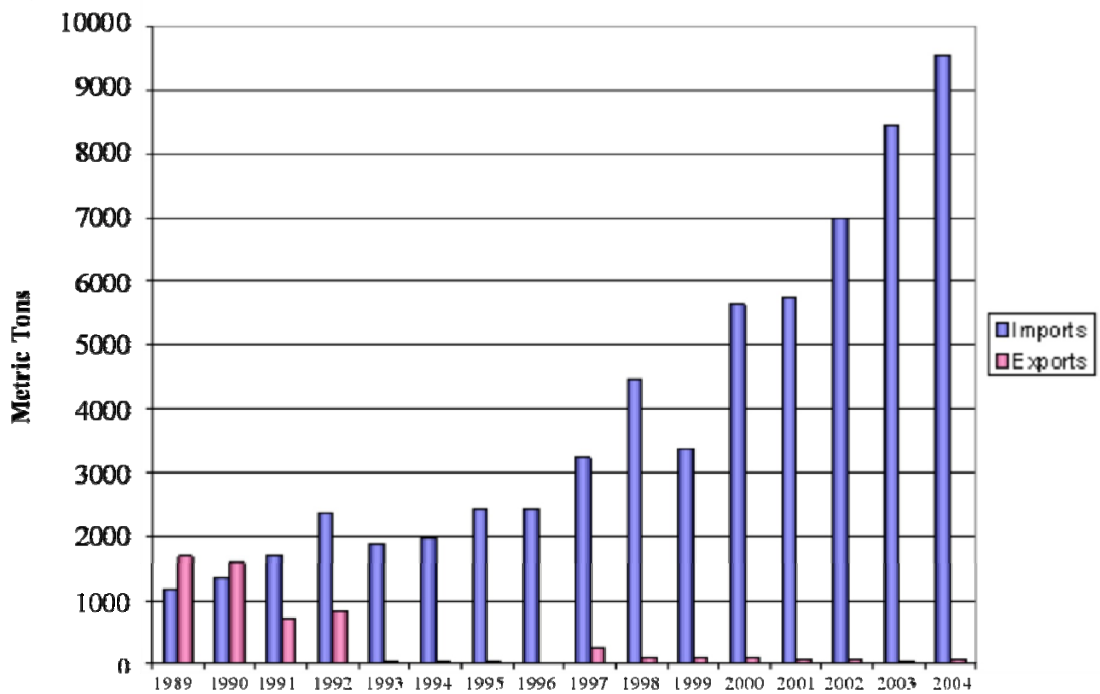
It must be noted, however, that not all goats slaughtered in the U.S. are done so under the federal inspection system. Goats are also slaughtered, for example, under state-inspection programs and on-farm slaughter. Non-federally inspected slaughter numbers may be significant. Some experts estimate that federal-inspection slaughter is 50 to 60 percent of total slaughter numbers (USDA-APHIS, 2005). The federal-inspection data, however, illustrate the increasing trend in the number of goats slaughtered in the U.S., signifying an increasing demand for goat meat.

Since limited data exists on the number of head sold directly off the farm, the exact number of goats sold direct to consumers is unknown. The USDA-APHIS (2005), with input from industry experts, estimates federal inspection slaughter represents between 50 and 60 percent of total slaughter. If this is the case, total slaughter for fiscal year 2004 may have been between 930,000 and 999,000 head.

***Imports/Exports***

Domestic production of goat meat is currently supplemented by imports of chilled and frozen meat from other countries, mainly Australia and New Zealand. Imports of goat meat have risen dramatically from 1989, when the U.S. was a net exporter of goat meat (Figure 2). Between 1990 and 1991, the U.S. changed from a net exporter to a net importer of the product. In 2004, the net U.S. imports totaled just over 9,400 metric tons valued at over $28 million. This translates to an estimated 695,000 goat-equivalents based on a 30 pound carcass and 2,204 pounds per metric ton (Gipson).

**Figure 2. Imports and Exports of Frozen/Chilled Goat Meat**

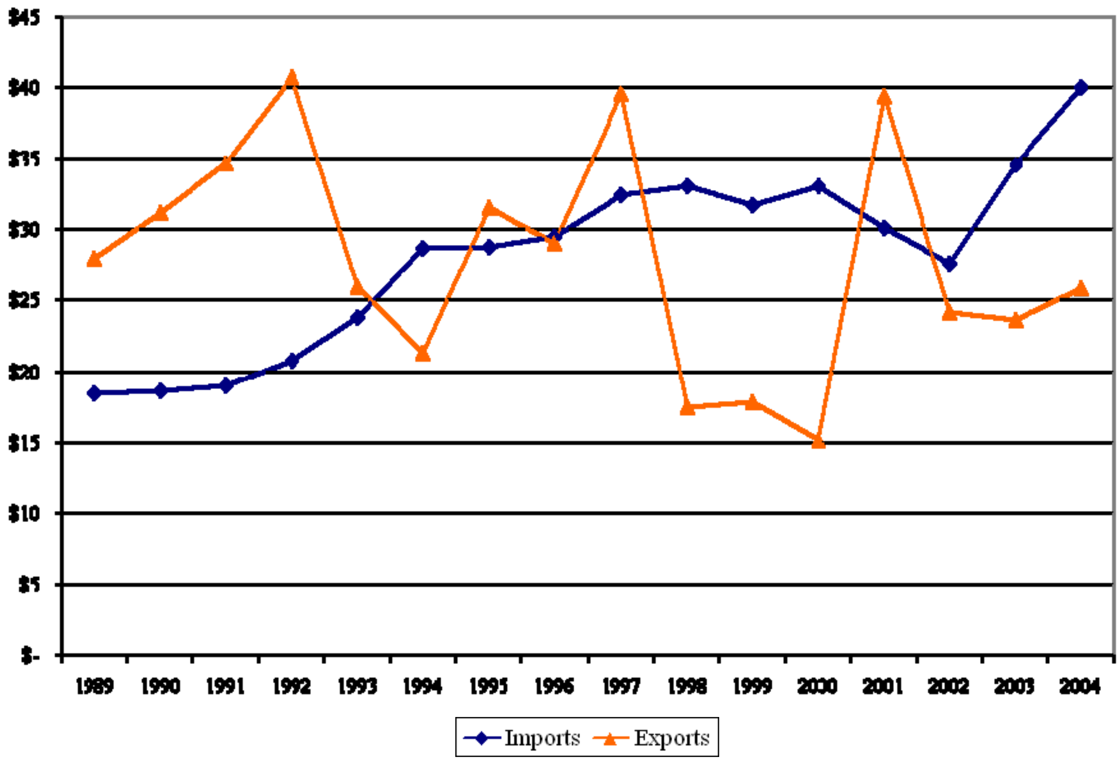



Source: USDA Foreign Agricultural Service. U.S. Trade Data. August 2005.

Export values for the period 1989 to 2004 have varied widely between about $15 per 30 pound carcass equivalent in 2000 and just under $42 in 1992 (Figure 3). The average export value over the time period is just under $28. Both quantity and quality of product exported and that available from other sources are reflected in the price fluctuations.

Import values have typically trended upward over the same time period. The lowest import value between 1989 and 2004 came in 1989 at around $18.40 per 30 pound carcass equivalent. The highest import value was seen in 2000 at just under $40 with the average at just over $28.

**Figure 3. Import and Export Values: 30 Pound Carcass Equivalent**




Source: USDA Foreign Agricultural Service. U.S. Trade Data. August 2005.

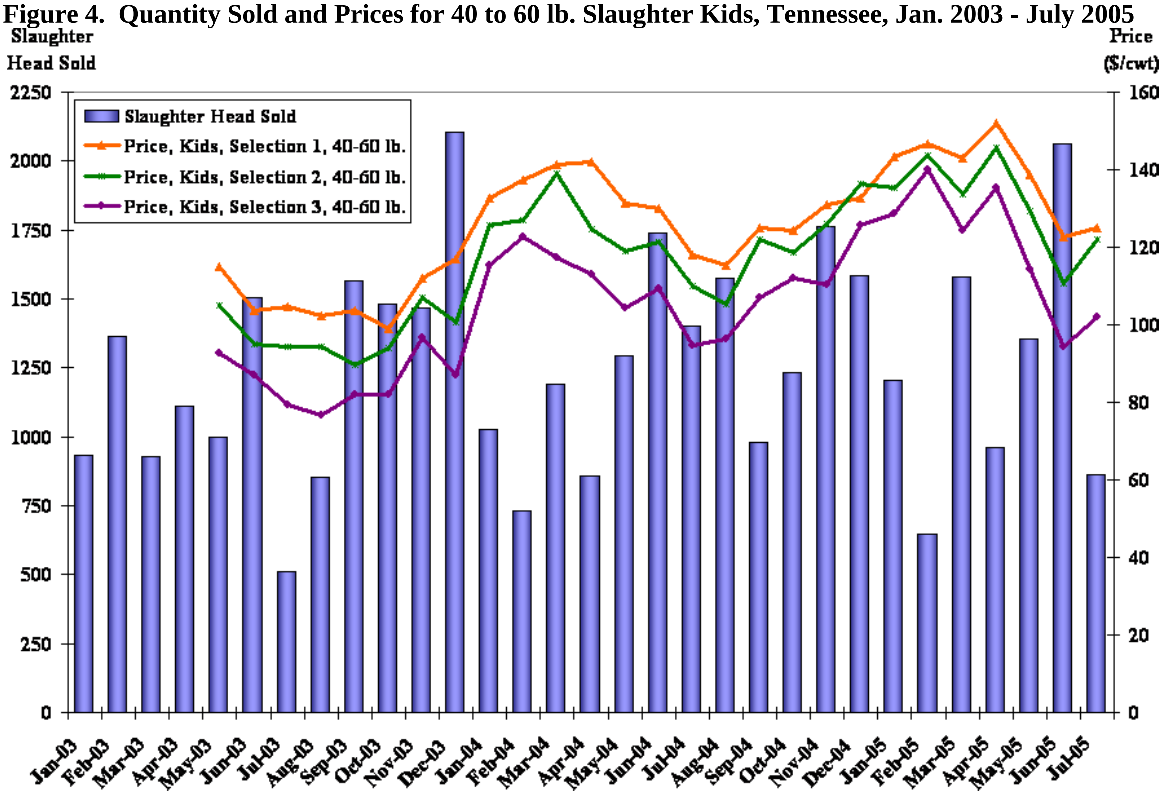
By combining U.S. production (federally-inspected slaughter) and net import data, an estimated 1.3 million goats were slaughtered to satisfy U.S. demand in 2004. Of these, over half were imported, indicating potential to increase domestic production if consumer preferences can be met and cost of production can compete with import prices.

***Tennessee Graded Goat Auction Data***

The USDA Agricultural Marketing Service and Tennessee Department of Agriculture collect sale data from graded goat auctions in Tennessee and compile them into bi-weekly market reports. The data from these reports have been analyzed to form a short historical perspective of the quantities and prices of slaughter goats sold at auction in Tennessee.[4]

Figure 4 shows the total slaughter head sold and the monthly average prices for 40-60 pound slaughter kids, Selections 1-3.[5] The market for goats in Tennessee appears to be somewhat cyclical with quantities and prices varying throughout the year. Quantities range from a low of 510 head in July 2003 to a high of 2,103 head in December 2003. Prices for Selection 1 kids range from a low of $99.10/cwt in October 2003 to a high of $152/cwt during April 2005. The goat market illustrates the law of supply and demand with prices higher when quantities are lower and vice versa. Selection 1 kids bring a higher premium than both Selection 2 and Selection 3 kids, showing that quality is important to buyers. There appears to be a slight trend upwards in the prices received at the auctions from May 2003 through July 2005. This may be partially explained by the observation by Darrell Ailshie, manager of the Tennessee Livestock Producers, that the quality of goats run through the auction has increased with more producers selling selection 1 kids in comparison to just two years ago.

**Figure 4. Quantity Sold and Prices for 40 to 60 lb. Slaughter Kids, Tennessee, Jan. 2003 - July 2005**




Source: Tennessee Department of Agriculture and USDA Agricultural Marketing Service.

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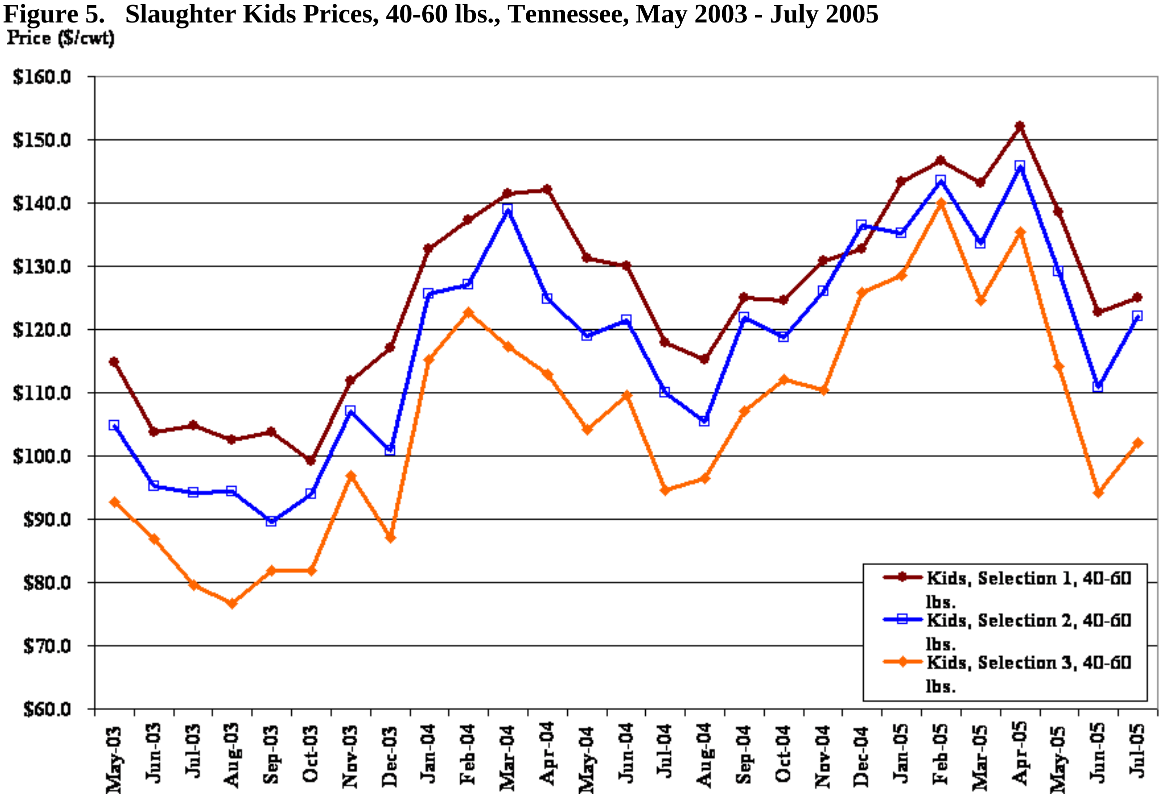
[4] The data on the quantity of slaughter head sold are monthly totals from January 2003 through July 2005. The price data for the slaughter goats sold are monthly averages from May 2003 through July 2005.

[5] The USDA adopted live goat selection criteria based on muscle conformation of slaughter kids. Selection 1 goats have superior meat type conformation, Selection 2 goats have average meat type conformation and Selection 3 goats have inferior meat type conformation. Please refer to the discussion on Institutional Meat Purchase Specifications in this manual for more detailed information.

Figures 5, 6 and 7 show the monthly average prices for slaughter goats sold at auction in Tennessee from May 2003 to July 2005. Figure 5 shows the average prices for slaughter kids from 40 to 60 pounds. Figure 6 shows the average prices for slaughter kids from 60 to 80 pounds, and Figure 7 shows average prices for slaughter bucks and does/nannies.[6] Slaughter kids receive higher average prices than both slaughter bucks and slaughter does. Slaughter bucks receive higher average prices than slaughter does. The monthly average prices for slaughter kids appear to be more cyclic and unstable than prices for slaughter bucks and slaughter does. This is most likely explained by the seasonal demand (usually around certain ethnic holidays) for meat from slaughter kids. Again, the apparent upward trend in prices from May 2003 through July 2005 can be seen in the figures, but it is more obvious in the kid market in comparison to the more gradual price increase in the slaughter buck and slaughter doe market.

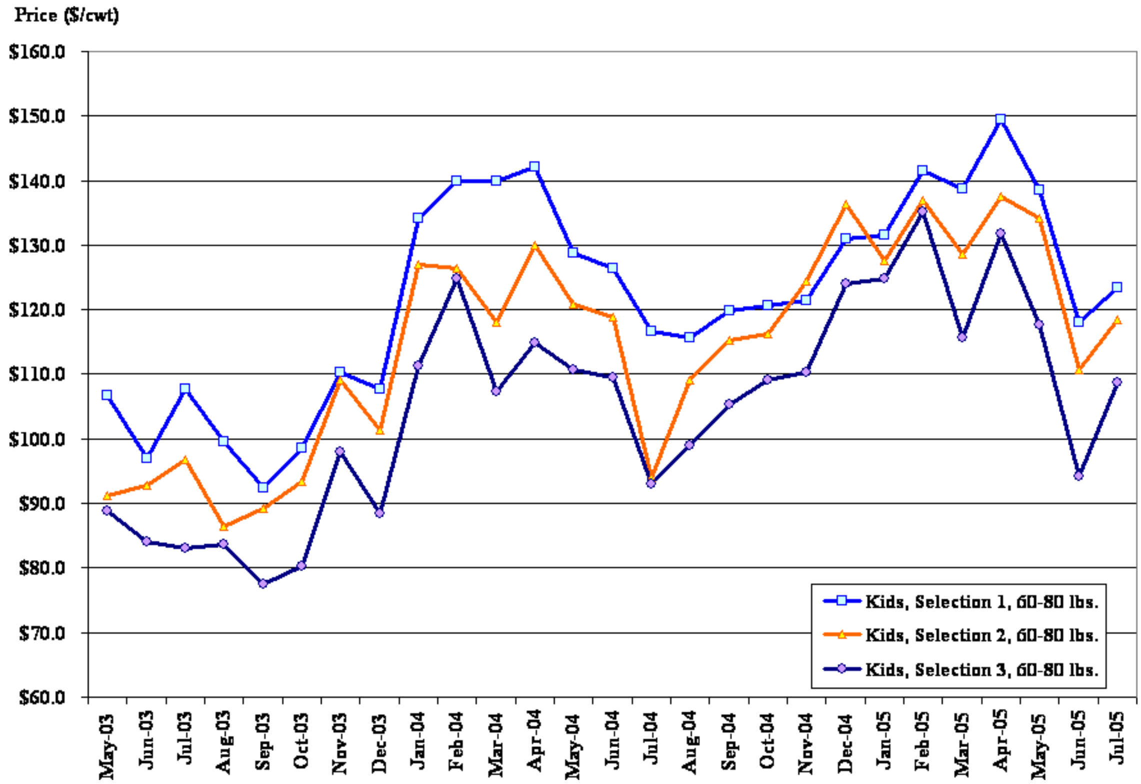
**Figure 5. Slaughter Kids Prices, 40-60 lbs., Tennessee, May 2003 - July 2005**




Source: Tennessee Department of Agriculture and USDA Agricultural Marketing Service.

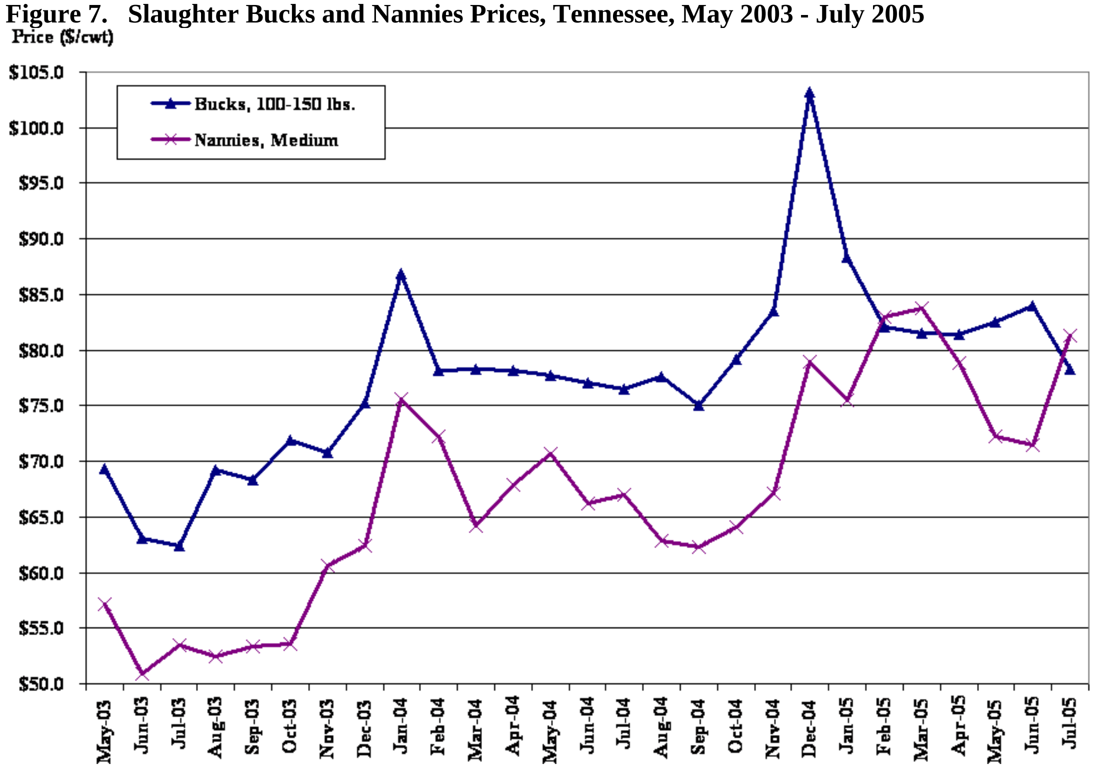
[6] Female goats or does are referred to as “nannies” in the TDA market reports.

**Figure 6. Slaughter Kids Prices, 60-80 lbs., Tennessee, May 2003 - July 2005**




Source: Tennessee Department of Agriculture and USDA Agricultural Marketing Service.

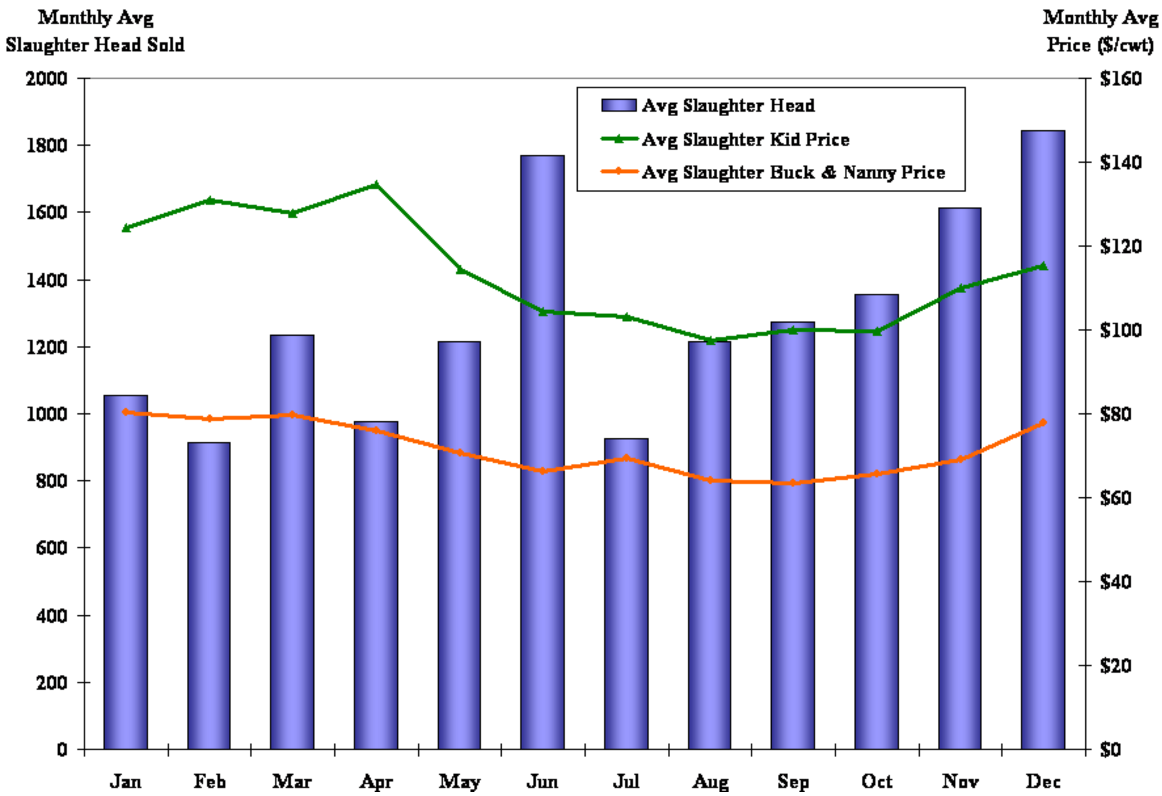
**Figure 7. Slaughter Bucks and Nannies Prices, Tennessee, May 2003 - July 2005**




Source: Tennessee Department of Agriculture and USDA Agricultural Marketing Service.

In order to confirm an apparent pattern of seasonality in the sale of slaughter goats, monthly average quantities and prices were calculated. Figure 8 shows that there is some seasonality within the goat market. Apparently, there are more slaughter goats sold at auction during June and December with fewer head sold during the months of February, April and July. This could be partially explained by the fact that goats are seasonal breeders. Prices are higher in the spring (during February through April) and generally lower in the late summer and early fall (during August through October). April appears to have the highest prices on average which may be explained by higher demand for Easter kids.

**Figure 8. Monthly Average Quantity and Prices for Slaughter Goats, Tennessee, Jan 2003 - Jul 2005**




Source: Tennessee Department of Agriculture and USDA Agricultural Marketing Service.

The USDA-APHIS research indicates that prices throughout the U.S. in 2004 for live young goats at auction ranged an average of $1.00 to $1.05 per pound with maximum prices around $1.40 per pound.

### *Consumption Trends*

An important aspect of marketing is identifying the specific target audience or target consumer for a product. One way to identify this target consumer is to analyze trends in consumption. Producers need to become familiar with who consumes goat meat, where those consumers are located and why they consume goat meat. Understanding the "who, where and why" will help producers in determining the ideal "what" for the consumer. In other words, this information should provide producers with insight as to the ideal product or meat goat to produce.

The majority of people who consume goat meat in the U.S. are from a variety of ethnic groups. Previous research indicates that the main ethnic groups who consume goat meat in the U.S. are Muslim, Hispanic/Latino, Jamaican/Caribbean, Asian, Italian and Greek populations (Larson and Thompson, 2005; Yang, 2003; Pinkerton, 1995). The predominantly white, middle-class population consumes relatively little goat meat (Pinkerton, 1995).

Ethnic populations are generally located in or near large metropolitan areas in particular regions of the U.S. As a result, goat meat is mostly consumed in the northeastern U.S. and along the east and west coasts where large metropolitan areas are more abundant (Schoenian, 2005; Pinkerton, 1995; Drinkwater et al., 1994). Other large metropolitan areas in the midwest such as Chicago, IL, Columbus, OH, Detroit, MI and Minneapolis, MN are seeing an increase in goat meat consumption (Larson and Thompson, 2005; Mangione, 2005; Ohio Cooperative Development Center, 2003). Similar trends are likely to occur in the Southeastern U.S. as the U.S. Census Bureau has documented rapid growth in the Hispanic/Latino population in this region during 1990 through 2004, and this growth is expected to continue into the foreseeable future.

Ethnic groups typically consume goat meat because of religious and cultural traditions. According to Pinkerton (1995), ethnic and religious practices identity a significant component of a consumer’s self concept. Ethnic consumers may try to maintain their ethnic identity through their traditions and religion which often dictates food preferences. Harwell and Pinkerton (1993) noted the consumption of goat meat is interwoven into the structure of religious observation and tradition. For example, the consumption of goat meat rises dramatically during traditional religious holidays such as Christmas, Easter and Ramadan in areas where certain ethnic populations exist (Pinkerton, 1995).

### *Target Audiences and Preferences*

Since the majority of goat meat consumers within the U.S. are from a variety of ethnic groups and religious backgrounds, these consumers have unique preferences for goat meat ranging from the type of live goat they want to purchase (from young milk-fed kids to older cull bucks or does) to different harvest and processing methods (religious rituals and/or custom harvest). Table 2 lists several ethnic and religious populations within the U.S. who may be a producer’s target audience. The table also lists the target audience, type of animal they prefer (size, gender and age), processing preferences and seasonal demand. Meat goat producers should familiarize themselves with the information in this table and further investigate preferences of their target audience to ensure that they produce the appropriate goat product.

**Table 2. Target Audiences for Goat Meat: Animal Type Preference, Processing Preferences and Seasonal Demand**

| Target Audience | Animal Type Preferences* | Processing Preferences | Seasonal Demand |
|---|---|---|---|
| Hispanics or Latinos | • Young milk-fed kids, cabrito, 15-25 lbs. live weight<br>• Young goats, 25 lb. carcass weight or 50 lb. live weight<br>• Young bucks, 65 lb. live weight | • Skinless<br>• Feet off<br>• Head on | • Cinco de Mayo<br>• Easter |
| Muslims | • 35 lb. carcass weight, 70 lb. live weight<br>• Lean carcass (discriminate against fat) | • Halal slaughter<br>• Slaughter and processing cannot be done in facility used to harvest swine<br>• Head on<br>• Skinless | • Start of Ramadan, Month of Fast<br>• Eid-al-Fitr, Festival of Fast Breaking<br>• Eid-al-Adha, Festival of Sacrifice<br>• Celebrate birth of child |
| Somalis | • 35-40 lb. carcass (Perceive larger carcasses are from older goats and therefore lack quality)<br>• Prefer grass-fed goats<br>• Prefer fresh meat over frozen | • Halal (but will sometimes accept Kosher)<br>• Slaughter and processing cannot be done in facility used to harvest swine | |
| Caribbean Islanders<br><br>(Haitians & Jamaicans) | • Mature bucks, 140 lb. live weight<br>• Older, poor-conditioned goats<br>• Young smelly bucks, 60-80 lbs. live weight | • Headless<br>• Skin-on<br>• Feet on<br>• Heavily singed<br>• "Cubed" bone-in meat | • Summer Months<br>• Jamaica's Independence Day (August 6th) |
| Chinese | • 60-80 lb. live weight | | • Winter – Chinese New Year |
| Jewish | • Young goats | • Kosher | • Passover<br>• Yom Kippur |
| Christian Roman/Western | • Young goats, 22 lb. carcass weight or 45 lb. live weight<br>• Milk-fed kids, 18 lbs. or more live weight | | • Easter<br>• Christmas |
| Christian Greek/Eastern Orthodox | • Young goats, 22 lb. carcass weight or 30-45 lb. live weight | | • Easter<br>• Christmas |

*Animal type preferences may differ within each culture/ethnic group depending upon seasonal demand.
Sources: (Gipson; Schoenian, 2005; Mangione, 2005; Larson & Thompson, 2005; Yang, 2003)

Table 3 provides a list of several ethnic holidays where goat is sometimes consumed. Meat goat producers should become familiar with the holidays that are important to their target audience. Different calendars are used by different groups to determine when holidays will occur. For example, Muslims use a lunar-based calendar, Eastern Christians (Greek) use the Julian calendar, and Western Christians (Roman) use a Gregorian calendar. More information on ethnic holidays can be found on-line at http://interfaithcalendar.org.

**Table 3. Holiday Calendar for Marketing Goats to Ethnic Consumers**

| | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Eid al Adha | Jan. 10*<br>Dec. 31* | Dec. 20 | Dec. 9 | Nov. 28 | Nov. 17 |
| Islamic New Year | Jan. 31 | Jan. 20 | Jan. 10 | --- | Dec. 8 |
| Chinese New Year | Jan. 29 | Feb. 18 | Feb. 7 | Jan. 26 | Feb. 14 |
| Start of Passover | April 13 | April 3 | April 20 | April 9 | March 30 |
| Christian Easter | April 16 | April 8 | March 23 | April 12 | April 4 |
| Orthodox Easter | April 23 | April 8 | April 27 | April 19 | April 4 |
| Cinco de Mayo | May 5 | May 5 | May 5 | May 5 | May 5 |
| Independence Day | July 4 | July 4 | July 4 | July 4 | July 4 |
| Jamaican Independence Day | Aug. 6 | Aug. 6 | Aug. 6 | Aug. 6 | Aug. 6 |
| Start of Rosh Hashanah | Sept. 23 | Sept. 13 | Sept. 30 | Sept. 19 | Sept. 9 |
| Yom Kippur | Oct. 2 | Sept. 22 | Oct. 9 | Sept. 28 | Sept. 18 |
| Ramadan Begins | Sept. 24 | Sept. 13 | Sept. 2 | Aug. 22 | Aug. 11 |
| Eid al-Fitr Ramadan Ends | Oct. 24 | Oct. 13 | Oct. 2 | Sept. 21 | Sept. 10 |
| Start of Hanukkah | Dec. 16 | Dec. 5 | Dec. 22 | Dec. 12 | Dec. 2 |
| Christmas | Dec. 25 | Dec. 25 | Dec. 25 | Dec. 25 | Dec. 25 |

*The Muslim Calendar is lunar based so this holiday actually occurs twice in the U.S. during 2006.
Sources: Maryland Small Ruminant Web Page at http://www.sheepandgoat.com/articles/ethniccalendar.html, Interfaith Calendar Web Page at http://interfaithcalendar.org.

### *Target Audiences in Tennessee*

It is not only important to know the tastes and preferences of the target audience, but also to consider the populations of this group as well as their geographic locations and income or buying power when evaluating demand. These population characteristics are indicators of market potential and important to know when developing marketing strategies.

In Tennessee, the largest and fastest growing ethnic minority group who consumes goat meat is the Hispanic[7] population. The resident Hispanic population in Tennessee grew 16.6 percent from the year 2000 to 2003. As of July 1, 2003, the United States Census Bureau estimated the resident Hispanic population in the state to total 146,000 persons. Projections by the Tennessee Department of Health predict this population to reach almost 230,000 by 2010.

The resident Hispanic population in Tennessee, however, is not evenly distributed across the state. Davidson County had the highest resident Hispanic or Latino population in 2003 with just under 32,000 persons (Table 4). Shelby County followed with 26,434 resident Hispanics. Rutherford County followed a distant third with just under 7,000 Hispanic persons. Hamilton, Montgomery and Knox counties each had over 5,000 resident Hispanic persons.

**Table 4. Top 10 Counties of Resident Hispanic Population, 2003**

| County | Resident Hispanic Population | | Rank (High=1) Resident Hispanic Population 7/1/2003 |
|---|---|---|---|
| | 7/1/2000 | 7/1/2003 | |
| Davidson | 26,401 | 31,976 | 1 |
| Shelby | 23,600 | 26,434 | 2 |
| Rutherford | 5,149 | 6,981 | 3 |
| Hamilton | 5,539 | 6,049 | 4 |
| Montgomery | 7,197 | 5,829 | 5 |
| Knox | 4,869 | 5,418 | 6 |
| Hamblen | 3,352 | 4,562 | 7 |
| Williamson | 3,257 | 4,064 | 8 |
| Bedford | 2,858 | 4,043 | 9 |
| Maury | 2,273 | 2,902 | 10 |

Source: U.S. Census Bureau. Annual Estimates of the Population by Race Alone and Hispanic or Latino Origin for Counties: April 1, 2000 to July 1, 2003. Available online http://www.census.gov/popest/counties/asrh/CC-EST2003-RACE6.html/. Accessed March 9, 2005.

There are limited current data as to the number of Muslims in the state of Tennessee. In 1990, the Muslim population was estimated at about 0.1% of the entire state population or about 4,877 Muslim people (Kosmin & Lochman, 1993). The majority of Muslim people were located near the larger metropolitan areas within the state such as Memphis, Nashville, Knoxville and Chattanooga.

[7] For simplicity, the term "Hispanic" is used to describe Hispanic and Latino.

***Willingness to Pay***

An important aspect of demand is the willingness and ability of a consumer to purchase a certain quantity of product at a particular price. The results of a focus group in Ohio and a study in Central Alabama may assist Tennessee producers in determining approximate prices consumers are willing to pay for goat meat.

A focus group on the growing Somali population in Ohio was conducted by the Ohio Cooperative Development Center (2003). The focus group consisted of two meat market owners (one male and one female), a male consumer of Halal[8] meats and a woman who works with Somali women and is a goat meat consumer. The Somalis indicated that they paid an average of $0.80 to $0.85 per pound live weight or $60.00 per head during 2003.[9] The focus group identified that these individuals were willing to pay an average retail price of $1.99 per pound for frozen goat meat and $2.99 per pound for fresh goat meat in 2003.

In Central Alabama, twenty grocery stores[10] were targeted for a study to determine the demand for goat meat in the area (Fraser, 2004). Samples of goat (burgers, barbecue, stew and curry) were prepared and transported to each grocery store site. One in five individuals asked to participate in the consumer demand study on goat meat agreed, resulting in a total of 101 participants. Of the 101 participants in the study, only 82 participants agreed to sample the goat meat. Fraser (2004) noted that the fact that only one in five people at the stores were willing to participate in the study and even fewer were willing to sample the goat meat shows a strong negative bias against eating goat meat by the average consumer. This may mean that consumption of goat by mainstream consumers is highly unlikely in the near future. Even so, the Central Alabama study shows a small segment of the population (generally consisting of ethnic groups and members of certain religions) has interest in buying and eating goat meat.

The Fraser study results indicate most participants (66 percent) were willing to buy goat meat from a grocery store, 14 percent of participants insisted on buying their goats from a local farmer and having the meat custom processed, while 20 percent preferred to purchase it from a meat shop. Forty-one percent of the tasters indicated holidays were the most likely time they would buy or be willing to buy goat meat (Fraser, 2004). The samplers were willing to pay a weighted average price of $3.25 per pound while some respondents indicated willingness to pay different prices for different cuts of goat meat (Fraser, 2004).

Both the Ohio and Central Alabama study show a range of prices that consumers are willing to pay at the wholesale and retail levels. Apparently, consumers are willing to pay

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[8] "Halal" describes meat harvested in the manner prescribed by Muslim law.
[9] Refer to product preferences in Table 2 for description of product traits desired by typical Somali consumers.
[10] Stores chosen were from locally-run franchises known to be responsive to consumer needs in large and small metropolitan areas as well as large rural communities. Most of the stores were in areas with a majority African-American population.

more for fresh product as compared to frozen. Meat goat producers need to make sure that they price their product at a price that is both high enough to cover their costs (and make some profit) and a price that their potential customer's deem fair and hence willing and able to pay.

## Marketing Mix Considerations

The marketing mix is a major component of a marketing plan which describes the methods that will be used to attract customers to an enterprise or product and make the transaction between the buyer and seller. The strategies developed and should be tailored to the specific target audience and the preferences of those customers and to meet the goal of the operation. Marketing strategies include the four Ps of marketing:

1. *product* definition
2. market channel or *place* to sell the product
3. optimal *price*
4. *promotion* of the product

### *Product*

Like other livestock species, goats may be marketed on a live basis or as meat products. The live animal may be sold as breeding stock, as a feeder animal to finish out for later harvest or as a slaughter animal to be taken to a processing facility. Goat meat is known as chevon, cabrito or goat meat. Chevon, a word of French origin, is a general term for goat meat from goats of any age. Cabrito, a term of Spanish origin, refers to goat meat from young kids.

Although most goats are eventually harvested for meat, there are several breeds that have been raised specifically for their meat. Several of these meat breeds have been marketed throughout Tennessee. Meat breeds include but are not limited to the Boer, Kiko, Spanish and the Myotonic (Wooden-leg, Stiff-leg or Tennessee Fainting) goat. Additionally, several breeds of dairy, hair and crossbred goats are marketed in Tennessee.

Meat goat producers may be more successful if they are able to produce the optimal product demanded by their target consumer. Producers must keep in mind that different ethnic groups have special product demands at different times of the year. Again, it is first important to know the target consumer and the product they prefer. For example, a meat goat producer interested in selling kids for the Easter market must first determine when he needs to have kids ready to sell. To do this, the producer must factor in the length of time to get the kid to an ideal weight as well as the time needed for gestation and breeding.

The Empire State Meat Goat Producers Association has developed a formula to help determine approximate breeding dates to have goats ready for particular markets and different seasons throughout the year. The formula allows producers to calculate the number of days on feed it will take for a kid to reach the desired final weight, given an estimated birth weight and average daily gain. Using the days on feed calculation, a calendar and a few other pieces of information, the producer can determine the estimated date on which to release bucks into the herd.

$$\frac{\text{(Final Weight – Birth Weight)}}{\text{Average Daily Gain}} = \text{Days on Feed}$$

Other information needed to calculate desired breeding date includes:

- Sale date (typically 10 to 14 days before the holiday/cultural tradition to allow for custom slaughter and processing)
- Desired final live weight (or carcass weight – goats typically have a dressing percentage[11] of between 35 and 55 percent with an average of 45 percent)
- Average pounds of gain per day (typically ⅓ to ½ pound per day, but varies by environment and breed)
- Birth weight (typically 6 to 8 pounds, but varies by breed and sex)
- Length of gestation (typically 150 days)
- Length of heat cycle for the doe is 18 to 21 days (bucks are typically introduced 10 to 12 days before the desired breeding date)

For example, Farmer Clark wants to have meat goat kids ready to sell to customers during the Easter holiday. Easter is on April 8 in 2007 for his target audience. Farmer Clark plans to sell the goats around March 28, 2007 so the goats can be processed in time for the holiday.

Farmer Clark has done the appropriate market research to find out local customers prefer kids weighing around 40 pounds live weight for Easter. Farmer Clark keeps good records and knows goat kids in the herd have an average daily gain of ⅓ pound per day and an average birth weight around 7 pounds. Using these three numbers, Farmer Clark is able to calculate how many days it will take to get a 7 pound kid to 40 pounds by March 28. Farmer Clark uses the formula to estimate the number of days the kids will need to be on feed to reach the desired weight:

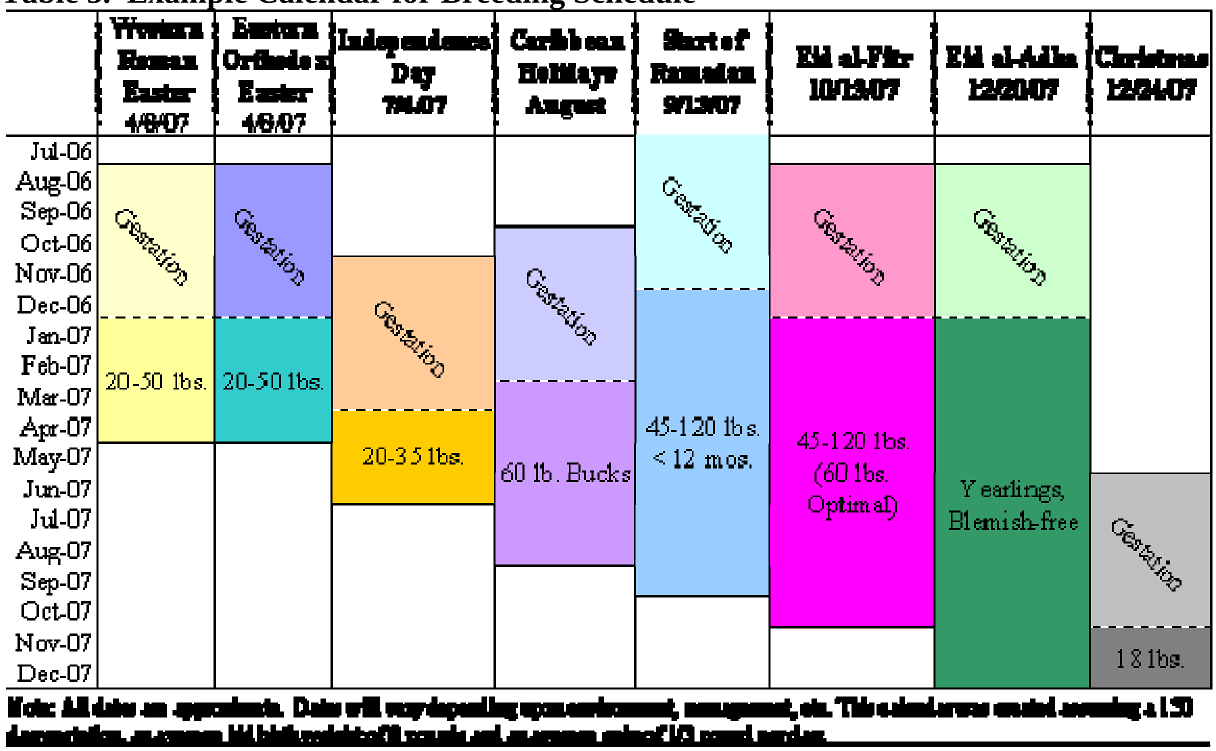
$$\frac{\text{(40 lbs final weight – 7 lbs birth weight)}}{\text{⅓ lb per day average gain}} = \text{99 days on feed}$$

The formula estimates it will take Farmer Clark approximately 99 days to get a kid weighing 7 pounds at birth to a final weight of 40 pounds. Farmer Clark works backwards through the calendar and determines that the dams in the herd must be kidding by December 19, 2006. Since the average gestation is around 150 days, Farmer Clark will need to make sure the does are bred by July 22, 2006. Farmer Clark will need to put bucks with the does the second week of July.

[11] Dressing percentage = (Hot Carcass Weight/Live Weight) x 100

A meat goat producer may want to develop a table like the example shown in Table 5 to determine the approximate breeding dates to produce the optimal product for their particular target audiences. Meat goat producers are encouraged to construct their own calendars using their own herd records or estimates for each variable.

**Table 5. Example Calendar for Breeding Schedule**




Grading Standards for Fresh Goat

Prior to 2001, there were no standardized grading criteria for evaluation of fresh goat and descriptions of goat meat cuts (Mattingly & Cox, 2001). By the end of 2001, however, the USDA-AMS announced a new Institutional Meat Purchase Specification (IMPS)[12] series for fresh goat. The IMPS Fresh Goat series establishes three grade levels for live slaughter kids based upon conformation or the amount of muscling of the animal. Live slaughter kids can be sorted into one of three grades: Selection 1, Selection 2 or Selection 3. Selection 1 kids are the most muscular and therefore deemed the highest quality. Selection 2 slaughter kids have average muscle conformation and slaughter kids which grade Selection 3 are considered to have inferior muscling.

In addition to selection criteria for live animals, the IMPS Fresh Goat series outlines detailed descriptions for goat products and establishes specific ordering options for purchasers through a codification system. The IMPS for fresh goat also contains a special requirements section which provides marketing options addressing class, breed type, forage type, organic certification and slaughter method preferences (Mattingly & Cox, 2001).

[12] The USDA AMS goat standards can be found on-line at http://www.ams.usda.gov/lsg/imps/imps11.pdf.

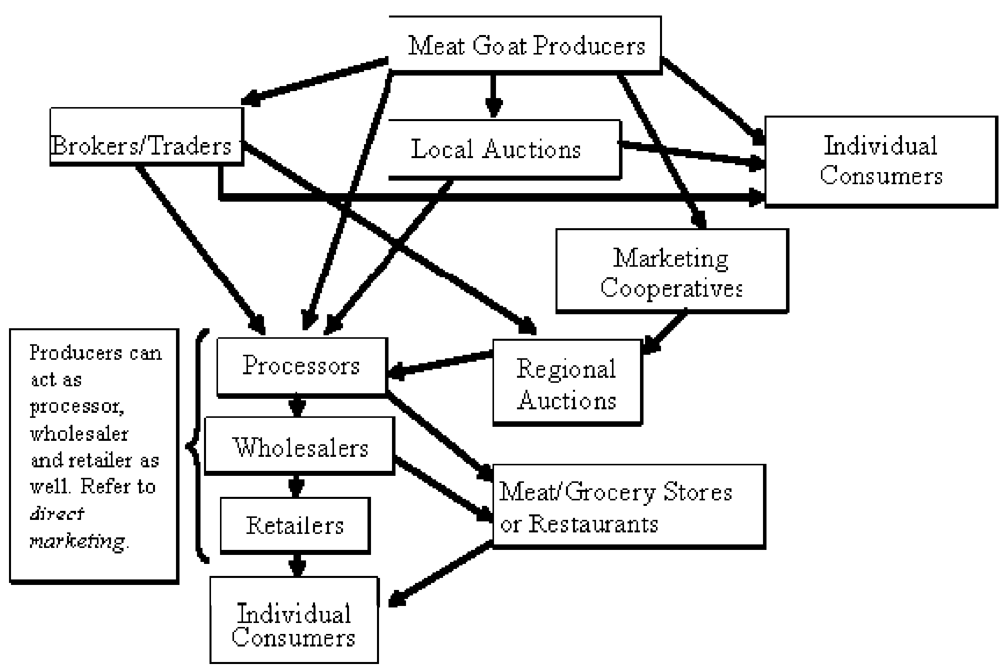
Implementation of the IMPS Fresh Goat series results in improved marketing efficiency as retail, food service and institutional buyers depend on the standardized code referenced IMPS item descriptions when they go to the marketplace to purchase meat items (Mattingly & Cox, 2001). It also improves the transmission of market signals to meat goat producers especially the ability to see that buyers pay higher prices for Selection 1 slaughter kids in comparison to both Selection 2 and 3.

***Market Channels (Place)***

The marketing channels for goats are similar to marketing channels for other livestock in the U.S., however the number of head sold at each level is quite different. In general, a greater portion of goats are sold directly off the farm or at auction in comparison to other livestock species (USDA-APHIS, 2005). Figure 9 illustrates the marketing channels for goats at all levels of the market from the producer to the end consumer.

Meat goat producers can market their goats to individual consumers, through a marketing cooperative, through local auction markets, to meat processors or to brokers or traders. The goats will then travel through the supply chain until the meat is purchased by the individual consumer. Meat goat producers may also fill the other roles in the supply chain and act as the processor, wholesaler and/or retailer as well by processing and marketing goat meat to meat shops, grocery stores, restaurants or individual consumers.

**Figure 9. Marketing Channel for Meat Goats**




Source: Adapted from Degner, R. (1996). *Marketing Goat Meat: A Persistent Challenge.* Proceedings from the Southeast Region Meat Goat Production Symposium. Tallahassee, FL. Pp. 1-3.

Direct Marketing to the Consumer

Direct marketing is one alternative in which the meat goat producer sells his meat goats or goat meat directly to the end consumer. Live goats may be directly marketed from the farm. This typically occurs by way of an on-farm visit where the customer chooses and purchases the live goat. The customer may then either take the goat to harvest or take it to someone else to do so. The producer may also deliver the live goat for the customer to a custom slaughter plant.

A producer may choose to market goat meat instead of live animals. In this case, the goats must be slaughtered, processed and packaged in a federally inspected facility and stored appropriately.[13] The meat may then be sold to end consumers through an on-farm retail market, area farmers' market or Web site. Producers may also decide to sell the meat wholesale to restaurants, grocery stores or specialty meat shops.

In recent years, many goat producers are seeing the advantage of marketing their meat goats directly to someone further down the supply chain (Larson & Thompson, 2005). The idea of eliminating the middlemen and switching roles from 'price-taker' to 'price-maker' is attractive to these meat goat producers. However, each middleman that is bypassed also represents a service that the farmer must be prepared to provide or contract for personally (Larson & Thompson, 2005). Farmers must determine whether or not the benefits of direct marketing outweigh the costs associated with the extra time and management required.

Successful direct marketing is often the result of hard work, good planning and marketing savvy (North Carolina Farm Bureau, 2004). For this reason, it is important to focus direct marketing efforts on the most receptive audiences. Meat goat producers must conduct market research and become familiar with the demands by their potential customers. Finding and keeping the appropriate market outlet or target audience is important and will decide the producer's success or failure in meat goat marketing.

Although there are many advantages to direct marketing, several disadvantages also exist. One disadvantage of direct marketing to consumers is that the producer must be able to deal with customers. Meat goat producers who are uncomfortable dealing with their customers will most likely prefer another marketing method. Direct marketing may require customers to visit the farm which may add to farm liability risk. Cultural differences may make transactions difficult, and language barriers may exist. In addition, on farm sales may be seasonal with the majority of farm visits occurring a few days before specific holidays (Stanton, 2000). Another challenge to direct marketing is trying to find local customers. Meat goat producers who do not have access to local customers may need to find another alternative to market their goats instead of directly off the farm.

Dr. Tatiana Stanton, sheep and goat Extension associate at Cornell University, (2000) writes that meat goat producers whose farms are located near large metropolitan areas with ethnic populations generally have more success at direct marketing. It is often

[13] More information about regulations related to this topic is discussed later in the chapter.

important for the meat goat producer to establish a relationship with his customers and allow them to come to the farm to select the goat they would like to purchase (Stanton, 2000).

## Auctions

A large number of goats are sold through auctions. Auctions provide a convenient sale for the producer, but producers incur more risk because the price they receive depends largely on the supply of other goats for sale as well as the competition among buyers.

According to Stanton (2000), producers may be able to improve their chances for a greater price by attending sales that specifically sell goats. Auctions that sell specifically goats and those that are graded may also improve the chances for a better price. As of September 2005, the Tennessee Livestock Producers hosts two graded goat sales in Tennessee with one in Thompson Station and the other in Somerville.

Goat producers may also improve their price opportunity by doing research on historical price and supply data from the auction barns. Producers who sell their goats during periods of high demand such as those seen during particular ethnic holidays may receive higher prices. Additionally, producers who sell their goats when quantities of other goats are low will generally receive higher prices as well.

## Brokers/Traders

Brokers or order buyers buy livestock for a fee for others in the marketing chain such as feeders, live markets, and processors. Traders buy and re-sell livestock to make a profit on price and weight differences.

Darrell Ailshie, manager of the Tennessee Livestock Producers, has known of a few producers marketing their goats to brokers but says this does not happen very often. Marketing to brokers or traders is difficult for individual producers to generate a high enough quantity of goats to meet the brokers' demands. Typically, brokers and traders in Tennessee attend the graded goat sales so they can purchase a high enough quantity to fill their orders.

## Collaborative Arrangements for Meat Goat Producers (Cooperatives and/or Alliances)

A collaborative arrangement among meat goat producers requires agreement among members to work together, for an extended period of time to achieve a common goal. A meat goat producer may find numerous opportunities for collaborating with other producers. A collaborative arrangement among producers may be beneficial by allowing for cost savings or higher revenues.

Collaborative farmer groups are usually not quick or easy to establish. Successful collaborative efforts take a great deal of time, commitment, communication and planning. Development of collaborative farmer ventures usually begins when a group of farmers with similar issues or challenges begin to look for ways to achieve together what seems impossible or impractical alone. It may be difficult for individual goat producers to maintain a constant supply of product which is often necessary for optimal efficiency in processing, transportation and marketing.

Farmers that seek to have more control over the success of their operation or industry often look to a collaborative venture as a possible solution. Collaborative ventures can provide group strength in negotiating terms of sale with buyers. Collaborative farmer arrangements can be as simple as pooling goats for sale in larger lots to creating a legal processing cooperative to operate a harvesting and processing plant and marketing a branded meat product.

Collaborative meat goat ventures may take on many forms including legally organized cooperatives, associations or alliances. Legally organized cooperatives are often developed to address issues which require capital investments, handling of money, significant legal issues or a bona-fide cooperative structure. Associations are often developed as a means of formalizing collaborative promotion programs, educational and networking opportunities and public relations activities. Alliances are often developed for the purpose of developing a structure to pool goats from several producers and then market larger, uniform lots of goats to buyers. Marketing alliances provide a "strength in numbers" opportunity and oftentimes create new marketing opportunities for small-scale producers.

### *Price*

Price is an important aspect of marketing and is determined by the laws of supply and demand. Price is derived, however, in different ways depending upon the marketing channel.

At an auction for example, the price is determined by buyers bidding on a specific product. The producer can influence the price received by the type and quality of animal offered for sale which is influenced by genetics, production and management practices. The producer can also influence price by marketing the goats through the auction at a time when demand for goats is higher.

Producers direct marketing goats or goat meat will need to set prices for their products, and setting prices can be complicated. The price should be set high enough to cover producers' costs and earn a profit and still be low enough for consumers to be willing and able to pay. This will be influenced by costs of production[14], competitor pricing, quality of product, customer preferences, relationships with customers and many other factors.

Pricing may be complicated by other factors as well. Prices for goats sold off the farm may vary widely among producers. In addition, goats may be priced in a variety of ways including price per head, price per pound of live weight, price per pound of carcass weight or price per pound of meat. Producers should determine the pricing method that

[14] Refer to the economics chapter for a sample budget.

works best for their operation. Goats sold at auction are typically priced per pound of live weight or per head. Goats sold directly from the farm can be priced per head or per pound of live weight. Goats sold from the farm but taken to a custom slaughter facility may also be priced per pound of carcass weight. Goat meat sold directly to consumers may be priced per pound of carcass weight if a whole or half carcass is sold or per pound for particular cuts.

Stanton (2000) recommends that producers have a fixed price for all on-farm customers unless they like to bargain. Producers who do bargain must remain consistent with all of their customers because customers who feel they have been treated unfairly will tell their neighbors within their community and it will reflect negatively on the producer.

Producers should consider varying the price of certain goats dependent upon different size, age and quality characteristics. However, if producers choose to vary their prices, they must effectively communicate to their customers why certain goats are priced differently than others (Stanton, 2000).

### *Promotion*

Promotion is vital to building the perception customers have of the product being offered. Promotion is not only advertising, but incorporates several communication methods to inform potential customers about a product. Promotion includes advertising, word of mouth referrals, public relations and sampling of products. Having a well-developed and quality Web site can also be an effective promotion tool.

#### Advertising

Advertising is a relatively well known method of promotion. However, advertising can be expensive, and it can be difficult to measure its success. Producers who are considering doing some advertising should try to find the method that will best reach the desired audience. The following are a few tips for advertising:

- Place ads in local newspapers (especially those newspapers with an ethnic audience)
- Place ads in trade publications such as *The Goat Rancher* or *Meat Goat Monthly* if appropriate to the target audience
- Place flyers with details about the farm and goats for sale in areas frequented by potential buyers (i.e. ethnic grocery stores, local college/university, laundromat, factory that employs a large number of ethnic workers)
- Consider translating advertising materials into the primary language of the target audience

#### Word of Mouth Referrals

Positive word of mouth referrals can be an effective promotional tool. Meat goat producers should remember to encourage their satisfied customers to tell their neighbors, family and friends about your operation and product.

Personal relationships are extremely important to some ethnic groups. A meat goat producer targeting an ethnic group for the first time should consider arranging a meeting with key leaders within an ethnic community to help spread the message about the product (Stanton, 2000).

Public Relations

Building positive public relations are integral to the success of many businesses, and this is the same case for farmers marketing goats. Meat goat producers should strive for strong positive relations within the goat industry from members of the local ethnic community to fellow meat goat producers. Some tips to help build positive public relations include:

- Submit press releases with photos of your farm and farm products to magazines, radio, newspapers and associations followed by the target audience
- Write articles for trade publications
- Maintain a mailing list of past customers and/or interested persons and send newsletters or updates about the farm and goats for sale
- Attend goat shows, seminars and field days to interact with people who are interested in goats
- Consider donating a goat at a field day or youth event to receive positive recognition and good will
- Consider becoming a member of one of many meat goat associations throughout Tennessee and the U.S. such as: International and American Boer Goat Associations, American Kiko Goat Association, American Meat Goat Association, American Tennessee Fainting Goat Association, Tennessee Valley Goat Association, Tennessee Goat Producers Association, Middle Tennessee Goat Association and numerous others

Web site

Since computer technology and the Internet are becoming a part of more and more people's lives, a Web site could be an effective promotional strategy. A Web site will enable a producer to display pictures of the farm and goats as well as communicate to potential consumers. Meat goat producers with limited computer experience may want to hire a Web site designer to help them develop a high quality Web site. It is important to keep all of the information on the Web site current. In addition, a map with clear directions to the farm as well as contact information for the farm will be very useful to potential customers.

## Regulatory Considerations

By direct-marketing goat meat and, in some cases, live animals, farmers will likely encounter an additional realm of regulatory questions and issues. It is important for producers to fully investigate all regulations associated with their operation.

*Disclaimer: The information contained in this section is for educational purposes only and is not an interpretation of laws or regulations. The information is deemed correct and accurate to the best of the ability of the authors and reviewers, based on information utilized at the time of their review. Laws and regulations are often enacted, repealed and amended.*

### *Direct-Marketing of Goat Meat*

Meat sold in the U.S. is required to meet or exceed federal meat inspection standards, administered by the USDA Food Safety and Inspection Service (FSIS). Although states are allowed to administer state-inspection programs for meat sold within state lines, Tennessee has opted to utilize the federal inspection program for meat intended for sale both intrastate and interstate (Dalton et al., 2003).

The federal meat inspection and food standards require meat sold to be harvested, processed and packaged in consumer packaging in a USDA-inspected facility. The product must also be labeled with the product name and ingredients, source or farm name and address, net weight and the USDA seal. Packaging must also include safe handling information.

Direct marketers of meat are also required to obtain the proper permits from the Tennessee Department of Agriculture Regulatory Services. Producers retailing goat meat directly to consumers are required to obtain a retail permit. Producers wholesaling meat to distributors, grocery stores or restaurants are required to obtain a wholesale permit. If the product is stored somewhere other than the USDA-inspected facility, a warehouse license may be needed (Sanford and Woodson, 2005).

Specialists with the University of Tennessee Center for Profitable Agriculture surveyed 10 USDA-inspected slaughter facilities in the state who indicated they harvested animals for the public (Dalton et al., 2003). Goat harvest was conducted at seven of the facilities, which indicated a total of 1,612 goats slaughtered at those facilities during the year. The facilities reported slaughter fees for goats between $20 and $50 per head and processing fees of $0.30 to $0.50 per pound (carcass weight). Additional results from the study including a directory of the facilities participating in the study are available on-line at http://www.utextension.utk.edu/publications/pbfiles/PB1727.pdf.

Not all slaughter facilities are USDA-inspected. A facility may be exempt from USDA inspection when the facility offers slaughtering and/or processing services on a *custom* basis. These facilities are referred to as *custom-exempt*. Custom-exempt facilities slaughter or process animals owned by someone other than the establishment and when the products will not enter into commerce. For example, an individual may purchase a goat from a farmer and have the goat slaughtered and processed at a custom-exempt facility in order to have meat for the individual's use at a holiday celebration. The individual would not, however, be legally able to take that meat and sell it. Custom-exempt facilities, although exempt from USDA inspection, are subject to regulation by the state Department of Agriculture. The custom-exempt regulations are similar to the federally-inspected requirements, and the custom-exempt facilities must meet the same Good Manufacturing Practices (GMPs) as the federally-inspected facilities (Dalton et al., 2003).

Direct marketing of food products introduces farmers to additional liability risk. Farmers should assess and develop methods to manage this risk, which may include the purchase of food product liability insurance.

### *On-Farm Harvesting*

When selling live animals from the farm, producers may be faced with questions related to on-farm harvesting. At least two questions may arise: 1) Can the producer/landowner legally harvest the animal for the customer? and 2) Can the customer legally harvest the animal on the farm?

In the first case, the farmer cannot legally harvest and/or process the animal for the customer's use. The activity of the farmer would be considered *custom* harvest. To enable the farmer to conduct slaughter, (s)he would need to have the necessary facilities and be in compliance with the Department of Agriculture's regulations for a custom-exempt slaughter facility, including the federal Good Manufacturing Practices. The facilities necessary will depend upon the specific activities to be conducted. Producers interested in learning about the facility requirements should contact the Tennessee Department of Agriculture Regulatory Services for more information. The GMPs are listed in University of Tennessee Extension publication PB1399 called *Getting Started in a Food Manufacturing Business in Tennessee* (pages 18-30), and is available on-line at http://www.utextension.utk.edu/publications/pbfiles/pb1399.pdf.

Facilities that manufacture, process, pack or hold food for human or animal consumption in the United States must also register with the Food and Drug Administration (FDA) as required by the *Public Health Security and Bioterrorism Preparedness and Response Act of 2002*. The registration process provides FDA with information on the business including names and contact information of responsible persons and products produced. Registration can be accomplished on-line at www.fda.gov or through the local FDA office. There is no fee for registration.[15]

In the second case, that of whether the customer can legally harvest the animal on the farm, no Department of Agriculture regulations related to slaughter or inspection exist. Questions remain as to the requirements or recommendations for disposal of offal and other environmental regulations and as to product and landowner liability. The farmer may be taking on additional liability risk in the event of an injury to a customer during the harvest process or sickness of the customer due to consumption of the meat product (Sandford and Woodson, 2005).

[15] Morris, William C. *Getting Started in a Food Manufacturing Business in Tennessee*. University of Tennessee Extension Publication PB1399. Revised June 2005.

## Conclusions

Marketing of meat goats or goat meat is an important consideration for meat goat producers. It is more than the reactive action of selling goats whenever they reach a certain weight. Marketing should be a proactive activity and should include the identification of a target audience and use of knowledge of that market's needs and preferences to drive the definition of the product, choice of market channel, pricing considerations and promotional methods.

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# STATUS OF THE TENNESSEE GOAT INDUSTRY

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Goats are an environmentally adaptive specie of livestock, extremely opportunistic and afford the small limited resource landowner(s) an alternative enterprise. The goat provides food security, high quality protein (for human nutrition), biological land enhancement and many ‘value-added’ products to increase revenue generated on a holistically sustainable rural farm.

Meat goat numbers have been significantly increasing within the US since the early 1990's but goat meat consumption has surpassed available supply, based on ethnic group statistics. The importation of goat meat (30 pound carcass equivalent) surpassed exported in 1994. There is no longer an export value for goat meat; the import value has tripled (Pinkerton, Nuti and McMillin).

Goat production plays a major role in changing farming systems and economic transformation. With the decrease in planted tobacco acreage and income from this traditional crop, the production of goats becomes a natural alternative. Another example is that hog numbers have plummeted drastically since the mid-1980’s yet those facilities are still functional on many farms; the structures and land being readily adapted to meat goat production.

Tennessee State University and the University of Tennessee have recognized that goat production is increasing on small rural farms. This increase in goat numbers ranks Tennessee second in the US with a major concentration of goats in middle Tennessee (Census 2002). An extension specialist position has enabled the universities to: a) target major production management weaknesses; b) establish a producer data base in TN (635 individual farm families in the 95 counties to date) and surrounding states; c) disseminate pertinent information on a timely basis and d) establish a demonstration herd of goats at the Cheatham County River Road Extension and Research Farm near Ashland City.

County agent based program presentations and farm visits were conducted in 22 counties in Tennessee with 369 people attending. Statewide programs reached 981 people, national and international seminars and conference presentations had 319 in attendance. Throughout the year, relevant small ruminant presentations attracted 560 individuals from various ethnic backgrounds and diverse production management operations. And, a survey was conducted (Peischel 2004) to obtain input for future meeting topics and insight into producer challenges and management production practices.

Goat producers that have attended educational meetings and participated in a survey noted their major goat production challenges (in order of priority) as: 1) health maintenance and disease management, 2) marketing, 3) forages and pasture management, 4) internal parasite control, 5) economics, 6) breeding stock procurement and genetics, 7) nutrition, 8) general management, 9) dairy goat production, 10) reproduction, 11) anatomy and physiology, 12) housing and equipment, 13) predation control, 14) goat products and value-added incentives and 15) land base security.

Healthy goats are an asset and an economical advantage to a business. Purchase healthy goats with a herd health maintenance program already in place. Stress, an important factor to minimize, has an effect on the goats' susceptibility and/or resistance to disease. Having a biosecurity program outlined and enforced on your farm will help minimize transmissible diseases.

Marketing has been an overlooked factor when considering a meat goat business. The demographics of an area need to be assessed, as do consumer requirements and infrastructure (slaughter/processing, storage/transport), before making production decisions. There are many products to market from a meat goat enterprise: a) live goats as breeding stock, seed stock and stockers, b) land enhancement through land rejuvenation, pasture restoration, weed abatement and forest health, c) increasing water quality through stream bank enhancement and riparian area restoration, d) increasing wildlife habitat, duck flyways, e) meat as live animal sales, niche and direct marketing, f) value-added goat products (deli meats, soap) and g) other pursuits (leather, farm stays, fibre) – the list is endless.

Pasture management and the production of forage-fed goats are vital to the financial success of a business. The goat prefers to select 90 percent of its' diet as brushy vegetation and forbs and only 10 percent as grass. Therefore, through management, the producer needs to retain mixed specie vegetation in pastures. Research has shown that plant (sericea lespedeza, trefoil, chicory, plantain, etc.) species high in condensed tannins can function as natural dewormers (Min 2003).

Internal parasites have been noted throughout the state as a major factor in increased monetary expense, labor input and loss of goats. By maintaining a pasture height of more than 6 to 8 inches and managing the pasture based upon the growth of the vegetation, it is possible to regain control of the health of the goats. Increasing the plane of nutrition, scoring body condition and doing fecal analysis more than four times a month will help immensely.

Understanding economics – knowing that you have a financial plan, a valuation of all stock and the business itself, a profit and loss statement so gross margins can be assessed – is as important in meat goat production as it is in other businesses. A business analysis will help to establish the gross revenue generated from each business or enterprise along with the cost of generating that revenue. It will evaluate the net profit for each enterprise and determine if a reasonable return for time spent has been obtained. By diligently completing a business analysis, an in-depth understanding of effectiveness and options available becomes clearer.

There are more small ruminant producers beginning to use livestock guardian dogs with their goats and sheep. The breed of guardian dog selected should be based upon the type of predator in the geographic area, the environment and the topography. With the concern of scrapie in the US, it is advised that the dogs be fed a non-meat additive dog food.

Portable shelters of all types are gaining in popularity as they can be easily moved to take advantage of rotational grazing.

Sixteen meat processing facilities were identified with 14 confirming their USDA-inspected facilities status. Of the 14, only 10 provide USDA-inspected slaughtering for the public. And, of the 10 USDA-inspected slaughter facilities, only 6 slaughter goats (2 in middle, TN with 2 each in the east and west region of the state (Holland 2003). It was interesting to note that slaughtering capacity is in excess at the present time, compared to actual number of head slaughtered (25,447 head of goat capacity vs. 1,612 head of goats slaughtered).

Four USDA inspected goat-processing facilities across the state are using Islamic (Halal) approved methods during slaughter (Baker 2004). This is critical as various ethnic populations of Tennessee are increasing and they are the major consumers of goat meat. Ethnic groups of notable populations are Muslim, Asian, and Hispanic. The Hispanic population of Tennessee has increased 284 percent (US Census Bureau) between 1990 and 2000. Other ethnic groups whose populations consume goat meat are Greece, the British Isles, South Africa, Italy, Portugal, Caribbean, etc. According to (Cupit 2003), the Nashville's Farmers Market has a strong international connection with 25 nationalities among vendors who cater to an ethnic audience.

There are livestock sales facilities scattered throughout the state selling various classes of goats (Somerville, Savannah, Knoxville, Thompson Station, Lewsiburg, etc.) with Thompson Station being noted as a preferred graded sale. Since Tennessee is a long, narrow state, producers use various livestock auction sale barns that border the state (AL, KY, MS and VA). Other opportunities for producers to pursue to sell goats are Tel-O-Auctions, video sales, alliances, and niche and direct marketing.

At this time, there is minimal distribution of goat meat and value-added products into super markets or restaurants of non-ethnic background. Goat meat is considered a lean, red, healthy meat (USDA) and since more Americans are becoming health conscious, the natural market is slowly opening up.

| Cabrito (the Healthy Red Meat) | | | | | |
|---|---|---|---|---|---|
| Roasted (3 oz) | Calories | Fat(g) | Saturated Fat(g) | Protein(g) | Iron(g) |
| | | | | | |
| Goat | 122 | 2.58 | 0.79 | 23 | 3.2 |
| Beef | 245 | 16 | 6.8 | 23 | 2.2 |
| Pork | 310 | 24 | 8.7 | 21 | 2.7 |
| Lamb | 235 | 16 | 7.3 | 22 | 1.4 |
| Chicken | 120 | 3.5 | 1.1 | 21 | 1.5 |

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Chapter Two

# PART I: BUSINESS AND FINANCIAL PLANNING AND MANAGEMENT FOR MEAT GOAT OPERATIONS

John Campbell, Rob Holland and Aaron C. Robinson

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The central economic issue for the manager of a meat goat enterprise is to produce products at a cost low enough and sell products at prices high enough to generate a profit. A key issue with this equation is for managers to know their cost of production and fully understand their market opportunities. Success will involve appropriate business planning; record keeping and analysis; risk management; whole-farm financial analysis; enterprise budgeting; and evaluation, using appropriate performance measures.

## Business Management and Planning

### Overview

Operating a successful business requires solid business planning and management. This is true for large businesses, small businesses, rural businesses and farm businesses. Increasing competition in a global economy, quickly changing consumer preferences, new production techniques, environmental responsibilities, rapidly expanding and adopted technology, tight profit margins and innovative marketing opportunities require that farmers exercise sound business management and marketing techniques.

Most successful businesses have some type of business management plan. Many management plans are written in great detail and conform to a fairly standard business plan format. Formal business plans are helpful and oftentimes required when seeking outside funding from a bank or other lender of capital. Whether it is a formal written business plan that includes the generally accepted business plan sections or a more informal scheduling plan, the planning process has proven to be an important function for successful businesses and farm enterprises.

Goat producers should make overall business planning a routine part of the management of their enterprise. It is often a natural tendency for farmers to spend a significant amount of their time and resources conducting "production" activities. However, like other successful business operators, successful farm managers find a way to balance their time between production, marketing and financial management.

Managers of many failed businesses mention "lack of capital" as a primary reason for business failure. However, because businesses often do not adequately plan, additional capital often just postpones the eventual failure of the business. In fact, improper or a total lack of planning is the primary reason for business failures.

### Mission, Goals & Tactics

At the basic level of planning, managers of meat goat enterprises should determine the overall mission of the enterprise. The mission should clearly state why you have the enterprise and how raising meat goats fits with your personal and professional priorities. The mission statement should be written and carefully worded to provide an adequate description of the role and reason for your involvement with meat goats.

Once the overall mission of the meat goat enterprise is described, specific goals of the enterprise should be drafted. Goals for meat goat enterprises should be concise statements that describe certain performance measures which, once achieved, will help meet the overall mission of the enterprises.

Goals for meat goat enterprises should be "S.M.A.R.T," which means they should have five basic components. S.M.A.R.T goals should be Specific, Measurable, Attainable, Rewarding and Timed.

**S**pecific - - goals should be well-written, concise, straightforward and definitive.
**M**easurable - - goals should be measured in quantitative terms so progress can be monitored.
**A**ttainable - - goals must be achievable and not in conflict with other goals.
**R**ewarding - - the achievement of a goal should be rewarding in some way.
**T**imed - - goals should have a time limit for achievement.

When writing S.M.A.R.T goals for a meat goat enterprise, it is often helpful to begin each goal statement with an action word such as "provide," "increase," "create," "ensure" or "develop." Consider setting goals for certain levels of sales, production and profit.

Once performance goals have been identified, specific tactics or action steps should be identified. Tactics are the day-to-day operational details that will be performed to achieve the enterprise goals. Tactics are the production and management activities that must be performed to run the enterprise and meet the goals. Tactics are the items that appear on the farm manager's "to-do" list.

Following is a worksheet to assist in developing a mission statement, goals and tactics for a meat goat enterprise.

Mission Statement:

Goals:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Tactics:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

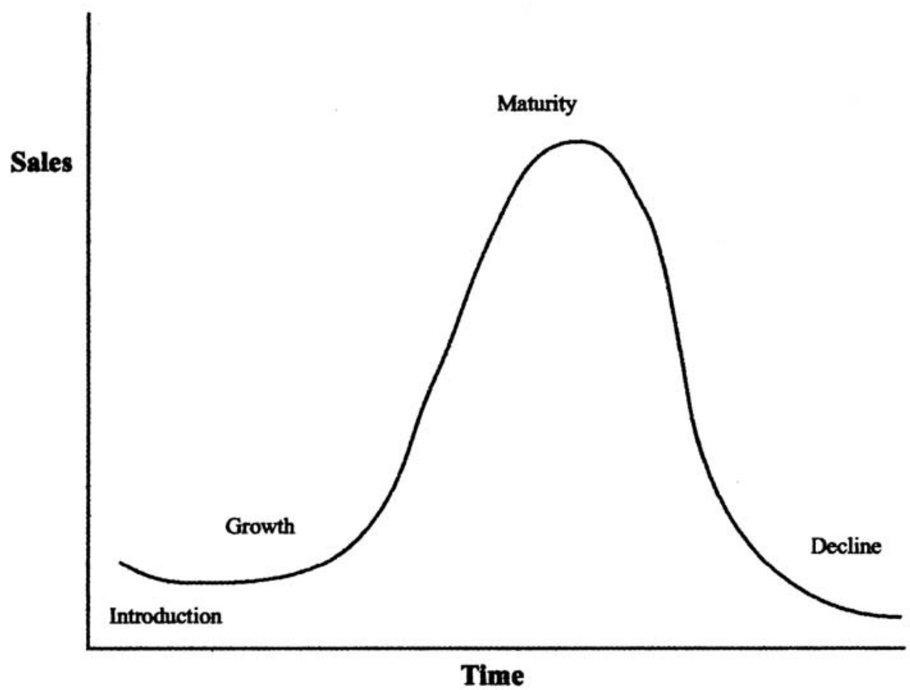
______________________________________________________________________

______________________________________________________________________

**Business Life Cycle**

Goat farmers need to be aware that it takes more than a good idea to achieve success. The old adage "people don't plan to fail, they fail to plan" often holds true for new livestock enterprises. Goat farmers must plan for success. While no one should start a new farm enterprise prepared to fail, adequate planning should be invested in developing procedures or an exit strategy to implement if things do go wrong. Every enterprise has a life span that is depicted by its business life cycle. A business life cycle is normally defined by four stages: introduction, growth, maturity and decline. Figure 1 depicts the four stages of a typical business life cycle with regard to the introduction, growth, maturity and decline in sales over time.

**Figure 1. Four Stages of a typical Business Life Cycle**



Some business life cycles will experience a slow introduction and growth stage, a short maturity stage and a rather quick decline stage. It is important to understand the typical cyclical life span of a small business. During the introduction and growth stages, many new farm enterprises often do not generate sufficient net income to serve as a family's only source of income. Sometimes, enterprises do not even remain at maturity long enough or while at maturity may still not provide adequate levels of net income. Therefore, other sources of income are often necessary. Unfortunately, many businesses enter the decline phase shortly after introduction. A management objective should be to maintain the enterprise in the maturity stage for as long as possible.

Studying the reasons for most business failures can be helpful in extending the life cycle of a goat enterprise. Following is a list of 10 leading causes of business failures.

1) Insufficient business/enterprise planning
2) Lack of adequate capital in the start-up and growth stages
3) Going into business for the wrong reason
4) Manager gets worn out and/or underestimates the time requirements
5) Family pressure on time and money
6) Being at the wrong place at the wrong time
7) Lack of market awareness
8) The manager falls in love with the enterprise and cannot make objective decisions
9) Lack of financial responsibility and awareness
10) Lack of a clear focus

## Business Plan

Proper identification and written descriptions of a mission, goals and tactics for a meat goat enterprise will provide a strong foundation for the development of a complete business plan. Additional steps involved with proper enterprise planning includes conducting market research, identifying the target market and developing a multi-year financial plan that includes an analysis of start-up costs, annual cash flow statements, income statements, balance sheet and enterprise budgets. All of these activities are easily documented in a written business plan.

A business plan provides a structure that guides the business planning and on-going business management process. A written business plan is a tool that describes and defines the many details of a meat goat enterprise. A good business plan can help identify potential business-failure characteristics and improve the chances for business success. A business plan is a road map that identifies business goals and presents a plan for achieving them.

Development of a business plan should be a basic management practice for goat producers. A business plan does not have to be long nor expensive, but it does require an investment of time and attention. A business plan should provide a detailed description of the business operations, including the key sections outlined below.

## Example Business Plan Format

Overall description of the business
- Definition of the business / history
  - Mission
  - Goals
  - Tactics
- Legal business structure/organization
- Future plans

Management overview
- S-W-O-T analysis (Strengths-Weaknesses-Opportunities-Threats)
- Organizational structure
- Personnel
- Labor costs
- Job descriptions
- Insurance
- Operational guidelines

Description of the products planned to market
- Product lines
- Niche product potential
- Sources of supplies, costs

Market analysis and development of marketing strategies
- Description of the market conditions
- Marketing methods planned
- Target markets
- Competitor analysis
- New market opportunities

Financial plan
- Past/historical financial statements
- Balance sheet
- Financing plan
- Pro forma income statements and cash flow statements
- Enterprise budgets
- Start-up cost estimates
- Break-even analysis

Other
- Exit strategy
- Tax returns
- Legal documents
- Contracts and agreements
- Other supporting documents

## Obtaining Financing

Insufficient planning and lack of capital are the most frequently cited reasons that businesses fail. Whether you are starting or expanding a goat enterprise, sufficient capital is essential. However, it is not enough to simply have sufficient capital -- knowledge and planning are required to manage it well. These qualities ensure that entrepreneurs avoid common mistakes like securing the wrong type of financing, miscalculating the amount required or underestimating the cost of borrowing money.

Before inquiring about financing, ask yourself the following:

- Do you need more capital or can you manage existing cash flow more effectively?
- How do you define your need? Do you need money to expand or as a cushion against risk?
- How urgent is your need? You can obtain the best terms when you anticipate your needs rather than looking for money under pressure.
- How great are your risks? All business enterprises encounter risks, and the degree of risk will affect the cost and availability of financing alternatives.
- In what stage of development is the enterprise? Financing needs are often most critical during start-up and transitional stages.
- For what purposes will the capital be used? Most lenders require that capital be requested for very specific needs.
- What is the general status of the overall industry for your enterprise? Depressed, stable or growth conditions require different approaches to financial needs and sources. Businesses that prosper while others are in decline will often receive better funding terms.
- Is your financial need seasonal or cyclical? Seasonal needs for financing generally are short-term. Loans for cyclical industries are designed to support a business through depressed periods.
- How strong is your management team? Management is one of the most important elements assessed by financial sources.
- Perhaps most important, how does your need for financing mesh with your business plan? Most lending sources will use your business plan to see how the enterprise will function in the start-up and growth stages.

Significant start-up costs can make the early days (and years) of a new enterprise stressful. It takes time to get an enterprise off the ground. Successful and non-successful ventures often appear similar in the early months, but some start making money before others, while some businesses never make money.

Funding for an enterprise comes from either one or a combination of two primary sources - equity and debt. Equity is the owner's contribution to the start up of the enterprise. Equity is the money that stays in the business and does not have a definite repayment schedule. Equity is a critical component of an enterprise that is in need of additional funds.

Debt funding (or a loan) is critical for enterprises that do not have sufficient equity to finance the business needs. Loans are generally set-up with a fixed payment schedule. As a general rule, lenders may require that equity represent 25 to 50 percent of the total start-up costs for a new business. The most common source of equity is from the owner, but may also originate from friends and family. Loans are generally obtained from commercial banks, government agencies or some other third party that sets a specific repayment schedule. Loans may be secured or non-secured. Non-secured loans are based entirely on the borrower's financial strength and past performance. Secured loans require that assets be used as collateral to secure the loan.

Funding for enterprises most often comes from personal investments, lending institutions, friends and relatives, outside investors, government agencies and other sources. As Table 1 shows, the money to start a new enterprise most often comes from personal resources, commercial lending institutions and friends and relatives.

**Table 1. Sources of Start-Up Capital for Entrepreneurs Starting a New Business Venture**

| Source of Capital | | Start New Business |
|---|---|---|
| **Personal resources** | | *60%* |
| **Commercial lending institutions** | | *23%* |
| **Friends & relatives** | | *9%* |
| **Other sources** | | *4%* |
| **Outside investors** | | *3%* |
| **Government agencies** | | *1%* |

*Personal investment* is the most-often used source of capital for new enterprises. It is estimated that personal resources are responsible for 60 percent of the capital for new business ventures.

*Commercial lenders* generally offer two types of loans for new enterprises – term loans and line-of-credit. Term loans are generally for fixed asset loans; that is, they are used to purchase real estate and equipment. The loans are collateralized with the assets purchased. As such, lenders generally extend a loan for a percentage of the value rather than full value for the goods. Such loans usually take the form of installment loans with regularly scheduled payments over a fixed period of time. A line of credit is often used to satisfy the working capital needs of an enterprise. Funds from a line of credit may be used to purchase inventory, take purchase discounts, make payroll and purchase required inputs. While some lenders may take accounts receivable and inventory as collateral, be prepared to use additional assets to secure these loans. Borrowers are expected to pay off seasonal lines of credit at least once a year. Small business borrowers generally draw down and pay off seasonal lines of credit several times a year.

It is often difficult to borrow money from friends and relatives. However, friends and relatives represent a source of 9 percent of start-up funds for new business enterprises.

*Outside investors* who contribute funds to fledgling businesses are often considered venture capitalists who have financial resources to invest. These folks stand to make a significant return on their investment if the enterprise takes off. Outside investors are often interested in new ventures that stand to pay a significant return if successful or they are just interested in investing in certain types of enterprises that interest them.

*Government agencies* tend to represent a rather small part of start-up funds for new ventures. However, funds are available from various state and federal agencies in the form of low-interest loans and grants. The exact planned use of the funds will significantly influence whether government funding is a reasonable source or not. The Small Business Administration and US Department of Agriculture may be the best sources of possible funding for meat goat enterprises. In recent years, grants have become an important part of the evaluation phase of alternative and value-added agriculture enterprises. Grants are often used to fund the development of feasibility studies and business plans and may also be available to provide some start-up expenses. Grants are most often available from a variety of government agencies, but private foundations and other sources also make grant funds available for some enterprises.

*Other sources* of financing include credit cards, foundation funding and community development funding.

The Five Cs of Credit are factors that lenders use to evaluate a loan request. Be sure to think about each of these from a lender's point of view.

| | |
|---|---|
| Character | You are important to the lender. Are you honest, a good manager and experienced in business? Will you make every possible effort to repay the loan? Also, what is your previous history regarding loans? Have you been late on payments in the past? Have you ever filed for bankruptcy? If you answer yes to one or both of the last two questions, you will have to convince your lender that you will repay this loan in a timely and efficient manner. |
| Capacity | Will your business generate enough revenues to repay the loan(s)? If the business fails, do you have the personal capacity to repay the loan? |
| Collateral | What collateral will you pledge? If the business fails, will the value of the collateral cover the loan? How easily could it be sold? Some lenders accept co-signers as collateral; in this case, the co-signer's character and capacity is important. However, some lending institutions may be reluctant to accept co-signers. In this case, you may think about using personal assets such as your home, vehicle or stock shares as collateral for |

| | |
|---|---|
| | the business loan. Before you pledge these assets, think carefully about losing them if the business fails. |
| Conditions | Market conditions and trends are of utmost importance to a lender. The projected changes in your target market, trends (both economic and social) of your community and market, and the seasonality of your business will be considered. The lender will also look at your competition and your plans to deal with them. Lenders' experiences with similar businesses will help influence their decisions. |
| Capital | The size of your commitment to the business is critical. Lenders will hesitate to risk their funds if you are not risking a substantial amount yourself. Lenders will rarely invest more than 60 percent of the total amount needed for a new small business. You should be prepared to invest as much capital in your idea as you can "reasonably" risk. |

**Establishing and Using a Farm Financial Record-Keeping System**

For years farmers have been reporting financial information on a variety of forms for various reasons. Effective management of a farming operation today requires that records be kept so managers can make informed decisions affecting the profitability of their farms.

Some lending institutions require detailed business and personal information on everything a farmer owns, as well as the status of unpaid loans. They may also require production records and an estimate of expected sales and expenses for the next year. Increasingly, regulations point toward the keeping of chemical application records and soil and water conservation plans for environmental concerns. The Internal Revenue Service (IRS) requires farmers to report cash sales, expenses, depreciation and information on government program participation.

Farm records are often maintained only for IRS filing purposes. While tax records are necessary, additional information may be needed for informed management decisions. Farm business decisions that are not based on accurate farm records may lead to less profit. The efficient management of a farm operation requires sound record-keeping and record analysis.

**Why Keep Records?**

Records are important for many reasons:

Proof: The IRS can ask for proof of income, expense and inventory items reported on tax returns.

Decision-Aids: Farm managers use records to construct balance sheets, cash flow and income statements, and other financial aids for making more-informed decisions in such areas as machinery purchases, adding or deleting enterprises, size expansion, etc.

Institutional Requirements: Some lending agencies and governmental bodies require financial and/or production records be maintained over a number of years. For example, the government farm program requires certain production and acreage records be reported and maintained by the farm owner. Also, "planning" for conservation compliance and other aspects of soil and water management essentially become historical records over time.

Environmental Regulations: Increasingly, farm owners are being asked to keep records about chemical use, livestock waste applications and irrigation water use on their farms.

Not all record-keeping systems allow records to be kept for all the reasons stated above. The farm owner or manager needs to decide on the system which best fits his/her farm situation.

## Selecting a Record-keeping System

Selecting a record-keeping system should depend on the expected use of the records. There is no "best" record keeping system for all situations, but, at minimum, a farm records system should:

- provide accurate and necessary information,
- fit into the farm organization or framework, and
- be available in a form to aid decision-making.

The person responsible for keeping the records should develop a habit of regularly and accurately posting transactions. Making all financial transactions through a bank (checking) account can be useful. For an accuracy check, the monthly statement should be reconciled with the checkbook and record-keeping system.

A **double-entry accounting system** provides the most detailed accounting of farm business transactions. A significant amount of time is usually needed to learn and implement such a system. The simpler **cash accounting system**, with inventory adjustments, will suffice for most farm operations, and as an accepted method of reporting income and expenses for tax purposes.

The use of computers and computer software has expanded on farms in recent years. However, a hand recording system is still useful for many farmers. When selecting a record-keeping system, both hand and computer systems should be considered.

## Table 2 - Example of Whole-Farm Record Keeping

| | | INCOME | | | EXPENSE | | |
|---|---|---|---|---|---|---|---|
| Date | Description | Kids | Cull Does | Corn | Feed | Supplies | Fuel |
| 10/1 | Sold 20 kids @ 65 lbs/hd | $1,300 | | | | | |
| 10/1 | Purchased feed (1 ton) | | | | $165 | | |
| 10/3 | Sold 2 does @ 75 lbs/hd | | $105 | | | | |
| 10/6 | Purchased supplies | | | | | $165 | |
| 10/8 | Purchased 1500 gals of diesel | | | | | | $3,900 |
| 10/11 | Sold 2000 bu of corn | | | $4,600 | | | |

## Table 3 - Example of Enterprise Record Keeping

| | | INCOME | | | EXPENSE | | | ENTERPRISES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Breeding Goats | | Corn | |
| Date | Description | Kids | Cull Does | Corn | Feed | Supplies | Fuel | Income | Expense | Income | Expense |
| 10/1 | Sold 20 kids @ 65 lbs/hd | $1,300 | | | | | | $1,300 | | | |
| 10/1 | Purchased feed (1 ton) | | | | $165 | | | | $165 | | |
| 10/3 | Sold 2 does @ 75 lbs/hd | | $105 | | | | | $105 | | | |
| 10/6 | Purchased supplies | | | | | $165 | | | $125 | | $40 |
| 10/8 | Purchased 1500 gals of diesel | | | | | | $3,900 | | $150 | | $3,750 |
| 10/11 | Sold 2000 bu of corn | | | $4,600 | | | | | | $4,600 | |

**Analyzing Farm Records**

Once a farm record-keeping system has been established, the benefit of analyzing the records can begin. Decision-making can be greatly enhanced by analyzing both production and financial records and their impact on profitability.

A number of financial analysis tools can be used when accurate and complete farm records are available. These tools include the **balance sheet**, **income statement** and **projected monthly cash flow statement** (including family living expenses). These three financial statements provide information for making short- and long-term financial decisions.

The balance sheet gives the farm manager a "snapshot" of the net worth on a specific date. The **net worth** is the value of all assets on the farm less the amount of money owed against those assets.

Year-to-year profits are calculated on the income statement, also known as the profit/loss statement. The income statement is used to calculate net cash income, adjusted by changes in inventories and capital items.

The projected monthly cash flow statement is used to look ahead to the next year of operations. By projecting a cash flow for the next year, potential cash shortfalls can be noted and appropriate changes in the farm operation can be analyzed.

**Enterprise Records**

Enterprise records contain all the income and expenses associated with a single enterprise. An enterprise can be any crop or type of livestock produced on the farm. As a minimum, enterprise records should contain all cash income and direct cash expenses for that particular enterprise. Direct expenses for kid production would include feed, health costs, supplies, marketing, etc. Direct expenses for pasture could include seed, fertilizer and chemicals. There are also indirect enterprise expenses that are more difficult to assign to a specific enterprise. These include fuel, equipment repairs, property taxes, insurance and other whole-farm expenses. In addition, there are non-cash expenses such as depreciation and family labor. Enterprise records can also contain quantities used of specific inputs as well as the dollar cost. This information can be very helpful in the event of extreme price fluctuations of some inputs. Enterprise records can be used to compare the profitability of different enterprises.

Enterprise records are very useful for developing enterprise budgets (discussed later in this chapter). Enterprise budgets can be a primary source of information when using whole-farm budgeting, especially when considering various sizes of operation.

Enterprise records become more important as the number of enterprises on a farm increase. Enterprise records for a farm that only produces slaughter kids for market and pasture would be relatively simple. But if there are other enterprises such as hay for feed, hay for sale and other types of livestock, record keeping by enterprise becomes more complex and requires more effort from the farm manager. In addition, some farms could have more than one goat enterprise. A farm could be buying feeder kids and growing them to larger weights in addition to producing kids from a doe herd. Expenses for this would be different from expenses of the breeding doe herd. Some producers could also have distinctly different doe herds that would need separate records. For example, a producer could have a commercial herd marketing mainly through auctions and private sales and at the same time have a registered herd that is marketed as breeding animals.

Enterprise records can be used to help producers determine which enterprises are profitable and which are not. This decision making process is also sometimes called opportunity costing. Decisions that can be supported by enterprise records include whether to produce or purchase hay or whether to own equipment or use custom work.

**Sales Records**

Estimating income from goat sales is an important aspect of the overall management of the goat enterprise. Income estimates are almost always more accurate when there is historical information on which to base projections. Just having a dollar figure for goat sales may not tell a farm manager much about what was really sold off the farm. Sales records should include date, description of animal/animals sold, number sold, weight (if sold by pound), price, sale expenses, and market name/buyer. The following example in Table 4 includes all classes of goat sales.

## Table 4 - Example Whole Herd Goat Sales Record

Year 2006

| Date | Description | No. Head | Total Weight | Price Per Unit | Price Unit | Gross Sales | Sale Costs | Net Sales | Buyer/Market |
|---|---|---|---|---|---|---|---|---|---|
| 4-15 | Kids | 2 | 100 | 125.00 | Cwt | 125.00 | | 113.00 | John Jones |
| 5-2 | Cull Doe | 1 | 70 | 71.75 | Cwt | 50.23 | 7.00 | 43.23 | TLP |
| 6-24 | Breeding Doe | 1 | | 90.00 | Head | 90.00 | | 90.00 | Lazy G Farm |
| 8-20 | Kids | 25 | 1625 | 115.00 | Cwt | 1868.75 | 175.00 | 1693.75 | TLP |

Tables 5 through 7 show examples of another method of sales records where a separate page is used for each class of goat sales.

## Table 5 – Example Kid Goat Sales Record

Year 2006 Kid Sales

| Date | Description | No. Head | Total Weight | Price Per Unit | Price Unit | Gross Sales | Sale Cost | Net Sales | Buyer/Market |
|---|---|---|---|---|---|---|---|---|---|
| 4-15 | Kids | 2 | 100 | 125.00 | Cwt | 125.00 | | 113.00 | John Jones |
| 8-20 | Kids | 25 | 1625 | 115.00 | Cwt | 1868.75 | 175.00 | 1693.75 | TLP |

## Table 6 - Example Cull Breeding Stock Sales Record

Year 2006 Cull Breeding Stock Sales

| Date | Description | No. Head | Total Weight | Price Per Unit | Price Unit | Gross Sales | Sale Cost | Net Sales | Buyer/Market |
|---|---|---|---|---|---|---|---|---|---|
| 5-2 | Cull Doe | 1 | 70 | 71.75 | Cwt | 50.23 | 7.00 | 43.23 | TLP |

**Table 7 - Example Breeding Stock Sales Record**

Year 2006 Breeding Stock Sales

| Date | Description | No. Head | Total Weight | Price Per Unit | Price Unit | Gross Sales | Sale Cost | Net Sales | Buyer/ Market |
|---|---|---|---|---|---|---|---|---|---|
| 6-24 | Breeding Doe | 1 | | 90.00 | Head | 90.00 | | 90.00 | Lazy G Farm |

Some producers may have a desire to keep sales records by computer. Producers can design a spreadsheet to record information to fit their needs.

## Summary

Keeping and analyzing farm financial records are essential requirements for the efficient management of a farm business. Accurate records and resulting analysis help farmers make financial and production decisions, comply with tax laws and other governmental regulations and support loan applications. Traditional hand record-keeping systems continue to work well for many farmers; computerized record-keeping and analysis programs have been accepted and used by a number of farmers, also. Developing and using a farm record-keeping system will allow the farm manager to make more informed decisions affecting the profitability of the farm.

Additional information on keeping and using farm records is available through the MANAGE program of University of Tennessee Extension. Contact your local University of Tennessee Extension Office for more information.

## Assessing Risk

Almost all agricultural enterprises are subject to both price and production risk. It is generally accepted that higher returns are consistent with higher levels of risk. The goal of most farm management is to manage and reduce risk to an acceptable level rather than completely eliminate all risk from the farming operation.

Risk in agriculture production may come in one or more of these forms:

1. Production and yield risk – Drought and/or disease can reduce production and possibly increase the cost of production.
2. Market and price risk – Market factors such as supply and demand for any given product may lead to low prices for your product.
3. Business and financial risk – Conditions in the financial world of which farmers have no part can lead to situations such as rising interest rates and limited availability of credit.
4. Technology and obsolescence – Rapid changes in technology can change the structure of an industry. Also, machinery and equipment can quickly become obsolete.

5. Casualty loss risk – Assets can be lost due to accident, fire, wind, hail, flood or theft.
6. Social and legal risk – Environmental risks associated with pesticide use, pollutants and feed additives are becoming more commonplace.
7. Human risk – The health of the farm manager is often overlooked as a risk to the farm. What will happen if the manager is unable to perform necessary farm tasks?

### Developing Farm Plans

A farm plan is basically an outline - a road map of the proposed operation of the farm business. It indicates what to produce, how much to produce and how to produce it.

Basically, there are two types of farm plans – a long-run plan and a short-run plan. The long-run farm plan is an estimate of the resource allocation that is likely to yield greatest net returns over a period of years. It is based on family goals and shows the changes in farm business organization that must take place to attain those goals. If technology or input or output prices change materially, the long-run farm plan would be revised even though it was initially made for several years. The short-run or annual plan should be made to fit the individual year. It implements the transition from the present farming system to the proposed long-run plan. Both the long-run and short-run farm plans must be flexible if they are to be realistic and serve the purpose for which they are intended.

Long-run and annual plans can be developed using the FINPACK Computer Farm Analysis package. Intensive farm planning using FINPACK is offered by University of Tennessee Extension as an educational program at no cost and no obligation to participating farm families. All financial information is confidential. The planning can be done at the farm assisted by an area farm management specialist. Area farm management specialists are located across Tennessee. For more information and to request assistance from an Area Farm Management Specialist, contact any county University of Tennessee Extension office.

FINPACK is a comprehensive financial planning and analysis system designed to help producers understand their financial situation and make informed decisions. FINPACK provides tools to effectively use your farm records to make business analysis, long-range planning and cash flow planning as complete, easy and meaningful as possible.

FINPACK provides three tools to help producers and those who work with them evaluate farm finances. These tools – year end analysis, cash flow planning and long-range planning – provide information on the past, present and future financial status of a farm business. FINPACK helps producers answer the following questions. “Where am I?” “Where do I want to be?” “How do I get there?”

**Long-range planning** compares alternative farm plans for long-run profitability, debt repayment capacity and potential for net worth growth. You can compare the long-range viability of your current operation with alternative plans which may involve new enterprises, new resources, different sizes or combinations of current enterprises, changes in efficiency or changes in debt structure. Long-range planning enables you to easily investigate the feasibility of a change before it is implemented.

**Cash flow planning** projects farm cash flows for one or more years of business. Based on your plans for crop and livestock production and sales, capital purchases and sales, loan payments and other transactions, the cash inflows and outflows are projected monthly or annually for up to ten years. You can use cash flow planning to project annual operating loan needs and the timing of borrowing and repayment during the year.

**Financial analysis** analyzes the financial performance of a farm business in the past year. You can complete a whole farm analysis, or you can analyze each enterprise on the farm. Based on the farm's financial position at the beginning and end of the year and income and expenses during the year, you can examine the past year's profitability, liquidity and solvency. If used year after year, you generate a historical database that allows you to evaluate financial, production and efficiency trends.

**Who can benefit? –** All farm families interested in assessing their management strategies and alternatives can benefit. The program has proven useful in motivating some farm families to seriously explore alternatives for increased profits while the planning process has reassured others that they are on track.

### Enterprise Budgets

An enterprise budget is an estimate of projected income and expenses associated with the production of a commodity. Most agricultural operations include a combination of several crops and/or livestock. While the whole-farm income statements allow the producer to determine total farm profitability, analyzing the effects of changes within the operation should be done by examining the enterprise budgets. Enterprise budgets break the operation down into segments (profit centers) in order to tell which commodity is contributing to profitability and which commodity is losing money. An enterprise is a distinct part of the farm or ranch business that can be analyzed separately and is usually based on some production unit such as one breeding doe.

Enterprise budgets can be either historical or projected. Historical enterprise budgets are the same as income statements by enterprise and are created using actual income and expense information. Projected enterprise budgets attempt to estimate income and expenses in the future. These projected enterprise budgets are best started from historical enterprise income statements. Any estimates of changing costs or income should be conservative. If the budget is for a new enterprise, research on expected income and expenses should be the basis of the budget.

**<u>How enterprise budgets are constructed?</u>**

Before explaining how enterprise budgets are constructed, there is some terminology that will be used in this section of enterprise budgets. The words cost centers and support centers are defined and explained as follows:

**Cost centers** are referred to as transactions associated with "adding value" to a commodity or, in this case, small ruminants for sale. Cost centers represent different phases of production for goats. They should be used when no animal will be available for sale at the end of the production cycle or if the production cycle will not complete by year-end. If the animals are weaned and available for sale by the year-end, this transaction will go under "Profit Centers", which are not discussed in this section.

**Support centers,** as the heading suggests, "support" the operation. There are four typical support centers – machinery & equipment, finance, general & administrative, and labor. Costs accumulated in the support centers are usually overhead costs that are hard to charge at the time of purchase. For instance, the entire cost of a tractor repair cannot be charged to "Hay Profit Center" when the same tractor is being used in the production of several other commodities.

According to Brenda Duckworth, CPA & Extension Program Assistant, when enterprise budgets are developed for the first time, records from the whole farm or ranch are usually the starting point. The allocation of cost to the individual enterprise is an important item in the development of useful enterprise budgets. Some costs are easily allocated, but for certain fixed costs, it's not always clear how the allocation should be made. The key to allocating costs is to be realistic in estimating expenses so a true picture of profitability is expressed.

Duckworth explained that an enterprise budget starts with the income potential of the commodity. The producer will need to estimate production and price to generate the expected revenue from the commodity.

Costs are broken down into two groups, variable costs and fixed costs. The variable costs are those that can be directly tied to the enterprise and can be changed in the short run. Examples of variable costs are veterinarian costs for bucks, does and kids. Variable costs are the same on a per-unit basis, and vary with the size of the enterprise (example – number of head of goats, acres planted, etc.). Variable costs are usually already figured at the per-unit rate, so those costs should simply be multiplied by the number of units to arrive at the variable cost portion of the enterprise budget.

Fixed costs are those costs the business is committed to pay regardless of whether livestock is raised during the current planning period. Producers who have already invested in land, machinery and buildings are committed to owning these resources for the upcoming production period or year. Fixed costs include depreciation and insurance on machinery, equipment and buildings; interest on machinery, equipment, buildings and land; and land taxes, to name a few. For ease of daily recordkeeping, these costs are collected in **support centers** and **cost centers** (defined and explained above).

Fixed costs are constant as a total, but vary on a per-unit basis. As an example, suppose the total property taxes of the business are $1,000. For plainness, let's say the operation only raises goats. If the operation has 25 does, the cost per doe would be $40 ($1,000 / 25 = $40). If the operation has 50 does, the cost per doe is $20 ($1,000 / 50 = $20). If the operation has more than one commodity, an allocation criterion will have to be established, and the total cost allocated accordingly.

Both fixed and variable costs are considered when deciding whether to continue production. However, most producers will eventually face the problem of not covering all their costs for an enterprise in a production year. In the short run (when at least some costs are fixed), the producer should stay in production if it appears that revenue will at least cover variable costs. If variable costs cannot be covered then continued production, even in the short run, only makes things worse. In the long run, a farmer or rancher should continue production only if **all** costs can be covered. Anything short of that usually results in cash flow deficits and the erosion of net worth.

**<u>What to do with enterprise budgets once I have them?</u>**

The primary focus of bookkeeping and reporting is so that a producer can make well-informed decisions. Enterprise budgets have the capacity to inform management about the feasibility of a new enterprise, as well as providing guidelines to spending limits. Just as with a personal budget, enterprise budgets can keep the only controllable part of financial planning (spending) within predetermined goals.

A business-minded producer will evaluate each commodity within the operation to determine where money is being made and where it is not. Budgets can help identify this, as well as areas where he/she could cut costs, become more efficient, breakeven prices for marketing and operations level of risk exposure within the enterprises.

**Budgeting for Kid Production**

The meat goat production budget estimates goat sales and economic cost and returns, and includes interest expenses for resources used in the goat enterprise. It is assumed existing land resources are used. Producers often need cost and return information. The basis for many decisions depends upon an estimate of annual enterprise costs and returns. This budget is intended only as a guide. Producers should use their own information when available and personalized adjustments to this budget should be made as needed. The "your farm" column should be used to calculate your own production costs and breakeven prices.

This budget format can be used to compare the kid production enterprise to other enterprises a farm operator may be considering. As such, some expenses that apply to the whole farm may not be included in a particular enterprise budget. These expenses can be included when doing whole-farm analysis as was discussed in the farm planning section.

The interest expenses reflect the fact that capital invested in goat production is costly, regardless of its source. Borrowed capital entails a cash interest charge for repayment to lenders. Capital provided by the owner results in a non-cash opportunity cost, due to the fact that the capital could have been invested elsewhere and earned interest when the capital was invested in goat production. The foregone interest is a cost to the owner, but it is not a cash expense.

Labor expenses are included in the budget to reflect the cost of hired and/or owner labor. Labor provided by the owner results in a non-cash opportunity cost, due to the earnings foregone by the owner for employment in other agricultural enterprises or off-farm jobs. Hired labor would be a cash expense. In either case, labor is costly and must be properly accounted for.

The enterprise budget for a 50-doe herd is shown in Table 8. The budget assumes 1½ weaned kids per doe per year (75 for the total herd). With a doe replacement rate of 20 percent, 10 female kids are retained for replacements. Kids are born in winter and weaned at approximately 5 months of age. Sixty-five kids would be available for market in the fall.

***Revenue***

Kids are assumed to sell at an average weight of 65 pounds and sell for $100 per hundredweight. Nine cull does are sold (assuming 1 cull doe dies). Total revenue for the herd is $4,666 or $93.32 per doe.

***Variable Expenses***

Variable expenses are those expenses that occur during a year of goat production. Feeding the animals is the largest expense and includes hay, grain and pasture. Hay requirements are based on the does and buck consuming 3.5 pounds of hay per day for 120 days of winter feeding. Corn requirements (for winter supplement) are one pound per one day for 100 days for each kid and one-half pound per day for each doe for 90 days. Pasture expenses assume a lower level of management and inputs than for traditional beef cattle pasture. The pasture stocking rate is 3.33 does per acre.

Variable expenses also include salt, minerals, veterinary and medicine costs, marketing, machinery (for hay feeding) and interest on operating capital for six months. Variable expenses total $2,802 for the herd or $56.04 per doe. Return above variable expenses is $1,864 or $37.28 per doe.

***Fixed Expenses***

Fixed expenses include depreciation, repairs and interest costs for buildings, equipment, and fences as well as livestock investment interest costs. Table 9 details these costs. The barn is assumed to be used one-half time for goat production and the remaining time for other uses. Depreciation and repairs total $539.61 or $10.79 per doe while interest expenses total $439 or $8.78 per doe. Total annual variable expenses plus depreciation and repairs plus interest total $3,871 or $75.61 per doe.

Table 8 GOAT PRODUCTION (50 DOES AND 1 BUCK)
ESTIMATED REVENUE AND EXPENSES

**The basis for many decisions depends on an estimate of annual enterprise costs and returns. This budget is intended only for a guide. Producers should use their own information when available. Personalized adjustments to this budget should be made as needed. The "your farm" column should be used to calculate your own production costs and break-even prices.**

| ITEM | DESCRIPTION | UNIT | QUANTITY | PRICE | TOTAL | PER DOE | YOUR FARM |
|---|---|---|---|---|---|---|---|
| ***REVENUE*** | | | | | | | |
| Kids (1) | 65 Head | cwt | 0.65 | 100.00 | 4225.00 | 84.50 | |
| Cull Doe (2) | 9 Head | cwt | 0.70 | 70.00 | 441.00 | 8.82 | |
| | | | | | --------------- | --------------- | -------------- |
| | | **TOTAL REVENUE** | | | 4666.00 | 93.32 | |
| ***VARIABLE EXPENSES*** | | | | | | | |
| Hay (3) | | ton | 10.71 | 55.00 | 589.05 | 11.78 | |
| Corn (4) | 50 Does | bu/doe | 0.80 | 2.75 | 110.00 | 2.20 | |
| | 75 Kids | bu/kid | 1.75 | 2.75 | 360.94 | 7.22 | |
| Pasture (5) | | acre | 15.00 | 22.00 | 330.00 | 6.60 | |
| Salt & Minerals | | head | 50.00 | 1.00 | 50.00 | 1.00 | |
| Vet & Med | | head | 50.00 | 14.00 | 700.00 | 14.00 | |
| Marketing | | head | 74.00 | 5.50 | 407.00 | 8.14 | |
| Hauling | | head | 74.00 | 0.75 | 55.50 | 1.11 | |
| Machinery (6) | | hour | 14.00 | 7.50 | 105.00 | 2.10 | |
| Operating Interest - 6 months | | | 2707.49 | 7.00% | 94.76 | 1.90 | |
| | | | | | --------------- | --------------- | -------------- |
| | | **TOTAL VARIABLE EXPENSES** | | | 2802.25 | 56.04 | |
| | **RETURN ABOVE VARIABLE EXPENSES** | | | | 1863.75 | 37.28 | |
| ***DEPRECIATION AND REPAIRS*** | | | | | | | |
| Depreciation (7) | Buildings, equipment | | | | 88.75 | 1.78 | |
| Repairs | Buildings, equipment | | | | 47.25 | 0.95 | |
| Depreciation | Buck | | | | 41.67 | 0.83 | |
| Depreciation | Fences | | | | 196.64 | 3.93 | |
| Repairs | Fences | | | | 130.30 | 2.61 | |
| Machinery | | hour | 14.00 | 2.50 | 35.00 | 0.70 | |
| | | | | | --------------- | --------------- | -------------- |
| | | **TOTAL FIXED EXPENSES** | | | 539.61 | 10.79 | |
| | **TOTAL VARIABLE & FIXED EXPENSES** | | | | 3341.86 | 66.84 | |
| **RETURN TO LAND, LABOR, CAPITAL, MANAGEMENT, RISK** | | | | | 1324.14 | 26.48 | |
| ***INTEREST*** | | | | | | | |
| Doe & Buck (8) | 7.00% | | | | 271.25 | 5.43 | |
| Bldgs. & Equip | 7.00% | | | | 55.13 | 1.10 | |
| Fences | 7.00% | | | | 91.21 | 1.82 | |
| Machinery | | hour | 14.00 | 1.52 | 21.28 | 0.43 | |
| | | | | | --------------- | --------------- | -------------- |
| | **TOTAL INTEREST EXPENSE** | | | | 438.87 | 8.78 | |
| | **TOTAL VARIABLE, FIXED, INTEREST EXPENSE** | | | | 3780.72 | 75.61 | |
| **NET RETURN TO LAND, LABOR, MANAGEMENT, RISK** | | | | | 885.28 | 17.71 | |
| ***LABOR EXPENSES*** | | | | | | | |
| LABOR | | hour | 100 | 8.00 | 800.00 | 16.00 | |
| | **TOTAL ALL EXPENSES** | | | | 4580.72 | 91.61 | |
| | **RETURN TO LAND, MANAGEMENT, RISK** | | | | 85.28 | 1.71 | |

**FOOTNOTES TO TABLE 8**

(1) Revenue assumes a 150% weaned kid crop with 10 kept for replacements.

(2) 20% of does replaced each year; sell 9 cull does, assume 1 died.

(3) Does and buck consume 3.5 pounds of hay per day for 120 days.

(4) Kids consume 1 pound of corn per day for 100 days. Does consume 1/2 pound per day for 90 days.

(5) Pasture stocking rate is 3.3 does per acre.

(6) Machinery cost is for 50 hp tractor to feed hay.

(7) Assume 1/2 use of buildings for goats.

(8) One buck is purchased for $125 and used for 3 years. Does are valued at $75.

**Table 9   Building, Equipment and Livestock Fixed Expenses**

| ITEM | COST ($) | LIFE (YEARS) | DEPREC. ($/YEAR) | INTEREST ($/YEAR) | REPAIRS ($/YEAR) | TOTAL ($/YEAR) |
|---|---|---|---|---|---|---|
| ***Buildings and Equipment*** | | | | | | |
| Pole Barn, 500 sq. ft., 6 months | 2750 | 20 | 68.75 | 48.13 | 41.25 | 158.13 |
| Feeders and Waterers | 200 | 10 | 20.00 | 7.00 | 6.00 | 33.00 |
| Permanent Fence, 3233 ft. @ $0.67 per foot | 2166 | 25 | 86.64 | 75.81 | 108.30 | 270.75 |
| Energizer | 200 | 4 | 50.00 | 7.00 | 10.00 | 67.00 |
| Cross Fence, 1600 ft. @ $0.15 per foot | 240 | 4 | 60.00 | 8.40 | 12.00 | 80.40 |
| | | | -------------- | -------------- | -------------- | -------------- |
| **TOTAL BUILDLINGS AND EQUIPMENT** | | | 285.39 | 146.34 | 177.55 | 609.28 |
| ***Livestock*** | | | | | | |
| Buck | 125 | 3 | 41.67 | 8.75 | n. a. | 50.42 |
| Does | 3750 | | n. a. | 262.50 | n. a. | 262.50 |
| | | | -------------- | -------------- | -------------- | -------------- |
| **TOTAL LIVESTOCK** | | | 41.67 | 271.25 | | 312.92 |

***Labor***

One hundred hours of labor are assumed for this enterprise and charged at $8.00 per hour for a total of $800. Adding this to variable and fixed expenses results in total budgeted expenses of $4,581 or $91.61 per doe. Subtracting total expenses from total revenue leaves a return to land, management and risk of $85 for the herd or $1.71 per doe. When looking at this figure, remember that the owner has received a 7 percent return on all capital invested, excluding land, and $800 in wages. If there is no outstanding debt and the owner provides the labor, then the return to owner labor and capital is $1,324 annually.

***Sensitivity Analysis***

The budget in Table 8 estimates returns when production levels, resource use levels and prices are held at constant assumed values. The potential variability in returns was analyzed by modifying key assumptions and estimating the sensitivity of net returns to changes in these variables.

In Table 10, the effects of kids weaned per doe and market price are examined. Market price varied from $85 to $115 per hundredweight, while kids weaned varied from 1.2 to 1.8 per doe. Returns to land, management and risk for the whole herd are estimated for each combination of kid production and market price. The intersection of $100 per hundredweight selling price and 1.5 kids weaned per doe ($85.28) matches the return to land, management and risk from the revenue and expenses table. Each intersection of market price and kids weaned per doe in the table reveals the return to land, management and risk to that combination of market price and kids weaned per doe. This analysis shows the importance of selling more kids per doe. It also shows how variations in market price can significantly affect returns.

**Table 10 The Effects of Varying Kids Weaned per Doe and Market Price on Returns to Land, Management and Risk.**

| Price Per Cwt. | Kids Weaned Per Doe 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 |
|---|---|---|---|---|---|---|---|
| **85.00** | -1211.28 | -990.35 | -769.41 | -548.47 | -327.53 | -106.60 | 114.34 |
| **90.00** | -1048.78 | -811.60 | -574.41 | -337.22 | -100.03 | 137.15 | 374.34 |
| **95.00** | -886.28 | -632.85 | -379.41 | -125.97 | 127.47 | 380.90 | 634.34 |
| **100.00** | -723.78 | -454.10 | -184.41 | **85.28** | 354.97 | 624.65 | 894.34 |
| **105.00** | -561.28 | -275.35 | 10.59 | 296.53 | 582.47 | 868.40 | 1154.34 |
| **110.00** | -398.78 | -96.60 | 205.59 | 507.78 | 809.97 | 1112.15 | 1414.34 |
| **115.00** | -236.28 | 82.15 | 400.59 | 719.03 | 1037.47 | 1355.90 | 1674.34 |

In Table 11, the effect of kids weaned per doe and market weight are examined. Market weight varied from 56 to 74 pounds, while kids weaned varied from 1.2 to 1.8 per doe. Returns to land, management and risk for the whole herd are estimated for each combination of kid production and market weight. The intersection of 65 pounds selling weight and 1.5 kids weaned per doe ($85.28) matches the return to land, management and risk from the revenue and expenses table. Each intersection of market weight and kids weaned per doe in the table reveals the return to land, management and risk to that combination of market weight and kids weaned per doe. This analysis shows the importance of pounds of goat sold on returns.

**Table 11 The Effects of Varying Kids Weaned per Doe and Market Weight on Returns to Land, Management and Risk.**

| Market Weight | Kids Weaned Per Doe 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 |
|---|---|---|---|---|---|---|---|
| **56.00** | -1173.78 | -949.10 | -724.41 | -499.72 | -275.03 | -50.35 | 174.34 |
| **59.00** | -1023.78 | -784.10 | -544.41 | -304.72 | -65.03 | 174.65 | 414.34 |
| **62.00** | -873.78 | -619.10 | -364.41 | -109.72 | 144.97 | 399.65 | 654.34 |
| **65.00** | -723.78 | -454.10 | -184.41 | **85.28** | 354.97 | 624.65 | 894.34 |
| **68.00** | -573.78 | -289.10 | -4.41 | 280.28 | 564.97 | 849.65 | 1134.34 |
| **71.00** | -423.78 | -124.10 | 175.59 | 475.28 | 774.97 | 1074.65 | 1374.34 |
| **74.00** | -273.78 | 40.90 | 355.59 | 670.28 | 984.97 | 1299.65 | 1614.34 |

Management is often a determining factor concerning these variables. High levels of management will result in more kids weaned per doe, larger selling weights and higher prices (relative to current market conditions).

**Remember that information in this budget should be used only as a guide. Producers should use their own information in developing budgets for their farm.**

## Budgeting for Finishing Feeder Goat Production

The feeder goat production budget estimates sales and economic cost and returns, and includes interest expenses for resources used in the feeder goat enterprise. It is assumed existing land resources are used. This budget is intended only as a guide and producers should use their own information when available. Personalized adjustments to this budget should be made as needed. The "your farm" column should be used to calculate your own production costs and break-even prices.

This budget format can be used to compare the finishing feeder goat enterprise to other enterprises a farm operator may be considering. As such, some expenses that apply to the whole farm may not be included in a particular enterprise budget. These expenses can be included when doing whole farm analysis as was discussed in the farm planning section.

The rationale for including interest and labor expenses in the budget is discussed in the kid production budget on page 21, Table 8.

The feeder goat enterprise budget assumes a 50-head unit. Table 12 contains estimated costs and return per head. The budget assumes purchasing a 35-pound kid and feeding to a market weight of 65 pounds. Death loss is assumed at 5 percent and is deducted from revenue per animal sold. Estimated weight gain is 0.33 pounds per day for 90 days.

***Revenue***

The slaughter goats are assumed to sell at an average weight of 65 pounds and sell for $100.00 per hundredweight. Revenue per head is $61.75 ($65.00 less 5% death loss of $3.25).

***Variable Expenses***

Variable expenses are those expenses that occur when feeder goats are purchased. The cost of the animal to feed is a variable cost. This budget assumes purchasing a 35-pound goat for $75 per hundredweight. Feeding the animals, which for this budget includes grain and pasture, is the second largest expense after the purchase of the feeder animal. The feeder goats consume 1.25 pounds of a 16 percent protein feed per day for 90 days. Pasture expenses assume a lower level of management and inputs than for traditional beef cattle pasture. The pasture stocking rate is 6 feeder goats per acre.

Variable expenses also include salt and minerals, veterinary and medicine costs, marketing, interest on the purchase cost of the feeder animal and interest on operating capital for 90 days. Variable expenses total $49.27 per head. Return above variable expenses is $12.45 per head.

**Table 12** FEEDER GOAT PRODUCTION ON PASTURE
ESTIMATED REVENUE AND EXPENSES PER HEAD (50 Head Unit)

**The basis for many decisions depends on an estimate of annual enterprise costs and returns. This budget is intended only for a guide. Producers should use their own information when available. Personalized adjustments to this budget should be made as needed. The "your farm" column should be used to calculate your own production costs and break-even prices.**

***Days on Feed*** 90 ***ADG*** 0.333

| ITEM | DESCRIPTION | UNIT | QUANTITY | PRICE | TOTAL | YOUR FARM |
|---|---|---|---|---|---|---|
| ***REVENUE*** | | | | | | |
| Slaughter Kid | | cwt | 0.65 | 100.00 | 64.97 | ____ |
| Death Loss | % | | 5.00% | 64.97 | 3.25 | ____ |
| | | | | | ---------------- | -------------- |
| | | **TOTAL REVENUE** | | | 61.72 | |
| ***VARIABLE EXPENSES*** | | | | | | |
| Feeder Kid | | cwt | 0.35 | 75.00 | 26.25 | ____ |
| Feed (1) | 16% Protein | lbs | 112.50 | 0.075 | 8.44 | ____ |
| Pasture (2) | | acre | 0.17 | 22.00 | 3.74 | ____ |
| Salt & Minerals | | head | 1.00 | 1.00 | 1.00 | ____ |
| Vet & Med | | head | 1.00 | 3.00 | 3.00 | ____ |
| Marketing | | head | 1.00 | 5.25 | 5.25 | ____ |
| Hauling | | head | 1.00 | 0.75 | 0.75 | ____ |
| Interest on Feeder | 90 | days | 26.25 | 7.00% | 0.46 | ____ |
| Interest on Variable Cost | 90 | days | 22.18 | 7.00% | 0.39 | ____ |
| | | | | | --------------- | -------------- |
| | | **TOTAL VARIABLE EXPENSES** | | | 49.27 | ____ |
| | **RETURN ABOVE VARIABLE EXPENSES** | | | | 12.45 | |
| ***DEPRECIATION AND REPAIRS*** | | | | | | |
| Depreciation (3) | Buildings, equipment | | | | 0.89 | ____ |
| Repairs | Buildings, equipment | | | | 0.47 | |
| Depreciation | Fences | | | | 3.24 | ____ |
| Repairs | Fences | | | | 0.88 | ____ |
| | | | | | --------------- | -------------- |
| | | **TOTAL FIXED EXPENSES** | | | 5.49 | ____ |
| | **TOTAL VARIABLE & FIXED EXPENSES** | | | | 54.76 | ____ |
| **RETURN TO LAND, LABOR, CAPITAL, MANAGEMENT, RISK** | | | | | 6.96 | |
| ***INTEREST*** | | | | | | |
| Bldgs. & Equip | 7.00% | | | | 0.55 | ____ |
| Fences | 7.00% | | | | 1.44 | ____ |
| | | | | | --------------- | -------------- |
| | **TOTAL INTEREST EXPENSE** | | | | 1.99 | ____ |
| | **TOTAL VARIABLE, FIXED, INTEREST EXPENSE** | | | | 56.75 | ____ |
| **NET RETURN TO LAND, LABOR, MANAGEMENT, RISK** | | | | | 4.97 | |
| ***LABOR EXPENSES*** | | | | | | |
| LABOR | | hour | 0.75 | 8.00 | 6.00 | ____ |
| | **TOTAL ALL EXPENSES** | | | | 62.75 | ____ |
| | **RETURN TO LAND, MANAGEMENT, RISK** | | | | -1.03 | ____ |

(Table continued on page 26)

**BREAKEVEN PRICE PER CWT. SOLD**

| COST INCLUDED | AMOUNT | PRICE/CWT. | YOUR FARM |
|---|---|---|---|
| Variable (Cash Expenses) | 49.27 | 75.84 | |
| Death Loss | 3.25 | 5.00 | |
| Depreciation and Repairs | 5.49 | 8.45 | |
| Interest on Buildings & Equipment | 1.99 | 3.07 | |
| Labor | 6.00 | 9.24 | |
| **Total All Costs** | 66.00 | 101.59 | |

**FOOTNOTES TO TABLE 12**

(1) Kids consume 1.25 pounds of 16% feed per day for 90 days.

(2) Pasture stocking rate is 6 feeder kids per acre.

(3) Assume 1/2 use of buildings for goats.

## ***Fixed Expenses***

Fixed expenses include depreciation, repairs and interest costs for buildings, equipment and fences. Table 13 details these costs. The barn is assumed to be used one-half time for goat production and the remaining time for other uses. Depreciation and repairs total $5.49 per head, while interest expenses total $1.99 per head. Total annual variable expenses plus depreciation and repairs plus interest total $54.76 per head.

**Table 13 Building and Equipment Fixed Expenses**

| ITEM | COST ($) | LIFE (YEARS) | DEPREC. ($/YEAR) | INTEREST ($/YEAR) | REPAIRS ($/YEAR) | TOTAL ($/YEAR) |
|---|---|---|---|---|---|---|
| ***Buildings and Equipment*** | | | | | | |
| Pole Barn, 250 sq. ft., 6 months | 1375 | 20 | 34.38 | 24.06 | 20.63 | 79.06 |
| Feeders and Waterers | 100 | 10 | 10.00 | 3.50 | 3.00 | 16.50 |
| Permanent Fence, 2,434 ft. @ $0.69 | 1679 | 25 | 67.16 | 58.77 | 25.19 | 151.11 |
| Energizer | 200 | 4 | 50.00 | 7.00 | 10.00 | 67.00 |
| Cross Fence, 1,200 ft @ $0.15 per foot | 180 | 4 | 45.00 | 6.30 | 9.00 | 60.30 |
| | | | --------------- | --------------- | --------------- | --------------- |
| **TOTAL BUILDINGS AND EQUIPMENT** | | | 206.54 | 99.63 | 67.81 | 373.97 |

## ***Labor***

Three-fourths hour of labor per head is assumed for this enterprise and charged at $8.00 per hour for $6.00 per head labor cost. Adding this to variable and fixed expenses results in total budgeted expenses of $62.75 per head. Subtracting total expenses from total revenue leaves a negative return to land, management and risk of $1.03 per head. When looking at this figure, remember that the owner has received a 7 percent return on all capital invested, excluding land, and $6.00 in wages per head. If there is no outstanding debt and the owner provides the labor, then the return to owner labor and capital is $6.96 per head.

***Breakeven Analysis***

A break-even analysis follows the calculation of returns to land, management and risk. A finisher of feeder kids would like for returns to cover total cost. However, this goal is not always achievable. A finisher will want to recover at least the variable cost of production at any particular time. Over the long term, the finisher must cover all costs for the enterprise to be profitable. The break-even table shows the price needed to cover certain types of expenses. In this example, $75.84 per hundredweight is the price needed to recover variable (cash) expenses. To cover all expenses, a selling price of $101.59 per hundredweight is needed. Break-even analysis can be useful in aiding the finisher in making decisions regarding purchasing feeder kids at any particular time.

***Sensitivity Analysis***

The budget in Table 12 estimates returns when production levels, resource use levels and prices are held at constant assumed values. The potential variability in returns was analyzed by modifying key assumptions and estimating the sensitivity of net returns to changes in these variables.

In Table 14, the effects of purchase price and sale price are examined. Purchase price varied from $60 to $90 per hundredweight while sales price varied from $85 to $115 per hundredweight. Returns to land, management and risk are estimated for each combination of purchase price and sale price. The intersection of $100 per hundredweight selling price and $75 per hundredweight purchase price (-$1.03) matches the return to land, management and risk from the revenue and expenses table. Each intersection of selling price and purchase price in the table reveals the return to land, management and risk to that combination of selling price and purchase price. This analysis shows the levels of profit and loss depending on the relationship of purchase and sale price.

**Table 14 The Effects of Varying Purchase Price and Sale Price on Returns to Land, Management and Risk**

| Sale Price | Purchase Price Per Cwt. | | | | | | |
|---|---|---|---|---|---|---|---|
| Per Cwt. | 60.00 | 65.00 | 70.00 | 75.00 | 80.00 | 85.00 | 90.00 |
| **85.00** | -4.95 | -6.73 | -8.51 | -10.29 | -12.07 | -13.85 | -15.63 |
| **90.00** | -1.86 | -3.64 | -5.42 | -7.21 | -8.99 | -10.77 | -12.55 |
| **95.00** | 1.22 | -0.56 | -2.34 | -4.12 | -5.90 | -7.68 | -9.46 |
| **100.00** | 4.31 | 2.53 | 0.75 | **-1.03** | -2.81 | -4.59 | -6.37 |
| **105.00** | 7.40 | 5.61 | 3.83 | 2.05 | 0.27 | -1.51 | -3.29 |
| **110.00** | 10.48 | 8.70 | 6.92 | 5.14 | 3.36 | 1.58 | -0.20 |
| **115.00** | 13.57 | 11.79 | 10.01 | 8.23 | 6.44 | 4.66 | 2.88 |

In Table 15, the effect of average daily gain and sale price are examined. Average daily gain ranged from 0.18 pounds per day to 0.48 pounds per day. Returns to land, management and risk are estimated for each combination of average daily gain and sale price. The intersection of $100 per hundredweight selling price and 0.33 pounds average daily gain (-$1.03) matches the return to land, management and risk from the revenue and expenses table. Each intersection of selling price and average daily gain in the table reveals the return to land, management and risk to that combination of selling price and average daily gain. This analysis shows that average daily gains of greater than 0.33 and sale prices above $100 per pound are needed for positive returns under these assumptions.

**Table 15 The Effects of Average Daily Gain and Sale Price on Returns to Land, Management and Risk**

| Sale Price | Average Daily Gain | | | | | | |
|---|---|---|---|---|---|---|---|
| **Per Cwt.** | **0.18** | **0.23** | **0.28** | **0.33** | **0.38** | **0.43** | **0.48** |
| **85.00** | -21.19 | -17.56 | -13.92 | -10.29 | -6.66 | -3.02 | 0.61 |
| **90.00** | -18.75 | -14.90 | -11.05 | -7.21 | -3.36 | 0.49 | 4.34 |
| **95.00** | -16.30 | -12.24 | -8.18 | -4.12 | -0.06 | 4.00 | 8.06 |
| **100.00** | -13.86 | -9.58 | -5.31 | **-1.03** | 3.24 | 7.52 | 11.79 |
| **105.00** | -11.41 | -6.92 | -2.44 | 2.05 | 6.54 | 11.03 | 15.52 |
| **110.00** | -8.97 | -4.27 | 0.44 | 5.14 | 9.84 | 14.54 | 19.25 |
| **115.00** | -6.52 | -1.61 | 3.31 | 8.23 | 13.14 | 18.06 | 22.97 |

Management is often a determining factor concerning these variables. High levels of management will result in lower death loss, higher average daily gains, larger sale weights and higher prices (relative to current market conditions).

**Remember that information in this budget should be used only as a guide. Producers should use their own information in developing budgets for their farm.**

## Herd Performance Measures

Herd performance measures can be used to evaluate the efficiency of the doe herd, track progress of the herd over time, indicate potential problems and assist in establishing goals for the operation. Herd performance measures are simple and practical calculations that focus on genetic and management factors affecting performance.

**Number of Exposed Females** includes the number of mature does and replacement does in the herd. Each female has the potential to conceive, raise and wean offspring. This figure should only be adjusted lower by the number of females sold or transferred from the herd. The number of exposed females should be adjusted higher if exposed or pregnant females are purchased or transferred into the herd.

**Kidding Percentage** is a measure of the success of the breeding season. Kidding percentage is calculated by the following:

$$\frac{\text{number of kids born (live and dead)}}{\text{adjusted number of exposed females}} \times 100$$

**Kid Death Loss Percentage** is an indicator of the success of the kidding season, as well as the growing phase of the kid crop from birth to weaning. This measure is calculated as follows:

$$\frac{\text{Number of kids that died from birth to weaning}}{\text{Number of kids born}} \quad \text{x} \quad 100$$

Kid death loss percentage can be affected by a number of factors, including kidding difficulty, the kidding season, environment, herd health and condition of the doe herd. A reasonable goal is to keep kid death loss percentage at 4 percent or less.

**Weaning Percentage** is a measure of the overall reproductive efficiency of the doe herd and is determined by:

$$\frac{\text{Number of kids weaned}}{\text{Adjusted number of exposed females}} \quad \text{x} \quad 100$$

Producers should keep in mind the cost of production for their operation. An effective manager does not focus solely on performance measures. Each producer should strive to determine the optimum level of weaning percentage for their operation. It is possible that the costs associated with achieving an extremely high weaning percentage may outweigh the added returns from additional pounds of goat produced.

**Average weaning weight** provides an indication of the productive ability of the sire(s) and the doe herd and is calculated as follows:

$$\frac{\text{Total pounds weaned}}{\text{Number of kids weaned}}$$

Comparing average weaning weights over time can indicate improvement (or lack of) in the performance of different sires and does. Average weaning weights may also reflect changes in management and/or environmental conditions. However, weaning weights alone are not a good indicator of the overall productive efficiency of the doe herd. It is possible to have relatively high weaning weights and a relatively low weaning percentage. Higher weaning weights do not always result in higher profits.

**Pounds Weaned per Exposed Female** provides a measure that combines reproductive performance and productive ability (pounds of goat produced) and may be calculated by either of the following:

$$\frac{\text{Total pounds weaned}}{\text{Adjusted number of exposed females}}$$

Or

Weaning percentage x average weaning weight.

Pounds weaned per exposed female is a measure of the overall performance of the doe herd. It can be used to track progress of the herd over time, as well as to evaluate the affects of management decisions and changes. Table 16 show the pounds weaned per doe exposed for several combinations of weaning percentage and selling weight. Table 17 provides a worksheet for producers to calculate herd performance measures.

**Table 16**

| **Effect of Weaning Percentage and Average Weaning Weight on Pounds Weaned Per Exposed Female Percentage** | | | | | | |
|---|---|---|---|---|---|---|
| | Average Weaning Weight (lb.) | | | | | |
| Weaning Percentage | 75 | 70 | 65 | 60 | 55 | 50 |
| | Pounds Weaned per Doe Exposed | | | | | |
| 170 | 127.5 | 119.0 | 110.5 | 102.0 | 93.5 | 85.0 |
| 150 | 112.5 | 105.0 | 97.5 | 90.0 | 82.5 | 75.0 |
| 130 | 97.5 | 91.0 | 84.5 | 78.0 | 71.5 | 65.0 |
| 110 | 82.5 | 77.0 | 71.5 | 66.0 | 60.5 | 55.0 |

**Table 17**

| Herd Performance Measures Worksheet | | |
|---|---|---|
| Name:______________________________ County:____________________<br>Kidding Season (Beginning Date:__________) (ending Date: __________) | | |
| A | Females Exposed for Current Kid Crop | |
| B | Exposed Females Sold or Transferred<br>(Before end of breeding season) | |
| C | Pregnant Females Sold or Transferred Out | |
| D | Exposed and /or Pregnant Females Purchased or Transferred In | |
| E | Adjusted Exposed Females<br>(A – B – C + D) | |
| F | Number Kids Born | |
| G | Kidding Percentage<br>[(F ÷ E) x 100] | |
| H | Number of Kids that Died<br>(kids lost at birth and up to weaning) | |
| I | Kid Death Loss Percentage<br>[(H ÷ F) x 100] | |
| J | Number of Kids Weaned | |
| K | Weaning Percentage<br>[(J ÷ E) x 100] | |
| L | Average Kid Weaning Weight | |
| M | Total Pounds Weaned<br>[(J x L) or group weight] | |
| N | Pounds Weaned per Doe Exposed<br>(M ÷ E) | |
| | | |

Source: Boggs, et. al. (Ferguson. MBP)

## Individual Performance Records

Individual performance records are most useful to the goat producer in selecting and culling individual animals within the herd. Each animal must be permanently identified in order to compile information on individual animals. Weaning weight is one measure of the performance of individual does. Performance records are often used in animal selection and culling. Please refer to the Genetics Section for more information on using individual performance records.

## Performance Measures for Finishing Feeder Kids

For goat producers who purchase feeder kids for a growing program, individual identification is also needed if the producer wishes to obtain performance information. Performance measures for feeding operations include death loss percentage, morbidity rate and average daily gain.

**Death Loss Percentage** or mortality rate is a measure of the number of deaths associated with a group of feeder kids and is calculated as follows:

$$\frac{\text{Number of dead feeder kids}}{\text{Beginning number of feeder kids in the group}} \times 100$$

Death loss percentage can have a drastic impact on the profit potential for a group of feeder kids. An acceptable goal is 4 percent. High death loss percentages may indicate health and/or immunization problems that need to be addressed.

**Morbidity Rate** is a measure of health problems or sickness associated with a group of feeder kids and is determined by the following:

$$\frac{\text{number of individuals treated for sickness or injury}}{\text{Beginning number of feeder kids in the group}} \times 100$$

High rates of morbidity or sickness will increase costs (additional medication and labor) and decrease the overall performance (average daily gain) of the group. Acceptable levels of morbidity rates may vary depending on the source of the feeder kids, previously administered health programs and seasonal conditions. An acceptable goal is 10 percent.

**Average Daily Gain** is an indicator of performance of the stocker animal and is calculated as follows:

$$\frac{\text{Ending weight – beginning weight}}{\text{Numbers of days in the feeding program}}$$

Rates of average daily gain will vary depending on genetics, season, environment, feed and forage resources, management practices and animal health. Due to the variations in average daily gain, acceptable goals may differ for various groups of feeder kids. Goals for average daily gain should be based on hitting target end weights and include estimates of the costs associated with achieving that rate of gain.

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Chapter Two

# PART II: VALUED-ADDED PRODUCTS

Karen Jackson

Various forms of value-added enterprises can be incorporated into a meat goat production operation. A value-added product means a producer adds value to the animal instead of selling the standard way at a livestock auction barn. Value can be added through meat, hides, horns, milk and breeding stock. Remember, laws change and that is the producers' responsibility to stay updated and comply.

<u>Prepared Meats</u>
Producers can add value through the carcass in various ways. First, if a processing facility (USDA inspected) and commercial kitchen (USDA certified) is available, sausages, jerky, stew meat and chili can be made to sell to the public. Specialty meat cuts and whole carcasses can be made available to high-end restaurants. Barbeque, stew meat, ground goat for burgers or meat loaf can be sold to barbeque restaurants and/or directly to the consumer. These same types of products can be prepared and distributed at field days and taste-testing in-store promotions.

<u>Slaughter</u>
A major concern when direct marketing meat is processing; facilities needed will depend on the type of processing done. If selling to stores and restaurants, then a USDA processing facility for goats is needed. A custom processing plant can be utilized when selling directly to the consumer (UT Extension PB 1727). Some producers constructed processing plants on their own farms. This involves higher costs, because inspectors must be paid and the facilities will have to meet state and federal requirements. The same applies when building a commercial kitchen. When pursuing a value-added enterprise such as this, request appropriate regulations from state and local health departments as well as the FDA and USDA. In Tennessee, check the TN Department of Agriculture Website for rules and regulations. UT employs farm management specialists and has a Center of Profitable Agriculture that can assist getting a cost analysis to evaluate making a profit with this new enterprise (Chapter 2, Part I).


Marketing Cooperatives

A cooperative is a business that is owned and controlled by the individuals who use its' services. Three thousand two hundred agricultural cooperatives, with a membership of three million, account for around $103 billion in net business volume through co-ops (University of Wisconsin, 2006). By forming a co-op goat producers could possibly pool enough goats to sell in graded lots though tel-o-auctions, internet auctions and video board sales. These lots can be shipped to the main processing and packing plants. Lots will contain similar animals; the producer usually receives a premium price for their livestock. A dedicated and knowledgeable marketing manager is a main ingredient for success. This individual understands contracts and guarantees with the buyer and the availability of various products from cooperative member producers.

Direct Marketing

Direct marketing carcasses depends on the religion, ethnicity and tradition of the culture of consumers in the geographical area and the quality of meat goats available. A Greek or European restaurant wants a different class of goat meat than someone of Hispanic or Middle-Eastern origin. Develop a rapport with customers, let them express their preferences.

Adding Value with Milk Products

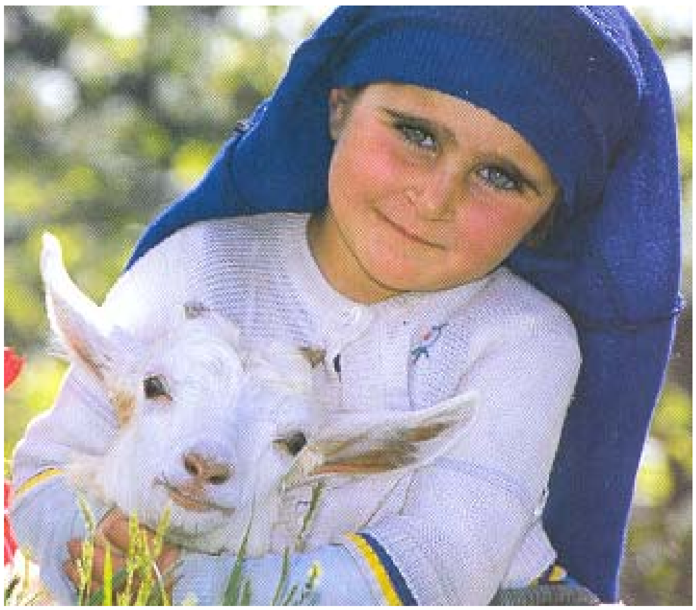
Although this is a Master Meat Goat Producer Course, there is still the possibility of using goat milk in bath and beauty products. Dependent upon the breed and management system, some meat goats can be milked after weaning.

Bath and beauty products include soaps, lotions and bath salts. Governing regulations depend on the type of product made and the state the product(s) is made in and/or sold. Current rules and regulations are available on the web at FDA, USDA and other governmental agencies sites. Goat milk soaps and lotions are becoming popular. Soaps are easier to make and have a longer shelf life than the lotions. Lotions have more regulations because they are considered a beauty aid.

Before deciding to make these products, create a budget based on the prices of all ingredients and supplies needed. This will determine if the enterprise will be profitable. Cost is always a factor when making these products, because customers want to pay reasonable prices for the product. A detailed marketing plan is the first step in planning sales for your products and a successful business experience. These items can be sold in gift shops, farmer's markets, flea markets and spas.

Hides and Fiber
In addition to dairy and meat products, hides and fiber can provide a value-added side business. The quality and age of hide determines the type of items manufacturers produce (clothing, boots, saddles, etc.). In addition to clothing, goat hides can be used for art and crafts.

Some goats produce fiber in the form of cashmere (the winter fine hair undercoat), and some Spanish meat breed lines have been selected for their cashmere in addition to their meat. Cashmere *fibre* is stretchy, silky and usually has a high yield. This fiber is used around the world to make high-quality garments, adding more value to goats.



Photograph courtesy of HEIFER International

All goats have guard hair, which is most prominent in bucks. This hair is scalded mainly from un-castrated bucks less than 1 year old with the scarfskin and made into brushes in China.

Angora goats produce mohair. This is a high-quality, lustrious fiber, allowing similar processing as cashmere. In addition to garments and accessories, many doll makers like to dye mohair to make doll hair. It is very fine quality and craftspeople want a raw or semi-raw product.

Breeding and Driving / Packing Stock

Breeding Stock
Depending on which type of goats you raise, you can add value to a herd by selling quality breeding stock (reference Chapter 6). Quality breeding stock is not just bloodlines, quality breeding stock is selected for parasite resistance, hardiness, survivability in the environment, birth weight, weaning weight, rate of gain, ease of kidding, milk ability, mother ability and disposition.

Building and maintaining a reputation as a moral and ethical business individual is important when selling breeding stock. Sell a high quality product to producers and build a return-client business.

Driving and Packing Stock

A well-trained driving goat can be sold or rented out at parties and fairs. A goat can pull up to twice its own weight in a well-balanced cart. In Millington, TN at the Goat Days Festival each year there is a driving goat chariot race. New York has a driving goat 4-H project and Washington has driving goat competitions during its state fair.

In addition to driving, goats can be used as pack animals. A goat can carry up to 1/4 of its own weight. They are better equipped than mules and horses to handle rugged mountain-sides, pack well together in a group and survive well on the brush available to them in the woods and mountains. A well-trained pack goat can be rented out to hikers and campers who want a truly unique experience in the backcountry.

Photograph courtesy of Rex and Terri Summerfield

Remember, when contemplating a value-added products enterprise, develop a marketing plan to evaluate feasibility and effectiveness. Run cost analysis and consult with specialists in these areas for insight and to avoid pitfalls in business startup. It takes hard work and determination to be successful.

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Chapter Three

# GOAT HEALTH

Janet Bailey, Fred Hopkins and Sharon Patton

Health problems are an ongoing concern for the goat producer. Goat producers often report sickness and death in their animals. In most surveys, internal parasitism due to common stomach worms is listed as the goat producer's biggest problem. Prevention of health problems is generally more cost-effective than treatment after the problem occurs, although some sickness is seen in even the best-managed goat herd.

Most diseases do not lead to death of the animal. However, disease can cause sickness where the animal recovers, but costs are incurred from the need for labor and medicine for treatment. Production losses, such as less growth or milk production, are often more costly than the expense of treating animals that get sick and recover. Some diseases result in animals that get sick and never really recover. In these cases, the cost of treatment is generally greater than in animals that do recover since sickly animals are usually treated for a longer period of time. In addition reduced milk production or growth can be very costly, so these animals may often be culled prematurely due to this chronic health problem. Generally though, the most costly type of disease is subclinical disease, where the animal suffers lost milk production or growth but never shows any other signs of disease. These animals tend to remain in the herd for longer periods of time and may spread contagious disease to other animals in the herd. An effective herd health program is the most cost-effective method of dealing with disease problems.

A healthy herd does not just happen from vaccinating and deworming, but results from a farm management program that makes disease less likely to become established and cause problems. Several general areas are important in disease prevention.

Biosecurity is a series of management procedures that reduce the risk of disease coming onto the premises or spreading through the herd if introduced. External biosecurity is aimed at keeping diseases off the farm. Most goat disease is brought into the herd by newly purchased animals. New additions should come from herds that are known to be free of important diseases, have a good herd health program and can provide health records so the vaccination and deworming schedules are known. New herd additions should be isolated from the rest of the herd for 30 days. This gives time for animals to be observed for any disease symptoms. Also, needed vaccinations can be given so that the animals have some immunity before entering the herd. It is also a good idea to perform or have a fecal analysis and/or FAMACHA testing performed so the correct dewormer, also known as anthelmintic, can be used (refer to parasite control). Finally, testing for disease using blood samples or other means can be done and the results known before the new animals have contact with the herd.

Another important source of disease is people. People who have been in other herds the same day and have not changed clothes and footwear can spread disease.

Trucks can carry manure and disease-causing organisms on their tires, so outside trucks should not enter your pasture.

Internal biosecurity is aimed at keeping disease from spreading within the farm once it arrives. Most contagious disease spreads most readily from younger to older animals and having a pasture or pen system that keeps young weaned animals away from adults is a big help in disease control. People and pests such as mice and pigeons can spread disease from one group to another, so pest control plus a secure feed room can be very useful. Caretakers should contact young animals first and sick animals last.

Equipment that is used by or on one or more animals can spread disease. Cleaning and disinfecting reused syringes and needles can eliminate the spread of blood-borne disease. Feeders and waterers used by sick animals should be disinfected before use by well animals. Stock trailers that are not cleaned out between uses can also be a problem due to leftover manure. Disinfection means to render free of germs and can only be done effectively once the equipment is clean. Some common disinfectants that are relatively effective include chlorohexadine and Clorox™(1:10 dilution).

Well-nourished animals tend to be healthy animals, while poorly nourished ones are more likely to get sick and more difficult to treat successfully. Deficiencies or imbalances in dietary energy, protein, zinc, calcium, selenium, copper and others have all been associated with health problems in goats and other animals.

Only a few animal-health products are available with FDA approval for use in goats, so most products are used in an extra label manner. As a result, dosages and withdrawal times before animals can be used for food are often based on best guesses. Generally, animal-health products have an expiration date and use of a product after this date may result in poor results due to loss of product potency. Vaccines require storage at refrigerator temperature (36 to 42 degrees F), but few people know the temperature their refrigerator maintains. A vaccine kept at lower or higher than recommended temperatures will lose its effectiveness more quickly than normal.

# DISEASE: DEFINITION, CLINICAL SIGNS, COMMON ILLNESSES, PREVENTION AND TREATMENT

## Definition

Webster defines disease as a particular destructive process in an individual. Even though that definition seems relatively straightforward, disease and disease processes can be complicated and sometimes difficult to detect, identify, and treat. This section will discuss several aspects of disease including various clinical signs that indicate sickness in the goat, common diseases that are seen in meat goats, and prevention and treatment of those diseases.

### Clinical Signs

Disease can affect the goat in several ways. One may find a goat with nasal discharge that is coughing, breathing hard and refusing to eat. In this case, sickness is relatively obvious. When the goat appears relatively normal but appears to have a slightly rough hair coat and intermittent diarrhea, disease is not so obvious. Whether disease is clinical, as in the first goat, or subclinical like the second, it is costly to the meat goat producer. The loss of an animal or the weight loss, treatment cost and labor cost involved in the treatment of a sick animal equal loss of income to the producer.

So, how does one detect disease? One of the main principles in detecting disease in an animal is relatively simple: You have to know what's normal to be able to detect the abnormal. The normal physical parameters of the goat are listed in Table 1.

Table 1

**Normal Parameters of Adult Goats**

| | |
|---|---|
| Rectal Temperature | 102°- 104° F* |
| Ruminations | 1 to 2 per minute |
| Pulse | 70 to 90 beats per / min |
| Respiration | 15 to 30 breaths per / min |

* Temperature may increase due to stress or environmental conditions. Normals tend to be higher for kids.

Most goats are alert, attentive and curious. Goats that appear tired, lag behind and separate themselves from the others should be checked for illness. Sick goats may appear humpbacked and carry their tail down. Other signs of illness include limping, breathing hard, coughing, weight loss, diarrhea, pallid mucous membranes, ataxia (acting drunk) and not being able to rise and/or walk. The list of signs could go on and on.

There are two important things to remember about goats and illness. The first is that goats as well as all animals will, on many occasions, show many of the same signs with sickness that we may show. For example, if we have a fever, we usually don't want to eat or drink. If we have bruised our foot or sprained our ankle, we will limp. If we have an illness that lasts for several weeks or months, we will lose weight and strength. The second important thing to remember about goats is that they don't ALWAYS show signs of illness until it may be almost too late. Because goats may mask signs of illness, an observant and conscientious producer who checks his or her goats regularly will recognize subtle signs and begin treatment, while a not-so-observant producer may need to get ready to possibly lose some goats because he or she has waited too late. The following section about common diseases and their presentations is intended to help producers become aware of both obvious and subtle signs in sick goats.

## Common diseases seen in Tennessee meat goats

Several books have been written about diseases in goats and their diagnosis, prevention and treatment. There is no way to include all diseases in a comprehensive manner in this section. This section is intended, however, to point out some of the most common illnesses seen in Tennessee's meat goats and to provide the producer with the knowledge to make educated decisions about recognizing and preventing disease. This section will not, for the most part, include specific treatment options or drug dosages. These are areas that need to be discussed with a producer's veterinarian or extension agent. Many of the diseases that will be discussed can look the same and be difficult to diagnose. Some are also zoonotic (passed to humans). Therefore, it is imperative that producers contact their veterinarian to help with final diagnosis and treatment of disease. Also, many animal health products are not approved by the FDA for use in goats, but are used "off label." This means that the drugs/antibiotics may not be approved for goats or are being used at a dosage not approved for goats. A valid veterinary/client/goat relationship must exist for a veterinarian to prescribe these drugs.

**Bloat**

Bloating is not seen as commonly in goats as it is in cattle and sheep. In any animal, bloat is considered a medical emergency and should be treated as such. Bloat or rumen distension is basically an accumulation of excess gas or froth in the rumen. Frothy bloat is seen in goats more commonly than gas bloat.

Regardless of the type of bloat, abdominal distension, particularly on the left side, occurs along with signs of colic and anxiety. As the bloat progresses, animals become more and more uncomfortable and may begin stomping their feet, urinating frequently and showing signs of respiratory distress. If not treated soon, animals will become recumbent which means lying down and die.

Treatment differs depending on which type of bloat the animal is experiencing. Treatment should only be attempted by a producer who is very adept and comfortable at passing a stomach tube and/or orally dosing a goat with relatively large amounts of liquid medication. Aspiration pneumonia, delay of proper treatment and death may occur if the animal is not treated properly. If one has any question at all about his or her ability to treat the animal, call a veterinarian immediately. Passage of a stomach tube (using a speculum or some type of guard) into the rumen will usually relieve gas bloat. Frothy bloat may be treated with cooking oil or mineral oil orally at a dose of 100cc to 200cc. One ounce of dioctyl sodium sulfosucinnate (DSS™) may also be given orally for frothy bloat and is usually very effective. Again, treatment should probably not be attempted without the aid of a veterinarian.

Prevention of bloat basically consists of controlling the diet and slowly introducing any changes into the diet. If goats have been confined all winter, it is not a good idea to suddenly turn them out on a lush, spring pasture and let them consume all they want. Let them adapt to the pasture gradually. Some pastures, such as those with high tannin content are not as likely to cause bloat, but precautions should still be taken. One to two hours before turning them out, feed dry hay and then let them out for a short period of time. Gradually increase the "turn out" time over one to two weeks. Concentrate feeds should also be introduced into the diet gradually to give the rumen time to acclimate. The inclusion of ionophores such as Rumensin™ (at recommended dosages) also may help when acclimating to concentrate feeds.

## Caprine Arthritis-Encephalitis (CAE)

Caprine Arthritis-Encephalitis is a viral infection that may affect the joints, lungs, brain and mammary glands of the goat. The most efficient way this virus is transmitted is through the kid ingesting the dam's colostrum. Once a goat has CAE, it always has CAE. Signs of an infection may not be visible for months to years. Fever is not commonly associated with this disease. The most common presentation of this disease is arthritis.

The arthritic form of CAE usually occurs in goats older than 6 months, usually around 1 to 2 years of age, but may occur anytime in adulthood. This form may begin as an on-again, off-again lameness or as an acute lameness. Some goats may get progressively worse while others may seem completely well only to relapse again and again. The "knee" or carpal joint is the most common joint affected, but one may also see problems in the stifle, fetlock and hock. A single joint may be involved or one may see multiple joints involved, depending on the individual animal and the severity of the disease. Commonly, swelling and heat are noted at the joint or joints affected. More subtle signs would include not keeping up with the herd, difficulty rising or strange posture, and weight loss. Even though some goats may do pretty well and remain relatively stable for long periods of time, most steadily get worse and worse with debilitating arthritis.

The neurological form of CAE usually affects kids from 2 to 6 months of age. Progressive weakness of the back legs that leads to eventual paralysis is the hallmark of this form. The course of the disease may last from several days to weeks with the kid remaining relatively bright and alert and still hungry. Other forms of CAE include chronic pneumonia and low to no milk production in the dam. Most infected goats, however, may show only weight loss or no detectable signs at all.

No specific treatment for CAE exists. The main goal in treating the arthritic form is to lessen the animal's discomfort. Regular and proper foot trimming, administration of pain relievers, good bedding and pasture management are all ways to help. Remember, however, that the goat you are treating is a source of infection to all the other goats in the herd.

Prevention of CAE may be complicated and eradication of CAE from the herd is quite labor intensive. Purchase goats from known CAE-negative herds (easier said than done). Principles of isolation of new animals brought should be followed. Testing and culling of all positive animals should eradicate the virus from the herd. If a large number of animals in the herd test positive, there are still some steps one can take without culling most of the herd at the same time.

1. Keep positive animals separated from the rest of the herd.
2. Since CAE is known to be passed in the colostrum, remove kids from the dam before they are allowed to nurse. This may be difficult to do with meat goat kids.
3. Kids that are removed should be isolated and raised on pasteurized goat milk, cow milk or milk replacer.
4. Do not use syringes, needles, tattooers, etc. between animals without first properly disinfecting them.

## Caseous Lymphadenitis (CL)

Caseous lymphadenitis is caused by the bacteria *Corynebacterium pseudotuberculosis.* The organism enters the goat through small abrasions or lacerations in the skin and mouth. The point of entrance determines where one will see this disease's most characteristic sign – swelling and abscessation of the superficial lymph nodes close to the point of entrance.

Signs usually include swelling of the lymph nodes and draining tracts, which contain a greenish, cream-colored, pasty substance that looks a lot like cheese. Most all affected animals act normal in every other way. In some animals, however, abscessation of internal lymph nodes may occur with the result of chronic weight loss and/or pneumonia.

Treatment of CL involves draining or surgically removing the abscessed nodes. When attempting to treat CL, please remember two very important points: the exudates or material from the abscess can survive in the environment for a long time and are infective to other goats. Also, the disease can spread from goats to humans. When draining the abscess, one must make sure that the pus is collected and properly disposed of, preferably burned. The goat should be kept in strict isolation until no more drainage from the abscess has occurred, and the lesion is covered by healthy skin. Previous antibiotic therapy has not been shown to be very beneficial, and many times, culling the affected animal is probably the best treatment.

Prevention of CL involves several important factors such as isolation, proper housing and facilities, disinfection and control of external parasites. Blood testing newly purchased goats may help. Remember to look for lumps and bumps when purchasing animals and keep new animals in isolation from the rest of the herd. Isolation is not always 100 percent effective with CL because it may take two to six months for abscesses to occur after initial infection. Housing and facilities should be maintained and objects that may cause skin injuries kept to a minimum. Needles, syringes and tattooers should be cleansed and disinfected after use. A commercial vaccine is available, or owners may want to ask their veterinarian about having a vaccine made from the bacteria that exists on their farm. External parasites should be controlled. If a goat is itching because of external parasites, it is much more likely to have abrasions and small lacerations in the skin, thereby providing an entryway for *Corynebacterium pseudotuberculosis.*

## Contagious Ecthyma (Soremouth)

Contagious ecthyma is a contagious, zoonotic disease of goats caused by a virus. Contagious ecthyma is also called orf, soremouth, scabby mouth and contagious pustular dermatitis. It is most commonly seen in young kids, but may also be seen in adult goats that have not previously been exposed to this particular virus.

The most common sign of this disease is exactly what its various names allude to – a sore, scabby mouth. Lesions consisting of small papules that progress to crusty scabs are most commonly seen on the lips. Scabs may also be seen on the face, coronary band, teats, scrotum, vulva and ears. Lesions usually go away on their own in two to four weeks. Contagious ecthyma does not usually cause problems in adult or young goats, except that it is very unsightly and as its names suggest, contagious. Occasionally young goats acquire a secondary bacterial infection with contagious ecthyma. The combination of these two infections may produce sufficient pain while nursing for the kid to cease nursing. In these cases, the kid must be supplemented with fluids and nutrients.

Treatment depends on the severity of the lesions, the degree of secondary bacterial infection and the location of the lesions. Again, this is a zoonotic disease. Anyone handling the affected goat should wear gloves. Antibiotic therapy should be initiated in kids with severe secondary bacterial infection. Udder salves may be used on teats to decrease the pain caused by the scabs and to keep the teats pliable. Rarely, one may see mastitis due to compromise of the teat's defense system with scabs. Antibiotics are also recommended in these cases. Because of the zoonotic potential, natural regression of the lesions and the fact that most animals remain relatively normal, contagious ecthyma is not routinely treated.

Prevention consists of isolation, an understanding of the persistence of this disease in the environment and possible vaccination depending on your herd and your veterinarian's recommendation. However, vaccination introduces the virus into the herd and so should only be used in herds where the problem already exists. All affected animals should be isolated. This alone may not guarantee further outbreaks. The scabs on infected animals contain the virus, and this particular virus can stay in the environment for months to years. The good news is that once an animal is infected, that animal develops a certain amount of immunity that will last for some time.

**Footrot, Foot Scald and Founder (Laminitis)**

Footrot is a contagious, bacterial infection of the soft tissue (interdigital space) between the toes of the hoof. Foot scald is a milder form of the disease that often precedes foot rot. It is relatively common in Tennessee due to our temperate climate. Footrot can be seen at any time of the year, but it is more common in the spring and early summer due to increased rainfall. The warm, wet weather softens the skin between the toes of the foot, thereby making it more susceptible to injury and infection.

A goat with footrot may have a slight limp, be excessively lame, or refuse to walk at all. The extent of clinical signs depends on the severity of the disease. Upon examination, one will see swelling, redness and pus in the interdigital space. It is not uncommon for more than one foot to be infected.

Treatment may consist of antibiotics, proper care and trimming of the foot, and environmental control. Depending on the severity of the disease and the number of goats affected, one or all of the above treatments may be used. Antibiotics can be delivered systemically, as topical applications and in footbaths (goats don't usually like footbaths). Trimming of the feet is important for two reasons. First, it removes dead tissue and allows more penetration of topical antibiotic preparations. Secondly, trimming of the foot may correct any overgrowth or abnormalities that might be causing extra pressure on the interdigital space or predisposing it to injury. Once animals have been treated, they should not be kept in a wet or muddy environment for at least two days. Infected feet should be reexamined and treated at two week intervals until the feet are normal.

Prevention consists of observation, correct and consistent foot care, and environmental control. Animals should regularly be observed for limping or lameness. Affected animals should be separated from the herd. New animals should be checked for swelling or redness between the toes and be isolated. Feet should be watched for overgrowth or abnormalities and trimmed accordingly. Trimming equipment should be disinfected between animals, and the trimmings from infected animals should be disposed of so that pets or other animals cannot move them back to the barn or pasture. Those successfully treated should not be turned out on a pasture where any other infected goats have been for at least 14 days. Rock piles assist good "foot health" by naturally wearing off excessive hoof growth. Weekly footbaths may help in times of wet, warm weather. Environmental control consists of trying to maintain a somewhat dry condition even in wet weather. Bedding should be changed regularly, appropriate drainage systems should be in place and the environment should be clear of objects that may injure the foot. A vaccine is available for sheep. Its effectiveness in goats has not been determined and even in sheep, it is usually recommended as only one part of a multi-system prevention approach.

### Founder

Founder or laminitis is a non-infectious inflammation of the lamina (inside structures) of the foot. Founder may be acute, which means the disease acts in a relatively short and possibly severe course, or founder may be chronic. Chronic founder usually persist over a long time and deformities in hoof conformation are common. Founder is usually seen more commonly in goats that are fed high amounts of grain or are going through ration changes to richer feeds. Founder may also be seen after severe infection or in cases of accidental grain overdose (they got into the feed bin).

Goats with founder appear uncomfortable. Affected hooves in acute founder will be warm to the touch with no evidence of footrot in the interdigital space. Also, unlike footrot, founder usually affects two or more feet. This means that either both the front feet or both the back feet are involved. The most common presentation is painful front feet. Goats may be in pain to the point where they will walk on their knees instead of their feet. Rarely, all four feet may be involved. In chronic founder, the conformation of the hoof becomes distorted and deformed. Goats may appear to be wearing "slippers" on their feet because of a long, upturned toe.

When founder is acute, it is important to identify the cause and treat accordingly. Pain relievers such as phenylbutazone and flunixin meglumine (Banamine™) should be used. These help keep the animal mobile, which in turn helps with increasing the blood supply to the hooves. Foundered goats should be fed only grass hay until they recover, and then brought back slowly and cautiously to full feed. With chronic founder, one must feed a decreased amount of grain (if any at all), do not change pastures or rations quickly, and frequently trim the hooves to keep conformation as normal as possible.

Prevention of laminitis deals with controlling factors that cause founder. Sudden changes in diet should be avoided, as well as excessive feeding of grain. Infections should be treated promptly and effectively. As in footrot, maintaining a good, clean environment and regular hoof care is important.

**Listeriosis**

Listeriosis is a bacterial disease that may infect several species of animals, including humans. The organism can survive for years in the environment over a broad range of temperatures and pH, and can be shed from apparently healthy goats. This disease occurs most commonly when feeding silage and/or round bales, but can also occur in goats on pasture, especially if grazing or browsing areas that are wet and boggy. Listeriosis occurs more commonly in the winter, but can happen anytime of the year. The disease may occur in several forms, but the most common form affects the goat's nervous system. It is most common in animals 6 months of age or older.

The organism is thought to enter the body through the lips and mouth and then move to certain nerves. It causes a variety of neurological signs ranging from simple depression and a failure to eat, which progresses to a dropped jaw, inability to retract the tongue and eat; moving in one direction continuously (circling); and finally, recumbency. A fever may or may not be present. It is common for goats to show problems with their eyes with listeriosis, and eyes may become slightly discolored.

Treatment consists of large doses of antibiotics and supportive care. Penicillin or oxytetracyclines may be used, but one should consult a veterinarian on treatment dosage and regimen. Patients will probably need help with eating and drinking if the disease has progressed far enough. A producer should ensure the sick goat is getting plenty of fluids and may want to mix feed with water into slurry, so it is easier for the goat to swallow. Intensive nursing care may be required. Remember, listeriosis is zoonotic, so one should use particular caution when handling these goats.

Prevention of listeriosis involves isolation and environmental management. Infected animals should be isolated, and animals that die should be disposed of promptly (burning or burying). Contaminated equipment should be disinfected. Try to keep goats in areas where the organism does not thrive and where goats will not get constant abrasions and puncture while grazing or browsing. Try to keep the environment clean and feeders free of manure and molding or rotted old hay. Store feeds properly.

**Overeating Disease**

The term "overeating disease" leads one to believe that this disease is caused by exactly that – overeating. It is actually caused by a bacterium called *Clostridium perfringes*. These bacteria usually live in the soil and the intestinal tract. When certain conditions occur, they will multiply rapidly in the intestines and produce a lethal toxin. Two things must happen for the bacteria to multiply to this extent: conditions must favor multiplication and the normal movement of the intestine slows down, allowing foodstuff to pass through slowly. This condition is commonly seen when goats that have not been acclimated to green pastures are allowed in lush, fast-growing pastures or cereal crops.

Heavy grain feeding or heavy milk access may also cause this illness. Any illness that actually slows down the intestinal tract may also predispose an animal to "overeating disease."

Kids may be found dead with no signs of sickness beforehand. In young kids, the disease lasts from several hours to little over a day and usually results in death. High temperatures and signs of colic are common. Watery diarrhea with depression, ataxia (wobbly, acting drunk) and recumbancy soon occur. Convulsions may occur and many animals are found comatose. The disease is also seen in older kids and may be seen in adults. Usually, as the animal becomes older, signs are not as severe. The animal may be sick for several days or signs may last for several weeks. These animals are usually off their feed and have severe diarrhea that comes and goes. With proper treatment and time, these animals usually recover. Treatment consists of antibiotics and antitoxin.

Unlike many of the other diseases discussed in this publication, there is a vaccine that helps prevent this disease. Prevention includes vaccination and good feeding practices. Changes to the diet should be made gradually, and both adults and kids should be vaccinated.

### Pneumonia

Pneumonia in the goat may be caused by numerous different organisms such as bacteria, viruses, parasites, fungi, etc. Certain management practices will also predispose goats to pneumonia. Poor ventilation, crowding, improper housing, wet bedding, poor nutrition, decreased colostrum intake and severe changes in the weather can all predispose an animal to developing pneumonia.

Nasal discharge, failure to eat, breathing hard, coughing and isolation from the rest of the herd are all signs of pneumonia. Fever is usually present, depending on the cause and course of the disease. Weight loss is common.

Treatment usually includes antibiotics for pneumonias that are bacterial in origin. Dewormers are used if lung worms are suspected or diagnosed by fecal examination. Other products may be used depending on the cause of the disease. Supportive treatments such as vitamins and nonsteroidal anti-inflammatory drugs are also used to help the animal regain strength and to help with pain and high temperatures. Producers need to make the animal as comfortable as possible with dry bedding, food and fresh water nearby. Isolate any affected animal from the herd.

Prevention deals with good management practices, early detection and isolation of new animals. Proper stocking densities, good nutrition, good ventilation for those confined and clean, dry surroundings help a tremendous amount in decreasing the amount of pneumonia seen in a herd.

### Polioencephalomalacia (PE)

PE is one of the few diseases we will talk about that is not caused by a bacteria, virus or parasite. PE is the result of low thiamine (vitamin B 1) levels in the body.

Normally, rumen bacteria produce enough thiamine for the body. When something happens that alters the environment of the rumen, production of thiamine decreases, as does the uptake of thiamine by the body. Sudden changes in the feed, moldy feeds, use of feeds high in molasses, excessive concentrate feeding, stress of weaning, high dietary sulfur content and overdosing of certain drugs may decrease the production and uptake of thiamine, thereby causing PE.

PE may be seen in all goats, but weanlings and young adults appear more susceptible. Early signs of PE include elevation of the head while standing, staring off into space or blindness, circling, excitability and wandering aimlessly. As the disease progresses, one may see "jumpy" eyes, rigidity of the limbs, convulsions and recumbency. Fever is not usually associated with this disease unless the goat is convulsing. If no treatment is initiated, goats usually die in 24 to 72 hours.

The only effective therapy is thiamine. If thiamine is given, response to the treatment is usually seen within a relatively short time. In mild cases, thiamine is all that is needed, and goats usually return to normal. If the course of the disease has progressed to a severe state before treatment, thiamine usually cannot undo all the damage that has been done. One may see residual blindness, decreased mental capacity and some residual neurological signs.

Prevention basically consists of avoiding the factors listed above that cause PE. Avoid sudden dietary changes and moldy feeds or feeds high in molasses. Increased roughage and decreased concentrate feeding will also help avoid PE. If weanlings are involved, review the weaning procedure. Make sure they are consuming sufficient roughage before weaning so that normal rumen flora development occurs. Good-quality, free-choice mineral, free access to good-quality forage and supplementation of the grain ration with thiamine or brewer's yeast may also be considered.

### Scrapie

Scrapie is a contagious disease seen rarely in goats. Scrapie is much more common in sheep. In most cases of scrapie in goats, a history of contact with infected sheep is found. Clinical scrapie has only been seen in adult goats. An infected animal may not show signs for months to years.

One of the major signs of scrapie in sheep is intense itching. This sign is also seen in goats, but neurological signs are most frequently seen. One of the first signs seen in goats may be irritability and a change in posture. As the disease slowly progresses over time, one may see hypersensitivity to handling, wobbling, shaking muscles, stumbling, falling easily and weight loss. In the last stages of disease, the animal refuses to eat, becomes extremely thin and finally dies if not destroyed first. Fever does not occur in this disease.

There is no treatment for scrapie, and it is a reportable disease. The USDA has an active control program in place and they should be contacted for specific information. The risk of scrapie can be reduced by maintaining a relatively closed herd. Commingling of sheep and goats should be done only when the infection status of the sheep is known.

Any goat that is showing uncoordination, intense itching or neurological signs should be isolated from the rest of the herd until a definitive diagnosis of the problem is made.

## Parasites: Internal and External

### Internal Parasites

The list of internal parasites in the goat herd is numerous; all cannot be included in this chapter. Therefore, the most common and most costly will be included, along with life cycles of the parasite and control measures in the herd. Since internal parasites are generally considered to be one of, if not the most, important problem facing Tennessee goat producers, this section will be more comprehensive than the previous sections in this chapter. The most common internal parasites discussed will be *Haemonchus contortus* (the barber pole worm) and *Teladorsagia* (the brown stomach worm). Coccidiosis will also be included.

### Common Stomach Worms

The two most important worms of the goat are *Haemonchus contortus* (the barber pole worm) and *Teladorsagia* (brown stomach worm). The general life cycles of these two are similar. Females lay eggs, which pass to the outside in the manure within a couple of days. The eggs can hatch in as little as one day or as long as more than a month depending on the weather. The baby worm (larva) hatches, eats bacteria in the manure and goes through a couple of stages of development over a period of a few days to a week. The larvae can go into a state of arrested development (hypobiosis) for up to three months if weather conditions are not good for its survival. If or when conditions are good, the larvae will leave the manure and climb up nearby blades of grass and wait to be eaten by a goat. Usually, the larvae will travel no more than 12 inches from the manure to the blade of grass and will climb no more than 4 inches up that blade of grass. The larvae are swallowed and go to the goat's stomach, where they mature into adults and attach to the lining of the stomach. This entire process can take as little as 17 to 21 days.

At certain times of the year (the winter or summer), the immature worms in the stomach may go into arrested development (hypobiosis) and later mature when weather is more favorable or after deworming. The result is a large number of adult worms in the stomach all at once and sudden signs of worm infestation a week to 10 days after deworming. The eggs and larvae are susceptible to weather extremes like heat and drying but generally can survive in Tennessee pastures for two to six months. Adult goat worms live for about 6 months.

*Haemonchus contortus* is a threadlike worm that is less than 1 ½ inches long and seldom recognized in goat manure. The female worm has a red and a white stripe spiraling down its body, giving it the appearance of a barber pole. The red stripe is the worm's intestine full of blood and the white stripe is its uterus full of eggs. The adult worms attach to the lining of the goat's stomach, bore into the stomach wall and suck blood. A heavy infestation of *Haemonchus contortus* can remove up to 10 percent of the goat's blood per day and death can quickly result. Individual females can lay up to 5000 eggs per day. *H. contortus* eggs hatch at temperatures above 50 degrees F and hatch best at temperatures between 80 and 90 degrees F. The larvae of this worm have a thick covering (cuticle), which helps protect them from drying out and they can survive 30 to 90 days in hot weather. This makes the worm more likely to be a problem in the summer.

*Teladorsagia* ( brown stomach worm) is the other important worm of the goat. This worm is even smaller than *H. contortus*. The eggs of this parasite will hatch at temperatures above 40 degrees F. The larvae can easily overwinter in Tennessee and arrested development of larvae is common in the winter. These worms attach to the stomach lining and produce irritation, which results in incomplete digestion of feed.

Weight loss and diarrhea may result from *Teladorsagia* infestation. *Haemonchus* results in anemia and pale color of the gums and around the eyes. Loss of blood protein can result in an accumulation of fluid under the jaw (bottle jaw). Sudden and unexplained death can result. Photograph 1, goat with diarrhea; photograph 4, goat with bottle jaw; photograph 2, goat with normal mucous membrane color and photograph 3, anemic goat. (Photographs at end of chapter, Page 28).

Control of internal parasites in the herd includes many factors, such as simple principles of isolation, nutrition, pasture rotation, stocking density, judicial use of dewormers and knowing when it's time to cull.

Isolation practices, as stated before, are important. A goat can appear perfectly healthy and normal on the outside while harboring all types of parasites and disease on the inside. When purchasing a new addition to the herd, certain steps can be taken to avoid introducing disease.

**Isolation of New Goats**

Make sure the goat is checked when it arrives and isolate it from the herd for four weeks. Look for lumps, bumps, pale gums, soremouth or any abnormalities. Check the goat for intestinal parasites by doing a fecal egg count. If the goat has worms (which it probably will), deworm it using an effective dewormer at a proper dose for the animal's weight. In 10 to 14 days, perform another fecal egg count. The fecal egg count should have decreased by at least 90 percent. If the fecal egg count has not decreased by 90 percent, the goat is harboring parasites that have become resistant to the dewormer that was used. If that is the case, the animal will have to be dewormed with two different CLASSES of dewormers and checked again in seven to 14 days. During the isolation period, check the goats regularly for any signs of disease, keep isolation pens as clean as possible and soiled bedding removed. Sanitation is very important in parasite control. The isolation pen where goats were kept should be cleaned and disinfected with all bedding removed and placed away from further animal contact. If new goats were on a small pasture, this pasture should not be used for other goats for several months.

**Fecal Egg Counting**

Fecal egg counting (FEC) is a relatively simple, relatively accurate lab technique that can be a big help in making better decisions in goat parasite-control programs. FEC can help determine which dewormers are effective in the goat herd (Table 1, Page 27), which animals are more susceptible to worm infestation, the approximate adult parasite load the individual goats and the likely immature parasite load on a given pasture. However, FEC is only useful for counting trichostrongylid-type worm eggs such as *Haemonchus*. This technique is not useful with coccidia or tapeworms even though both may be identified using this technique.

Generally, the entire goat herd need not be sampled for FEC to be useful. However, the same animals often need to be sampled over and over, and these animals do need to be identified. Recommended sample sizes for various sizes of goat herd or grazing units are:

8 animals or less →sample all of the herd
8 to 50 animals→ sample at least 10 animals
More than 50 animals→sample at least 15 animals or 10% of the herd

The FEC can be done at the time of FAMACHA testing; just before planned deworming; or in March, June, September and December. In some herds, depending on the management strategy, FEC may need to be done more often. Manure collected for FEC needs to be fresh and you need to know which animal provided the sample. Samples are best collected from the rectum of the animal using rubber gloves. Samples can be collected from the ground if you see the goat pass that manure and the sample still appears fresh and glossy. The samples should be put in individual plastic zippered bags and marked with the animal's ID and the date of collection. If the samples cannot be processed soon after collection, the samples should be refrigerated, but **never** frozen.

Supplies for performing FEC are relatively inexpensive and easy to obtain:

- Small plastic zippered bags for storing samples
- A black permanent marker pen for labeling bags
- Rubber gloves to protect hands during fecal sampling
- Wooden craft sticks or plastic spoons to move and crush fecal pellets
- 3-ounce (bathroom size) paper cups to mix manure and flotation solution
- 35-cc syringe with the tip plugged with clay or glue to measure flotation solution and manure samples
- 8 ounce plastic cup or old coffee cup to hold the 35-cc syringe upright
- A McMaster slide (available from Chalex Corporation www.vetslides.com or 425-391-1169, $15 to $20 for two or more)
- 1- or 2-cc syringes or an eye dropper to fill the chambers in the McMaster slide with FEC mixture
- A microscope with a mechanical stage and capable of 100x magnification ($200 or more)
- A tea strainer or gauze to filter the FEC mixture, if desired
- Paper towels to clean up your mess!
- Pictures or drawings of a typical trichostrongylid egg
- Records to keep track of results
- FEC flotation solution

Preparation of fecal egg-counting solution requires simple ingredients and household measuring cups. The solution can also be purchased ready to use. All these solutions are made of saturated solutions of various salts or sugars. Mixing these solutions with manure causes the worm eggs (and air bubbles) to quickly float to the top of the solution. Two solutions commonly used for fecal egg counting are:

1. FEC salt solution is made by measuring ½ cup of regular, non-iodized table salt and mixing with 2 cups of hot tap water. Stir the mixture until no more salt dissolves in the water. If all the salt does dissolve, add a little more salt. Allow the solution to sit for one hour after mixing. A little salt should be left on the bottom of the container. This will make sufficient solution to do 16 fecal egg counts.

2. FEC sugar solution is made by mixing 1 cup of sugar with 1 cup of hot tap water as described above. However, this solution is sticky and can mold with time.

The procedure for performing fecal egg counting is simple to do, but requires some attention to detail.

1. Choose a location where electricity is available and making a mess is ok.
2. Pour FEC solution up to the 28 cc mark on the plugged 35 cc syringe.
3. Remove fecal pellets from the bag one at a time and add to the FEC solution until the 30 cc level is reached. This will likely take three or four pellets depending on the size.
4. Empty the syringe contents in a small paper cup.
5. Use a craft stick or plastic spoon to thoroughly mash up the manure pellets so that worm eggs are released into the FEC solution. Alternatively, use the craft stick to press the manure pellets through the tea strainer and then stir the mixture thoroughly.
6. Just after stirring, use a small syringe or the eyedropper to withdraw some of the mixture to fill the chambers on the McMaster slide. Another method is to crimp the brim of the small paper cup to form a spout and use this to fill the slide.
7. Tilt the slide away from you slightly. Put the syringe, eyedropper or crimped cup up to the gap between the upper and lower parts of the slide and add the mixture until the entire chamber is filled. If the chambers don't completely fill or there are air bubbles in the chamber, tilt the slide down and tap it on a firm surface to empty both chambers. Refill both chambers.
8. Put the slide on the microscope stage with the grid side up and so that the slide can be easily moved around.
9. Focus the microscope on the dark grid lines. The debris will settle while the worm eggs (and air bubbles) will float to the top where they are easily seen.
10. Start at one corner of the grid and position the slide so that one grid line is on each side of the field you can see through the microscope.
11. Search down (or up) each of the rectangular grid spaces, counting the worm eggs that you see. Repeat on the other side of the slide. Multiply the number of eggs you see by 50 to equal fecal egg count for that sample.
12. Remove the slide from the microscope, turn the slide up on its side and tap on a firm surface to empty the chambers. Do the same with the plugged syringe

and allow both to drain before using again. Discard the cup and craft stick or spoon.

The information resulting from FEC testing can be used in several ways:

1. Consider deworming when the average FEC is above 1000 in the spring or summer or above 2000 in the fall or winter.
2. Take samples at the time of deworming and again 10 to 14 days later. If the dewormer is effective, average fecal egg counts should be reduced 90 percent in the samples taken 10-14 days after deworming.
3. Animals with persistently high fecal egg counts can be culled from the breeding herd.

**Nutrition**

Nutrition is also important in helping control disease caused by parasitism. In various studies, data has shown that goats receiving a well-balanced, nutritious diet are much more likely to be able to resist disease than undernouished goats. Be sure to especially watch does after kidding, animals under stress, and new animals introduced into the herd to make sure these animals are maintaining acceptable body condition.

**Avoid Overcrowding**

Overcrowding is definitely one way to ensure parasite problem. Stocking rates of more than six goats per acre make worm problems more likely. Some even recommend no more than two goats per acre. Alternatively, goats should be turned into a pasture when the average grass height is 10 inches and removed from that pasture when the average grass height is 5 inches. With barberpole worms, the female may pass 5,000 to 10,000 eggs per day. One can easily see how a lot of goats with a lot of worms can contaminate a pasture quickly. By overcrowding, goats do not have access to any "parasite-free" areas because there are too many animals passing too many worm eggs for there to be any "parasite-free" areas. Overcrowding also produces stress, which can decrease appetite (remember nutrition) and also decrease the body's immune system, resulting in disease.

**Pasture Rotation**

Pasture rotation is also very important in parasite control. Many times pasture rotation is more easily said than done, and below are some guidelines that one can follow to make the concept of pasture rotation easier.

1. Goats that are browsing rather than grazing will pick up fewer worms. The worm larvae cannot climb up browse plants for the goats to eat them. Goats that are grazing short grass will pick up more worms than goats grazing longer grass. Goats don't like to eat grass shorter than 5 inches or so, and worm larvae are concentrated in the lower parts of the plants.

2. Give the pasture a rest. Research shows that pastures that are rested for three months during the warm part of the year and six months during the cooler months have very few worm eggs or larvae left to infect the animals.
3. Take a cutting of hay from the pasture. This takes away some of the parasites and most all of the parasites' cover from temperatures and environmental conditions.
4. Graze the pasture with horses or adult cattle to decrease worm populations or use multi-specie grazing.
5. Use relatively "safe" pastures for animals that are least resistant to parasites, such as young kids.

Pasture rotation is very important. Recent studies have also shown that pasture type may be important in controlling parasites. Pastures that contain forages with high tannin content, such as sericea lespedeza, have tentatively been shown to decrease the parasite burden of the herd.

Isolation, nutrition, overcrowding and pasture rotation are all important principles that help control the parasite burden of the herd. The only thing that kills the parasites, however, is dewormers. There is a catch to JUST using dewormers to control the worm population – many parasites have become resistant to dewormers over time. Studies have shown resistance to almost all common dewormers in different herds across the country. Resistance has developed because of underdosing, dosing too often, changing dewormers too frequently and not practicing the principles of isolation, which may introduce resistant parasites into the herd. So, how does one tell if dewormers are working and how does deworming judiciously help avoid more parasite resistance?

1. Do fecal egg counts before deworming and 10 to 14 days after deworming.
2. Never underdose. Divide the animals into different groups based on similar weights. Dose each individual group according to the heaviest animal in that group.
3. Talk with your veterinarian about different dewormers, their effective dosages and if resistance has been seen in your area to any dewormers.
4. Hold the goats off feed for 12 to 24 hours before deworming. This removes feed from the stomach and makes the dewormer more effective. When using a benzimidazole dewormer and dosing at a normal dose, fasting may make the dewormer more effective.
5. Make sure goats in the herd are closely monitored at times when they are more susceptible to parasites, when parasites are in arrested development or when the environmental temperatures and moisture conditions favor parasite survival and transmission. Examples of animals more susceptible to parasites would be does before kidding (usually mid-winter), does shortly after kidding, young goats in general (but especially those that have been recently weaned), and goats that seem unthrifty. Examples of environmental temperatures and moisture conditions include: moderate to warm temperatures, rain after a dry spell and humid conditions.
6. Wait at least 72 hours after treatment before turning the animals onto an uncontaminated pasture.
7. Be careful with information that is not based on scientific studies. Such "natural" dewormers as diatomaceous earth, herbs, different organic supplements, etc. have NOT been proven to be effective against many of the most dangerous intestinal parasites.

8. Rotating from one chemical class of dewormer to another no more than once a year slows the onset of worm resistance to dewormers.
9. The most effective time to deworm goats is when the largest number of worms are in the goats and can be killed. These times would be around the time of kidding, in June after grass growth slows, at the time of weaning kids (you may want to repeat in three to six weeks) and in the early winter. Many producers deworm more often than this, but it is likely that their herd would benefit from pasture management practices that would reduce the goat's exposure to worm larvae.

The last management practice and oftentimes the hardest to implement is to cull animals that are continuously unthrifty (Photograph 1, page 28) and have to be continuously dewormed. Resistance and resilience to parasites are inherited qualities. Certain breeds have even been proven to have more resistance to parasites than others (Spanish and Tennessee "fainting" goats compared to Boer goats). If one has a doe that has to be dewormed often, there's a good chance that her kids will also have to be dewormed often, and their kids, and so on. Consider this – if one continues to cull animals that require regular deworming, sooner or later one will end up with a herd that will be more productive with less cost.

### Using the FAMACHA System

One may use the FAMACHA system to choose when to deworm certain individuals in the herd without having to deworm the whole herd. This saves money and helps combat parasite resistance. As with everything, there can be some disadvantages to using FAMACHA. Before using this system, make sure to understand its advantages and disadvantages and exactly how to use it.

Named for its originator, the FAMACHA system uses examination of the lining of the goat's eyelids (Photograph 2, page 28) to determine the presence of paleness (anemia) (Photograph 3, page 28) associated with blood loss as an effect of the most common intestinal worm of goats. The degree of paleness is used to decide whether to deworm an individual animal. These results in less use of dewormers and the ability to identify goats in the herd that are most susceptible to worm problems.

*Haemonchus contortus* is the most common problem worm in goats in the Southeast. This worm attaches to the wall of the true stomach of goats and sucks blood as a food source. Goats can lose up to 10 percent of their blood volume (Photograph 4, page 28) a day and death can quickly result from *H. contortus* infestation. Most goats are somewhat resistant to worm problems. Twenty to thirty percent of a goatherd will spread most of the worm eggs and have most of the health problems associated with this worm. The FAMACHA system allows the susceptible minority of goats to be identified, treated and culled.

### Advantages of the FAMACHA System

Resistance and resilience to worm problems in goats are moderately heritable, so progress can be made by selection. Resistance is the ability to resist worm infestation and resilience is the ability to resist the *results* of the worm infestation once it occurs.

FAMACHA allows the 20 to 30 percent of goats that are more susceptible to worm problems to be identified and treated as needed and eventually be culled from the herd.

The development of resistance problems to dewormers can be slowed by the use of the FAMACHA system. When all goats in the herd are dewormed at once, those worms that survive deworming are much more likely to be somewhat resistant to the dewormer used. When only part of the herd is dewormed, the resistant worm eggs are diluted by the susceptible worm eggs passed by untreated goats in the pasture. The result is that more of the worms that animals pick up are susceptible to a given dewormer.

Only about 30 percent of the herd is responsible for 80 percent of the worm eggs passed onto the pasture. Deworming only problem goats does nearly as good a job of reducing the number of worm eggs on a pasture as does deworming all goats. Deworming fewer goats costs less money and takes less labor than deworming all goats. If good records are kept, problem pastures and situations can be identified.

### Disadvantages of the FAMACHA System

Successful use of the FAMACHA system requires purchase of a card, some training, attention to details and records. The card is copyrighted. More information is available at www.scsrpc.org or famacha@vet.uga.edu.

The FAMACHA system is only useful for the control of *H. contortus*. Other worms may be a problem in the herd. Producers must also consider other worms and other problems can cause anemia in goats. You must know which dewormers are effective in the herd before the use of FAMACHA system. The FAMACHA system will not replace effective herd and pasture management, but can be an important part of that management system.

### Using the FAMACHA System

1. Using the Modified McMaster technique or other testing systems, determine which dewormers are effective in the herd.
2. Examine all goats every two to three weeks in the spring and summer and every four to six weeks in the fall and winter. Problem herds, goats less than 6 months of age and heavily pregnant does may need to be examined more often. In large herds, a sample of the herd may be examined but the problem animals will probably be missed.
3. To check sample goats, push up on the upper eyelid with one hand and pull down on the lower eyelid with the other hand. This exposes the mucous membranes that line the inside of the upper and lower eyelid.
4. Using the FAMACHA card (and not just your memory!), determine whether or not the mucous membranes are paler than normal. Score the mucous membrane color according to the color it best matches on the card (1 to 5). Check both eyes if you are unsure what score to give that animal. If it seems that these mucous membranes are between two numbers, use the higher number.
5. Record the goat’s identification and its FAMACHA score.

6. Deworm only goats with a FAMACHA score of 4 or 5 if the goat otherwise appears healthy. Treat those animals scoring 3, 4 or 5 if:

    a. More than 10 percent of the herd is usually treated
    b. The animal scoring 3 has other indications of problems such as weight loss, sluggishness or bottle jaw
    c. The animal is heavily pregnant
    d. The animal is less than 6 months of age

The FAMACHA system, if used conscientiously, can be an effective part of parasite control in the goatherd (Reference photographs, page 28).

**Meningeal Worm Infestation**

The immature stage of the meningeal worm, *Parelaphostrongylus tenuis*, can migrate onto the spinal cord and brain of goats, producing irritation of the covering of the spinal cord and signs of disease.

*P. tenuis* is commonly found in whitetail deer, though it rarely causes disease in these animals and they cannot directly spread the problem to goats or other animals. However, deer do pass the immature form of this worm in their manure, which may then be eaten by snails and slugs. Goats may accidentally eat the snail or slug, picking up the worm. The worm then migrates through the goat's body, ending around its spinal cord. The presence of the immature worm irritates the covering of the spinal cord, causing signs of this disease.

Goats with meningeal worm infestation are usually bright, alert and eating well during the early stages of the disease. Other signs include itching, weakness, staggering, paralysis, blindness and death. Veterinary diagnosis is based on typical signs and blood testing for an increase in certain types of white blood cells. Treatment of meningeal worm infestation is subcutaneous injection of ivermectin (various brands) given at the rate of 2.5 cc per 100 pounds of body weight once, followed by 1cc once a day for five days.

Also, fenbendazole (Safeguard®, Panacur®) given orally at the rate of 7cc per 100 pounds of body weight has been successfully used.

**Coccidiosis**

Coccidiosis is also a very important internal parasite. Unlike the barberpole worm and brown stomach worm, coccidia are not worms but small one-celled parasites called protozoa. If one has goats, they will have coccidia. Coccidiosis (showing signs of being infested with coccidia) usually only occurs in younger kids because of immature immune systems and older goats under stress. The environment where the goats are kept also plays a huge role in the development of the disease. Coccidia love dark, damp barns with old bedding. Feeding off the ground and dirty feed troughs also contribute to the success of coccidia.

Coccidiosis affects kids at least 1 month of age or older. It may also occur in younger kids, but this is not common. Diarrhea is usually the most common sign along with weight loss, poor hair coat and decreased appetite. The diarrhea may quickly progress to watery, bloody diarrhea with dehydration and, if left untreated, death. Other intestinal parasites and infectious diarrheas may mimic coccidia. Therefore, it is best to have the animal examined by a veterinarian who can confirm coccidia by performing a simple, inexpensive fecal test.

Coccidia is treated with a variety of drugs depending on the herd, the number of animals that are affected, the severity of the disease and the previous history of the farm. Many of the drugs that are used to effectively treat coccidia are not approved to be used in goats. Coccidia have also become resistant in some areas to drugs that are commonly used. It is probably best to contact your veterinarian or Extension agent to find out which drugs are still effective in your area and may be used.

Prevention is best accomplished through sanitation. It is best to keep barns clean and free of old bedding. Feed off the ground, clean feed troughs regularly and provide adequate drainage in barns and pastures. Coccidia can live for a long time in dark, damp areas. Sunlight and heat are detrimental to this organism. Certain feed additives such as decoquinate and Monensin™ have been proven to help prevent coccidiosis outbreaks and should be used in times of potential stress.

**External parasites**

Some external parasites of goats that will be discussed in this chapter are lice, mites and ringworm. External parasites are important in the goat herd because they usually cause loss of production and most are contagious. The insecticides that are commonly used to treat external parasites are many and varied. Mixing instructions and any label warnings should be noted and followed. Some regularly used anthelmintics also help with external parasite control. Veterinarians and Extension agents can help producers choose which insecticides best fit their particular herd.

**Lice**

Lice are very small and, depending on the type, may or may not be visible to the naked eye. They live on the goat and complete their life cycle there. Several different types of lice may be found on goats. Lice are usually transmitted from one animal to another by simple contact. One usually sees louse infestations more commonly in the winter months.

When a goat has lice, it will appear uncomfortable and scratch. Hair coats may be dull and matted and hair loss from scratching is common. Raw areas may appear on the skin, and these areas may become infected with secondary bacterial infections. Weight loss can occur because the animal is uncomfortable and nervous and scratching all the time instead of eating.

Many good insecticides are available to treat lice. If lice are found in the herd, it is best to treat the whole herd. Some treatments may recommend reapplication in two to three weeks because of the louse life cycle and the efficacy of the insecticide against the louse egg.

**Mites**

Several different varieties of mites affect the goat, including ear mites. Mites cause intense itching, hair loss and scab formation. Mites found in the ears cause head scratching and hair loss on the ear. Flaky, scabby lesions may be found on the outside of the ear with yellowish-white wax on the outside. Miticides are routinely used, and just like lice, mites generally have to be treated more than once because of their life cycle.

**Ringworm**

Ringworm is not a "worm" as many think as it is actually a type of fungal infection. Ringworm is usually seen on the face, ears, neck or legs although it may present anywhere on the body. Most goats with ringworm are not "itchy" but usually have areas of crusty scabs on their skin. Hair loss and redness of the skin may also occur. Most cases of ringworm will heal without treatment in about two months. Treatment is usually recommended because of the unsightly appearance and contamination to both the environment and other herd mates. When treating a goat with ringworm, remember that this is also contagious to humans. Treatment of ringworm involves using a fungicide (betadiene, chlorahexidene, etc.) for relatively long periods of time.

## Prevention of common diseases

In the goat herd, principles of disease prevention may be summed up by isolation, sanitation, nutrition and selective breeding with some vaccination for *Clostridial* diseases. Many of these principles overlap with biosecurity. Biosecurity and prevention go hand in hand in helping the producer maintain a safe and disease-free herd.

Isolation is a very important prevention measure. Goats may appear completely normal but be harboring resistant intestinal parasites, lice, caseous lymphadenitis and numerous other diseases. Isolation is covered in the parasite section and biosecurity sections of this chapter. The important points are:

1. Isolate new arrivals for at least one month.
2. Check goats closely in isolation for any abnormalities or signs of disease. Follow the previous suggestions for deworming. Trim and disinfect feet at this time.
3. Goats that become sick during isolation should either be culled or put in a separate isolation pen or facility.
4. Goats within the herd that are sick should be isolated from the others.
5. Feed, water and treat these goats last. A producer can easily carry CL on his or her boots or clothes to other goats. It is not a bad idea to have one pair of boots for the isolation facility and another for the rest of the farm. Wash hands well.
6. Make sure that when goats leave isolation, the pens and facilities are cleaned and disinfected properly.
7. If a goat within the herd travels to another facility where goats and sheep are present, it is not a bad idea to isolate on return to the farm.

8. Before turning out isolated goats to the rest of the herd, go through and check each goat again for any abnormalities.

Caseous lymphadentis can stay in the environment for long periods of time. *Listeria* loves dark, rotten, wet areas. Coccidia thrive in damp, dark areas. Foot rot is seen most commonly in muddy, wet environments. Ringworm loves dirty facilities. The list of organisms that cause disease, and thrive, multiply and infect in dark, damp, dirty areas goes on and on. Keep facilities, watering troughs, feed troughs, etc. as clean and dry as possible. Sanitation and disinfection go a long way in helping prevent disease and disease outbreaks.

Polioencephalomalacia, founder, "overeating disease" and bloat are all caused by problems in the diet. Nutrition is discussed elsewhere (Chapter 8) but its importance regarding disease is well worth mentioning here. If an animal is stressed and not eating well or is not on a proper diet, that animal's immune system will be compromised and disease will follow. If an animal's diet is changed suddenly without any acclimation period, one will see problems. Proper nutrition and good feeding practices are not only essential in growth and reproduction, but also in disease control and prevention.

As mentioned previously, a doe with constant intestinal parasites that has to be dewormed often will produce offspring that have to be dewormed often. Some disease resistance and/or resilience can actually be hereditary (consider sheep and scrapie). We genetically select for superior conformation and reproductive traits. To a certain degree, we can also select for health traits. Cull animals that are always unthrifty – keep animals that do well with a minimum amount of care. Sooner or later, one should have a healthier and more productive herd.

Vaccinations are also important in preventing disease in the goat herd. There is not one single vaccination schedule that can fit all herds, since all herds are different. Depending on facilities, herd history and vaccination status of that herd, when to vaccinate and with what will differ. A veterinarian should be consulted to help tailor a vaccination program for a specific herd. The only diseases discussed in this chapter that are commonly vaccinated against in goats are the overeating disease and tetanus. Many vaccines will be combinations that include both these clostridial diseases. A common vaccination protocol usually consists of vaccinating pregnant does in the last month of pregnancy. Kids from vaccinated does may be vaccinated at 4 to 6 weeks of age and then boostered in three to four weeks. Kids from unvaccinated does should be vaccinated between 1 and 3 weeks of age and then boostered every three to four weeks for two boosters. Bucks and yearlings may be vaccinated at the same time as does. As stated earlier, this vaccination schedule may differ depending on the herd's history and management practices. Vaccination for clostridial diseases is much less expensive than the loss of an animal and well worth the producer's time and effort. It is the one disease of all the common diseases seen in goats that can largely be prevented by vaccination.

**Kidding**

Normal pregnancy length of the doe is about 150 days, but can vary. Does near the end of pregnancy will show relaxed pelvic ligaments, an enlarged and longer vulva and udder enlargement. Does due to kid should be neither fat nor thin (Body Condition Score of 2.5 to 3 if using 1-5 scale or Body Condition Score of 4 to 6 if using 1-9 scale) and have adequate exercise.

Does are more likely to kid during the day. The first stage of labor occurs as the uterus contracts and pushes the offspring up against the cervix. Older does may not show any signs of this first stage of labor, but first kidders may leave the herd, appear restless with laying down and getting up, and frequent urination and defecation. First stage labor longer than 12 hours may indicate a problem and the does should be examined.

Straining to kid marks the start of the second stage of labor. The afterbirth appears first, then the front legs and head or both rear legs. Most does kid laying down, but older, more experienced does may complete the entire process standing up. Most does will complete kidding within two hours of the beginning of straining and any doe that has been straining longer than one hour without making progress should be examined.

Passing the afterbirth is the last stage of kidding and should be completed by six hours after the last kid is born. Does that have not passed their afterbirth by 12 hours after the end of labor may have a problem and should be examined. Lochia is a red-brown, odorless discharge from the doe’s vulva, which is normal for up to three weeks after kidding.

Does to be examined should have their vulva cleaned with soap and water and then thoroughly dried. Someone with small hands and arms can enter the birth canal further and with less discomfort than examiners with larger arms. Lots of obstetrical lubricant should be used and all movements and manipulations should be done gently to avoid injury to the doe.

The most common causes of birth difficulties in the doe is abnormal posture of one or more offspring where the head or both legs are turned back rather than properly entering the birth canal. The examiner should carefully determine how the kid in the birth canal is being presented and try to correct that kid’s posture to normal presentation. The first step in delivering the abnormally presented kid is to raise the rear end of the doe. This can be done by standing her with the front end lower than the rear or by having someone lift the rear of the doe.

Raising the rear of the doe allows the kid to move back into the abdomen where there is more room and various problems can be corrected more easily. If the head is turned to the side, gentle pulling of the mouth to the side and back will often straighten out the head. Sometimes, a snare of some sort will need to be placed in the mouth so that the head can be pulled back. Bended legs can be straightened in a similar fashion by grabbing the leg below the first joint you find and moving the leg to the outside and then to the back.

Always make sure that the heads and limbs you are working on belong to the same kid. Once the kids are delivered, they should be left with the doe so that she will claim them and let them nurse.

## Summary

This section has provided the producer with useful information in principles of herd health, biosecurity and common diseases seen in goats and the treatment and prevention of these diseases. One needs to remember the concepts of isolation, commingling, sanitation, disinfection, nutrition and vaccination in the prevention of disease. These concepts, if followed, will guide the producer into a more profitable and enjoyable herd.

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## Table 1. Commonly Used Goat Dewormers And Their Dosage

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Most of these products are not federally approved for use in goats and legal extra label use requires veterinary advice and adherence to federal extra label use regulations. Producers using products not approved for goats or at a different dose or route of administration take responsibility for assuring that product residues are not present in meat or milk at the time of consumption. **The University of Tennessee has not tested these products for safety or effectiveness in goats.**

| Chemical Class | Generic Name | Example Brand Name | Metric Dosage | English Dosage | Comments |
|---|---|---|---|---|---|
| Benzimidazole | Albendazole | Valbazen 11.36% suspension | 7.5 gm/kg | 3 ml/cwt-by mouth | not for use in early pregnancy |
| Benzimidazole | Fenbendazole | Safeguard 10% suspension | 20 mg/kg | 9ml/cwt-by mouth | federally approved for goats at lowest dose |
| Benzimidazole | Oxfendazole | Synanthic 9.06% suspension | 10 mg/kg | 5ml/cwt-by mouth | |
| Macrocylic Lactones | Moxidectin | Cydectin 0.5% Pour-on | 500 ug/kg | 5 ml/cwt-by mouth | |
| Macrocylic Lactones | Ivermectin | Ivomec 0.08% Sheep Drench | 300ug/kg | 18ml/cwt-by mouth | |
| Cholinergic Agonists | Pyrantel Pamoate | Strongid T Equine Anthelmintic Suspension | 25 mg/kg | 20 ml/cwt-by mouth | |
| Cholinergic Agonists | Morantel Tartrate | Rumatel Medicated Premix | 10mg/kg | See label directions | federally approved for use in goats |
| Cholinergic Agonists | Levamasole | Levasole Sheep Wormer | 8 mg/kg | 2 boluses/cwt | |

Photograph 1

Photograph 2

Photograph 3

Photograph 4

# Integrated Parasite Management for Livestock

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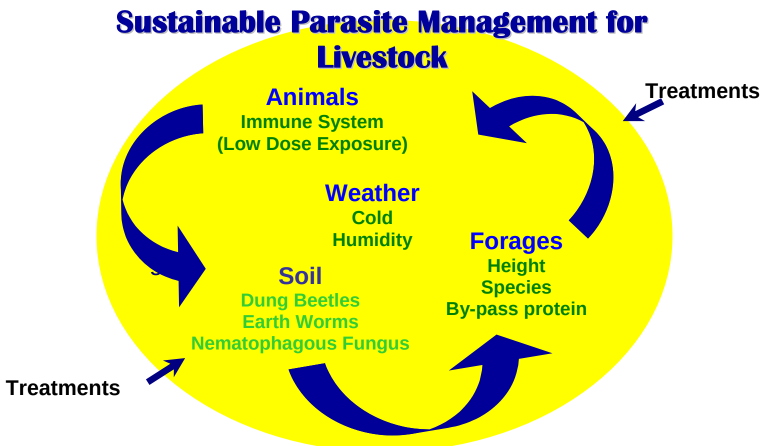
## Introduction




Internal parasites are considered by some to be one of the most economically important constraints in raising livestock. Confinement and pasture-based animals are almost certain to be exposed to worms at some point in their life. This is certainly true for goats.

Most producers are aware of the problems that worms cause, which range from decreased productivity of their animals to death. Animals are usually routinely dewormed with different commercial chemicals, by owners using a variety of deworming schedules. Every dewormer on the market has had some resistance built up to it by the internal parasites that infest livestock. This resistance means that not all the worms are killed during deworming. The surviving worms pass that genetic resistance on to offspring.

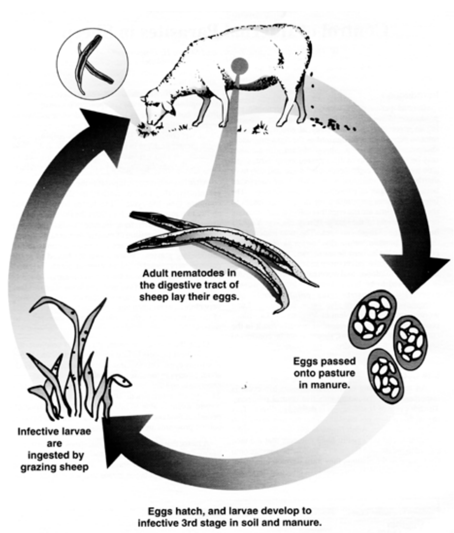
The seriousness of the issue cannot be stressed enough, especially with goats. More and more goat herds are finding they have no chemical dewormers left to use. The worms are resistant to every one of them. This has changed the strategy of dealing with internal parasites. We are no longer as interested in killing all the worms, as we are in preserving the susceptible worms. This is such a different way of thinking; it takes a while to adjust the way a producer deals with worms in their herd. But it will become ever more important if we are to retain any chemical dewormers for emergency use.

As a result, this problem has caused people to look for alternatives. Much attention both in the research community and on the farm is being devoted to discovering ways to prevent and treat internal parasites without relying on heavy doses of chemical dewormers. Many people claim this treatment or that control measure works, but there are more questions than answers. There is no simple alternative way of preventing or treating worms, nor will there be. By looking at the whole farm as an interrelated system, it becomes apparent that there are parts of the system that can be managed to decrease internal parasites and their effects. These management adjustments not only postpone the day when chemical controls no longer work, but they also may decrease costs and increase the overall health of the animal.

**Parasite Life Cycle**

Goats and sheep are infested by the same species of worms. Cattle are mainly infested by other species. The barber pole worm, *Haemonchus contortus*, is a stomach worm that can severely affect goats and sheep. It is a bloodsucking worm, which can cause severe anemia and death.

This parasite has a simple life cycle, as illustrated here.




http://www.ext.vt.edu/pubs/sheep/410-027/figure1.html

**Nutrition**

Nutrition plays a major role in how well animals are able to overcome the detrimental effects of internal parasites. In fact, the signs of parasitism can often be used as a symptom of some other problem, usually poor nutrition. In an article in the Journal of the American Veterinary Medical Association in 1943, researchers showed that sheep placed on a high plane of nutrition were able to reduce their worm burden significantly and many of the sheep were even able to cure themselves (1).

**Pasture Management**

Management of animals, pastures and any loafing areas is the key to reducing the amount of internal parasite problems in livestock. An understanding of the life cycles of the different parasites within the whole soil-plant-animal system will help show the interrelationships

between these three components. Managing internal parasites is just like managing fleas in dogs and cats. The major part of the parasite life cycle is outside of the animal. This point will help the producer to choose management strategies that reduce parasite levels on his or her farm and decrease the usage of chemical dewormers. The same principle is used in integrated pest management for vegetables and other crops.
Many farmers closely monitor their animals but pay little attention to the plants and soil. Pasture contamination by infective larvae is the primary factor to deal with. If you start with an understanding of the interrelationship between the animal, the plants it eats and the soil on which those plants grow, then it becomes clearer how parasites infect the animal and how they can be managed so as not to cause as many problems. Everything a farmer does to his or her animals, including the grazing management, has an impact on the numbers of internal parasites their animals will have.

By looking at the whole farm as an interrelated system, it becomes apparent that there are parts of the system that can be managed to decrease internal parasites and their effects. For example, animals that continuously graze a pasture eat the grass into the ground, while contaminating the soil with so many parasites that nothing outside of regular deworming with chemicals will control them. This can especially be disastrous for goats, as they quit grazing when the pasture forage mass falls to a level of three to five inches. By using controlled grazing methods that allow pastures to rest and soil life to function well, contamination can be reduced. This reduction occurs because soil organisms, including earthworms, dung beetles, and nematophagous fungi will destroy or keep a lot of the parasite eggs and larvae from developing. Keeping the grass in a more vegetative stage, and tall enough to provide the animal with adequate forage, will provide better nutrition to keep the animal healthier, strengthening the immune system to prevent the adult worms from producing eggs. Parasites do not cause as much harm to a healthy, well nourished animal. The parasites that are present will not deplete the host as much as in an animal that is malnourished. Parasite loads affecting wildlife generally do not cause the death of the host, because the parasites need the host to survive. The same principle applies to livestock.

Pasture contamination can be reduced through management. Livestock will avoid manure piles and the grass surrounding them. This behavior also helps them avoid eating larvae. The height of the pasture sward can affect parasites. The majority of worm larvae crawl only one inch from the ground onto plants, so not allowing animals to graze below that point will cut down on a lot of infestation. This is one reason sheep tend to have more problems with internal parasites. They eat much lower to the ground than cattle do, picking up higher numbers of larvae. Therefore, it is important to monitor grazing sheep closely so they don't graze too low. Larvae migrate from the manure no more than 12 inches from the manure pile. If livestock are not forced to eat close to their own manure, they will eat fewer larvae. This holds true even for goats and sheep which scatter the manure "berries" as they walk.

With sheep and goats, the most important time to control pasture contamination is during the periparturient rise, which is the sudden release of infective larvae and eggs within the ewe's intestinal tract. This occurs right after kidding, and is due to the doe's immune system becoming temporarily less effective. By treating animals at this time, the exposure to newborn and young lambs (those most susceptible to parasites) is minimized.

Good grazing management includes the use of clean pasture to minimize re-infection. Clean pasture is pasture that has not been grazed by the host animal (in this case, goats) for 12 months, and therefore is not contaminated with worm larvae. It may be new pasture, pasture grazed by livestock such as cattle or horses which do not share parasites with sheep (goats do share parasites with sheep), or pasture that has been hayed, renovated, or rotated with row crops. There is some killing of parasites on pasture during the winter due to freezing and thawing; however, snow cover insulates the larvae. Summer is the time in the Southern states when most larval kill will occur on pastures. Sunlight will kill them, and this occurrence can be used to determine which pastures can be used in the fall and into the winter. Grazing down to 2-4 inches from the ground allows more sunlight to get to those larvae and increases their chances of drying out and being killed.

Warmth, oxygen and moisture are the three most important things that increase the chances that larvae will survive on pasture (5). Knowing when your pastures are apt to be driest and hottest will help you manage them better for parasite control.

Good sanitation is a defense against parasites. Feed troughs and water sources located where they can be contaminated with feces will increase the chances of livestock infestation. This is only one reason not to water directly from ponds, or to allow animals continuous access to water sources. Feeders should be cleaned and elevated. Kidding areas, as well as other holding areas, should be clean and dry. Prevent the transmission of infestations from new arrivals to the herd or flock by deworming them before arrival and again three weeks later.

**Herbal leys**

Herbal leys are pastures that have a combination of grasses, legumes and forbs, plants most of us know as weeds. The concept was developed in the early 1900s in Clifton Park. Although all the plants are important for nutritional purposes, it’s the forbs and some of the legumes which is the focus for those of us looking for alternatives for chemical dewormers.

Most of the plant research has been aimed at sheep and goats, as they are the animals most severely affect by worms. But the concepts will fit all ruminants. There are a number of plants that have been researched, but I will discuss the ones most apt to have application in the northeast United States.

These plants contain either condensed tannins, or sesquiterpenes as the compounds showing anti-worming activities.  The plant which research shows has the most definitive effect on worms is sericea lespedeza. Goats grazing sericea had FECs drop to extremely low levels in two days time (Min, 2004). Within two weeks after the goats were removed from the sericea, the FECs had climbed back to pregrazing levels. Sericea has high levels of condensed tannins. Now sericea is a noxious weed in the central U.S. In the eastern U.S., it’s hard to establish and hard to maintain stands. However, birdsfoot trefoil, which can be grown in the northern U.S., appears to have the same effect. The condensed tannins prevent the adult worms from laying eggs. There is some preliminary evidence that they also have an effect on the vigor of the worms, but that has not been substantiated. Chicory is another pasture plant that has been shown to have a negative effect on internal parasites (Marley, 2003). Puna chicory is a forage variety that can be grown in the United States.

These plants can be planted within pastures or hedgerows or most preferably in an herbal pasture that animals have access to periodically. Many of the herbal forbs are highly palatable, have a longer rest period than the grasses, and can be more easily overgrazed. By having an herbal "medicinal" pasture, the animals can be offered it for a short period of time, and rested otherwise.

**FAMACHA testing**

The FAMACHA test is a system of testing sheep and goats for the level of anemia due to Haemonchus infestation, imported from South Africa. The eyelids are each pulled down to expose the conjunctiva or pink part of the eyelid which is then compared to an eye color chart. Goats which have a score of 3, 4 or 5 are at risk of dying from Haemonchus and should be dewormed. Those with a score of 1 or 2 should not be dewormed. Research has shown that is very effective in identifying those animals at highest risk from dying due to parasites (4). The research has also shown that about 20% of a herd will have 80% of the worm problems. It's important to identify those 20%, and cull them and their offspring from the herd.

This test should be used so that animals that show no signs of parasites are not dewormed. This keeps a level of refugia, those worms still susceptible to chemical dewormers, out on pastures, barnyards and in animals. It is also useful to help determine how well the strategies outlined in the rest of this article are working for the producer.

In many instances the only dewormer still effective is Cydectin. Therefore, do not use that dewormer at all if another dewormer is still effective on your farm.

Trainings on the use of this system are being offered around the country. More information on this system, and where to find a training, can be found on the website of the Southern Consortium on Small Ruminant Parasite Control at www.scsrpc.org

**Animal Selection**

Research for all ruminant species is showing that 80% of parasite problems occur in only 20% of a particular herd or flock. While it can be difficult to cull an organic animal based on its parasite status, doing so may benefit the farm by improving the overall health of the herd, increase the amount of milk produced and sold and decreasing contamination of pastures for newborn calves.

Keep records of animals with high FECs. If an animal does need to be dewormed with ivermectin, seriously consider culling that animal and any offspring or siblings. Do not overlook the genetics of the bulls. If one calf crop has more problems with worms, consider the possibility it is due to the bull used that year.

Producers who add parasite susceptibility to their list of culling factors find that in 2-3 years they have greatly decreased the incidence of parasite problems in their herds or flocks.

### Herbal Deworming Products

There are several herbal deworming products, besides diatomaceous earth, which may have some potential. There has been on farm studies of several of these (Allen, 1998, Drazenovich, 2003, Murphy, 2001). All have been carried out on sheep farms. Grazing management, with clean pastures at the beginning of the season, has been one of the primary strategies seen to be effective. However, there is some indication that some of these products may have a beneficial effect. The effect may be due to something other than direct effect on the worms.

Most of these products have wormwood (*Artemisia absinthium*) as the main ingredient, which should be used with caution, if at all, on pregnant animals. Some also require a tonic to be given on weeks when the deworming treatment is not given. For producers with many animals, using these products may be prohibitive. However, dairy producers who are handling their animals individually every day will have an easier time of administering these products.

The latest product to be tested on sheep for deworming is a garlic product called Garlic Barrier (Noon, 2003). Garlic has known antibacterial effects, which may be the effect responsible for its success as a deworming product. Bacterial enteritis often accompanies parasitic disease. This study showed that egg counts went down after sheep were treated with the garlic product.

While I have not tried any of these products, I am working with a farm in central Arkansas for the second year that is interested in transitioning their sheep flock to organic production. Parasites are their biggest concern. Last year we managed the sheep flock strictly with rotational grazing and mixed grazing with beef cattle. This year we will be adding in an herbal dewormer plus seeding some pasture area to sericea lespedeza this spring and puna chicory this fall. I also want to try planting *Artemisia absinthium* and allow the sheep access to it to see if they will willingly graze it.

### Soil Organisms

There are several soil organisms that can have an impact on parasites. Managing pastures to favor populations of beneficial soil organisms will decrease parasite levels on pastures.

Oxygen is the primary requirement for worm eggs and larvae to survive and develop. Earthworms have been shown to ingest worm eggs and larvae, either killing them or carrying them far enough below ground to keep them from maturing. Dung beetles ingest and disperse manure, taking it to their burrows, thus keeping eggs and larvae from developing. There are also nematophagous fungi that produce “traps” that engulf and kill parasitic larvae. These fungi are more delicate than other fungi, so there are rarely great numbers of them in the soil. If the soil is depleted or out of balance, other, more dominant microorganisms will replace these fungi. Research in Louisiana at LSU has been done very successfully using nematophagous fungi to Spores were fed to sheep that passed through into manure before developing into fungi. These fungi then eliminated the eggs from those manure piles extremely well. There are hopes that this will be available to producers as a commercial product in 2006.

The amount of time that feces remain on the pasture has an effect on the number of parasite larvae that survive and mature. Anything that hastens the breakdown of the feces will lessen the number of larvae. This can include the soil organisms mentioned above, mechanical dragging of pastures, poultry or other animal disturbance and the consistency of the feces themselves.

**Effect of Ivermectin on Dung Beetles**

Resistance development by worms is not the only problem with ivermectin. There is concern today about the effects of ivermectin on soil organisms, especially dung beetles. Research has shown that the use of ivermectin kills dung beetle larvae for up to 45 days through residue in the manure. Manure from livestock treated with ivermectin does not break down as fast, either. Other dewormers, including cydectin, don’t appear to have the same effect.

**Immunity**

While it is usually neither possible nor advisable to completely eliminate internal parasites in goats or other livestock, reduction of parasite load can be achieved.. Most animals develop immunity against internal parasites, though not to the level that is developed against viruses and bacteria. This immunity keeps the parasites from reproducing but rarely kills them. An example of an effective parasite control program can be found in Tennessee. Dennis Onks, superintendent of the Highland Rim Experiment Station in Springfield, Tennessee, has not wormed the adult cattle on the farm in eight years. They are wormed at weaning and then not again. They have never shown any signs of internal parasites and their condition is excellent. These animals are on a high plane of nutrition, have a low stress level, and are strictly culled on production. All these things work together to produce an animal that shows no signs of internal parasites. This can be applied to goat herds also, selecting those animals and their offspring who rarely if ever show signs of parasitism.

It is the young animal whose immune system is not fully mature and the animal whose immune system is compromised by disease, inadequate nutrition, or other stress, which is most adversely affected by worms. Animals brought from western rangelands, for example, where the arid conditions keep parasites from surviving, have no immunity and are even more easily overwhelmed by worms.

Every farm is different. The parasite load of the animal depends on many variables − such as stocking density, time of year, the reproductive state of the animal, etc. Good nutrition plays a big part in how well the animal's immune system mounts the proper defenses, and in the animal's overall ability to tolerate the presence of some worms. Healthy and well-nourished animals will be able to develop resistance and resilience to worms and other parasites much better than thin animals that do not have good availability of quality feed (5). Resistance is the ability of an animal to prevent the establishment and maintenance of a parasite population within the gastrointestinal tract. Some individuals and some breeds show more resistance to parasitic infection than others. Research to identify characteristics in such individuals is a hot area. Culling susceptible animals can take advantage of this. Resilience is the ability of an animal to reduce production loss during a parasite infestation. Both of these traits are being looked at as ways of selecting animals that will be less susceptible to parasite effects. Animals that possess some genetic resistance or resilience can still be infected with worms. Therefore, you must keep in mind that this is just one more measure that will help control worm problems, not a cure by itself.

**Strategic Deworming**

There will be times when chemical dewormers are still going to be necessary to save the life of some animals. The situation, time of year and location will help determine which chemical dewormer to use. These dewormings should be strategically carried out in order to reduce the number of times needed. There are three main classes of wormers—the benzimidazoles, such as fenbendazole or Safeguard (white); the imidazothiazoles, such as levamisole (yellow); and the avermectins, of which ivermectin or cydectin (clear) is a member. Rotating these three classes yearly is an accepted rule for decreasing resistance buildup by the parasites themselves. It is critical to retreat three weeks later, especially with newly weaned animals. This kills those worms that were ingested and matured following the initial deworming. This has been shown to significantly reduce pasture contamination. But deworm ONLY those animals who need it.

It does little good to deworm livestock and return them to the same infected pasture. Do not deworm and immediately move animals to a clean pasture. All the dead worms, with very viable eggs in them, will be passed to contaminate the pasture. Instead, deworm, hold animals in their same location for 12-24 hours, and then move them to a clean pasture.

Appropriate management minimizes re-infection. There are several ways to utilize multiple animal species to control the worm population. Many producers raise goats and cattle. One technique that appears to work well is dividing your farm in half, with cattle on one half and goats on the other half. Midway through the grazing season, switch halves of the farm. Having one species of livestock follow another one will have a benefit. Letting the goats browse where they want to, but keeping the cattle rotating through pastures with just one strand of electric fence is yet another way of using cattle and goats together. The different livestock species will break up manure of other species and will not avoid those areas of pastures. This will break the life cycles of the parasites because their natural host will not be present.

Make sure that your dewormer is effective. If you are concerned that it isn't, have a veterinarian check the egg count in the feces of about 15 animals before treatment. After 10 days, check the egg count again. There should be at least an 85 percent kill. You may need to consult your veterinarian about the most effective dewormers for your area. If parasites become resistant to a particular family of dewormers, then you will have to switch families. Alternating families of wormers is a good way of slowing resistance to the dewormer. Many people alternate every time they worm. Research does not recommend this. Instead, use the same dewormer for a whole year before switching.

Do not use Cydectin unless there is absolutely no other choice. This is the only dewormer for which there is still any significant amount of killing effect left.

To implement any type of integrated parasite control program it is essential to know when loads will be highest, such as at kidding; where the young animals stay at those highest egg production times; how pastures can be divided and how long they can be rested in order to let eggs and larvae die. In addition, grazing height for goats is crucial. Goats will quit grazing when pastures fall below 3-5 inches in height. This lowers their nutritional status and if they have many worms in them, will shows of signs of worms even more quickly. This means the producer must have plenty of forage available for the goats, or else be supplementing with some other kind of feed. It is also essential to fully identify those animals having the most clinical signs through the use of the FAMACHA test and fecal egg counts.

If the producer has some idea of how much parasite infestation exists, this will also help in determining whether, and how often, chemical deworming should be given. Some scientists and producers say that rotationally grazed pastures do not aid in parasite control, because the rest period is usually not long enough to break the life cycles of parasites. Most pastures are rested between 21-30 days during the growing season, which is also the length of time it takes for infective stage larvae to develop. The goal is to lower the number of infective larvae that are ingested by the animal. The less time that animals are on a particular pasture, the less the pasture is contaminated with manure. If even one thing can be done to lower these parasite numbers, it will help reduce the need for chemical dewormers. Managing the length of time animals remain on a pasture is also important to remember. This is just one other item that has to be figured in when doing pasture planning for a season. Don't let those pastures be grazed too short!

### Conditions with Signs Similar to Parasitism

Keep in mind that there are other conditions that can mimic the signs of parasites. It is easy to assume that any unthrifty or thin animal with a rough hair coat or diarrhea is wormy. Internal parasites may be present, but the clinical signs are secondary or a symptom of some other, more insidious disease or condition. Any stressful condition, such as a weather extreme, can cause borderline clinical parasitism to become severe. If animals do not have enough forage or other feed in the fall so that they go into winter in good condition, this lack of condition will cause additional stress on the animal in other ways. This animal will be more apt to show extreme clinical signs of parasitism, including blood loss and death, than an animal which might have some internal parasites but is in good physical condition and is on a high plane of nutrition. In this case, poor nutrition is the cause of the animal's disease and worms are the symptom.

**Conclusion**

There is no one thing that can be given or done to replace chemical dewormers. It will take a combination of extremely good management techniques and possibly some alternative therapies. Do not think you can just stop deworming your animals with chemical dewormers. It is something you will need to change gradually, observing and testing animals and soil, in order to monitor your progress. Alternative parasite control is an area that is receiving a lot of interest and attention. Programs and research will continue in the pursuit of parasite control, using alternative and more management-intensive methods.

There are a number of steps to take when evaluating the impact of parasites on your farm and then determining a management plan.

- Determine if parasites are problem
- Fecal egg counts
- Overall physical condition
- Body condition scores
- Change location of does kidding
- Keep area dry and clean
- Divide pastures to rest more
- Rotate pastures
- Observe manure degrading soil organisms
- Plant forages with deworming activity
- Try herbal dewormers

It is essential to first determine if parasites are actually your problem. Fecal egg counts, physical and body condition and nutritional status will help you decide. Second, figure out if something simple like changing the location of calves will eliminate the problem. If changing the location is impossible, such as in a barn, make sure that the area is as dry and clean as possible. If a pasture is grazed and can't be rested for at least 6 months, divide it in half so that half can rest for a longer period of time. Keep older cattle off the pastures used for calves. Divide calves into smaller age groups and don't mix the groups until they are over five months of age. Rotate pastures as much as possible. Observe the presence of dung beetles and earthworms which degrade manure. Notice how quickly manure disappears from pasture. Explore the possibility of planting some of the listed plants as a way of decreasing the number of eggs and larvae contaminating the pasture. Lastly, try some of the herbal dewormers available.

There is still a great need for more research in the areas of forage plants and herbal deworming products. If herbal pastures can be developed that are effective in keeping pasture contamination and parasite numbers to a manageable level, this would be an effective and more applicable deworming strategy. The herbal deworming products are often dry material, require weekly or even daily treatments, and can difficult to administer if animals are all fed together. If farmers try any of these products, they need to keep careful records to ensure that credit goes to the correct thing. As one farmer told, his calf disease problems went away when he just increased the tender loving care he was giving his calves. Many producers unconsciously change their management when they start using a different product, yet still give the credit to the product.

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**Other Resources:**

- Sustainable Control of Internal Parasites in Ruminants
  Animal Industries Workshop Lincoln University 1997

- Sustainable Control of Internal Parasites of Sheep (SCIPS)
  www.sheepwormcontrol.com

## Holistic Health by Minimizing Stress

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Farmers realize that prevention is where they need to focus. Attention to nutrition, especially through controlled grazing, along with reduction of stress provides the best preventative strategies. As producers become more skilled in the management of their farms, they see the health of the whole system improve.

### STRESS MANAGEMENT

When stress is minimized, then animals remain healthier. This improves the profitability of the farm, by reducing the need for disease treatment. This makes it especially important to observe animals closely, and to provide them with the best nutrition possible through high availability of quality pasture.

#### Stress

Stress is the effect of change on an animal. It increases the susceptibility to disease and decreases the vitality or life force of the animal. There are two ways of looking at the effect of stress on an animal.

Stress acts upon the body setting up an imbalance**.** The body produces a reaction that may give rise to symptoms in its attempt to regain equilibrium. This means that the producer needs to look for that first symptom, or change in the animal's behavior, to prevent the animal from progressing into a full blown disease process. These symptoms may be subtle, and if the stress is mild, may be corrected by another change in the animal's behavior.

The second way to look at the effect of stress on the animal is to view the physiological changes. These changes are different depending on whether or not the animal is undergoing an acute, short term stress, or a chronic stress. Chronic stresses can be constant or intermittent. Intermittent chronic stress is much harder on the animal, as the animal just begins to recover when the same or different stress occurs. Acute stress causes the flight or fright syndrome to occur. Adrenaline is released, along with a small amount of corticosteroids. This kind of reaction indicates the animal is in control and can be seen as a good thing.

Chronic stress causes release of corticosteroids which take a long time to clear from the animal's body and indicate that animal has no control over its situation. Rumination and digestion stop, which also stops growth and reproduction. The white blood cells decrease in number and the lymph tissues shrink in size.

As a result the animal is less able to fight off disease and its vital force goes down.

No one living has 100% vitality. There are too many external forces that affect it at least a little. If you have 0% vitality, you are dead. At some point on the vitality scale, there is a point that clinical signs of disease start showing up. Above that point, we think of the animal as having some degree of health—the mind and body being in harmony with its environment. Any stress lowers that level of vitality and weakens the harmony, until, for that animal the vitality reaches a low enough point that disease shows up.

Every animal will be affected by different stresses differently. Nutrition, feeds, exposure to bacteria or other disease causing agents, reproductive status, age all have an effect, but not an equal effect on all animals. This is why one animal will get sick and not another one. When we treat the disease, and cause the signs to disappear, but don't take care of the underlying stress, we will have a less vital animal. In this case, the animal appears healthy, but isn't. So then, let's divide health into profitable health and unprofitable health. The animal's vitality has to be brought up to a level that achieves profitable health.

You can see that treating sick or otherwise unhealthy animals, even successfully makes no money for the farmer. It is a salvage operation. We need to start thinking of what stresses on in our herds and how we can avoid as many of them as possible. Any stress will increase the susceptibility to disease. But certain things will help the animal counteract stress better. Nutrition is the most important thing, followed by the animal's environment. It is also most economic to work on animals that are unprofitable but not "sick".

And remember that any treatment may help, but the degree to which it helps depends on where the animal is on the line of % vitality. If they aren't fed well, too crowded, dirty place to sleep, too pulled down from calving, or weathers too stressful, then they won't be profitable.

Animals that are getting an abundance of protein, without adequate fiber or energy to use that protein will not be as vital. Metabolic changes will occur, in the body's attempt to provide the energy, which will be a stress on the body. This stress will allow other conditions, usually internal parasites, to show up, that the animal's immune system would otherwise be keeping under control if its nutritional status were better.

Nutrition and environmental stresses are easier to control than some other. Psychological and other behavioral stresses are harder to measure and determine. Low-stress weaning and handling techniques change behavior. This includes treatment of sick animals. Research shows us the interaction between the animal and the treatment; how that treatment actually impacts the disease for which it is being used. It leaves out the animal-human part of that equation that also is a big factor in the health of that animal. Our thoughts and our actions affect the way our animals respond to any kind of stress and treatment. Farmers who use controlled grazing management, and thus are moving their animals frequently will have calmer animals in any handling situation.

The immune system's function is to ward off disease causing agents. Because of the destruction to it whenever the animal is under stress, this impairs its ability to fight and kill them. This is especially true when there are too many acute stresses or continuous, low-level, chronic stresses. Stress kills the rumen microbes, which slows or stops rumination. This reduces dry matter intake, which means the animal has to use its body reserves to meet its energy requirements. If the stress is short-term, the animal will be able to overcome these affects on its own, with no apparent problems appearing. If the stress is longer lasting or chronic, returns in a short period of time or there are multiple stresses on the animal, this may throw the animal below that threshold between health and disease. For example, a pregnant doeling is not only undergoing the stresses of pregnancy, kidding and lactation, but also is still growing herself. These are all physiological states for which she evolved. However, if there is inadequate or poor quality forage or feed available, rough handling or weather extremes occurring, these additional stresses may be too much for her body to compensate.

The animal's response to any new stress can decrease or disappear depending on how it is dealt with. If weather extremes occur gradually, for instance, the animal is able to adapt to the change in temperature and will not be as adversely affected. The first experience of handling, hauling or other new situations will determine how well the animal reacts subsequently to those things.

When animals get sick, get in the habit of thinking back over the last two weeks to determine the occurrence of any stress. Some will be possible to remedy. Others, such as weather, have to be lived with.

There are some diseases or conditions that will totally overwhelm the animal's defenses for which there is little the farmer can do or prepare for. Once again, having the animal at a peak nutritive level is the best defense in this case. Even though we can't say for sure which animals will get sick when, there are things that we can change to reduce the stress of certain situations.

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## Health Management and Maintenance for Meat Goats Browsing Native Vegetation

!! Healthy goats are an asset and an economical advantage !!

General Health Stats: Temperature: 102 to 102.5 F
Heart rate: 77 – 89 beats per minute
Respiration rate: 15 to 25 per minute
Rumination rate: 1.5 to 2 per minute

A functioning herd health program is one designed by the goat owner and their veterinarian. It is important to consult with neighbors and other producers in the same geographic area to understand the history of disease in the vicinity. This will give you input as to what diseases you might encounter and need to vaccinate (or manage) against. It will acquaint you with the wildlife species for that specific site and susceptibility of any transmissible diseases. If you are going to become certified as an organic meat producer, there are other regulations that you must comply with.

When you go to a farm/ranch to purchase goats, observe the animals for the obvious signs of good health.

a) Attitude – alert, inquisitive, aggressively browsing, relaxed with the guardian dogs (donkey, llama) in the immediate area
b) Appetite – eating or chewing cud
c) Eyes – should be clear, good blood vessels and third eyelid functioning
   Nose – moist and open nostrils without congested breathing sounds
   Gums – pink in color and 'pink up' fast after thumb pressure
d) Hair – smooth (not wiry) and not patchy
   Skin – supple, not scaly
e) Excretions – fecal pellets and light colored urine (yellow, tan)
f) Gait – relaxed, feet placed in balance while walking
g) Temperament - mixes well within the mob, minimal flight zone
h) Body condition score between 4 and 6 depending on physical status of the individuals in the mob and the mob overall

Purchase healthy goats with a herd health maintenance program in place. There are several important questions to ask the producer and other visual observations to make.

a) What vaccination program is being followed and why?
b) How often are fecal analysis done, what are the results and what is the deworming strategy (if any)?
c) Is stress on the goats minimized by the management and handling techniques?
d) Are livestock guardian dogs and herding dogs being used?
e) Foot health – no footscald, footrot or foot abscesses.

f) Major diseases to avoid: caprine arthritis encephalitis, caseous lymphadenitis, Johne's disease, chlymidia, leptospirosis, and contagious ecthyma.
g) Loose minerals are available in weather proof containers?
h) Water troughs are accessible, clean and the surrounding area is dry?
i) Teeth – full mouth, not loose or worn based upon age and use of goat.
j) Ability to maintain a positive body condition score under adverse conditions.

Stress, an important factor to minimize, has an effect on the goats' susceptibility and/or resistance to disease. Stress is the act of placing an adverse influence on a socially, physically and environmentally stable goat. That influence is transmitted to the brain, hormones are released and the defense mechanisms are decreased which increases susceptibility to infectious disease. Any changes that are made (nutrition, climatic, handling, transport, etc.) need to be done gradually and without the interference of stress.

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Chapter Four

# FORAGE CONSIDERATIONS FOR THE GOAT HERD

Richard E. Joost, Gary E. Bates and Gregory L. Brann

Forages are the backbone of any ruminant livestock operation. The ruminant digestive system is designed to utilize cellulose for a majority of the energy needs of the grazing animal. Goats have earned an undeserved reputation for eating low-quality forages, or possibly eating nearly anything. This view has developed from the fact that goats are capable of selecting a high-quality diet from a forage base that is not generally very high quality.

Goats are referred to as **browsers.** This means that goats select the leaves and tender growing tips of forbs and woody plants. These plant parts are much more digestible and higher in protein and mineral content than the woody (lignified) stems of the plant. The long narrow mouth of goats facilitates browsing and allows goats to survive and thrive on generally low-quality pastures and range that would not suffice for cattle or sheep. Other grazing livestock species prefer primarily grass or forbs in their diet due to mouth shape, grazing behavior and preference (Table 1).

Table 1. Typical botanical composition of diets of primary North American ungulate herbivores.

| | -------------Botanical Composition of Diet (%)---------------- | | |
|---|---|---|---|
| **Herbivore Species** | **Grass** | **Forb** | **Browse** |
| Cattle | 70 | 18 | 12 |
| Sheep | 57 | 23 | 20 |
| Goats | 39 | 10 | 51 |
| Horses | 81 | 5 | 14 |
| Bison | 93 | 5 | 2 |
| Deer | 10 | 34 | 56 |

Derived from Vallentine, 2001.

With this said, although goats may be able to do quite well on low-quality pasture, if we pay strict attention to the forage that is made available to goats, we can improve their productivity and general health. To better accomplish this goal, goat producers need a basic understanding of forage growth and management. This chapter will focus on some of the basics of forage management, including establishment of new pasture plantings, fertilization, principles of forage quality and the growth characteristics of various forage species.

## FORAGE BASICS

### Establishment of Forages

The proper establishment of forage species is essential to the success of new pasture plantings. If there is a desire to develop improved pastures, then several key principles must be followed to obtain a successful stand. There are two major methods of establishing forage species from seed. **No-till establishment** maintains vegetative cover on the soil surface, which reduces the potential for erosion during the establishment period. No-till also provides a firmer base for animals in the winter. **Conventional tillage** destroys existing vegetation and prepares a bare soil surface in preparation for seeding. Whether using reduced tillage or conventional tillage, good soil-seed contact is necessary to insure proper germination. If the seedbed is too cloddy, seed will not be able to get enough moisture to support germination and a spotty stand will result. A fine, firm seedbed is ideal for seedling establishment in a prepared seedbed situation. Typically, tilled seedbeds establish quicker, but can have more weed problems and are prone to pugging (compacting mud with hoof action) if grazed in wet conditions.

No-till establishment necessitates careful attention to weed control and may require the use of special equipment. Although no-till establishment can be performed without the use of a no-till drill, use of a drill generally results in better seedling establishment because the seed are placed in better contact with the soil surface. Effective control of competition from the plants already present in a pasture is essential for no-till establishment to be successful. Use of a burndown herbicide such as glyphosate or paraquat at planting will assist in seedling establishment. Glyphosate can be applied at 1-8 pints of a 4 lbs/gallon formulation to suppress existing vegetation. Glyphosate will take 10-14 days to control existing vegetation, depending on environmental conditions. The effects of paraquat are evident within 24-48 hours. A rate of 0.3 – 0.5 lbs/acre is sufficient to give desired control of existing vegetation to reduce competition. Glyphosate at higher rates will kill existing vegetation, while a single application of paraquat will typically suppress perennial vegetation but will allow regrowth over a period of several months.

There are a number of establishment alternatives that require less inputs and rely on the natural interactions of animals with the environment. It is possible to broadcast seed in the late winter or early spring into existing vegetation and rely on goat hoof action and freezing/thawing of the soil surface to incorporate the seed. Judicious grazing management with goats can be used to control weeds that are competing with the desired forage seedlings. Care must be taken when using goats for vegetation control to insure they do not graze too close to the ground surface and pull out the developing forage seedlings. As a general rule goats should not be allowed to graze below 6 inches above the soil surface.

When establishing pastures, care must be taken to insure that seeds are planted at the proper time and depth. If seeds are planted too early or too late in the season, seedlings may succumb to adverse environmental conditions. For example, planting too late in the fall may result in seedlings freezing out during the winter. The same problem may result from seeding too early in the spring. Even if seedlings survive freezing temperatures, they may be pulled from the ground by cycles of freezing and thawing and succumb to frost heaving. Seeding too late in the spring can result in stand loss due to heat and drought. Obviously great care must be taken to insure that seed are planted at the ideal time for the species in question.

If seeds are planted too deep, then seedlings may not reach the soil surface before the stored food in the seed is exhausted. If seeds are planted too shallow, the roots of the seedling may not be sufficiently deep to attain the moisture necessary to support growth. A general rule of thumb is to plant seed at a depth 8 times the diameter of the seed. For most small-seeded species a seeding depth of ¼ to ½ inch is ideal.

Using the proper seeding rate will insure that a sufficient number of seedlings develop to provide for an adequate stand. Rates are determined by the number of seed per pound of each forage species. Rates are increased to overcome seedling loss due to natural causes such as drought, heat stress and pests. Generally, 50-60 percent of the seed sown succumbs to competition, disease, insects, winter injury, drought or other causes within the first year after seeding. Therefore, suggested seeding rates are increased to take these factors into consideration. Careful attention to proper planting date, seedling rate and seeding depth is essential to insure successful pasture establishment.

Soil fertility at establishment may make the difference between success and failure. It is critical to perform a soil test prior to seeding to determine soil pH, phosphorus, and potassium levels. Soil samples should be collected for every part of the pasture that can and will be managed separately. A minimum of 15 random soil cores or slices from the surface six inches of the soil should be collected for each area that will be fertilized differently, with the area represented not amounting to more than ten acres. These cores should be thoroughly mixed together and then sent to the state soil testing laboratory through your county Extension agent.

Low soil pH can be a major contributing factor to stand failure. Many forage seedlings are very susceptible to the adverse effects of acid soils. This is particularly true of legumes. The relative tolerance of forage species to soil pH is given in Table 2.

Ideally, soils should be limed to pH 6.0-6.5 prior to planting, especially when establishing legumes. In addition to liming, care must be taken that adequate levels of P and K are present in the soil. A soil test should be taken prior to seedbed preparation or no-till seeding and suggested levels of P and K applied to support seedling growth. If legumes are included in the seed mixture the proper inoculum for the species being planted should be applied to the seed. This will insure that the legumes are nodulated with the proper bacteria for nitrogen fixation.

Table 2. Tolerance of forage species to soil pH.

| Legumes | Cool-season Grasses | Warm-season Grasses |
|---|---|---|
| | **High pH Soils (5.8-6.5)** | |
| Alfalfa | | |
| Sweet clover | | |
| | **Medium pH Soils (5.5-5.8)** | |
| Arrowleaf clover | | Johnsongrass |
| | | Sorghum-sudangrass |
| | **Low pH Soils (5.1-5.5)** | |
| Birdsfoot trefoil | Oats | Pearl millet |
| Crimson clover | Orchardgrass | Dallisgrass |
| Red clover | Reed canarygrass | |
| White clover | Wheat | |
| | **Very Low Soil pH (Below 5.1)** | |
| Korean lespedeza | Rye | Bermudagrass |
| Kudzu | Ryegrass | Crabgrass |
| Sericea lespedeza | Tall fescue | Broomsedge |
| Striate lespedeza | Timothy | |

To summarize, the key to successful pasture establishment requires strict adherence to the following steps:

1. Select the proper seeding rate
2. Plant within the proper seeding date window
3. Insure good soil-seed contact and plant at proper depth
4. Control competition from weeds and existing vegetation
5. Make sure soil pH and fertility are adequate by soil testing
6. Inoculate legumes

The guidelines in Table 3 give some ideas regarding potential hazards associated with successful establishment.

Table 3. Potential reasons for stand loss of forages during establishment.

| |
|---|
| **Failure to Germinate** |
| These are situations where the seed are planted into the seedbed, but no seed ever emerge from the soil surface and upon investigation it is found that the seed did not germinate. |
| Dry seedbed<br>Non-viable seed (the seed were dead at planting)<br>Hard or dormant seed (particularly with clovers)<br>Unfavorable temperature (too cold or too hot for germination)<br>Toxic herbicide residues in the soil<br>Waterlogged soil (not enough oxygen for germination) |
| **Failure of Seedlings to Emerge, but Seed Germinated** |
| This refers to situations where no seedlings are observed to emerge, but upon investigation it is learned that the seed germinated. |
| Planted too deep (seedlings die before reaching the surface)<br>Soil surface crusted (seedlings can't break through)<br>Poor seedling vigor (typically due to using old seed)<br>Insect or disease pest damage<br>Extreme temperatures (too cold or too hot) |
| **Seedlings Emerge but do not Survive to Maturity** |
| In this situation the seed germinates and seedlings are observed to emerge, but seedlings are killed before they can produce mature plants. |
| Soil fertility problems (low pH or inadequate N, P or K)<br>Insect or disease pest damage<br>Drought<br>Weed competition (shading, reduced water or nutrient availability)<br>No nodulation of legumes (plants succumb to N starvation)<br>Winterkill (seedlings freeze out or succumb to frost heaving)<br>Sandblasting (windborne soil particles damage seedlings)<br>Browsing too early (seedling roots are pulled from the ground) |

**Soil Fertility**

The availability of mineral nutrients is critical to optimum forage growth, regardless of whether the pasture is a new seeding or an established unit. In fact, proper fertilization can be a key to improving forage yield and quality of established pastures. The single most important soil fertility factor governing mineral nutrient availability and forage growth is soil pH. Most forages are best adapted to a soil pH of 6.0-6.5. Figure 1 shows that this corresponds to the point of major availability of most of the important mineral nutrients derived from the soil.

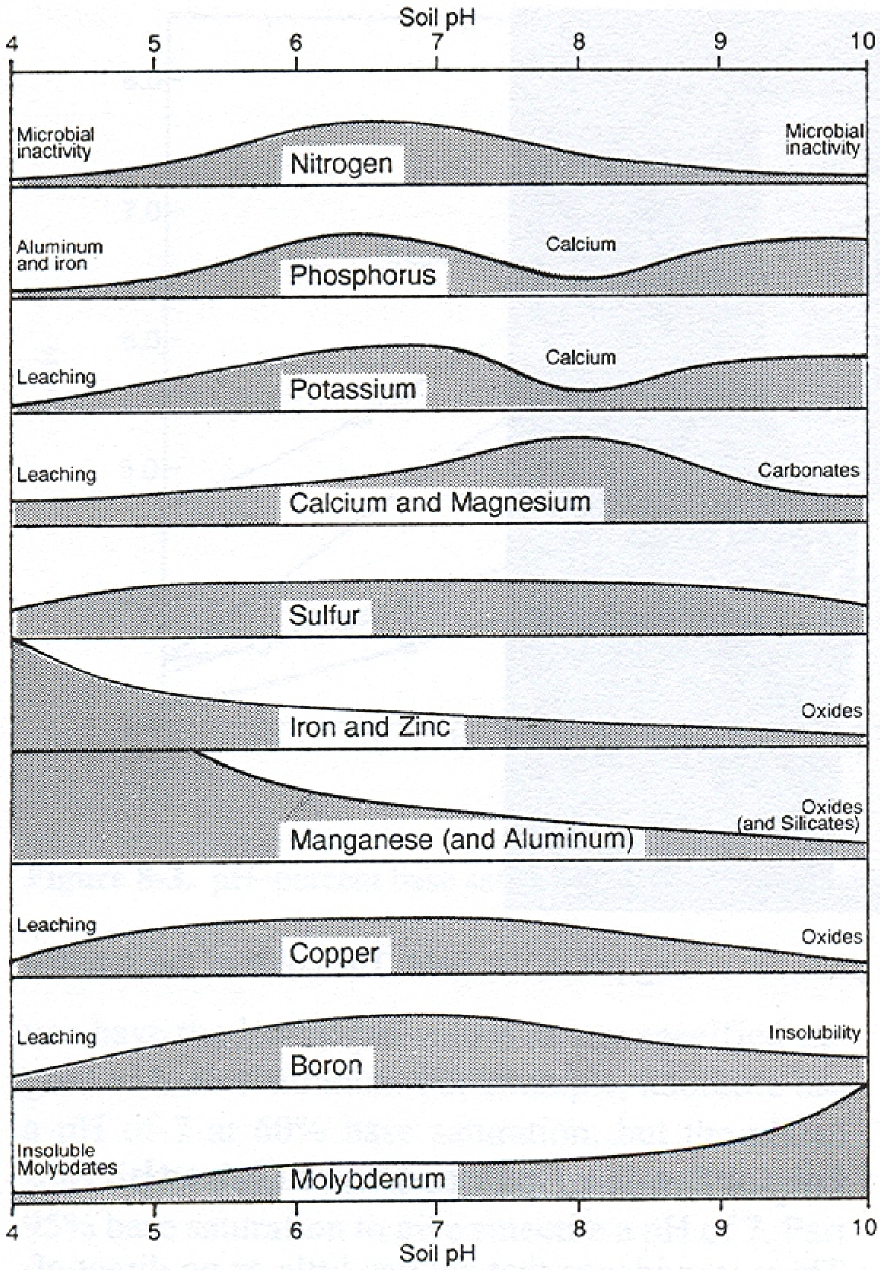


Figure 1. Relative availability of mineral nutrients in relation to soil pH.
From Troeh and Thompson, 2005

The major mineral nutrients important to forage and browse management for goats are nitrogen (N), phosphorus (P) and potassium (K). These are typically called the fertilizer or macro-nutrients and represent the three nutrients listed in a fertilizer analysis, such as 12-24-10 (12 % N, 24% $P_2O_5$ , 10% $K_2O$). By convention, N is always listed as a percentage of the element, while P and K are listed as their percentage composition of the phosphate and potash oxides, respectively. There is no adequate soil test for nitrogen, but typically a recommendation is made for the rate and timing of application of nitrogen based on desired plant growth.

Phosphorus is derived from deposits of rock phosphate commonly found in Florida, the Carolinas and Tennessee. This rock mineral is mined and reacted with acid to form phosphate fertilizers such as diammonium phosphate (DAP 18-46-0), monoammonium phosphate (MAP 11-52-0), or triple superphosphate (TSP 0-46-0). Phosphorus is primarily involved in energy storage and transfer and is very important to root growth in young plants.

Potassium is also a mined mineral. Large deposits of potassium minerals are located in Canada and New Mexico. These minerals are mined and conditioned to make granular KCl that is applied directly to fields as dry fertilizer. Potassium is important to plant water relations, winter hardiness and disease resistance. Therefore, potassium fertilizer applications are often made in the fall to insure good K fertility as pasture plants prepare for the winter. Much of the K in plants is contained in the stems, so if excess forage is harvested for hay, K levels are often reduced.

Generally, micronutrients such as iron (Fe), sulfur (S), boron (B), chlorine (Cl), copper (Cu), managanese (Mn), molybdenum (Mo), and zinc (Zn) are present in the soil in sufficient amounts to provide for plant needs. Liming can enhance the availability of these nutrients for plant uptake. Sometimes one or more of these nutrients may not be present in forage in sufficient quantities to provide for animal needs. The best way to overcome this problem is to provide mineral supplements on pasture to insure adequate mineral nutrition for the grazing livestock.

The best way to manage soil fertility on pastures is to develop a regular program of soil testing. Soil samples should be collected from each pasture unit that will be managed separately. You should also collect separate samples from areas that differ in soil type or past management. Often, steep slopes are managed differently from other land types, so steeper slopes should be considered separately from the rest of the field in sampling plans. In other words, if you are able and plan to apply different rates of fertilizer to different units, then these units should be sampled separately to monitor changes in fertility. This not only applies to separate pastures, but also to separate paddocks within a pasture.

The number of acres that each sample represents will be determined to some degree by the amount of variability in the pasture and the number of subdivisions you have. Each sample should consist of 15 or more randomly collected soil cores or slices from the surface 6 inches of the soil. These samples should then be mixed together in a clean, dry plastic bucket and a sample of dry soil place in a soil sample bag. Samples can then be submitted through your local Extension office to be analyzed by the state soil testing laboratory.

The results from the state soil testing lab will give recommendations based on the plant species you are growing for establishment and maintenance applications of P and K fertilizer. Establishment applications should be made when planting a new stand or renovating an existing stand. Maintenance applications should be made annually after the establishment year. Soil samples should be collected every other year to monitor changes in soil fertility. Excess application of potash can cause an imbalance of calcium and magnesium, which can result in grass tetany during periods of rapid forage growth and high animal demand for Mg.

**Forage Quality**

Although the amount of forage produced on a pasture is an important consideration, the quality of the forage that is available for browsing livestock is an even more important consideration. When we refer to forage quality we are referring to both the palatability and composition of the browse. Palatability relates to factors that influence the acceptability of the forage or browse to the grazing animal. This includes such factors as texture of the forage, hairiness of the leaves, the presence of thorns or spines on the plants, the amount of moisture in the forage and the leafiness of the plants. Other factors that may affect the desirability of pasture plants to grazing livestock include aroma, sugar content and mineral content.

There are several laboratory methods of evaluating forage quality. The two most commonly used are the Proximate Analysis System and the Detergent Fiber System. The Proximate Analysis System analyzes the digestibility of various forage components to come up with the proportion of the forage that is capable of being digested by the animal. This portion of the forage is termed the total digestible nutrients or TDN, and is made up of the digestible fiber, protein, soluble carbohydrates, and fats in the forage that are capable of being broken down.

The Detergent Fiber System uses a series of laboratory solvents to remove the various forage components. The first solvent is a neutral detergent solution that removes soluble sugars, starches, and proteins contained inside the plant cells. These materials are the portion of the forage that is readily digested by the animal. The residue that remains after this extraction is termed the neutral detergent fiber (NDF). The NDF residue is highly correlated with intake and is used to determine how much of a forage animals can consume. The next solvent used is a solution of sulfuric acid and detergent that dissolves the hemicellulose and some of the cellulose contained in the cell walls of forage plants. The residue that remains after this extraction is termed the acid detergent fiber (ADF). The ADF is highly correlated with forage digestibility and is used to estimate the percentage of forage dry matter that is digestible.

Either the proximate analysis system (which measures TDN or total digestible nutrients) or the detergent fiber system (which measures NDF and ADF) can be used to compare the relative digestibility of forage samples. Goats typically select the youngest, most tender portions of forage crops when they are browsing. To insure top quality it is best to maintain pastures in a young, vegetative state of growth (Figure 2). Not only does this result in the best forage quality, it also keeps the forage plants in their most rapid growth phase, resulting in increased forage yield. Allowing forage to become mature reduces the growth rate of the pasture and, if allowed to accumulate to the senescence stage beyond Phase 3, forage will actually be lost due to plant death and decay.

If the pasture has a heavy component of browse and forbs, goats should be allowed to graze these plants first, followed by cattle, to maintain a vegetative stand. If grazing a nearly pure grass stand, goats will prefer more mature grasses and graze from the top down, starting with seedheads.

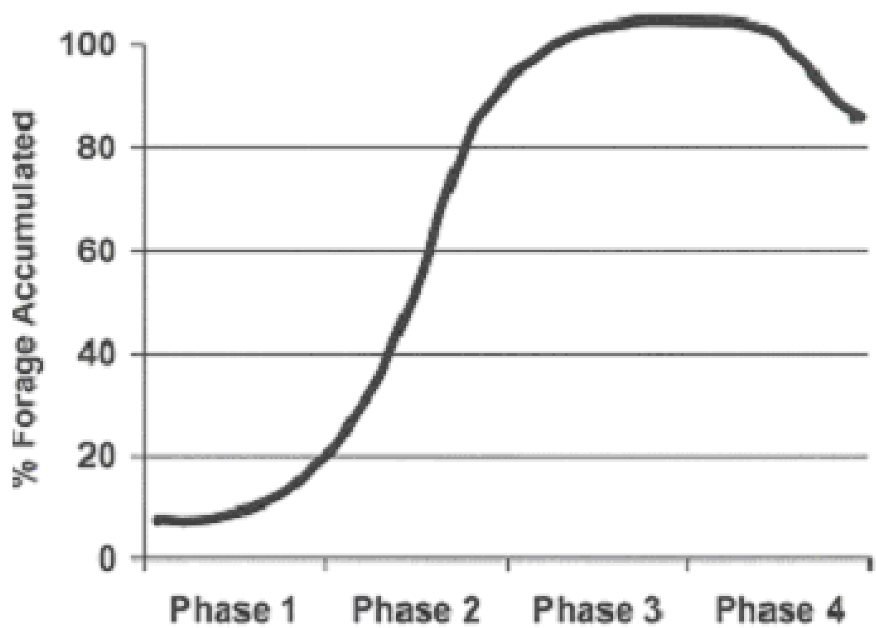


Figure 2. The standard growth curve of forage crops.

## PLANNING A FORAGE PROGRAM

### Forage Characteristics – Plant Type

To successfully implement a forage program for the goat herd, it is necessary to understand some basics with regard to forage plants. Knowing how forage plants grow, when they are productive and how they respond to various environmental conditions will assist in making the most effective use of the plants at your disposal.

Typically, forage plants for goats can be classified into four main groups: grasses and grass-like plants, forbs, legumes, and browse. Grasses differ quite markedly from other forage crops in a number of characteristics. Grasses generally have long, linear leaves with parallel veins and exhibit a fibrous root system. Early in the life cycle of grasses, most of the topgrowth is composed of leaves that originate from an underground crown. The crown is made up of a number of nodes that are tightly packed together so the leaves originate in somewhat of a clump. The internodes between the nodes do not elongate until flowering occurs, at which time the stem or culm of the grass emerges to expose and elevate the seedhead (Figure 3).

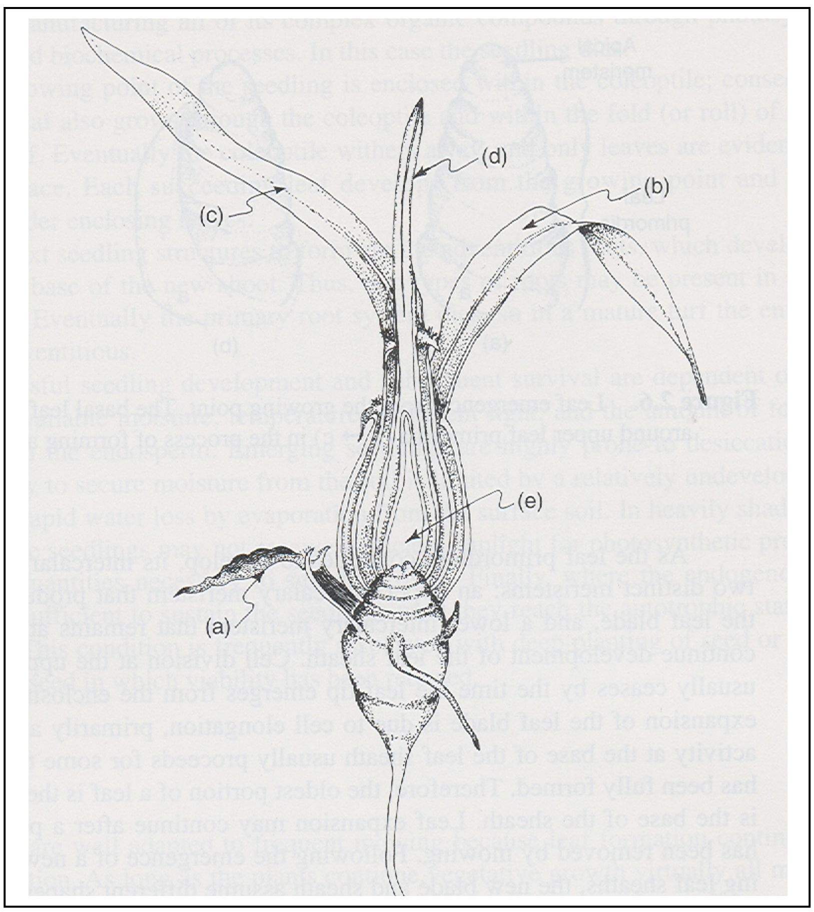


Figure 3. The crown of the grass plant. a) senescing leaf; b) mature leaf; c) newest fully expanded leaf; d) emerging leaf; and e) immature leaf enclosed in older leaves. From A. J. Turgeon. 1999. Turfgrass Management, 5th Edition. Prentice Hall

Forb is the term used to describe any non-woody plant other than grasses and grass-like plants or legumes. Forbs include things like chicory, docks, brassicas and other non-leguminous broadleaf plants. Dicotyledonous, or broadleaf plants tend to have their veins arranged in a net-like pattern in their leaves and have tap root systems.

Legumes are unique in that they typically fix atmospheric nitrogen and thereby naturally provide additional nitrogen to pasture systems. Legume plants form symbiotic nodules on their roots with bacteria that are capable of converting atmospheric N to ammonia that is then usable by the plant. This ammonia is then converted into plant proteins that either benefit grazing livestock or are provided to associated grasses as legumes die and decay. Goats, because of their tendency to select the leaves of broadleaf plants, can obtain a particularly high-protein diet on pastures with a high legume content, especially on pastures where very little N fertilizer is applied, since the leaves contain the highest protein concentration. The preference of goats for various legumes varies, in that they often prefer more high-tannin forages, such as lespedezas, to other legumes such as white and red clover.

Browse refers to the leaves and stem tips of woody plants. Goats tend to consume large amounts of browse if it is available. Since most of the available protein in plants is stored in the leaves, and the leaves and young stem tips are the most digestible portions of these woody plants, goats are able to obtain a fairly high-quality diet from this type of plant material.

Because grasses keep their growing point at or below the soil surface for much of their life, they are very tolerant of grazing and other defoliation. Legumes and other forbs are more susceptible to damage from grazing since the growing point is typically elevated (Figure 4).

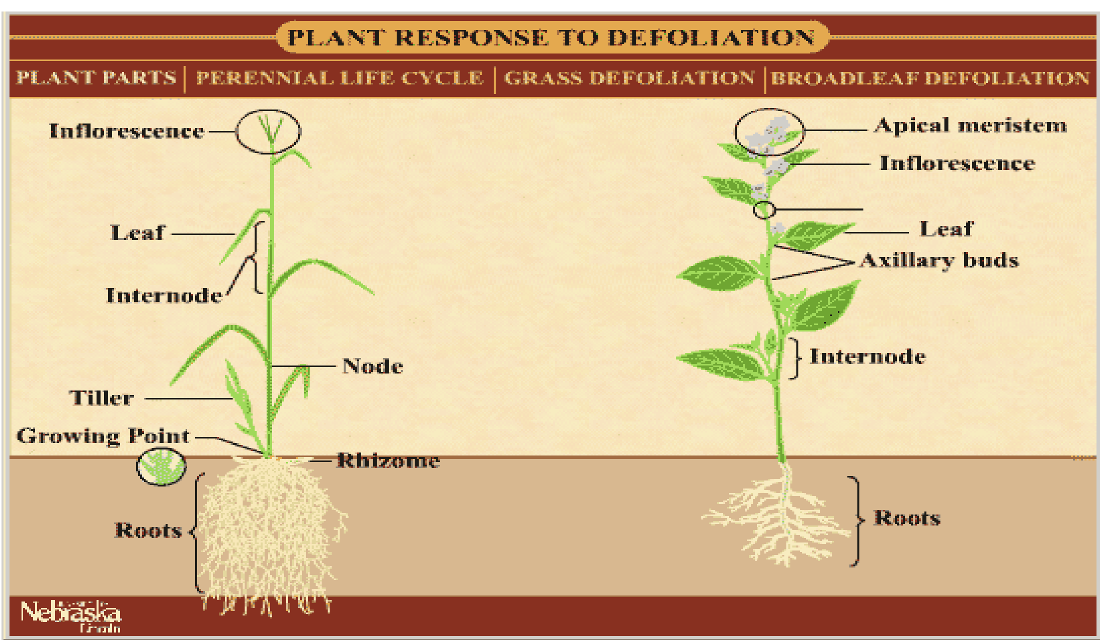

Figure 4. Comparison of the growing point of grasses and forbs or woody species. From Griffin, T., W. Schacht, W. Fick, and P. Hain. 2005. Library of Crop Technology Lesson Modules. http://citnews.unl.edu/croptechnology/viewLesson.cgi?LessonID=1123600615 – Animations (Verified 31 July 2006)

Therefore, if grazing livestock are allowed to graze these plants too close to the ground, their productivity will be reduced. If the main growing point is removed, these plants must regrow from buds at the base of the plant or in the axils of stem branches. There is some variation in this general rule with regard to the growth habit of various forbs. Plants that reproduce vegetatively through stolons (aboveground horizontal stems), such as white clover, are much more tolerant of grazing since their nodes are maintained at the ground surface. If goats are forced to browse too heavily, they will begin to remove bark from around the stems/trunks of these plants, which can often result in plant death. In fact, this is the basis for using goats to control undesirable woody vegetation. Goats should also not be forced to graze lower than a six-inch stubble to reduce their likelihood of ingesting parasites.

**Forage Characteristics – Physiology**

Forage crops can be classified into several groups based on their growth characteristics. Management practices need to be implemented with these characteristics in mind. One major classification of forage crops relates to their season of growth. The classification of plants as either cool-season or warm-season refers primarily to when they complete the majority of their life cycle. Grasses such as tall fescue and orchardgrass are cool-season plants because they produce the majority of their growth when temperatures are 60-80°F. Warm-season grasses, on the other hand, produce the majority of their growth when temperatures are 85-95°F. Although optimum temperatures for growth of legumes differ among individual species, typically most grow optimally at temperatures similar to that for cool-season grasses, but generally fall in a narrower range of 65-75°F.

Cool-season plants will typically produce the majority of their vegetative growth in late winter and early spring and flower in late spring to early summer, while warm-season plants will initiate vegetative growth in late spring and flower in mid to late summer. Planting cool-season plants too late in the spring will risk death of young plants due to high temperature and drought stress. Conversely, planting warm-season plants too late in the summer or fall will run the risk of loss due to winter kill, since the plants will not have time to develop adequate belowground biomass to survive the winter.

The final classification of importance to forage plants relates to their life cycle or the length of time a plant requires for development from seed to the point where it flowers and sets new seed. Annuals are plants that complete their life cycle in one year, developing from seed into a mature plant that produces seed in one year. New plants must develop each year from seed. Perennials, on the other hand, come back each year from vegetative organs such as stolons, rhizomes or roots and will generally set seed each year. The primary difference between annuals and perennials is that perennials come back each year from the original plant, while annuals must set seed to develop new plants each year. Therefore, if you are managing pastures that are based on annual forage species, you must either allow the forage crop to set seed or be prepared to replant your pasture each year. Some care must be taken with perennials so that they are not overgrazed. This allows for storage of carbohydrates in stolons, rhizomes and roots to support regrowth the next year.

## Useful Forage Species

Table 4 lists a number of species that may be useful in forage systems for goats in Tennessee and classifies them according to the plant types and physiological characteristics described above. Following is a short description of the use of each of these groups of forages and special management considerations for each group. For further and more in-depth discussion of specific management requirements for the individual species listed in Table 4, you should refer to “Southern Forages – Third Edition” by Drs. Don Ball, Garry Lacefield, and Carl Hoveland. (2002, Potash and Phosphate Institute, Norcross GA).

### Browse

Browse refers to the twigs, stem tips and leaves of woody shrubs and trees that goats utilize by selecting these nutritious portions. The long, narrow mouth of goats ideally suits them to utilize these species. Due to their preference for browse, goats may also be used to control woody species in pastures where these plants are not desired.

### Forbs

Goats also graze forbs, which are herbaceous plant species that are neither grass nor legumes. Included in this group are a number of nutritious weeds that are very acceptable to goats, and when grazed at a young stage of growth, are very palatable. These plants can be used very beneficially to fill production gaps of the major forage species. There are also forb species of limited nutritional value that are often avoided by goats, as well as species that at times have toxic properties. Both perennial and annual species exist and complete their life cycles in both the warm- and cool-season periods. We have grouped the forbs that are useful as forage together due to the limited number we are considering.

### Cool-Season Perennial Grasses

Grasses in this group make up the primary pasture base of Tennessee pastures. Their long growing season and high quality make them desirable forage crops. Their adaptation to cooler temperatures and greater soil moisture conditions may limit their productivity and survival in periods of prolonged summer drought. Goats will make use of these grasses but prefer them when they are more mature, allowing the goats to utilize the seedheads and eat the stems from the top down.

### Warm-Season Annual Grasses

These grasses typically need to be seeded each year and will provide grazing only during a two- to three-month period during the summer. Because these grasses must be established each year they tend to be more expensive than perennials causing their profitable use in goat production systems to be limited. Goats will use these species as they get more mature, eating seedheads and leaves from the top of the stem down, similar to their normal grazing pattern with cool-season grasses. This is particularly true of the sorghums and millets.

Table 4. Classification of some useful forages for goat pasture systems in Tennessee.

| | | | |
|---|---|---|---|
| **Browse** | | | |
| **Perennials** | | | |
| **Warm-Season** | | | **Cool-Season** |
| Cedar | Buckbrush | | Honeysuckle |
| Elm | Multiflora rose | | |
| Greenbriar | | | |
| Maple | | | |
| Oak | | | |
| Sumac | | | |
| Wild Plum | | | |
| Yaupon | | | |

| | | | |
|---|---|---|---|
| **Forbs** | | | |
| **Perennials** | | **Annuals** | |
| **Warm-Season** | **Cool-Season** | **Warm-Season** | **Cool-Season** |
| Burdock | Chicory | Lambsquarter | Forage rape |
| Plantain | Dandelion | Pigweed | Kale |
| Kudzu | | Ragweed | Swedes |
| Goldenrod | | | Turnips |
| Ironweed | | | |

| | | | |
|---|---|---|---|
| **Grasses** | | | |
| **Perennials** | | **Annuals** | |
| **Warm-Season** | **Cool-Season** | **Warm-Season** | **Cool-Season** |
| Bermudagrass | Kentucky bluegrass | Broadleaf signalgrass | Oats |
| Big bluestem | Matua Bromegrass | Crabgrass | Rye |
| Caucasian bluestem | Orchardgrass | Foxtail | Ryegrass |
| Dallisgrass | Reed Canarygrass | Pearl Millet | Triticale |
| Eastern gamagrass | Tall fescue | Sorghum-sudangrass | |
| Indiangrass | Timothy | Broomsedge | |
| Johnsongrass | | | |
| Switchgrass | | | |

| | | | |
|---|---|---|---|
| **Legumes** | | | |
| **Perennials** | | **Annuals** | |
| **Warm-Season** | **Cool-Season** | **Warm-Season** | **Cool-Season** |
| Illinois bundleflower | Alfalfa | Cowpea | Arrowleaf clover |
| Kudzu | Birdsfoot trefoil | Hemp sesbania | Berseem clover |
| Sericea lespedeza | Red clover | Korean lespedeza | Crimson clover |
| | Sweet clover | Partridge pea | Vetch |
| | White clover | Striate lespedeza | |

### Cool-Season Annual Grasses

These grasses can be overseeded on warm-season perennial grass pastures or established on fallow cropland to provide grazing in late fall and winter. They typically provide high-quality grazing but due to the need to establish them each year they are an expensive forage option. These forages have limited use in goat production systems.

### Warm-Season Perennial Legumes

These plants can provide a highly digestible, high-protein diet to goats. The ability of these plants to fix atmospheric nitrogen makes them an inexpensive protein source. They are especially desirable to goats, because goats are able to select primarily the leaves of these persistent species. Warm-season legumes initiate growth in late spring after soil temperatures reach 65°F. Many of these species contain high levels of tannins, which can help reduce parasite loads.

### Cool-Season Perennial Legumes

Although these species are termed cool-season, many continue to be productive throughout the summer. Periods of drought will reduce growth. These species also provide good, high-protein goat pasture. Birdsfoot trefoil is a species that contains elevated tannin levels that improve by-pass protein concentration and also help reduce parasite loads. It is slow to establish and may easily die out in pastures in Middle and West Tennessee due to drought and heat stress.

### Warm-Season Annual Legumes

These species will often naturally reseed themselves and can be an important, high-quality component of summer pastures. The lespedezas are high in tannin and may help reduce parasite loads. Partridge pea is a native species that is often planted for wildlife and goats relish its vetch-like leaves. The same is true of the common weed hemp sesbania.

### Cool-Season Annual Legumes

These species may be seeded in the fall to provide a higher quality late winter/spring pasture. Crimson clover and vetch will naturally re-seed themselves, so they can become an important part of pastures for a number of years if initially planted and allowed to adequately establish.

## Importance of Biodiversity

Biodiversity refers the assortment of forage species, varieties, growth forms and plant types that are present in a pasture. Although it may be simpler to manage a monoculture of grass because of its uniform response to fertilization and uniform flowering date, the productivity and quality of the forage produced from a more diverse mixture of plants can be much greater. This is especially true for goats, since they graze a wider variety of plant types and plant parts due to their browsing behaviors. Mixtures of grasses and legumes take advantage of the ability of legumes to add N to the pasture system through N fixation. The combination of the broadleaf canopy of the legume, combined with the more narrow erect leaf canopy of grasses, generally results in better capture of the available sunlight.

## GRAZING MANAGEMENT

### General Considerations

The goal in grazing management is to maintain grasses in the vegetative growth stage as long as possible so that the more digestible leaf tissue is the primary forage is available. The grazing preference of goats depends greatly on what forages are available. Goats differ somewhat in their preferences in that they will often selectively graze seedheads of grasses to obtain the high-energy carbohydrates stored in the developing seed. Goats will also preferentially select the leaves and young twigs of browse plants to obtain a high-protein, digestible diet. Typically, goats will select broadleaf plants including legumes over grasses, but this does not mean that goats will not eat grass leaves. When given a choice, goats will consume a diet composed of 40-60 percent browse, 10-30 percent forbs and legumes including broadleaf weeds, and 20-30 percent grass, including seedheads. These diet preferences affect how goats must be managed with regard to grazing.

If you are attempting to establish new tree plantings in a pasture or agroforestry situation it may be necessary to fence out the young trees to protect them from the goats. Goats can preferentially browse on the young trees, resulting in tree damage or death. This is the same reason that goats can be used to eliminate undesirable woody species from pastures. It is also possible to use intense grazing management, manipulating stocking rates and timing of grazing pressure in agroforestry situations, allowing goats to control undesirable weeds while not damaging tree saplings.

It is best not to use set continuous stocking with goats due to the potential problems this can create with parasites. It is possible to obtain improvements in pasture utilization and productivity with rotational stocking. Rotational stocking concentrates the goat herd on a small fraction of the total pasture (paddock) for short periods of time, resulting in more complete consumption of the available forage. The animals are then moved to another small section of that pasture and the process is repeated until the first paddock has produced enough re-growth to support the herd again. Paddock size and number of paddocks are determined by the growth rate of the pasture species that are present and the amount of forage required by the goat herd.

Most forage species exhibit a 28-35 day growth cycle. For this reason, the rest period between grazing periods needs to be approximately 21 days to maintain the forage plants in the active vegetative growth phase as mentioned above (Figure 2). It is best to base pasture management and rotation schemes on pasture growth and not on calendar days. Goats should be turned into new pasture when it reaches a height of 8-10 incehs and allowed to graze the forage to a six-inch stubble. Grazing below six inches can increase parasite problems. During periods of rapid pasture growth, re-growth may make it necessary to return to the first paddock before the herd has reached the last paddocks in the rotation. These paddocks can then be either harvested for hay or mowed to allow them to re-grow to a desirable vegetative stage before the next grazing period.

This system of rotating livestock through a series of pasture subdivisions provides the goat herd with a high-quality diet and results in better pasture growth by allowing the forage plants adequate rest to re-grow and store nutrients in their crowns and roots. In addition, there may be health benefits obtained by the herd from rotational stocking.

**Parasite Control**

Parasites are a major constraint to goat production. If goats are continually grazed on the same pasture, the potential for goats to ingest viable parasite eggs is increased. The closer to the ground surface goats are forced to graze, the more likely they are to ingest parasites. Although parasite eggs can survive up to 60 days, the number of viable eggs that remain after a 28-day rest period is greatly reduced. Also, the available forage canopy will be higher above the ground, which further reduces parasite intake. The use of taller-growing forages such as sericea lespedeza, pearl millet and kudzu will assist with reducing parasite intake, since the animals will graze higher above the ground. There is also good support for using forages containing high levels of tannin, such as lespedeza, to reduce parasite loads in goats. All of these forage management practices will assist in reducing parasite problems in the goat herd, but parasites should continue to be monitored using fecal sampling and/or FAMACHA.

**Mixed Species Grazing**

We have already discussed the preference of goats for the tender portions of woody species, grass seedheads and leaves of broadleaf plants. This differs a great deal from the preferences of other livestock species. Cattle typically prefer grasses, but depending on pasture composition, forbs and legumes may make up as much as half of their diet. Cattle consume forage by wrapping their tongue around a mass of forage and pulling the bite into their mouth, detaching the leaves from the plant by pulling their head back. Because of this grazing habit, cattle perform better on pastures that exhibit a high forage availability. If the pasture is too short, cattle will have to travel farther to get a full meal. Sheep, due to their cleft upper lip and tendency to nip off forage with their incisors, prefer pastures that are shorter, allowing them to be more selective in diet selection.

Given these differences in grazing behavior, it is possible to gain better pasture utilization by grazing multiple species together. The success of this practice will depend on the pasture composition and how well grazing is managed. If a pasture contains a significant proportion of woody species, goats can be effectively used in combination with cattle to make use of this browse which may increase grass growth by reducing shading and competition from the woody species. Typically, if cattle and goats are grazing the same land, a stocking rate of one goat per cow is the recommended. This stocking rate will not impact cattle grazing and will provide the best forage environment for both species. If pasture growth rates are high, sheep may benefit from cattle reducing the forage canopy height prior to their grazing. There are numerous benefits to the producer of utilizing mixed specie grazing. The primary benefit makes more efficient use of the available pasture, another benefit is that income will be diversified by having animals of different types for sale at different times of the year. This can result in more even cash flow than relying on income from the sale of one animal species.

Although it has been mentioned above, the use of goats for weed control deserves further discussion. Goats are an excellent resource for opening new land and gaining control of invasive woody species. Goats will browse new growth of woody species, reducing their vigor and allowing more desirable forage species a competitive advantage. Goats may also consume bark of some woody species, resulting in death of the plant due to girdling. Goats can also provide control of other broadleaf weeds such as ragweed and kudzu due to their preference for the leaves of these species. Further consideration of the use of goats for brush control is given in the paper entitled "Utilization of Goats in the Restoration / Enhancement of Land."

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# POISONOUS PLANTS

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Factors contributing to plant poisoning are starvation, accidental eating and browsing habits of animals. Starvation is the most common reason. Most woodland or swampy-ground pastures contain many species of poisonous plants. These are usually eaten only when animals have nothing else to eat.

Animals accidentally eat certain plants as they graze. A notable example of this is water hemlock. This plant emerges in wet areas, which are the first to become green in early spring. Animals eager to eat the fresh young grass may accidentally bite off the crown of this plant with fatal results. Another type of accidental poisoning occurs when large amounts of cockle are present in wheat, which is fed as grain.

Some animals on good feed in a dry lot or excellent pasture become bored with the same regular diet. They may eat unpalatable weeds or ornamental plants growing along fences. Goats and cattle like to vary the best kind of diet with a little "browse". Many ornamental or wild shrubs may be consumed, not because they are palatable but because the animal craves variation in its diet.

The severity of poisoning is related to the quantity of material eaten, the specie of animal eating the plant, portion of the plant and condition of the plant eaten, level of ground moisture, general health of the animal prior to ingesting the substance and the age and size of the animal. Therefore some livestock can eat some of the bad plants and under several of the mentioned conditions, fail to show symptoms of injury or poisoning. At other times death may occur.

Scores of plants contain material toxic to animals if eaten in sufficient quantity. Some of the plants are well known, some quite rare, some are useful, others are valued ornamentals. They may be grouped by the type of poison contained, the effect of their toxins or the part of the plant containing the poison. Some plants may contain several poisonous principles.

### *Cyanogenetic Plants*

These contain under certain conditions, prussic acid (hydrocyanic acid), a deadly poison which interferes with the oxygen-carrying ability of the blood. Death in these cases is usually rapid and with little outward symptoms. Members of the prunus family of plants, especially wild cherries, are dangerous. **Peaches, plums, wild cherry, and other stone fruits** belong to this group of plants. Wilting of the green leaves caused by frost, storm damage, or by cutting, changes a glucoside (glycoside) found in the leaves to hydrocyanic acid (HCN) and sugar. The sweet, wilted leaves are thus more attractive to animals than normal foliage. Hydrocyanic acid content varies widely, but under some conditions a few handfuls of leaves may be enough to kill a horse or cow. This type of poisoning should be suspected when sudden death of animals follows windstorms or early sharp frosts. These leaves apparently lose their poison after they have become dry; the limp, green or partially yellowed leaves are the most dangerous. **Sudan grass and sorghums** are also cyanogenetic plants. These plants are usually deadly when damaged or frozen. Aftermath sprouts following an early frost are particularly dangerous. Very little sudan grass poisoning occurs from animals trampling down plants and later eating them although this is often listed as dangerous. In dry weather, sudan grass is often pastured to the ground without ill effects. After sudan grass has been repeatedly frozen and the plants are completely dead, it is safe but not very valuable for pasture.

Once frozen, sorghum, sorghum sudan hybrids, or their aftermath should never be pastured. As long as the plants show any green color they may be very poisonous. Both frosted sorghum and sudan grass can be best and most safely utilized by ensiling them for at least two weeks before feeding. Normal ensilage fermentation safely eliminates the poisonous principle.

**Common milkweed**, a perennial that grows three or four feet high, has a heavy stem and leaves and is frequently found in pastures. The milky white sap is sticky and has a bitter taste but livestock eat the topmost, tender leaves if good forage isn't abundant. Remove plants by spading, pulling, cutting or plowing extensive areas and planting to cultivated crops for a year or two.

**Horse nettle** is a perennial plant, two-feet-high, with spiny stems and leaves, and smooth, orange-yellow berries. Fruits are more toxic than the foliage. It's a common plant in grasslands and fields and is a member of the nightshade family.

**Black nightshade** is an annual plant, two-feet high, with many branches. Leaves are variably smooth or hairy. The stems are angled in cross-section and sometimes spiny. Clusters of white flowers, one-fourth inch across, bloom in midsummer and are followed by small, black fruits. Both the foliage and green berries are toxic. The ripe berries are not poisonous. Black nightshade is widely distributed.

**Mountain laurels and rhododendrons** are evergreen shrubs of the Appalachian Mountain region. Plants grow five-feet tall and have glossy green leaves. Flowers appear in clusters at the ends of branches. Livestock eat the leaves in early spring when little other foliage is available. **Piedmont Azaleas** are deciduous plants of the Piedmont. Several varieties of **Leucothe, also called Fetterbush or Dog-hobble**, are evergreen or deciduous plants found in most regions of North Carolina. Weakness, nausea, salivation and vomiting are symptoms of poisoning. The preventative is to keep livestock out of areas where these plants are abundant.

***Plants Containing Deadly Alkaloids***

Fortunately these plants are unpalatable for most wild and domestic animals. **Water hemlock and poison hemlock** are deadly. Poisoning rarely occurs except in early spring when young plants are accidentally eaten, but the roots, stems, leaves and flowers are

always poisonous. Look for and learn to identify these plants in the summer when they are large and showy. The hemlocks are members of the carrot family and have showy, white, umbrella-like flower heads. The roots are the most poisonous parts of the plants. Cut the thick rootstocks lengthwise and you'll find air cavities separated by plate-like partitions of solid tissue. Drops of yellowish, aromatic, resin-like exudates containing the poisonous alkaloid appear at the cuts. Leaves and seeds contain little of the toxic substance and eaten in small quantities, either green or in hay, do little harm.
**Poison hemlock** needs dry land to grow and is often found in gardens as an ornamental plant. Flowers are often incorporated into large mixed flower sprays in rural churches and at social events.
**Water hemlock** - a perennial frequently found in wet, fertile soil - is a five-foot-tall plant with thick rootstocks, doubly compound leaves (fernlike) and small white flowers in umbrella-like clusters.
**Water hemlock** starts growth in early spring. Its green foliage may show up before most other plants leaf out. Livestock tug at the tender leaves and pull roots from the soil which are still soft from late winter rains. The combinations of foliage and roots in considerable quantity can be fatal. As a preventative, pull water hemlock plants from the soil during the summer when they can readily be found and destroy them. Plants usually are not numerous in an area.
**Poison hemlock** is a hollow-stemmed biennial, four-feet high, with double compound leaves resembling parsley and a large, white taproot like parsnip. Flowers are showy, umbrella-like clusters and appear in late summer. The poison is a volatile alkaloid, coniine, found in the foliage all season and in the seeds in late summer. Most livestock poisoning comes in the spring from eating fresh foliage.

**Mayapple, bloodroot, pokeweed, nightshade and hellebore** are other alkaloid-containing plants. They are rarely eaten except when animals are starving for better feed. Deaths from alkaloid-containing plants usually result from severe digestive disturbances, pain and nervous symptoms. Animals usually die in convulsions.

***Plants That Are Photodynamic***

This means photo-sensitive animals get a reaction. Conditions necessary for a reaction to occur are: 1) the animals must have white areas of skin (unpigmented); 2) the animals must eat a sufficient quantity of the plants; and 3) the animals must be exposed to bright sun. In typical cases, an animal suddenly becomes sore on the white areas of their bodies. Whole areas of white skin may raise up and slough off. White goats may become severely affected and die from this condition.

Some common plants, which cause photosensitization, are **rape, alsike clover, buckwheat, lantana, St. John's wort, and ornamental hypericums**. Both St. John's wort and ornamental hypericums have showy, golden-yellow flowers. Animals do not readily eat them. White goats frequently become badly "sunburned" when they are on rape pasture in bright, sunny weather with little or no shade. Alsike clover or other legumes may produce these symptoms in dairy goats under the above conditions.

***Plants That Produce Mechanical Injury***

A number of plants may have a spiny covering, long beards, fine hairs and when eaten may cause mechanical injuries or form hairballs in the stomach and intestines. Sand bur, downy brome grass, squirrel-tail grass, poverty grass, mesquite, and cocklebur are some of the offending plants.

***Some Other Poisonous Plants***

Comparatively few plants containing poisons grow in areas usually used as pastures. **Bracken fern** is very common in wooded areas and unimproved pastures. Most animals will not eat bracken fern if there is adequate pasture or other feed. In ruminants, such as goats, bracken fern must be consumed over a period of several weeks before toxicity signs develop. Affected animals are listless, show weight loss and may exhibit small hemorrhages on the mucous membranes. They may die from internal hemorrhages.

**Buttercups** contain an acrid, volatile alkaloid-amenenol, strong enough to blister the skin and cause inflammation of the intestinal tract. Cattle and goats poisoned by buttercups produce bitter milk and a reddish color. The toxic material volatilizes and is lost when buttercups are dried as in hay. A heavy growth of buttercup is an indication of low soil fertility. Have the soil analyzed and apply ground lime and fertilizers as their need is shown. The increased grass growth soon crowds out buttercups.

**Poison ivy** is widespread over most of the United States. It's a shrub or vine with woody stems that climb by attaching aerial rootlets to fences, walls, trees, etc. Leaves have three leaflets, glossy green and smooth at the edges. **Inflammation of the skin from contact with the plants is an affliction of goat keepers more frequently than of goats**. The infection can become serious and may need medical attention.

Several ornamental plants that are green outdoors or indoors are highly toxic. Goats should not be fed clippings from ornamental plants. Common poisonous ornamentals are **yew, delphinium, oleander, larkspur and lily-of-the-valley**. Goats should not be allowed access to these plants.

***Summary Listing of Poisonous Plants by Poisonous Compounds***

**Cyanogenetic Plants** (Glucosides - Glycosides)

Arrow grass, Black Locust, Blue Cohosh, Broomcarn, Buckeye (Horse chestnut), Cherry, Choke Cherry, Corn Cockle, Dogbane, Elderberry, Hemp, Horse Nettle, Indian Hemp, Ivy, Johnsongrass, Kafir, Laurel, Leucothoe, Lily of the Valley, Maleberry, Marijuana, Milkweeds, Milo, Nightshade, Oleander, Rhododendron, Sevenbark, Silver, Sneezewood, Sorghum, Stagger brush, Sudan grass, Velvet grass, White snakeroot, Wild Black Cherry, Wild Hydrangea.

**Alkaloid Containing Plants**

Aconite, Allspice, Black Snake Root, Bloodroot, Blue Cohosh, Boxwood, Celandine, Common Poppy, Crotalaria, Crow Poison, Death Camas, Dicentra, False Hellebore, False Jessamine, Fume wort, Hellebore, Hemp, Horse Nettle, Indian Hemp, Indian poke, Jimson weed, Larkspur, Lobelia, Lupines, Marijuana, Monkshood, Moonseed, Night shade, Pink Death, Camas, Poison Darnel, Poison Hemlock, Rattleweed, Rock Poppy, Spider Lily, Spotted cowbane, Spotted Water Hemlock, Stagger grass, Staggerweed, Sweet Shrub, Thorn Apple, Varebells, Wild Parsnip, Wolfs-bane, Yellow Jessamine.

**Volatile or Essential Oils as Poisonous Principle**
Baneberry, Buttercups, Crowfoot, Ground Ivy, Lobelia, Snakeberry, Spurge, White Cohish.

**Saponin-Containing Plants**
Bagpod, Coffee weed, Purple sesban, Rattlebox, Soapwort.

**Photosensitizing Plants**
Buckwheat, Goat weed, Klamath weed, Lantana, Rape, St. John's Wort.

**Plants That Cause Mechanical Injury**
Cocklebur, Downy Brome grass, Sand Bur, Squirrel tail grass.

**Tannin (Tannic Acid) as Poisonous Principle**
Oaks, Black locust.

**Poisonous Principle Not Exactly Known**
Inkberry, Poke weed.

**Web links, Books and Other Publications Concerned with Plants Known to Cause Problems When Eaten by Livestock**

***Plants Poisonous to Livestock and Pets in North Carolina***, Bulletin No. 414 (revised), by James W. Hardin and Cecil F. Brownie.
http://ceres.cals.ncsu.edu/wetland/poisonousplants/

***Poisonous Plants of North Carolina***
http://www.ces.ncsu.edu/depts/hort/consumer/poison/poison.htm

***Cornell University Poisonous Plants Informational Database***
http://www.ansci.cornell.edu/plants/

***Poisonous Plants of the Southern United States***
http://www.caf.wvu.edu/~forage/library/poisonous/content.htm

***Plants Poisonous to Livestock in the Western States***, USDA Information Bulletin No. 415.

***Poisonous Plants of Pennsylvania***, Bulletin No. 53, PA Department of Agriculture).

Chapter Five

# SILVOPASTURE in the SOUTHEAST

Joshua Idassi

## INTRODUCTION

Silvopastoralism is an agroforestry practice that intentionally integrates trees, forage crops and livestock into a structural practice of planned interactions. These interactions are managed intensively to simultaneously produce wood products, high-quality forage and livestock on an environmentally sustainable basis. Environmental issues such as biodiversity, wildlife habitat, soil stabilization, watershed characteristics, pollution abatement, carbon sequestration and scenic beauty are becoming increasingly important design elements of silvopastoral practices.

Forest and woodlands are common in all regions of the USA, including highly agricultural regions such as the Great Plains, South Central and North Central regions. Grazing these low-production lands is done because it makes sense to farmers and ranchers. Considerable amounts of forage may be available for grazing under trees in mature, open-canopied forest stands, such as the semi-arid conifer forest and savannah of the western USA. Even closed-canopy forest sites may produce considerable amounts of grazeable ground vegetation following timber harvest or natural stand opening events such as fire or wind fall.

Grazing by small and large ruminant livestock is an obvious way to make beneficial use of a vegetation resource that would otherwise remain unexploited. Grazing of native vegetation by cattle is by far the most common form of forest grazing in North America. Forested range grazing remains an extensive approach to forest resource use, often lacking the planned interactions among trees, forage and animals required to be true agroforestry.

Integrated forest grazing occurs when livestock are used to harvest native forest plants as part of a planned forest ecosystem management system. Livestock such as cattle and small ruminants (goats and sheep) are used as a tool to manage forest trees and their understory plant communities for multiple results such as timber, forage, wildlife habitat and water. In silvopasture, trees and livestock are combined with improved pasture plants to form a carefully designed practice that is an integration of intensive animal husbandry, silviculture and forage management.

This Chapter is developed using various sources. A compilation of references is listed at the end of the article. Photos and illustrations were compiled from Dr. An Peischel's collections.

## WHY SILVOPASTURE?

Silvopasture as an agroforestry practice specifically designed and managed for the production of trees, tree products, forage and livestock. Silvopasture has become an important tool to improve income opportunities on farms and ranches in the Southeastern United States. Silvopasture results when forage crops are deliberately introduced or enhanced in a timber production system, or timber crops are deliberately introduced or enhanced in a forage production system. As a silvopasture, timber and pasture are managed as an integrated system.

The trees are managed for high-value sawlogs (intermediate harvesting may produce pulpwood or posts and poles), while at the same time providing shade and shelter for livestock and forage. Trees can be planted into current forage systems, or woodlands can be thinned to accommodate additional growth of forage. Tree spacing in silvopastoral systems provides for compatible forage and forest production.

**Figure 1. Silvopastoralism: the complementary relationship between trees and pasture in a forest products and livestock production system.**

Silvopastoral systems are designed to produce a high-value timber component, while providing short-term cash flow from the livestock component. Figure 1 above illustrates the interactions among timber, forage and livestock. They are managed intensively to simultaneously produce timber commodities, a high-quality forage resource and an efficient livestock production. Overall, silvopastures can provide economic returns while creating a sustainable system with many environmental benefits. Well-managed silvopastures offer a diversified marketing opportunity that can stimulate rural economic development.

### Planning Considerations

Before new silvopastoral systems are established, the implications of merging forestry and agricultural systems should be explored thoroughly for economic and environmental considerations, along with local land use, zoning, cost-share program and tax regulations. Environmental requirements (e.g., planting trees, stream-side protection, wildlife habitat maintenance) also may vary with land use.

## Plant Considerations

When making tree and forage crop selections consider potential markets, soil type, climatic conditions, and species compatibility (Figure 2). The timber component should be:

- marketable
- high-quality
- fast-growing
- deep-rooted
- drought tolerant
- capable of providing the desired products and environmental services

**Figure 2. In a silvopastoral system, trees may be planted in pastures in a variety of spatial patterns.**

Select and use trees and planting/harvesting patterns that are suitable for the site, compatible with planned silvopastoral practices and provide desired economic and environmental returns.

The forage component should be a perennial crop that is:

- suitable for livestock grazing
- compatible with the site (soil, temperature, precipitation)
- productive under partial shade and moisture stress
- responsive to intensive management
- tolerant of heavy use

## Livestock Selection

Potential livestock choices include cattle, sheep, goats, horses, turkeys, chickens, ostriches, emus, rhea or game animals such as bison, deer, elk, caribou, etc. The selected livestock system must be compatible with tree, forage, environment and land use regulations. In general, browsing animals such as sheep, goats or deer are more likely to eat trees while large grazing animals such as cattle or elk are more likely to step on young trees. Younger livestock are more prone to damage trees than are older, more experienced animals. Livestock are more likely to impact broadleaf trees than conifers.

## Design and Establishment

Silvopastures can be established on any land capable of simultaneously supporting tree and forage growth. However, silvopastoral systems can require a relatively large land base to sustain timber and livestock production continuity. A source of local technical assistance is essential to develop a silvopastoral system matched to local conditions and landowner objectives.

Appropriate establishment methods depend on:

- woodland/forest type (e.g., site conditions, tree species, age, pattern and spacing) or existing pasture situation
- whether even-aged or uneven-aged forest stands are anticipated
- landowner objectives (e.g., timber products, environmental benefits, wildlife, etc.)

**Figure 3. Trees can be planted evenly at wide spacing (eg. 10 x 10 m), in rows with forage alleys (of 10-30 m width) between, or in clusters.**

Tree pattern is an important factor for silvopasture success. Trees can be evenly distributed over the area to optimize growing space and light for both trees and forage. Alternatively, grouping trees into rows or clusters concentrates their shade and root effects while providing open spaces for pasture production. Trees are typically pruned to increase light penetration and develop high-quality sawlogs.

## MANAGEMENT

A successful silvopasture requires understanding forage growth characteristics and managing the timing and duration of grazing to avoid browsing of young tree seedlings. Livestock, especially browsers such as small ruminants, should be excluded from tree plantings during vulnerable periods. Improper management of silvopastures can reduce desirable woody and herbaceous plants by over-grazing and soil compaction. Thus, intensive management of livestock grazing is the key to success.

Available management tools include:

- tree harvesting, thinning and pruning
- fertilization to improve both forage and tree production
- planting legumes for nitrogen fixation and forage production
- multi-pasture and rotational grazing
- rotational burning
- supplemental feeding
- developing water sources (e.g., stock tanks, windmills, solar-powered pumps, hydraulic rams, ridge reservoirs, etc.)
- locating salt/mineral licks and walkways to encourage uniform livestock distribution
- fencing (e.g., standard or electric), tubing, plastic mesh, repellents and seasonal livestock exclusion to reduce damage to young seedlings

**Figure 4: Goats used for land enhancement and riparian restoration projects.**

## A BUNDLE OF BENEFITS

Integrating trees, forage and livestock creates a land management system to produce marketable products while maintaining long-term productivity. Economic risk is reduced because the system produces multiple products, most of which have an established market. Production costs are reduced and marketing flexibility is enhanced by distributing management costs between timber and livestock components.

Comprehensive land utilization in silvopastoral systems provides a relatively constant income from livestock sale and selective sale of trees and timber products. Well-managed forage production provides improved nutrition for livestock growth and production. Potential products of the tree component include: sawtimber, veneer logs, pulpwood, firewood, pine straw, posts and poles, harvested game, nuts, fruit, ornamental flowers and greenery, tree sap products, mushrooms, organic mulches, medicinal herbs and other secondary products.

### Woodland and Forage Benefits

Grazing and browsing can enhance tree growth by controlling grass competition for moisture, nutrients and sunlight. Well managed grazing provides economical control of weeds and brush without herbicides, maintains fire breaks and reduces habitat for gnawing rodents. Fertilizer applied for forage is also used by trees. In addition, livestock manure recycles nutrients to trees and forage.

### Livestock Benefits

Some forage species tend to be lower in fiber and more digestible when grown in a tree-protected environment. Trees that provide shade or wind protection can have a climate-stabilizing effect to reduce heat stress and wind-chill of livestock. Protection from trees can cut the direct cold effect by 50 percent or more and reduce wind velocity by as much as 70 percent. Livestock require less feed energy, so their performance is improved and mortality is reduced.

### Environmental and Aesthetic Benefits

Silvopastures can increase wildlife diversity and improve water quality. The forage protects the soil from water and wind erosion, while adding organic matter to improve soil properties. Silvopastures provide an attractive landscape with an aesthetically pleasing "park-like" setting. In contrast to concentrated livestock operations, silvopastoral systems are less likely to raise environmental concerns related to water quality, odors, dust, noise, disease problems and animal treatment.

### Drawbacks

- The cost of protecting trees from livestock, which in wide plantings can be more than the trees themselves. If trees are subsequently pollarded, this will remove the time and cost involved in restocking the tree component.
- Many high-value deciduous timber trees grow with poor (crooked) form without the sideways light pressure of a forest. Correction pruning and/or the use of nurse trees can overcome some of these problems.

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# Keys for Silvopasture Understory Management

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The first key point for managing silvopasture understory is establishing or encouraging plants that accomplish your objectives and that are adapted to the site. If your objectives focus on domestic grazing animals such as goats, then grass, forb, and woody understory strains that have been selected for adequate forage quality and production will be preferred. If your objectives focus primarily on wildlife habitat management, then understory plants that address the specific animal's appropriate cover and food resource needs should be managed.

The second key point for managing silvopasture understory is maintaining sufficient sunlight penetration through the overstory. Strategic thinning and pruning are prudent management practices for timber production and are practices that are equally important in managing the grass and forb components of the system.

The third key point for managing pastures is to provide recovery periods for the understory forage plants. Without recovery periods, the choice forage plants will be overgrazed repeatedly, resulting in weakened plants that cannot replenish the root system. In order to have sustained understory performance, it is crucial to have the ability to rotate livestock through a series of silvopastures, thus providing recovery periods for the understory.

Understory recovery periods can only be implemented when the silvopastures have functional livestock water and cross fences. Technological advances in livestock water system design and fence materials have helped create an environment where rotating livestock from one silvopasture to another can be convenient and affordable.

Water is the most important nutrient in livestock management. Animals acquire water primarily through forage moisture and drinking water. As air temperature rises and dry matter content in feedstuffs and forage increases, drinking water requirements rise. Availability of dependable, good quality drinking water can be a serious limiting factor in grazing management.

The first step in designing a water system for livestock is to determine the water requirements for the kind, size, age, and breed of livestock.

Meat goats require an average of 2 gallons of water per day[1]. Uniform silvopasture shade and an ample supply of fresh drinking water are useful tools for livestock management, particularly at higher temperatures. The thermal neutral zone for goats is

50 to 68 degrees Farenheit[2]. As temperatures rise above the thermal neutral zone, daily water intake increases.
Dairy breeds need significantly more water than meat breeds. Dairy goats should probably have access to a minimum of 3.5 pints of water for every pint of milk produced.

Remember that livestock and wildlife secure some of their water intake from the forage and browse that they consume. As forage moisture levels rise, supplemental water requirements are reduced. Conversely, as moisture levels in forage decrease, supplemental water requirements increase.

Next, assess the distribution possibilities. For best livestock performance, the ideal water system would provide fresh, drinking water in each pasture, minimizing travel distance from any location in the pasture. This may be a rather lofty goal for some livestock operations and will not be possible in many situations, but is a good mark to aim for when planning for the long term.

Daily livestock water intake increases as travel distance to water decreases. In fact, in Missouri, Dr. Jim Gerrish observed that water consumption for beef cattle was 15 percent higher in thirty-two acre paddocks with water in every field (less than 600 feet of travel) than in similar systems with water available at a single source where cattle had to travel between 600 and 2,000 feet to water.

Many successful graziers utilize a lane system for livestock to walk to a central location for water. This kind of operation lends itself more to level terrain, and locations with only slight erosion hazard. Although developed for beef cattle, the following table is adapted from the Journal of Animal Science, issue 31:130, and illustrates how water intake has the potential to affect intake of feedstuffs or forage.

| Water Intake | Optimal | Decrease 20% | Decrease 40% |
|---|---|---|---|
| Feed Intake | 13.6 lbs. | 13.0 lbs. | 10.6 lbs. |
| % Change | | $\pm$4.5% | $\pm$22% |

Finally, consider water supply available and implement the best system for your situation. Water supply options include wells, creeks, ponds, spring developments, or even municipal or rural water systems. Hydraulic rams, solar pumps, sling pumps, and pasture pumps have application in certain situations.

Ponds can provide a good, reliable source of drinking water for livestock and wildlife. In many situations, it is advisable to utilize a pipeline and tank in conjunction with the pond in order to have optimum quality water for livestock. Studies have confirmed that livestock have higher weight gains when fresh, clean water is available. Also, placement of water sources might be used as a method of managing livestock herd movements to some advantage.

Fence systems are the most straightforward method of managing livestock grazing. Modern, energized fence systems allow producers to install effective and modestly priced permanent and temporary cross fences that can be used to provide for the “recovery periods” as discussed earlier.

In silvopasture systems, energized fences have distinct advantages over conventional fencing in that they are more easily moved, more resilient to falling limbs or trees, often more economical to install, and can provide a psychological barrier to livestock that may be more effective than the physical barrier presented by conventional barbed wire fences. Permanent, energized fences can be successfully constructed from 12.5 gauge, class 3 galvanized, hi-tensile, steel wire.

Four to five strand fences with posts spaced up to 40 feet may be adequate cross fences for goats and sheep. Additional strands would normally be necessary for more critical “boundary” fences.

Temporary, portable fences (polywire or polytape on reels with tread-in posts, or electric net fences) allow managers to stockpile pastures for winter allocation. They can also be used for allocating warm-season forages in small segments, greatly enhancing the manager’s ability to provide optimum, understory “recovery periods” as discussed earlier.

Because an energized fence is strictly a psychological barrier, fence energizers can only be effective if: 1) The system is adequately grounded, and 2) The fence carries enough current to deliver a “determent” shock to the livestock when contacted. The energizer should be properly sized for the given situation (plan for one joule output per mile of fence), grounded with at least 3 feet of ground rod per joule output, and protected from lightning strike on the fence, as well as on the “incoming power” side.

AC powered units are generally the best choice for energizing a fence when a 220 or 110 volt power source is available. For remote areas, battery powered systems can be employed. Solar recharge for the battery may be necessary in order to have a practicable system.

A few simple tools for energized fence management can make life much more enjoyable. For example, before installing hi-tensile wire, acquire a “spinner” to reel out the wire without adding twists. Otherwise, the installer may become disenchanted with fence construction prematurely. Another wise investment for fence construction is the simple, in-line switch. Employing numerous and strategically located switches can save miles of walking to locate shorts in the system. For for locating shorts in the system, a digital voltmeter is indispensable.

With the proper energized fence materials, tools, and construction approach, the fence management can be workable, affordable, and effective. The objective for a fence and water system is to facilitate the incorporation of understory "recovery periods." Using adapted understory plants, maintaining sufficient sunlight penetration, and employing understory recovery periods are the keys to successful understory management in silvopastures.

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## A Primer for PROVIDERS of Land Enhancement Services

AnPeischel-Goats Unlimited

***Introduction***

Land enhancement can encompass the rejuvenation of lands, fire breaking, fuel load reduction, weed abatement, creation of defensible space, restoration of streams / stream banks, land cleaning ….. the list is endless. The projects that can be pursued are expansive, from agricultural farm land and rangelands to orchards and timber producing forests. It is an all encompassing business but, goats, under control are being used to enhance land productivity. To accomplish this, biodiversity must be maintained, the physiology of plants and soil understood along with the ability of man to make environmental, economical and socially sound decisions.

The management goal encompasses the use of all ecosystems – biological and environmental – (ecology, plant physiology, hydrology, climatology, forestry, soils, economics, animal science, sociology and wildlife) with the success of the project centering around the flexibility of management plans and the ability to replan. The service provider (livestock owner), is therefore utilizing the natural energy flow from the sun. To utilize this natural energy flow efficiently – control – the time of grazing/browsing, the area to be grazed/browsed, the season of grazing/browsing, the plant specie to be grazed/browsed and the livestock specie used to graze/browse.

To successfully accomplish the challenges utilizing goats as a land cleaning tool, there are several major determinations that need to be established before the start of the project(s). First, a goal for the land is established and the final landscape goal is described by the individual(s) owning the lands. Then, the landowner, along with the livestock owner, discuss the established goals and desired landscape. It is at this point in time when an experienced service provider will do an initial site survey analysis, stay in communication with the landowner and make the final decision as to whether livestock are the best solution to attain the final landscape goal.

As a service provider (owner of the livestock), you must be successful not only as a land and livestock production manager but also as a business manager. Listed below and discussed are some major considerations that need to be addressed to facilitate success.

### <u>Business Plan</u>

The most important first step of any business venture is a plan. If you don’t have a plan, how do you know in which direction to proceed and how do you know when you’ve gotten there? And during the planning process, research is conducted and a lot of first-hand contacts made. You need a financial plan so that enterprise evaluation can be incorporated into the business decisions. With a financial plan, a profit and loss statement is generated indicating gross margin – gross income and variable and fixed expenses. In the planning process, stock flow, stock allocation and the valuation of the different classes of stock are obtained in a “before and after” inventory assessment.

Why bother to do a business analysis? Since consistency and predictability of production management is the major goal, it will produce the gross revenue generated for each business fraction within your plan. The analysis will show the cost of generating the revenue and the net profit for each business segment. The important factor is obtaining reasonable return for the time spent and the ability to consider your effectiveness and, if necessary, the information that might lead you to pursue other options.

As you are progressing with your business plan, you will be developing goals and objectives for the business. The goals you set should be realistic, attainable and your production management land enhancement business sustainable. You are developing a business that must be marketable, economically feasible and able to produce the results of prospective clients. To successfully solicit the business, an understanding of many facets of 'paid to graze/browse' are necessary.

**Site Analysis and Description**

A major determining factor to the success of the business is that innate ability of the provider to do a quality assessment of the environmentally adapted plant communities on site. From this information will come a browse preference list including the time of year the livestock (and class of livestock) are most likely to select or prefer the vegetation in the watercatchment area. In the identification of vegetation composition and succession plant communities, poisonous plants and their toxins need to be identified along with the target plants. Soil texture and rainfall factor into erosion consequences if the percolation and infiltration capabilities are not understood. The sites need to be monitored, including an initial set of monitoring points. Vegetation monitoring can be through the use of photo points, transects, LandEKG, greenline vegetation composition measurements, water quality … the list is endless. Within this monitor process, basal and canopy cover are assessed as is ladder fuel and fuel continuity.

The provider needs to know the amount or total of browzable / grazable biomass as part of costing out the project. It is the providers responsibility to ask about the previous history of the site in question (previous livestock usage to reference disease potential, soil or water contaminants).

A base map of the area and specific sites under consideration is required. On this map, the perimeter is defined, ecological constraints and exclusions are noted and the topography detailed. This equates to the understanding of fire ecology and identification of shelter for inclement weather. Wetland(s) regulations need to be championed, EPA and NEPA requirements fulfilled, the ESP endorsed, Fish and Game Conservation Corridors and zoning restrictions respected. Neighbors and adjacent landowners need to be fully informed as to the intensions of the landowner anticipating the use of livestock lands enhancement.

**Overview of Operations or What it takes to make it happen!**

A). The two practices most commonly used to handle the goats for vegetation management are fencing and herding, or a combination of both. Portable solar powered polywire electric fencing allows mobility, flexibility and time confinement on target vegetation. There are various types of electric fencing available and its' use is the choice of the provider and the specific goal of the landowner. The most important component of the fencing operation is the energizer and the grounding system of the energizer and the fence. There is a list of other gear necessary for fence construction such as: chainsaw, weed eater, machete, tree pruners, rope, etc.

Portable welded stock panels are needed for the loading and unloading of trucks and trailers.

If you are herding the goats, a horse(s) and all pertinent gear is required.

Herding dogs are of unquestionable value. There are many breeds of livestock herding dogs, therefore select the breed that fits the environment and the nature of work expected from the dog. Feed for the dog should be of high quality, both fat and protein, and containing no ruminant animal byproducts.

B). Goats can consume more than a gallon to a gallon and a half of water a day when it is hot, dry, and / or the vegetation is decadent, highly lignified or fibrous. Fresh, potable water should be available at all times in easily accessible troughs. The water supply location should be specified on the base and site maps so that the provider knows if portable or fixed storage tanks are needed. It is detrimental for rapid fire suppression to have a readily available, easily accessible water supply. By knowing the type of water supply available, method of distribution can be determined (siphons, solar pumps, gravity, etc.).

C). Animal welfare and the issues related to the health and wellbeing of livestock are the first and foremost priority of the provider. A health maintenance program should be in place, internal parasite assessment current and no known zoonotic diseases or other transmissible diseases present. Body condition scoring is a top priority before going into a browsing project and monitoring the condition of the goats throughout the duration. The body condition of the goats at the initiation should be a BCS 6 (out of a possible BCS 9) and not drop below a BCS 4. Healthy animals are an asset to a land enhancement endeavor!

It is also important for the provider to select the correct specie, breed, age and class of livestock to be used in a prescribed herbivory venture. Animals that are adapted to the environment, climax vegetation, and topography are an asset. Those individuals or a mob that have experience working on previous projects are of great value.

D). Transportation will be needed for the goats / dogs, employee(s) and gear. In a business venture involving livestock, the amount of equipment needed can be extensive and the upkeep expensive.

E). The equipment needed by a provider to operate a business includes a living facility, water tankers, water troughs and hoses, ATV and wagon, livestock trailers, portable corrals and loading facilities, dog kennels and feeders, portable fencing and all related materials, portable shelters for inclement weather conditions, mineral / kelpmeal feeders and an array of small hand tools and tools for machine / engine repair.

F). Effective livestock guardians are of utmost value when working in an extensive, isolated or predator infested habitat. Remember that the most dangerous of all predators are domestic dogs that have joined as a pack to kill for the "thrill". The specie and breed of guardian required will be dependent upon class of livestock to be protected, topography, and type of predator (nocturnal or diurnal). Age, level of experience and number of guardians needed is based upon specie and aggression of predator, herd size and management practice (portable solar powered electric fencing / herding). A livestock guardian dog, less than two years of age, should not be asked to put their life on the line for livestock. Let them have the time to gain experience from an experienced mentor and be used as visual backup until they are at least two years old. As the number of guardians in use increases, each dog will find their niche in the working scheme of the mob. Understand each dogs duty within the mob before adding or deleting a dog from a functioning group.

G). On occasion, it will be necessary to supplement the goats with a protein or energy source depending upon the deficiencies in the vegetation, body condition score of the goats, weather and topography. A balanced, chelated mineral / vitamin mix containing less than ten percent salt should be available at all times. A base mineral / vitamin mix can be formulated and then individual ingredients added as the chemical composition of the vegetation changes. Sea kelpmeal supplies many of the micro elements necessary to stimulate the immune system and effectively utilize other macro mineral elements. The mineral / vitamin mix and the sea kelpmeal should be provided in separate all-weather feeders.

The livestock guardians on duty will need to be supplemented if the vegetation type available is not part of a succession community offering plants selected by horses / llamas / donkeys. Livestock guardian dogs will need to be fed a high energy, high protein food daily. The dog food should not have ruminant animal protein as an ingredient. Each dog requires their own feeder spaced to prevent squabbling at feeding time.

H). A catastrophe can happen in an instant. It can be fire, weather, a natural disaster or management induced. The provider needs to have a contingency plan already in place for the various incidences that could possibly arise and the ability to plan and replan should another event occur. The contact information and emergency notification list includes all individuals involved in the project, neighboring community, local authorities (police, fire), trucker(s) with accessibility to remove livestock with short notification, a radio operator monitoring the "fire" response team, humane society, etc.

## Insurance

A necessity!  A catastrophic event, of any kind, can occur at anytime.  Preparation is panic intervention!  It is vital that you carry enough insurance and the correct type of insurance not to lose your company, limited liability corporation, general partnership or sole proprietorship; however your business is configured.  Do not only consult your farm insurance agent, obtain legal consul.  The below are recommendations only; each provider will be working under specific conditions that change with each project. Therefore, recommendations are only made to assist you in addressing concerns with your insurance agent and legal consul.

*Comprehensive General Liability* insurance should be purchased with a minimum policy of two million dollars.  *Broad Form Property Damage* coverage will be based upon "what if" a specific situation happens.  It is determined by the provider upon site analysis the probable occurrence of property damage and type of damage that may be sustained. These concerns should be openly discussed with the client so that a consensus can be made and the policy purchased to satisfy both parties.  *Livestock and Full Mortality* insurance should cover both the animals working on the vegetation and their guardians. When purchasing this policy, consider the replacement value of the animals plus time and monetary value of lost browsing time for the project underway.  *Workmen's Compensation and Health* policies are determined depending upon circumstance:  a) are you a private contractor,  b) the client has specific demands outlined in the contract,  c) individual state regulations and  d)  pending federal requirements.

*Equipment* owned should be insured and include third party drivers.  This includes but is not limited to trucks, trailers (be sure contents are covered), ATV's, RV or camper trailer, fencing materials………..

Another consideration for insurance when working in fuel load reduction, creation of defensible space, ladder fuel management, and fire breaking is *Third Party Fire Fighting and Fire Suppression Expense Liability* coverage.

### Labor

Labor acquisition and retention has been one of the major weak links in the land enhancement business; the other is long term contracting with clients.  When interviewing perspective employees, know the experience and knowledge level of labor required to do specific projects.  After you have completed a site analysis, the number of employees required, employee knowledge and experience base, and how their salary base will be constructed (hourly, daily, monthly salary, by project, etc.) becomes more realistic.  Costing employees into the business plan entails food allowance, transportation (pickup, ATV, horse and gear), accommodations (travel trailer, RV, portaloo, etc.), other unsundryous items (cell phone, first aid kit) and the insurances discussed earlier.

There is a definite need to have a 'job description' so that each individual you are hiring knows exactly what is expected of them.  Give the employee an opportunity to digest exactly what the job requires so they can make a valid decision.  It will also be a basis for performance evaluation and measurement of employees in job security and pay raises.

- The contract that is written between the employee and employer needs to be read and discussed by each at an agreed time of convenience for both parties and in a mutual setting.  Then each party needs to sign the agreement 'in good faith'. Included in the contract, should be the location of the project(s), time of year or season, duration of the project and if there are job requirements within the project that might be different than in the employment contract.  The details for the project need to be specified as an 'addendum' to the contract when necessary. Salary consideration should be specified along with an indemnity clause and a release clause.  An indemnity clause will vary by state but the WORK to be accomplished must be identified in the contract.  Once again, a lawyer should draw-up all legally binding contracts or agreements.

***Contract and Services Negotiation Considerations***

As a service provider, of both livestock and ecosystem dynamics management, there needs to be a written contract with the land owner (private, national, government agency ….. the list can be endless) BEFORE any land enhancement is started or the livestock moved.  The land owner needs to specify the exact location of the project and provide clearly marked perimeters.  With this information, the dynamics of the project and approach are determined – whether this is a weed abatement, ladder fuel, firebreak, pond restoration, vegetative suppression, etc. project.  It also dictates number of goats (livestock) to be used, breed, age and class of individuals.  Time period should be specified with a start date and an end date.  Lead time for land enhancement contracts can be from two weeks to a year.  Remember, depending on the specie of livestock used, the physiological state of the vegetation and the time the stock want to eat that specific plant, varies annually.  To work successfully within a vegetation time frame, include an extension and or renewal clause upon written agreement of both parties.  Inclusion of this allows the provider to return to the site several times within a growing season if necessary to attain the client's desired landscape.

At initiation of the project, animal specie should be identified with adamant reiteration that animal welfare issues take precedence over all else.  A body condition score for each individual animal will be established at the start of the project and monitored throughout. Should the score fall below the established mark, then individuals will be removed from the group or, if deemed necessary, they will be supplemented or all removed from the project and offered high quality nutrition.

Fee assessment can be designed creatively for each project including a non-refundable setup and delivery charge.  A payment schedule with explicit dates and details defined will be negotiated along with a specified lead time.  Remember, the indemnity clause and that work to be accomplished must be defined within the contract.  Even though 'good faith and management practices' will be attempted – never lose sight of animal welfare issues!!

Contracts and the services offered under those contracts are site specific. There are many important items to be considered when negotiating a contract. Below is a random listing of ‘other possible’ inclusions:

- Specify the exact name of the ‘company/landowner’ and the ‘contractor’ with business address and phone number(s) noted
- Identify all local, county, state, and federal environmental legislation regulations, guidelines and standards so as to maintain compliance within the law
- Rules regulating any subcontractors must be detailed
- Terms relating to possible contract suspension or termination should be determined
- Fire – Any / All fire fighting costs/expenses incurred to extinguish any fire NOT caused by the contractor is the ‘company/landowners’ responsibility
- Agreement date and work commencement date should be in writing
- Security deposit retained or withheld to insure project completion must be noted
- The contractor does assume risks and dangers based on the nature of the operation but any negligence of the ‘company/landowner’ is their responsibility and liability
- Suspension and termination of contracts(s) can happen for various unforeseen conditions beyond the control of either party. An agreement designating number of days to leave a site under unanticipated circumstances must be in writing.
- If the costs of performing the work increase after the project has commenced, then by mutual consent and in writing, both parties can agree that the additional costs be covered by the ‘company/landowner’ or the contract can be terminated
- Should the ‘company/landowner’ re-evaluate the acreage to be treated and determines less acreage than originally stated, they are responsible for incurred costs to the ‘contractor’
- When vacating the browsing area, it has to be left in acceptable condition
- Working in areas with known predators (bear, mountain lions, wolves, coyotes, domestic pack dogs), protection of human life is of utmost importance. Be sure, if fire arms are used as a means of protection, they are within the limits of the law and the individuals using them are qualified and licensed
- In a commercial forest or re-planted plantation, know the number of trees per acre required to attain a healthy stand as required by the ‘owner’. Monitor the condition of the conifer(s) (seedlings) and manage livestock accordingly.
- All conditions regarding water sources (lakes, streams, buffer strips) must be in writing.
- Water quality and water retention is a major human resource concern.
- Indemnity clause, included in the business agreement/contract, should be spelled out by legal council in your state. It is a contract by which one engages to save another from a legal consequence of the conduct of one of the parties or of some other person. It generally obligates the indemnitor to reimburse the indemnitee for any damages. Remember that a contract as well as the intention of the parties, so be sure that the ‘work’ being done is spelled out explicitly in the contract.

Chapter Six

# GENETICS AND BREEDING

Dennis Onks

Heredity is a function of gene transfer and the environment in which genes and gene combinations express themselves. Understanding the basic inheritance of the genetic transfer and how the environment changes the expression of these genes allows producers to make reasonable decisions regarding the development of a sound breeding program.

A sound breeding program is designed to produce or market a particular type of goat product. The selection of these animals will be dependent upon the operation and the goals the producer has selected. This has to be defined by the producer in conjunction with the available resources of the livestock operation. Breeding programs differ for the industry segments due to the relationships among the important traits necessary for a successful goat venture. A producer may want to produce breeding stock, milk, fibre or meat. Each marketing point for these goals has a different set of values and characteristics that the breeder will need to incorporate into the breeding program. A marketing plan should be developed first, then an inventory of land and monetary resources, then a sound breeding program can be initiated to fit that marketing plan. The tools to develop such a plan will be discussed and the goat breed characteristics will be explored so the goat producer can make an initial decision of which breed will speed the results expected from the operation. Each of these areas are important and have to be addressed to increase the chance of success.

Other chapters of this manual deal with the mechanics to improve the production methods of reproduction, growth and carcass quality. A breeding program will allow the producer to make a better informed decision of which animal selections will improve these traits. To get a feel for the magnitude of genetics we start with a term called a **phenotype**. The goat phenotype is defined as the sum of the genetic (G) and environmental (E) variation, or differences between the animals in the herd and is described mathematically as $P=G+E$. In a normal goat population, the genetic variation accounts for 25 percent of the phenotype while the environment accounts for 75 percent! This means that producers can make more rapid changes to the goat performance by managing the effects of the operations rather than concentrating on genetics by itself. This does not mean genetics are not important, for they are, but improving the genetic component has to be accompanied by a herd environment that allows the genetic ability to be expressed.

An example of environmental variation is weather, which cannot be manipulated. However, other environmental components like structures or buildings and topography of the land resources can be used to protect the animals. Forages and feeding programs can be designed to complement the land resource and provide sufficient nutrition for maximum genetic expression. And, health and sanitation programs can be designed to minimize performance restrictions. Over time, the increased genetic ability of the animals has to be complemented with a better operating environment before we realize the true gains from a breeding program.

The traditional breeding program uses performance information to make decisions regarding which matings should occur. This information provides the basis for obtaining genetic material for improvement. This inheritance was described by Gregor Mendel and has been found to be additive between the parents of the offspring. What this means is that parents contribute equal amounts of genetic material. So we expect one half of the genes to come from the buck and one half from the doe. Having performance information on the animals allows us to make decisions on the resulting offspring. A simple example for a mating selection expectation using weaning weight requires weights from the buck and doe. If the buck weighed 50 pounds at 40 days and the doe weighed 35 pounds at the same age, we would expect a kid to weigh 37.5 pounds ( ½ of the buck weight, 25 pounds, plus ½ of the doe weight, 17.5 pounds). This is the basic method for using additive genetic information for expression of genes in the phenotype of an animal.

The cellular material of inheritance is stored in a double helix of DNA (deoxyribonucleic acid). Figure 1. shows the structure and connection of two strands of DNA which is a **chromosome**. The **centromere** is the structure that holds the strands together and is present in each cell. Since half of this material is transmitted to the offspring, the centromere allows the strands to separate. It will reconnect to a single strand from the other parent and this is the recombination that provides the genes to make improvement for the selected trait.

Figure 1. Chromosome

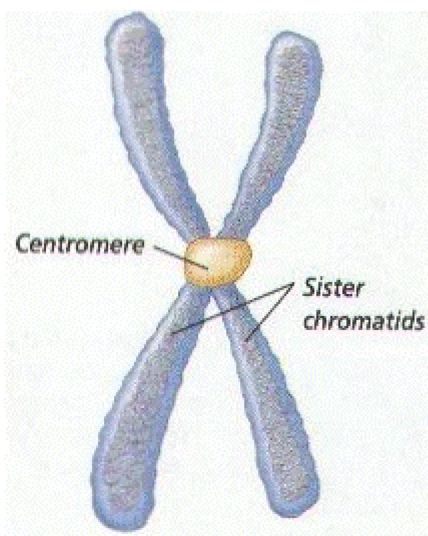



Table 1. shows the number of chromosome pairs for various livestock species. The goat has 30 pairs as compared to human's 23 or the chicken's 39.These strands are contained within the nucleus of every cell and contain all the information needed to express the phenotype of the animal and perform the bodily functions of life. Once combined, these strands have specific functions within the body and communicate by means of enzyme and neural stimulation to perform the required function. Each of these single chromosomes joins with

another to form a pair during fertilization, which causes the genetic diversity or variation between every animal. The more chromosomes within the species, the more genetic diversity and selection potential are provided. This segregation of chromosomes is why twins may be different in color or growth. It is the combination of chromosomes that determines the phenotype. By chance they usually are different.

Table 1. Chromosome Pairs

| Specie | Number of Pairs |
|---|---|
| Human | 23 |
| Cattle | 30 |
| Sheep | 27 |
| Swine | 19 |
| Chicken | 39 |
| Goat | 30 |
| Horse | 16 |

Millions of genes are attached to each chromosome and the probability of attaining the same combination is very low. Even when we mate close relatives, this method will provide genetic differences that can be used in a breeding program. One pair of chromosomes are called the sex chromosomes. One sex chromosome is an X and the other is a Y. During fertilization, the X chromosome will only attach to another X or a Y. This means that only XX and XY pairs will occur, which will determine the sex of the resulting offspring. Females are XX and males are XY. Since we have only the two combinations, this is why each animal has the same 50 percent chance of being a male or female.

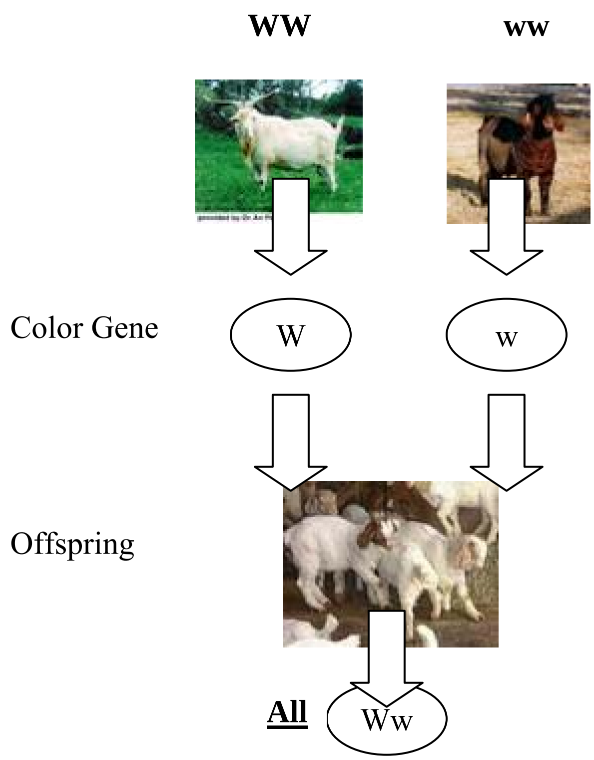
Since chromosome material can be reproduced, scientists have been able to clone animals and plants. This means the resulting offspring will be identical for genetic value. This technique will allow plants and animals to be used for different purposes, such as biopharmaceuticals and disease vaccination production. Using this technique for livestock production will probably not be economical, since we have other techniques that are better suited to increased production.

The phenotypic effect of genes is classified as **qualitative** and **quantitative**. This effect is separated because of the number of genes involved to completely express the trait. The qualitative traits are discrete and controlled usually by only one or two genes. This means the phenotype does not have any variation from one form to another. So, color, horns, dwarfism and other muscular or skeletonal traits are qualitative traits since they are discrete and have no intermediate forms of that trait. These type of genes usually are controlled by the dominant or recessive responses of the gene combination. Figure 2. shows the dominance effect of color. The white color is controlled by W gene. All combinations of W, whether WW or Wr, will be a white offspring, which indicates that the W gene is dominant. Only the ww combination will yield a white offspring. The same is true for most qualitative traits and will change only if more that one set of genes are involved in the effect. The horn or polled trait is another example since this trait is controlled by a single set of genes. The additive combinations that can result from a mating are usually 25 percent

HH, 50 percent Hh and 25 percent hh. The HH combination will be horned, the Hh combination will be horned, but the hh will be polled. When evaluating other qualitative traits, this same mechanism of dominance and additive gene effect will be used when we incorporate these traits into a breeding program.

Looking at some specific goat gene patterns for eye color and hair color, we find that eye color exhibits the same transfer pattern as the Figure 2. The blue eye color of the goat is reported to be dominant in the Nigerian, Angora and Myotonic breeds, while hazel appears to be the dominant color for most breeds. If true, then eye color seems to be controlled by one set of genes. If we use the blue color gene, named Bl as dominant and bl as the recessive gene, then a goat with the Bl Bl eye combination will be blue-eyed, Bl bl will be blue-eyed but carries the hazel gene. The bl bl combination, will be hazel-eyed with no blue gene. The probability of eye color for goats is the same as our horn example, 25 percent BlBl, 50 percent Blbl and 25 percent blbl.

**Figure 2.**




Selection for multiple goat hair colors gets more complicated, because more than two genes are involved. Three sets of genes are thought to be the main contributors of mulitiple goat hair color. The Agouti, A; Brown, B; and Spotting, S genes are used to map color and each may be modified by a Dilution, D gene to give the shading effect of red, black and brown. Basically, the D gene affects the production of 'melan' cells, which produce the respective colors. The genes AA <u>usually</u> produce a white goat, while the combination, Aa are red or tan. The deviation results from the effect of the B and S combinations. The dilution genes, D, will control the intensity of color. The B genes usually affect the shaded areas that will be black or chocolate-brown. The chocolate-brown is dominant over black and is controlled by the combination of A genes present. The buckskin color will be a combination of A and S genes. Having more pedigree information on the color patterns will help make selections to produce the desired color, but because the dilution gene interacts with the other color genes, the expected probability is not as easily calculated as other traits.

When we look at traits that have multiple genes affecting the outcome and which can be measured in smaller increments, these are called quantitative traits. Most production traits such as birth, weaning, carcass and milk weight; fibre characteristics; and body structure are quantitative. Results are not straight forward since they may involve many sets of genes. However, by having production information on the buck and doe, we can estimate the potential outcome of this mating. Before getting into the mechanics of making such estimates, we will discuss some of the genetic tools available for making selections and their expectations when applied to a breeding program.

The first tool is **heritability**. It is the percentage of gene transfer that an animal is able to transfer to its offspring. The traits are characterized as low, medium or highly heritable. More progress can be made in a single generation with highly heritable traits than with lower heritable traits. Progress can be made for all traits, but some will be faster than others. Table 2. has a listing of traits and their respective heritabilities.  The most highly heritable traits are the carcass traits. This means more progress can be made in one generation in these traits than the low heritable traits. Reproduction is a low heritable trait and different methods must be used to increase the performance of these traits. If you want to increase the weaning weight of your kids, selection of the right buck can make a significant impact on your weight with the first kidding. On the reverse side, if you are selecting for more kids, which is a lower heritable trait, the progress will not be as great and will take more time to improve future generations. For most breeding herds, 75 percent of the genetic progress can be attributed to the selection of the right buck. This is true because the buck will mate with many does in the same year and can be changed for the next mating, while the does are usually slower to leave the herd if production is satisfactory.

Table 2. Heritability Estimates for Goat Traits (by Dr. An Peischel, 2001)

| Trait(s) | Heritability % | Trait(s) | Heritability % |
|---|---|---|---|
| **Birth Interval** | **5 - 10%** | **Stature (Conformation & Frame)** | **45 - 50%** |
| **Birth Weight** | **30 - 40%** | **Rear Legs** | **15%** |
| **Number Born** | **15%** | **Wither Height** | **40%** |
| **Motherability** | **40%** | **Cannon Bone Circumference** | **45%** |
| **Weaning Weight** | **20 - 30%** | **Carcass Weight** | **45 - 50%** |
| **Yearling Weight** | **40%** | **Quality Grade** | **40%** |
| **Mature Weight** | **65%** | **Fat Depth** | **40 - 45%** |
| **Milk Yield** | **25%** | **Ribeye (loin) area** | **40 - 45%** |
| **Milk Fat %** | **55%** | **Cutability %** | **25 - 30%** |
| **Milk Protein%** | **50%** | **Muscling** | **40 - 45%** |
| **Udder Support** | **20%** | **Temperament** | **25%** |
| **Teat Placement** | **30%** | **Scrotal Circumference** | **50%** |
| **Feed Conversion** | **40%** | | |

- **Low Heritability (10-20%)**
- **Moderate Heritability (25-45%)**
- **High Heritability (50-70%)**

Since we know that more than one pair of genes impacts these quantitative traits, research has shown that we can estimate the relationship or **genetic correlation** between these production traits. A genetic correlation is a statistical measure of the degree of genetic association between two traits. Table 3. has a listing of traits and the accepted value of the genetic correlation among these production traits. Genetic correlations range in value between +1.0 and -1.0. Correlations near the extremes indicate very strong relationships, while correlations near zero suggest little or no association. Positive correlations suggest that increases in one trait will be accompanied by positive increases in the second trait, while negative correlations indicate that increases in one trait will be accompanied by decreases in the second trait. This tool accounts for the gene pool or environmental relationships that govern the expectation of performance between traits. Weight is highly related from birth to carcass. These correlations of 0.6 to 0.7 mean that selecting for increases in weaning weight will also increase birth and carcass weight, since it is a positive relationship. Correspondingly, weight has a negative relationship with dystocia or kidding ease. This shows that selection to improve weight can cause more dystocia, which will not increase herd numbers due to death loss. Understanding this information will allow you to make informed decisions for traits of interest and what the corresponding effects on other traits may be as the selection is made.

Table 3. Genetic Correlations among Traits

| | Weaning Weight | Carcass Weight | Scrotal Circumference | Hip Height |
|---|---|---|---|---|
| Birth Weight | +0.46 | +0.60 | +0.04 | +0.27 |
| Weaning Weight | | +0.71 | +0.34 | +0.53 |
| Carcass Weight | | | +0.30 | |
| Scrotal Circumference | | | | +0.14 |
| Hip Height | | | | |
| Dystocia | -0.74 | -0.31 | -0.01 | |

Table 4. shows a listing of **phenotypic correlations**. These values represent the association between the traits without the genetic or ancestor relationship that is accounted for in genetic correlations listed in Table 3. These phenotypic values can give us the local environmental effects of a breeding program or management schemes at the producers location. They are useful and easier to calculate for the producer who wants to check various trait relationships on a frequent basis. Remember that this estimate does not specifically account for the gene transfer that we get using genetic correlations. These values usually will be higher when compared with genetic correlations because of the added genetic component, but the direction will be the same, so we can assume that genetic progress is expredded using these phenotypic correlations.

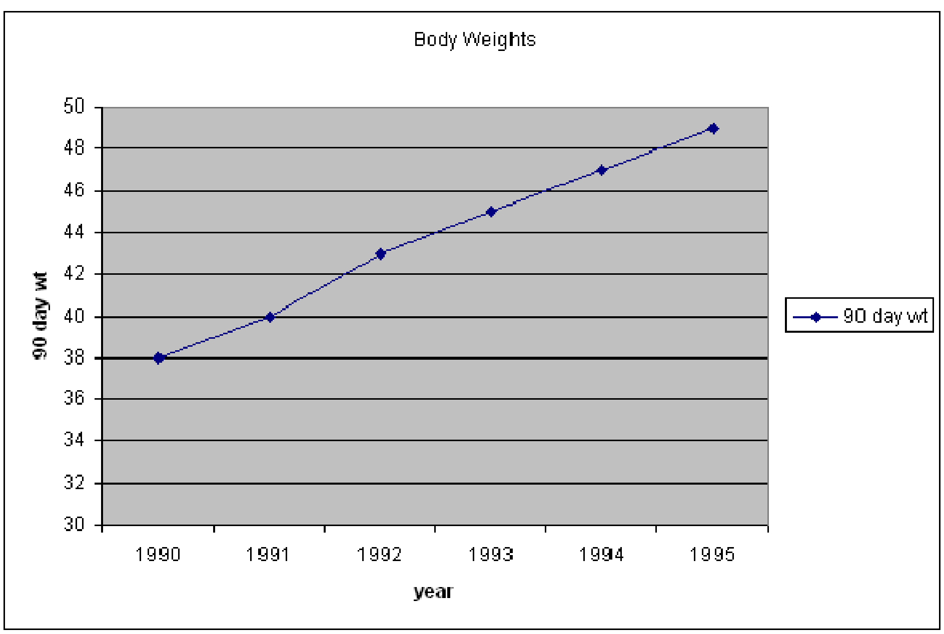
As you look over Table 4, you will notice that the weight traits are highly correlated in a positive direction. The values are higher than the genetic correlations in Table 3, so we feel confident that selection for weight, whether it is birth, weaning or carcass weight will increase weight for each of these traits. Too much selection pressure for weaning weight will increase the birth weight, which increases dystocia. Too much dystocia will result in death loss and this cannot be tolerated, so we have to be cautious as we make our breeding plans. Make yourself familiar with these relationships, so you can estimate the breeding effect on these traits as you develop your breeding plan.

Table 4. Phenotypic Correlations among Traits

| | Body Weight | Body Length | Heart Girth | Backfat | Loin Eye Area |
|---|---|---|---|---|---|
| Body Length | 0.92 | | | | |
| Heart Girth | 0.97 | 0.87 | | | |
| Backfat | 0.60 | 0.45 | 0.51 | | |
| Loin Eye Area | 0.90 | 0.74 | 0.89 | 0.79 | |
| Scrotal Circumference | 0.86 | 0.87 | 0.77 | 0.51 | 0.67 |

Another tool that will aid in our selection process is **genetic trend**. We want to assume that our management stays the same when collecting the data to make a graph. It is the plotting of data over time that will allow us to visually see how our selection and mating program has performed. It can also be used to see what effect our management changes has on the performance of the trait. If we mark the time that the change occurs and monitor the trait forward, it will show the trend that occurred following that change. It is easy to prepare, using data from the trait of interest. Place the average value of that trait on the appropriate value on the graph paper. Then continue to add this information for each year and it will provide us a visual line, that will show if we are increasing or decreasing the value of the trait of interest. Figure 3. illustrates the genetic trend for weaning weight in a Kiko herd in California. This tool allows us to visually see the long term breeding strategy effects and our degree of success.

Figure 3. Genetic Trend for Sex Adjusted Weight



BREEDS

We have discussed some of the available tools to improve goat herds. There are breeding methods that can be followed to make our breeding plan. Before we evaluate these plans, a look at the genetic material that is currently available and some of the breed characteristics can help us to find animals closer to our desired type rather than developing these animals with a breeding plan. This genetic material is what we call a goat breed. Before we knew how the basic inheritance of genetic material is transferred, the owners of goats were using their eyes to make their breeding decisions and we can use the same today to improve our herds. Adding the accumulated genetic information available today allows us to move forward faster than the breeders of olden times.

Some historians have told that the goat originally came from the northern mountains in present-day Iraq and Iran. Since that time of domestication, we have moved the goat to all parts of the world and bred them for the most important product that was needed in that location. Because of this, the goat has been improved to produce more meat, milk or fibre. Some 500 breeds and types of goats have been identified worldwide to date. A lot of these breeds are very similar in performance but have different color patterns, while many have the same color patterns but have been bred to produce fibre rather than meat or milk. What this has done is given us the many generations of selection for performance. This means we can speed the improvement of our goat operation by evaluating the qualities of these breeds and deciding if one of these breeds would be better suited to achieve our goals. We can't offer all the breed characteristics in this publication, but some of the most prevalent will be mentioned for the three primary products of dairy, meat and fibre.

The American Dairy Goat Association lists 8 breeds of dairy goats, six which are currently being registered. With this registration, you will see the breed standards set forth by the association and have access to production information which will aid in selection of the breed as well as information that is available on the bucks or does that are registered. Figure 4 has photographs for breeds being mentioned and described by the ADGA. Figure 5 addresses several meat breeds and Figure 6 notes two fibre breeds.

Figure 4. DAIRY BREEDS:

Alpine


Provided by Crystal D'Eon

Anglo-Nubian


Provided by Crystal D'Eon

La Mancha


Provided by Karen Lee

Oberhasli

provided by Dave Battjes

Saanen


Toggenburg

Alpine: The French-Alpine is a breed of goat that originated in the Alps. The goats of Alpine type that were brought to the United States from France, where they had been selected for much greater uniformity, size and production than was true of the goats that were taken from Switzerland to France.

Size and production rather than color pattern have been stressed in the development of the French-Alpine. No distinct color has been established, and it may range from pure white through shades of fawn, gray, brown, black, red, bluff, piebald, or various shadings or combinations of these colors. Both sexes are generally short-haired, but bucks usually have a roach of long hair along the spine. The beard of males is also quite pronounced. The ears in the Alpine should be of medium size, fine-textured and preferably erect.

The French-Alpine is a larger and more rangy goat and more variable in size than are the Swiss breeds. Mature females should stand not less than 30 inches at the withers and should weigh not less than 135 pounds. Males should stand from 34 to 40 inches at the withers and should weigh not less than 170 pounds. French-Alpine females are excellent milkers and usually have large, well-shaped udders with well-placed teats of desirable shape.

The French-Alpine is also referred to as the Alpine Dairy goat. Registration papers for this dairy goat use both designations, and they are synonymous. These are hardy, adaptable animals that thrive in any climate while maintaining good health and excellent production. The face is straight. A Roman nose, Toggenburg color and markings, or all-white is discriminated against.

Anglo-Nubian or (Nubian in the USA): Anglo-Nubians were developed in England by crossing British goats with bucks of African and Indian origin. The Anglo-Nubian is an all-purpose goat, useful for meat, milk and hide production. It is not a heavy milk producer but has a high average butter fat content (between 4 and 5 percent). The Anglo-Nubian breeding season is much longer than that of the Swiss breeds, so it is possible to produce milk year round.

As it is the best suited of the dairy goat breeds to hot conditions, the Anglo-Nubian has been used in grading-up programs in many tropical countries to increase the milk and meat production of local breeds.

The Anglo-Nubian is a relatively large, proud and graceful dairy goat. The Anglo-Nubian goat is named for Nubia, in northeastern Africa. The original goats imported from Africa, Arabia and India were long-legged, hardy goats that had some characteristics desired by goat breeders in England. English breeders crossed these imported bucks with the common short-haired does of England prior to 1895 to develop the Anglo-Nubian goat. In the United States the breed is usually spoken of as the Nubian.

The Anglo-Nubian is regarded as an "aristocratic" appearing goat and has very long, pendulous ears that hang close to the head. The Anglo-Nubian carries a decidedly Roman nose and is always short-haired.

Any solid or parti-colored coat is permitted in the Anglo-Nubian, but black, red or tan are the most common colors, any of which may be carried on combination with white. Usually there is shorter hair on the Anglo-Nubian males, particularly along the back and on the thigh, than is commonly found on the Swiss breeds.

The udder of the Anglo-Nubian is capacious but is sometimes more pendulous than that of the Swiss breeds. A mature doe should stand at least 30 inches at the withers and weigh 135 pounds or more, while the males should stand at least 35 inches at the withers and weigh at least 175 pounds. The Anglo-Nubian usually gives less milk than the Swiss breeds, but produces a milk of higher butterfat content.

The head is the distinctive breed characteristic, with the facial profile between the eyes and the muzzle being strongly convex. The ears are long (extending at least 1 inch beyond the muzzle when held flat along the face), wide and pendulous. They lie close to the head at the temple and flare slightly out and well forward at the rounded tip, forming a "bell" shape. The ears are not thick, with the cartilage well-defined. The hair is short, fine and glossy.

La Mancha: The La Mancha goat originated in Oregon by Mrs. Eula Frey from short-eared goats of a type found not only in La Mancha, but throughout Spain. It has excellent dairy temperament and is an all-around sturdy animal that can withstand a great deal of hardship and still produce. Through official testing, this breed has established itself in milk production with high butterfat.

The La Mancha face is straight with the ears being the distinctive breed characteristic. There are two types of LaMancha ears. In does, one type of ear has no advantage over the other.

1. The "gopher ear" is described as follows: an approximate maximum length of 1 inch but preferably non-existent and with very little or no cartilage. The end of the ear must be turned up or down. This is the only type of ear which will make bucks eligible for registration.

2. The "elf ear" is described as follows: an approximate maximum length of 2 inches is allowed, the end of the ear must be turned up or turned down and cartilage shaping the small ear is allowed.

Any color or combination of colors is acceptable with no preferences. The hair is short, fine and glossy.

Nigerian Dwarf: The Nigerian Dwarf is a miniature goat of West African Origin. Its conformation is similar to that of the larger dairy goat breeds. The parts of the body are in balanced proportion. The nose is straight. The ears are upright. The coat is soft with short to medium hair. Any color or combination of colors is acceptable, though silver agouti (roan) is considered a moderate fault.

The height limits for does are twenty-two and six tenths inches at the shoulder. The ideal height is considered to range between seventeen and nineteen inches. For bucks the limit is twenty-three and six tenths inches at the shoulder, while the ideal height range is considered between nineteen and twenty inches.

Oberhasli: The Oberhasli is a Swiss dairy goat. This breed is of medium size, vigorous and alert in appearance. Its color is chamois. Does may be black but chamois is preferred. Chamois is described as: Bay - ranging from light to a deep red bay with the latter most desirable. A few white hairs through the coat and about the ears are permitted. Markings should include two black stripes down the face from above each eye to a black muzzle; forehead nearly all black; black stripes from the base of each ear coming to a point just back of the poll and continuing along the neck and back as a dorsal stripe to the tail; a black belly and udder; black legs below the knees and hocks; ears black inside and bay outside; bucks often have more black on the head than does; black whiskers, and black hair along the shoulders and lower chest with a mantle of black along the back; bucks frequently have more white hairs through the coat than does. The face is straight. A Roman nose is discriminated against.

Saanen: The Saanen dairy goat originated in Switzerland, in the Saanen Valley. Saanen does are heavy milk producers and usually yield 3-4 percent milk fat. It is medium to large in size (weighing approximately 145 lbs/65kg) with rugged bone and plenty of vigor.

Does should be feminine, and not coarse. Saanens are white or light cream, with white preferred. Spots on the skin are not discriminated against. Small spots of color on the hair are allowable, but not desirable. The hair should be short and fine, although a fringe over the spine and thighs is often present. Ears should be erect and alertly carried, preferably pointing forward. The face should be straight or dished. A tendency toward a Roman nose is discriminated against. The breed is sensitive to excessive sunlight and performs best in cooler conditions. The provision of shade is essential and tan skin is preferable.

Toggenburg: The Toggenburg is a Swiss dairy goat from Toggenburg Valley of Switzerland at Obertoggenburg. They are also credited as being the oldest known dairy goat breed.

This breed is medium size, sturdy, vigorous and alert in appearance. It is slightly smaller than the other Alpine breeds, but the does weigh at least 120 pounds (55 kg).

The hair is short or medium in length, soft, fine and lying flat. Its color is solid, varying from light fawn to dark chocolate with no preference for any shade. Distinct white markings are as follows: white ears with a dark spot in the middle; two white stripes down the face from above each eye to the muzzle; hind legs white from hocks to hooves; forelegs white from knees downward with a dark lien (band) below the knee being acceptable; a white triangle on either side of the tail; white spot may be present at root of wattles or in that area if no wattles are present. Varying degrees of cream markings instead of pure white acceptable, but not desirable. The ears are erect and carried forward. Facial lines may be dished or straight, never Roman. Toggenburgs perform best in cooler conditions. They are noted for their excellent udder development and high milk production, and have an average fat test of 3.7 percent.

Figure 5. MEAT BREEDS:

Spanish

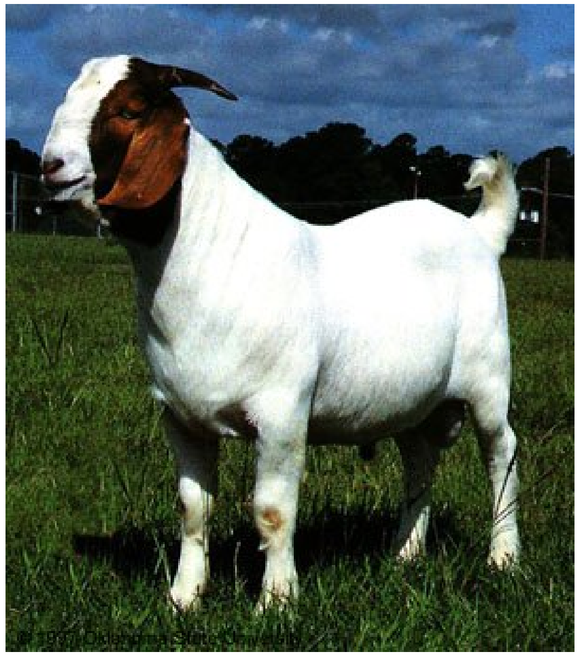

San Clemente

Myotonic (Wooden Leg)


Boer

Kiko

provided by Dr. An Peischel



Spanish: Goats were a common sight on early European sailing ships. They were desirable because of their relatively small size. They are agile and more feral, which makes them capable of eating higher levels of a brush diet than other breeds of milk and meat goats.

When Coronado, DeSoto and other Spanish explorers came to America, they brought goats as a meat source. Some of these goats either escaped or were released when alternate meat sources were discovered. That would have placed the first goats in Oklahoma and Texas in the early 1540s. Pockets of wild goats, descended from these animals, developed for more than 400 years before developing this livestock became profitable.

The trend for smaller, more agile goats was dominant in the wild. Small udders were essential. Cactus, thorns, rocks and any number of other obstacles would cut up large udders.

These feral goats became known as "Spanish" or "brush goat." Although not of a specific breed ancestry, they have developed through natural selection. The term has also become used to describe any goat of unknown ancestry. Most are wild or at least semi-wild. Size varies greatly due to climate, terrain and available breeding stock. Body shape, ear shape, horns, hair and color are not consistent.

Traditionally, in the United States goats have not been considered as a meat source. Ethnic groups have increased in the last few years from areas where goats are a staple in their diet. These recent groups have had the money and influence to attract the owners of wild goats. These owners have begun to change their strategy regarding their goats. Management tactics have been implemented to increase the size and meat characteristics of their animals. The fat content of the meat is considerably less than beef.

San Clemente: San Clemente Island is located off the coast of southern California. It is owned by the U.S. government and used and managed by the U.S. Navy. Feral goats, probably of Spanish orgin, have inhabited the island for several centuries, possibly since the 1500s. Later introductions may have come from the mainland Franciscan missions during the 1600-1700s, while farmers were responsible for later introductions.

The U.S. Navy became responsible for the island in 1934. Hunting and trapping were allowed, but in 1972, when a survey concluded that there were 11,000 goats on the island, a systematic removal program was begun. By 1980, an estimated 4,000 goats still remained on the island.

The Navy then proposed a shooting program to be conducted from helicopters, but was blocked in court by an animal welfare group, the Fund for Animals. This group used helicopters and nets to capture the goats, then took them off the island and found homes for them across the country. Practically all the goats were removed from the island in this manner.

San Clemente goats are relatively small, close to the maximum standard for dwarf breeds. They are considered a meat breed, though uncommonly fine-boned and deer-like. They are horned in both sexes. Although the island population once exhibited a wide range of colors and color markings, the goats are now mostly red or tan with black markings.

Myotonic (Wooden Leg): Myotonic goats are also called Wooden Leg goats, "stiff leg" or Tennessee fainting goats. These are one of the few goats that are indigenous to the U.S. There are two strains of this animal. Most of those found in Tennessee and the eastern U.S. are a smaller size, while most Texas herds tend to be somewhat larger, probably due to selective breeding for the meat market. In fact, some ranchers have renamed them Tennessee Meat Goats.

They also have a market as pets because they are unique. Myotonic means when they are frightened or excited they "lock up" and often fall over (faint) and lie very stiff for a few seconds. It is an over-simplification, but the chemicals that are rushed to humans' muscles and joints to prepare them for "fight or flight" are withheld in the Myotonic under exciting or frightful circumstances.

No one really knows their origin. There are two theories. One of the possibilities is that a private herd sold to a Tennessee farmer around 1880 was the beginning of the breed. A man named John Tinsley arrived in Marshall County, Tennessee, with four goats, a billy and three nannies, which he had brought from Nova Scotia. When he moved on a year later, he left his goats behind. It is believed that all the fainting goats in the U.S. can trace their origins back to these four. The other is that there was a spontaneous mutation of a herd in Tennessee about 1885, which resulted in the recessive gene.

Myotonic goats, which have been selected for meat production, are heavy-rumped, deep-chested animals. Most are black and white but multi-colors are not uncommon. They breed aseasonally, are easy kidders and have good milk production. Many breeders have noted the breed has the capability to produce two kiddings a year. They are good mothers, so in most cases a bonding pen is not needed. Since they are not good climbers and jumpers, they are somewhat easier to keep than other goats.

The American Livestock Breed Conservancy has placed this breed of goat on their "rare" list, with an estimated world population of fewer than 10,000. They have now been discovered as excellent crossbreed stock for the Boer goat that was imported from South Africa. The "fainting" gene is recessive; therefore, it is usually not expressed in crossbred animals.

Kiko: The Kiko is a meat breed that originated from large dairy males crossed with New Zealand feral does and then backcrossed to dairy males. This crossbreeding enhanced the size and meat production of the animals, while enhancing the milk production of the offspring.

The breed was selected from breeding stock produced under extreme environmental and vegetative constraints. This selection process produced animals with correct feet and legs, fertility and milk production. These animals are both polled and horned with a range of coat colors, white being the most dominant. The breed is well suited to survive adverse climatic conditions and demanding nutritional constraints without supplemental feeding.

Boer: The Boer is an improved indigenous breed with some infusion of European, Angora and Indian goat breeding many years ago. Several researchers agree that the indigenous populations were probably from the Namaqua Hottentots and from southward-migrating Bantu tribes. The name is derived from the Dutch word "boer" meaning farmer, and was probably used to distinguish the native goats from the Angora goats that were imported into South Africa during the 19th century. The present day Boer goat appeared in the early 1900s when ranchers in the Easter Cape Province started selecting for a meat-type goat.

The South African registry was established in 1959. Since 1970, the Boer goat has been incorporated into the National Mutton Sheep and Goat Performance Testing Scheme, making it the first goat breed involved in meat production performance testing.

The Boer goat is primarily a meat goat, with several adaptations to the region in which it was developed. It is a horned breed with lop ears and showing a variety of color patterns. The Boer goat is being used very effectively in South Africa in combination with cattle due to its browsing ability and limited impact on the grass cover. Producing weaning rates in excess of 160 percent the Boer goat doe is a low-maintenance animal that has sufficient milk to rear a kid that is early-maturing. The mature Boer goat buck weighs between 110-135 kg (~240-300 lbs) and does between 90 and 100 kg (~200-225 lbs).

Performance records for this breed indicate exceptional individuals are capable of average daily gains greater than 0.44 lb/day (200 g/day) in the feedlot. More standard performance would be 0.3-0.4 lbs/day (150-170 g/day). The ovulation rate for Boer goats ranges from 1 to 4 eggs/doe with an average of 1.7. A kidding rate of 200 percent is common for this breed. Puberty is reached early, usually about 6 months for the males and 10-12 months for the females. The Boer goat also has an extended breeding season, making possible three kiddings every two years.

Figure 6. HAIR OR FIBRE BREEDS:

American Cashmere


American Angora


Cashmere: Cashmere, the ‘Fiber of Kings,’ is produced from the lowly Cashmere goat. This fiber is so luxurious that the Arc of the Covenant of the Old Testament was lined and curtained with it. Sixty percent of the world’s supply of cashmere is produced in China and the remainder from Turkey, Afghanistan, Iraq, Iran, Kashmere, Australia and New Zealand. It is a new industry for the United States. The first Cashmere goats were imported from Australia and New Zealand in the late 1980s. Since then, several Cashmere breeders and growers have been producing breeding stock to launch this new industry in the US.

Cashmere goats are easy to raise. They are healthy animals and take only minimal care. They are not jumpers like many other goat breeds and standard woven wire sheep fencing will contain them. Minimal shelter is all that is required to house them due to the insulative properties of their dual coats, which is shed for the summer.

They are sheared once a year. A full grown adult buck will yield as much as 2.5 pounds of fleece. The fleece consists of two kinds of fiber, cashmere and guard hair. Average cashmere percentages are in the 20 percent range. The fleece can be sold to wholesale buyers or it can be dehaired and sold at retail prices to hand spinners.

Angora: The Angora goat originated in the district of Angora in Asia Minor. Mention is made of the use of mohair at the time of Moses, which would fix the record of the Angora some time between 1571 and 1451 B.C., according to the Angora Goat Mohair Industry publication from USDA (Miscellaneous Bulletin 50, 1929). Mohair became a valuable product in commerce early in the nineteenth century. To increase the supply of mohair available for export to the European countries, the Turks crossed the Angora goat with common stock to increase the poundage of salable hair. That continues today with the Cashgora, a Cashmere-Angora cross being raised in New Zealand. Probably there was no effort to keep the original Angora separate, and the general increase in size and vigor of the goats in the Angora area was, no doubt, partially the result of this infusion of other blood.

Angora stock was distributed to different countries, and Charles V imported a pair of Angoras to Europe about 1554. In 1765, the Spanish government made an importation and 20 years later a considerable number were imported into France. None of these importations were successful in establishing mohair production. On the other hand, Angoras were taken to South Africa in 1838, and from this importation and later importations, mohair production was established in that country. The Union of South Africa is one of the three leading mohair-producing sections in the world and is exceeded in production only by the United States and Turkey.

The most valuable characteristic of the Angora as compared to other goats is the value of the mohair that is clipped. The average goat in the U.S. shears approximately 5.3 pounds of mohair per shearing and is usually sheared twice a year. They produce a fiber with a staple length of between 12 and 15 cm.

The mohair is very similar to wool in chemical composition, but differs from wool in that it is has a much smoother surface and very thin, smooth scale. Consequently, mohair lacks the felting properties of wool. Mohair is very similar to coarse wool in the size of fiber. It is a strong fiber that is elastic, has considerable luster and takes dye very well. Mohair has been considered very valuable as an upholstering material for the making of plushes and other covering materials where strength, beauty and durability are desired.

The market valuation of mohair fluctuates more than does that of wool, but, in general, satisfactory prices are obtained for the clip. During depressed times, the market has favored fine hair. Fine hair is normally shorn from young goats.

**BREEDING METHODS:**

Having an understanding of the genetic principles and deciding upon a breed of goat to use in the production herd are the first steps to formulating a breeding plan. Evaluating the individual animals and herd production will give you the needed information on which traits need the most improvement. Once these areas are defined, producers can start to put the breeding plan on paper. Just as we have to keep good records for financial management, it is very important that this same record system is maintained on each animal in the production herd.

Having this production information allows us to use some methods that have been developed to concentrate on the desired traits and to increase our progress. Because we can produce more offspring from the buck side of breeding, we can assume that 75 percent of the genetic progress can be achieved with the selection of good bucks. This is not to say that it can't be done from the doe side, but the generation interval on the female side will cause the progress to be much slower.

The use of line breeding and in breeding is historically the method producers have used to establish breeds or lines of animals for their particular area. What these methods do is concentrate the gene pool for desirable traits. Using the same buck or doe parentage concentrates the gene pool and allows the animals to be reproduced more uniformly within the herd.

Line Breeding: This method follows the goat's sire or dam lines that express the most-desired traits in breeding plans. It can follow the buck or doe side of the pedigree or both. By selecting animals that have the same buck or doe line, you concentrate these genes and get expression on a more routine basis. The producer would make selections for Buck A and use his sons or does exclusively for replacements or mating in the herd. This concentration allows the introduction of other genes from previous matings and minimizes the use of only one buck or doe line.

In Breeding: This method is used to concentrate the genetics of a particular buck or doe pedigree into the herd. The selection process is to choose the same buck line for both the buck and doe. You would be using the same sire for both the buck and doe to be mated, which would incorporate these genetics at a greater rate than line breeding. It can be detrimental if certain qualities are present in the genetic makeup that are not desired. One example is cleft palate. This defect can be introduced by in breeding and is not desired since the offspring do not survive. In breeding and line breeding usually add some predictability to the resulting offspring, since you are selecting the traits and performance that these animals offer.

Out Crossing: When you begin a plan using the out crossing method, it usually means you have already been line breeding or in breeding and want to incorporate some traits from another line of goats or release the line breeding by adding completely new genetics. The technique can be done from the doe side by adding daughters selected from bucks that have been line bred. It is usually more costly since you are buying animals. The easiest method is to purchase the buck with the genetic traits desired and using him on the does.

Cross Breeding: This method incorporates the qualities from two different breeds to increase the trait being examined. It is quite successful because of the large genetic variation that exists between divergent breeds. It creates heterosis or hybrid vigor that is a non-additive effect. This is a percentage increase above the average response expected from the two breeds that make up the cross-bred animal. For most quantitative traits, you can expect a greater response with cross breeding by 10 to 20 percent. For example, if you chose weaning weight as the trait to increase and expected a 5-pound increase between your breeding lines, cross breeding with another breed would increase the response by one half pound or more due to the hybrid vigor between the two breeds. Heterosis is highest for the low heritable traits such as reproduction, and lowest for high-heritable traits such as yearling weight. This method allows the producer to incorporate needed genetics quicker by using what is available from other breeds rather than developing the same response within the current breeding program.

Production records will be the source of information that breeders must record to make satisfactory breeding decisions. It can range from the complex with body measurements such as height, horn length and circumference or hair length to complete carcass cutout of each type of meat with the fat, protein and amino acid content. A simple record would have the sex and color of the kids with some form of weight if selling meat or milk and hair yield if you are selling these products. Producing breeding stock will require the maintenance of pedigree and performance information in order to merchandise these to other herds. The breeder will have to make the decision of which records are necessary to achieve success in the operation.

Table 5. lists the response to inbreeding, linebreeding and crossbreeding strategies for various traits that are commonly used in making production decisions. Some of these require calculations to obtain and others are direct measurements. These traits are classified by the success that has been demonstrated when using a particular breeding plan. This rule of thumb will let us know which traits will give us faster results if we begin a particular breeding strategy.

Table 5. Trait response of inbreeding/linebreeding and crossbreeding

| Trait | inbreeding/linebreeding | crossbreeding |
|---|---|---|
| **Uniformity** | **Good** | **Poor** |
| **Fertility** | **Poor (to good with selection)** | **Good** |
| **Growth** | **Poor (to good with selection)** | **Good** |
| **Predictability** | **Good** | **Poor** |
| **Overall vigor** | **Poor (to good with selection)** | **Good** |
| **Longevity** | **Moderate** | **Good** |

## Useful Selection Calculations:

Since we usually do not have all kids born at the same time, it makes sense to correct the time-sensitive traits so a more accurate comparison can be made between animals. To calculate average daily gain, use the following formula to compare animals of differing ages.

**Average Daily Gain (ADG) =**

(Ending weight - beginning weight) divided by /(the age at the ending weight – the age at the beginning weight in days).

This will give the individual ADG for each kid. This calculation is usually made following weaning since we know the actual starting point to measure.

To make a better comparison between kids because of age differences, use the average age at the ending weight to adjust all ADGs. These values will provide a clearer picture between the animals, since the trait performance will be compared at the same age.

For example, the average age of the animals at the ending weight is 88 days, the adjusted ADG would be:

Adjusted (88 days) ADG = (ADG / age) times the adjustment days (88).

Example: A kid with a birth weight of 8 lbs weighed 40 lbs at 85 days of age. Because we know the birth weight and this is the actual starting weight of the kid; you can calculate the true gain from birth by subtracting this value. So, use this formula to correct for each kid's birth weight.

Adjusted (85days) ADG = 40 lbs - 8 lbs / 85 days = 0.376 lbs per day

Example:  For the herd, the average age of all kids is 90 days, to adjust the individual performance for this age difference, use the same information for the 85 day animal's adjustment; this is the formula to use:

**Adjusted ADG (90 days) =** 0.376 / 85 times 90 = 0.398 lbs per day

These formulas for adjusted values can be applied to any trait of interest when comparing animals within the herd. The most common are weights at birth, weaning and carcass quality traits.

## The most important trait is Reproduction.

For without it, no one will stay in the breeding business. Every herd should calculate their **Net Kid Crop** each year. It is defined as:

**Number of kids weaned divided by number of does in the breeding herd times 100.**

Example: If you have 30 does and wean 35 kids, the Net Kid Crop percentage is:

(35 kids weaned divided by 30 does equals 1.167) times 100 = 116.7 percent.

If this is below your expected goal, you have to look at individual records to determine which does are not producing to this level and they can be removed from the herd and replaced with does that meet your benchmark. This is also a good time to evaluate your buck performance by comparing the daughters of each for Net Kid Crop. Also look at your operating methods to make certain everything is available to give these animals the chance to perform.

By utilizing records such as these, it allows every producer to make better informed decisions as goals are set for production. Another tool for selection of animals is performance testing data for meat goats, dairy lactation data for milk goats and hair quality and yield for fiber production. Agricultural Experiment and Extension Centers in cooperation with Goat Associations, who have the facilities to manage livestock and record the necessary data collection usually conduct these tests. The Oklahoma Meat Goat Association, American Boer Goat Association, Texas A&M University, Fort Valley State and Langston University have conducted a test for a number of years.

Each location provides the following indexing report for individual animals entered into the test. An index score will be calculated based upon the following criteria:

- 30 percent on efficiency (units of feed per units of gain)
- 30 percent on average daily gain
- 20 percent on area of longissimus muscle (loin) at the first lumbar site as measured by real time ultrasound adjusted by the goat's metabolic body weight:

  <u>area of longissimus muscle (loin) / body weight to 0.75 power</u>

- 20 percent circumference around the widest part of the hind left leg as measured with a tailor's tape adjusted by the goat's metabolic body weight:

  <u>circumference of hind left leg / body weight to 0.75 power</u>

The adjustment to metabolic body weight is supposed to give lighter goats a fair comparison of muscling to heavier goats.

The deviation from the average of the parameters measured from the goats in the performance test will be used in the index calculation. Thus, the **average index score** for bucks on-test will be 100 percent. Bucks that are above average will have indexes above 100 percent and those below average will have index scores below 100 percent. Using this data allows breeders to select animals that perform at a higher level than exists in the current herd. Without information of this type and the principles previously discussed, we cannot expect to make maximum genetic progress for the traits desired.

**Expected Progeny Differences (EPD)** have been calculated for many livestock in recent years. This calculated information gives producers measurable estimates of genetic value for individual animals. It is based on the collected performance data of the individuals in the pedigree and combined with the offspring of those individual animals. This information is usually accumulated or housed at one site. That is because the same computer software programs are used to make the calculations using all available information. The American Boer Goat Association and the Texas Agricultural Experiment Station are developing a model for providing information of this type. It started with 6 Texas breeders and is open to all interested producers. This program is called BGIN (begin) and more information can be supplied by calling the American Boer Goat Association office in San Angelo, Texas

(325-486-2242). The initial data provided EDP's on 1300 animals for: birth weight, 90 day weaning weight, 150 day post-weaning weight and number of kids born. EPD information of this type will become more readily available in the future as other breeds and associations accumulate the data. Every breeder should plan to participate and use this information for herd improvements.

**Putting it all together:** How do we begin to use all of this information? The primary traits that should be included in all breeding plans for improvement are:

1. Reproduction
2. Adaptability
3. Growth

These traits are necessary for any operation to survive. Regular reproduction is necessary to produce offspring regularly and they must be able to adapt to the operation's environment and grow to the necessary weight for every segment of the industry. When we review Table 2, it states that the heritability of birth interval is low; birth weight, and motherability are moderate and scrotal circumference is high. This information indicates that faster progress can be made by selecting bucks and does for birth weight, motherability and scrotal circumference.

Reviewing Table 3 shows a negative correlation between birth weight and dystocia or kidding trouble and selecting for low birth weights should increase the survivability of the newborn. Using scrotal circumference as a selection criteria has a dual effect physiologically upon the animal. With almost a zero correlation for scortal circumference and birth weight, no increase in birth weight should result from larger scrotal circumference. Larger scrotal circumference indicates an increased ability to settle does because of more sperm production and there are indications that female offspring resulting from the mating usually mature earlier. This type of animal reaches puberty earlier, which allows them to conceive more routinely than later maturing offspring.

This type of strategy should allow producers to retain animals that will reproduce regularly under their particular management scheme. The producer will set the level of performance for each of these traits and animals that fall below this level will be removed from the herd. This strategy will work well assuming management is fairly constant, but remember that environment affects animal performance. Should a change in management occur, it may require a different selection criterion to accommodate the new management changes.

Adaptability is an encompassing trait that usually has to be determined by the producer about which combination of results are needed to make the desired selection changes. It may be a health-related issue, a temperament score, or the foraging ability and growth of the goat. These factors usually are scored as a numerical score that the producer will create, and each animal will be scored to reflect the direction of the trait. For example, you may cull or remove any animal that has to be treated for worms. This selection strategy will remove all the ones that cannot maintain a healthy intestinal tract under your management scheme. Over time you will have a herd that does not require worming, because you have selected animals that have a genetic tolerance to worms. It can be done.

Growth trait performance will depend upon the type of operation, for meat growth selection is different from a dairy or hair operation. Regardless, the producer makes the decision on the level of acceptable performance and this becomes the minimal point at which animals will be allowed to remain in the herd. For example, you may set the minimum 90-day weaning weight to be 50 pounds. Any doe that cannot produce this weight of kid will be removed. From the buck performance, if his offspring do not meet this level of performance another buck should be used. The method is the same for each trait that is considered important.

Using these breeding strategies will allow producers to make reasonable progress toward the desired goals. The progress will not be as quick since you are evaluating more than one trait. If additional traits are added, the progress will be even slower, since you are trying to select different gene pools. So a general rule to follow will be to <u>limit any selection process to three traits or less.</u> This plan will allow reasonable progress to be monitored and let a producer see results from the breeding plan and not get frustrated with the slow progress.

Selection pressure on more than three traits involves so many gene pairs, that correlated individual traits get diluted in single animals so that the positive effect of selection is moved slowly towards the breeding goal. If these traits are not negatively correlated to produce undesirable results, more progress can be monitored in multiple trait selection. An index score of production traits and economic values is the preferred method to incorporate large numbers of trait selection in a breeding herd. Then this yearly index score can be plotted on a graph, to indicate the genetic trend as shown in Figure 3.

Remember, this is not a one-time static process. As you achieve the level of performance set initially, you will alter these levels to increase or maintain that performance and possibly add another quality trait that will increase the value of your animals. In a dairy operation, a milk production level may be used for initial selection criteria. After that is attained, you may want to select for higher levels of milk fat at that same level of milk production. As improvement is attained, you usually strive to improve in the same or other areas of production.

First, decide upon the market you want to supply. For the meat market, you want to produce pounds of meat. This may be to supply kids for growing or you may decide to grow out the kid crop and sell to the packers. Each of these has different strategies in developing a breeding plan. The same logic is used for the dairy or hair industry; to sell pounds of milk or pounds of hair. The quality traits of these last two industries will have to be addressed, whether it is the fat content of the meat or milk or the fineness of the hair to be sold. Each trait has a monetary and genetic factor that has to be evaluated before it can be manipulated to improve the production of the herd.

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Chapter Seven

# Reproductive Management of Meat Goat Operations

Kyle Rozeboom and Fred Hopkins

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Reproduction is the most important factor that determines the profitability of a meat goat operation. The main goal for meat goat production must be an optimum litter size (2-3 kids) with a high weaning percentage and low death loss. An effective way to increase revenue from meat goat production is to increase the number of kids weaned per doe each year.

The purpose of the reproductive management section is to provide information that will help improve the reproductive performance and consequently, the profitability of meat-goat operations.

**The Structure and Function of the Reproductive System of the Buck and Doe**

A thorough understanding of the male and female reproductive tract is important for any producer as he or she attempts to improve the reproductive rate of their herd.

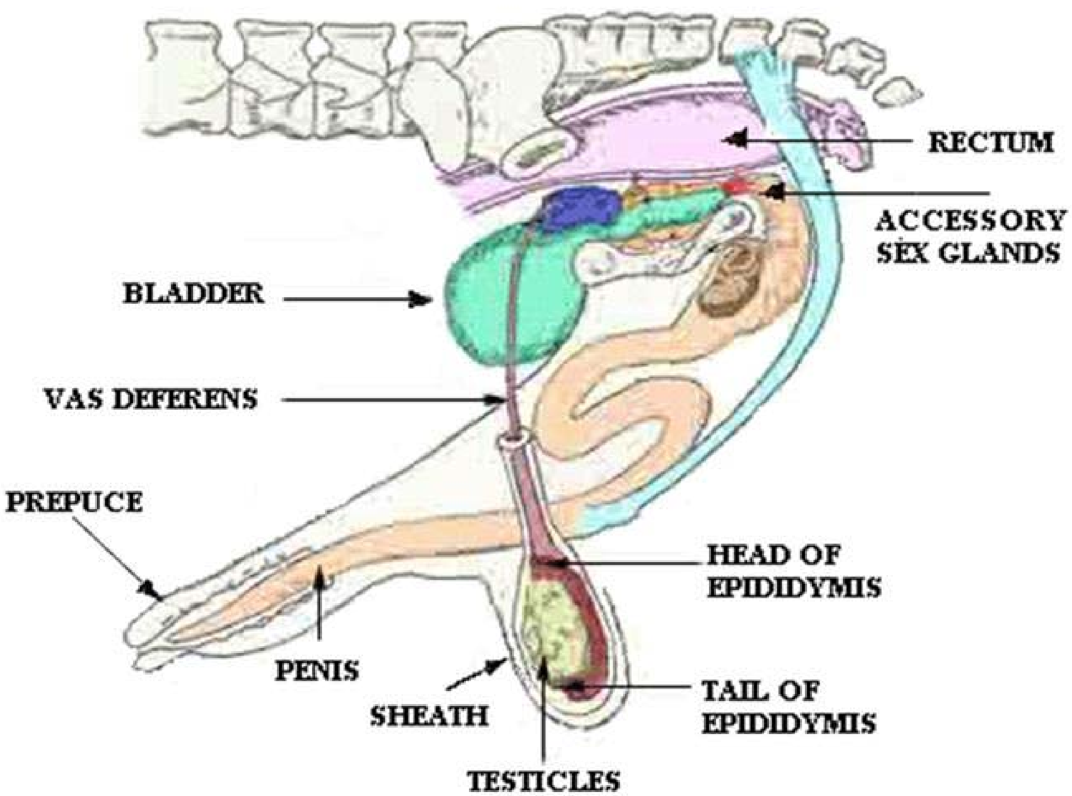


**Figure 1. The Reproductive Tract of the Buck (Source: Langston University)**

The male serves two major functions in reproduction: 1) to produce the male reproductive cell (sperm) and 2) to transport sperm and introduce it into the female reproductive tract at the proper stage of the female's estrous cycle. The reproductive organs of the buck include the scrotum, testicles, epididymis, vas deferens, penis and assessory sex organs.

Scrotum – The scrotum is a two-lobed sac that encloses the testes. It is located in the inguinal region (the area where the front of the legs meets the abdominal wall) between the rear legs of the buck. Its main function is in temperature regulation. During periods of cold weather, the smooth muscle that lines the scrotum, in conjunction with the cremaster muscle that surrounds the spermatic cord, contracts and causes the scrotum to draw the testicles closer to the body. This provides warmth. During periods of hot weather, these muscles relax allowing the testicles to distend down away from the body. The surface of the scrotum stretches, allowing a greater surface area. The surface contains both sweat and sebaceous glands (oil producing gland of the skin). Evaporation of the excretions of the glands cools the surface of the scrotal tissue and the testicles. For sperm production the scrotal temperature must be 5-7 degrees cooler than the body temperature of the buck. Improper scrotal function and poor testicular distention during hot weather may lead to temporary sterility in bucks due to increased testicular temperatures caused by the close proximity to the abdomen.

Testicles – Testicles are the primary sex organ of a buck and weigh about 100-150 grams. In mature bucks, they may change in size during the breeding season. Similar to the ovaries in the female, the two main functions of the testicles are to produce the male gamete (sperm) and the male hormone testosterone. The male goat has two testicles that are suspended in the scrotum outside the body. In the fetus, the testicles develop in the abdominal cavity near the kidneys. At or just before a buck is born, they descend through the inguinal canal into the scrotum. Failure of one or both testes to descend into the scrotum is known as cryptorchidism. Cryptorchidism usually causes sterility in bucks due to the elevated temperatures of the testicle within the abdomen.

Epididymis – The epididymis has four main functions: (a) carries the sperm from the testicle to the vas deferens, (b) acts as a storage reservoir for sperm, (c) allows sperm to continue to mature or develop and (d) concentrates the sperm.

Vas Deferens – The primary function of the vas deferens is to move sperm into the urethra at the time of ejaculation. It is a slender, muscular tube that runs from the tail of the epididymis to the neck of the bladder, where it joins the ampulla and accessory sex glands. Removing or closing off a section of the vas deferens is known as a vasectomy. In vasectomized animals (teaser bucks) the animal still produces testosterone and spermatogenesis (the process of producing sperm) continues, but it prevents the passage of sperm from the epididymis to the urethra.

Penis – The penis's main function is to deposit semen in the female reproductive tract. It also serves as the passage for urine to the exterior. The buck's penis is formed in the shape of an S curve. This is known as the sigmoid flexure. Relaxation of the penis retractor muscle and the increase in blood pressure in the penis allows the sigmoid flexure to straighten and extend the penis during copulation. There are also retractor muscles that return it to the body cavity. The external part of the penis is known as the glans penis. During an erection, the cavernous spaces of the erectile tissue become engorged with blood to increase its size and stiffen it for insertion into the doe. In the non-erect state, the glans of the penis is contained in the sheath. Mating time is very short in bucks. Intromission usually lasts less than 5 seconds. Bucks will generally throw their head back at ejaculation.

Accessory Sex Glands – The accessory sex glands of a buck include the ampulla, seminal vesicles, prostate gland and the bulbo-urethral gland (cowpers gland). The accessory glands function together to secrete fluids that make up seminal fluid. Sperm cells are suspended and transported through the male genital tract within this seminal fluid. Seminal fluid provides a medium for sperm transport, as well as providing energy substrates, buffers and nutrients needed to assure sperm cell motility and survival within the vagina and female reproductive tract. Normal seminal volume during ejaculation for a buck is 0.5-1.5 ml, with a concentration of 1.5-6 billion sperm cells/ml.

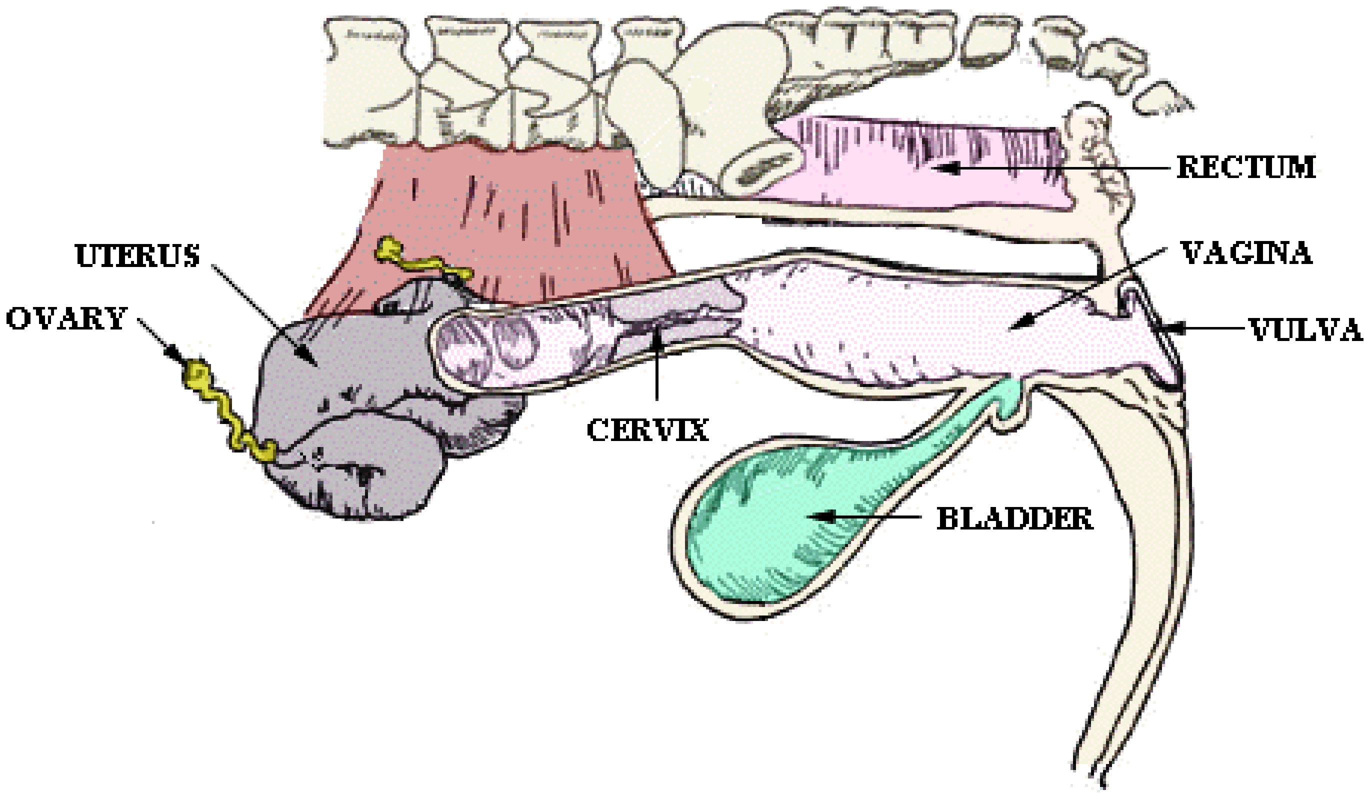


**Figure 2. The Reproductive Tract of the Doe (Source: Langston University)**

The female serves several functions in reproduction:

1. Provide ova (eggs)
2. Provide proper environment for fertilization
3. Nurture the embryo/fetus (gestation)
4. Deliver fetus to exterior
5. Feed the young goat (lactation)
6. Provide for proper behavior patterns
    A. Attracting male and mating
    B. Demonstrating maternal functions

The main reproductive organs of a doe include ovaries, oviducts, uterus, cervix, vagina, and vulva.

Ovaries – The ovaries are the primary sex organ of the doe and perform two functions: to produce ova (eggs) and to secrete female reproductive hormones (i.e., progesterone and estrogen). The ovaries of a mature doe weigh 0.5-3 grams, depending on stage of the reproductive cycle. The ovary differs from the testicles in that they only produce 1-3 eggs per cycle near the end of the heat period.

Oviducts (fallopian tubes) – This is where fertilization of the egg occurs. The oviducts are small tubular structures that lead from the horns of the uterus to the ovaries. The oviducts transport the ova from the ovary to the site of fertilization (ampullary-isthmic junction;) which occurs midway down the oviduct. At the same time, the oviduct moves the sperm cells in the other direction towards the ova from the uterus. Once fertilized, the egg passes back through the oviduct to the uterus for implantation.

Uterus – The uterus is a muscular sac that connects the vagina and the oviducts. The uterus is the site of fetal implantation and consists of two uterine horns with a common uterine body. It serves four main functions: 1) transports sperm from the vagina to the oviducts, 2) secretes hormones that maintain the corpus luteum (a yellow, progesterone-secreting mass of cells that forms from an ovarian follicle after the release of a mature egg) and thus pregnancy, 3) supports, nurtures and protects the developing fetus throughout gestation, and 4) initiates and provides passage for the fetus during birth.

Cervix – The cervix is a muscular canal-like structure that provides closure to the uterus of a doe. Its function is to protect the uterus during pregnancy. The cervix is tightly closed and sealed during pregnancy, but is relaxed and open during estrus or parturition (the act or process of giving birth). During breeding, the cervix also assists the movement of sperm from the vagina to the uterus, acts as a sperm reservoir and prevents the transport of damaged or dead sperm cells to the uterus.

Vagina – The vagina is the site of semen deposition by the buck during natural mating. The vagina gives access to the buck's penis at the time of breeding and receives the semen. Once deposited, sperm cells are transported into the cervix and seminal fluid is either absorbed by the vagina or expelled. The vagina also serves as the birth canal for the fetus during parturition.

Vulva – The vulva is the external opening of the female reproductive tract. It is the opening for both the urinary and genital tracts. It serves as the entrance for the penis during breeding and is the end of the birth canal during parturition.

**The normal reproductive characteristics of does and bucks are listed in Tables 1 and 2.**

Table 1**. Reproductive Characteristics of Does**

| TRAIT | AVERAGE | RANGE |
|---|---|---|
| Age at Puberty (mos) | 5-7 | 5-20 |
| Estrous Cycle Length (d) | 21 | 15-24 |
| Duration of Estrus (hrs) | 30 | 24-48 |
| Ovulation After Estrus Beginning (hrs) | 33 | 30-40 |
| Gestation Length (d) | 149 | 144-155 |
| Litter Size | 1.5 | 1-4 |
| Breeding Weight | -- | 60-75% of Adult Wt |

Table 2. **Reproductive Characteristics of Bucks**

| TRAIT | AVERAGE | RANGE |
|---|---|---|
| Age at Puberty (mos) | 4-6 | 5-20 |
| Breeding Age (mos) | 8-10 | 6-12 |
| Breeding Ratio for Mature Buck | 1:40 | 1:35-60 |
| Breeding Ratio for Young Buck < 1yr. old | 1:20 | 1:10-25 |
| Daily Sperm Production (billion) | 6.0 | 4.8-7.2 |
| Ejaculate Volume (ml) | 1.0 | 0.5-1.5 |
| Ejaculate Concentration (billion/ml) | 3.0 | 1.5-6.0 |

Puberty – Puberty is defined as the age of sexual maturity or the age at which an animal is capable of releasing gametes (spermatozoa and ova) and copulating. In goats it can occur from 4-20 months of age. Generally, bucks normally reach puberty at 4-6 months of age and doelings at 5-7 months of age. Age at puberty is influenced by factors such as breed, size, crossbreeding, inbreeding, health, nutrition and season of birth. Larger breeds tend to be slower to reach sexual maturity than do smaller breeds. Within a breed, those goats that grow faster tend to reach puberty more quickly than slower-growing contemporaries. This is related to the fact that most goats reach puberty at 40-60 percent of their mature size and those that grow faster and have proper nutrition attain this weight sooner. Increasing the plane of nutrition generally advances the onset of puberty but overfeeding will decrease subsequent fertility and may impair mammary tissue growth. Crossbred goats have been shown to reach puberty faster than purebred goats. Goats that don't have adequate nutrition, that are unhealthy and burdened with parasites are slower to reach puberty.

Selection for early puberty can have a positive influence on the lifetime reproductive rate of a doe. In general, most doelings are bred when they reach 1 year of age or 80-85% of their expected mature body weight based on their breed.

Seasonality – In general, are considered short-day breeders. This means they are in anestrus (an interval of sexual inactivity) during the spring and summer, and only cycle and breed during the fall when the days are getting shorter. Breeding season begins when the ratio of daylight to darkness begins to decrease and usually ends when the ratio of daylight to darkness is nearly equal. Normally, September through January is the season of peak breeding activity for goats; however, differences do occur among individuals and breeds and breeding activity can occur throughout the year. For example, goats from the tropics are non-seasonal breeders and kid year-round. This desirable trait of non-seasonality could be incorporated into a meat goat enterprise.

In seasonal breeders, both males and females are affected by photoperiod (the duration of an organism's daily exposure to light) with each showing the greatest fertility during the fall breeding season (short daylight length). During the spring and summer, bucks will often experience a reduction in sperm production, and a higher incidence of abnormal sperm cells. In some cases, bucks will become sexually inactive during the spring and summer.

Libido – Buck activity and fertility play a major role in the reproductive rate of a doe. Before the buck can provide adequate numbers of normal and viable sperm to the doe, he must first show the correct sexual behavior and seek out the females in estrus. This sexual behavior is called libido. A strong libido is necessary in order for a buck to mate with a high number of does during the breeding season. Bucks with high libido are more successful and have higher pregnancy rates than those with little interest in the does. Factors such as physical condition, genetics, environmental temperatures, and disease and parasites affect libido.

It has been shown in sheep that crossbred rams appear to have more libido and settle more ewes than purebreds. This was concluded by the greater conception rates in ewes exposed to crossbred rams than ewes exposed to purebred rams. This increased libido advantage in crossbred males has been reported in swine and cattle as well. Although no research currently exists in goats comparing crossbred to purebred bucks with regard to libido and breeding, the potential benefits of crossbred bucks may exist and could be of value in improving the efficiency of meat goat production.

It is important to maintain an acceptable buck-to-doe ratio (1:50 or less is recommended for mature buck). Exceeding this ratio may lead to a buck experiencing sexual exhaustion, leading to decreased libido and increased health and physical problems. There also appears to be an advantage to running bucks in groups versus alone. Body condition is also closely related to libido, as bucks that are obese, thin or undernourished have decreased libido. Feeding bucks and putting them on a higher plane of nutrition prior to and through breeding season are often considered good management practices to ensure buck performance.

**Estrous Cycle**

Goats are classified as seasonally polyestrous. This means that does have multiple estrous cycles only during certain periods of the year. This period normally occurs during the fall in goats. During this breeding season, reproduction of the doe is controlled by her estrous cycle. The estrous cycle in a doe is normally 21 days in length and can range from 15-24 days. The estrous cycle of a goat can be broken down into four periods: metestrus, diestrus, proestrus and estrus.

Metestrus and diestrus together are often called the luteal phase. Proestrus and estrus together are called the follicular phase. The periods of the estrous cycle occur in a cyclic and sequential manner except during period of anestrus. Anestrus is a period of cyclic dormancy when the female does not go through estrous cycles. Anestrous occurs during the off season in seasonal breeders, as well as during pregnancy and early postpartum.

**The parts of the estrous cycle are briefly described as follows:**

Estrus – Estrus is the period of sexual receptivity where the doe will stand (standing heat) to be mated by the buck. Estrus usually lasts around 30 hours in a doe but can range from 25-40 hours. During estrus the female is under the control of estrogen and will display female mating behavior. Rapid tail wagging, mounting and bleating in does are all secondary signs of estrus in does. Ovulation of 1-4 ova usually occurs at the end of estrus or few hours after estrus ends (metestrus).

Metestrus – Metestrus begins at the finish of estrus. It will normally last for 3-5 days. This is the period where the beginning formation of the corpus luteum (C.L.) takes place. Ovulation can occur during this phase in does. The C.L. is responsible for the secretion of the hormone progesterone. Progesterone is considered the hormone of pregnancy and is responsible for maintaining a pregnancy in does that have conceived.

Diestrus – Diestrus lasts between 10-14 days and follows metestrus. During this period the C.L. is fully functional and the secretion of progesterone is at its greatest point.

Proestrus – Proestrus lasts from 2-4 days. During this phase one of two things can occur. First, by day 17 the endometrial lining of the uterus can recognize that no embryo is present. This causes a release of prostaglandin, which lyses(removes) the C.L. The C.L regresses, removing the doe's source of progesterone. The doe now comes under the control of estrogen, which is being released by the ovary. Rapid follicular growth occurs and the doe begins to exhibit behavioral symptoms of the approaching estrus. In the event of pregnancy, the C.L. does not regress but remains functional and continues to secrete progesterone to maintain pregnancy.

**Gestation**

In goats the gestation length ranges from 146-155 days, with 149 being commonly used as the standard (Table 3, page 14). The length is influenced by genetics, maternal and fetal factors. It has generally been observed that younger does will have shorter gestation terms than older does. It has been shown that singles tend to be carried longer than multiple births and males longer than females. Be aware that most does of the same breed are similar but differences do occur.

During gestation, many changes must take place for the doe to prepare herself and the offspring for parturition. A doe must be provided the proper nutrition and health management as inadequate nutrition of the doe, especially in late gestation, can result in weak kids and a higher death loss. High temperatures during pregnancy may also cause the doe to give birth to small, stunted kids.

**Many factors affect reproductive efficiency in the goat. Fertility and prolificacy of the male and the female is determined by many genetic and environmental conditions. Some of the more important factors will be briefly discussed:**

Heredity – As in other species, some breeds and genetic lines of goats produce more multiple births than do others. Nubian goats, for example, are well known for prolificacy and commonly give birth to triplets. Also, within a herd it has been shown that selection of replacements based on the dam's ability to produce twins can increase the overall prolificacy of a goat herd. It is also interesting to note that bucks from more prolific breeds appear to be more fertile than those from less prolific breeds.

Age of dam – Age affects the reproduction rate of does. A doe increases in fertility and prolificacy as she approaches middle age (5-7 years). Middle-aged does produce a higher number of twins than do 2-year old does. It is recommended retaining these does in your flock as long as they remain functional and sound in their structure and mammary system.

Temperature – Elevated temperatures can affect fertility of the buck and doe. In the doe, temperatures above 90 degrees F for an extended period of time can decrease embryo survival and retard fetal development. In extreme heat, the doe is unable to maintain normal body temperature and goes into a state of heat stress. The mortality rate of embryos is especially high if does are subjected to these high temperatures from breeding to 8-10 days post breeding. High temperatures in latter gestation may cause smaller, weaker kids to be born. Fat does or those on excessive feed consumption are generally more affected by heat stress.

Bucks are affected by high temperatures in that they are very sensitive to prolonged periods of temperatures greater than 80 degrees F. Experiments have shown a decrease in fertility due to exposure to high temperatures. Lower sperm concentration, decreased sperm motility and a higher number of dead and abnormal sperm are all related to heat stress in bucks. Extended periods of exposure to temperature above 100 degrees have been shown to cause bucks to become sterile. The damage is not usually permanent and the bucks are usually fertile after 4-6 weeks of cooler temperatures.

To counteract heat stress, it is recommended to provide good shade and proper air circulation to keep bucks and does comfortable. Also, it is important to minimize activity by not working goats during periods of excessive heat. During breeding season it may also be necessary to keep bucks penned up in the shade in a cool place during the daytime when the temperature is at its greatest, and only allow the bucks to breed at night. This will minimize activity and lower the affects of heat stress on the buck.

Nutrition – A sound nutrition program has a great affect on reproductive characteristics of both the male and the female. Reproduction of the doe can be enhanced by a well-managed feeding program. Poor nutrition that inhibits development will inhibit reproductive efficiency and doe size is determined by both nutrition and genetics. Generally, it has been observed that larger does in a herd are more likely to produce multiple births than smaller, under-nourished does. Does that are thin, have a mineral imbalance or in a negative plane of nutrition (losing weight) will be more likely to have lower pregnancy rates, fewer numbers of multiple births and weaker kids than those with a stable or increasing plan of nutrition.

One commonly accepted nutritional management procedure that has shown to increase prolificacy in thin does is flushing. Flushing is an increase in the doe's plane of nutrition 2-8 weeks prior to breeding season so that the doe is in a gaining state before and during estrus. This may be accomplished by turning the doe out on a high-quality, pasture or feeding 0.5 -1.0 lbs of grain per head per day. Flushing will improve ovulation rate, which can result in a 15-20 percent increase in the number of kids produced in a herd. It is important to note, however, that responses to flushing are greater in does that are thin to moderate in body condition. Responses to flushing are usually not noticed in fat does with high body condition scores. It is also important that thin does are maintained on a proper plane of nutrition throughout gestation to help build body condition reserves, maintain pregnancy, and ensure healthy, vigorous kids at birth.

An adequate level of nutrition is also important to the development of young bucks and their future reproductive rate. Bucklings on a high level of nutrition will reach puberty earlier than those on an inadequate diet. Testicular size is also related to body growth and development. Research has shown that the testicular size of buck kids is positively correlated to the ovulation rate of their doe siblings.

Breeding animals are most often selected based on their ability to pass along economically important traits to their offspring. Any trait can be improved by selection if that trait is heritable (can be passed along to offspring), variable and measurable. Selection for reproductive abilities is not used as often as it should be. While reproductive traits tend not to be highly heritable, failure to provide some screening for reproduction can lead to problems. Heritability estimates (the percentage of difference in traits that is heritable rather than due to environment) for some economically important traits in meat goats are listed below:

| | |
|---|---|
| Age at first kidding - 50% | Stature - 45 to 50% |
| Multiple births -15% | Carcass weight - 45 to 50 % |
| Weaning weight - 45% | Quality grade - 40% |
| Weight at 7 months - 60% | Ribeye area - 40 to 45% |
| Mature body weight - 50% | Cutability - 25 to 30 % |
| Milk yield - 50% | Muscling - 40 to 45% |

Bucks are chosen based on their pedigree and/or traits such as birth weight, weaning weight and the milk production of female relatives. The buck's ability to sire multiple births is often considered. Inbreeding should be avoided, since highly inbred animals tend to be less fertile. Various other things should be considered when selecting a breeding buck. Bucks with birth defects such as less than two teats, hernias, overbites, underbites, cryptorchidism (testicles that do not descend in to scrotum) and the polled condition are good reasons not to use a particular buck. Conformation is important in that the buck should be able to move freely and be willing to mate often. Thin or fat bucks tend not to be efficient breeders. Another important aspect of fertility is scrotal circumference, since it is related to the number of sperm a buck can make on a daily basis. Scrotal circumference in 100-pound young bucks is said to average about 28 cm. Small scrotal circumferences should be avoided. More specific guidelines for scrotal circumference measurements are not currently available.

Breeding Soundness Evaluations (BSE), as performed by veterinarians, can identify a number of problems not seen on a more casual exam of the buck. In addition to a thorough physical exam, the reproductive system, including the penis and testicles, is examined. Finally, semen collection is performed so that semen quality can be analyzed. Semen can be collected from a buck using a electroejaculator or an artificial vagina. Minimum acceptable standards for goat semen include a volume of at least 0.5 cc, with a concentration of 200 million sperm cells per cc. In addition, at least 70 percent of the sperm should be motile and at least 80 percent should be shaped and formed normally (morphology).

Females are selected based on the same genetic parameters as bucks. Other important considerations include birth defects, the polled condition, body condition, conformation, attachment of the mammary gland, and examination of the vulva for evidence of malformation. Most animals reach puberty by the time they reach 70 percent of their adult weight but will increase in fertility for a time after that.

Sexual behavior is both instinctive and learned. Goats can begin to show sexual behavior well before sexual maturity and early as 3 months of age. However, they continue to become more efficient as breeders through the first breeding season. Some goats inherit lower levels of sex drive or libido than others and this inherited level of sex drive cannot be changed with treatment in a normal goat.

Sexual behaviors cause the male and female to seek one another out and mate at a time when pregnancy is most likely to occur. The most certain sign of heat in the doe is standing and allowing herself to be mated. Does in heat show other signs better if a buck is around. Female goats in heat will seek out the male and may on occasion mount one another. They are more aggressive and will bleat more often than normal. In addition, they have a swollen and reddened vulva with a clear to cloudy mucous discharge. Side-to-side tail wagging (flagging) is common. Their appetite will decrease and they will urinate more often than is usual. Bucks seeking out females in heat will be more aggressive, show a curled upper lip (the Flehmen Response) and run their tongue in and out before mating.

Most goat herds are bred using a natural mating system, where the male(s) run freely with the female at least during the breeding season. Recommendations for stocking rates for bucks vary from source to source. Various recommendations for mature bucks suggest that 20 to 100 females can be bred in a season, with younger goats being exposed to fewer females.

Using hormones for estrus synchronization of does is useful for shortening the kidding season and allowing timed artificial insemination (AI) of does. Several systems have been successfully used both in-season and out-of-season with does. Prostaglandins have been used in cycling does; generally, a 2-shot program is recommended. The injections are given about ten days apart and heat detection is used for determining which does to breed over the next five days. Progesterone given as an ear implant or a vaginal implant has been used in the U.S. but neither type of product is commercially available here at this time. Progesterone-like products in conjunction with other hormones have been used to cause out-of-season heat in does. Again, products for this purpose are not currently available in the U.S.

Artificial insemination (AI) using frozen semen has been used, with success in goats for a number of years. AI allows wider use of better males, with less need for bucks on the farm. Some equipment and training are needed as well as labor for heat detection and breeding. Also, few bucks are available with complete information on their genetic potential. In many cases, estrus synchronization is used to reduce labor for estrus detection. Most often, does are inseminated by passing a small tube through the cervix after it is identified by use of a vaginal speculum and light. Conception rates using thawed frozen semen have been reported as between 50 and 75 percent but this is by trained inseminators who have had lots of practice.

Embryo transfer is used infrequently for does. It is a good way to increase the number of kids a female can have, but does involve significant expense. An average of three pregnancies can be expected per procedure. The steps in embryo transfer include:

Donor selection
Recipient selection
Estrus synchronization of donors and recipients
Superovulation of the donor
Breeding of the donor
Embryo recovery
Embryo transfer to recipients

Pregnancy can be diagnosed in the doe by several methods. They are listed below with the expected accuracy of that method:

Blood or milk progesterone test at 19 to 24 days after mating (90%)
Blood or urine estrone sulfate test at 50 to 60 days after mating (near 100%)
Radiography after 70 days (near 100%)
Ultrasound after 35 days (90+%)

Does kid after an average 150 days of pregnancy. Triplet pregnancies are somewhat shorter than singles or doubles. Labor begins with uterine contractions, which force the fetus against the cervix and helps dilate it. Labor may last as much as 12 hours. Does will often not eat and will want to be alone. The birth process itself generally lasts for less than two hours as the does strains to push out one or more kids. Expulsion of the afterbirth should be completed within six hours, although a red-brown odorless discharge from the vulva may be seen for up to 3 weeks after kidding in normal does. Ninety-five percent or more of kiddings require no help, although abnormal presentations and oversize kids can cause problems. Does should be examined if they have been straining for more than one hour with no kids or afterbirth in sight. Washing the vulva, wearing a clean obstetrical glove and using lots of lubricant are important to success.

Kids are hardy, but a little care after birth can go a long way in assuring a healthy early life, especially if the doe is a good mother. Drying kids off with a towel helps prevent chilling in cooler weather. Rubbing the chest also stimulates breathing. Dipping the navel with 2 percent iodine or other suitable disinfectant helps prevent navel infections. Kids that have not nursed within four hours of birth should be fed colostrum at the rate of about 20ml per pound of body weight as soon as possible, and three times or more the first day of life.

Pseudopregnancy occurs in 3 to 5 percent of dairy does on some farms, especially in the late fall and winter. Does have udder development and an enlarged abdomen. Some pregnancy test, such as progesterone testing may show them to be pregnant. They will finally deliver a large volume of clear fluid. They may or may not repeat this next year and culling affected does should be considered.

Cystic ovarian disease is relatively common in goats, with about two percent of does being affected. Affected does will show signs of heat every few days, but they won’t become pregnant. Successful treatment requires the use of hormones which are only available by veterinary prescription; culling affected does should be considered.

Abortion in goats is most commonly noticed in the last 2 months of pregnancy and up to five percent of normal does may abort. Common infectious causes of abortion include Toxoplasma and Chlamydia. A number of other causes are occasionally diagnosed. Diagnosis of the cause of abortion is necessary for effective control, and requires the use of the state diagnostic lab.

The intersex condition is associated with the polled condition and is seen more frequently in certain dairy breeds of goats. These animals are genetically female but have a mixture of reproductive organs and are sterile; they should be culled from the herd.

| Breeding | Kidding | Breeding | Kidding | Breeding | Kidding | Breeding | Kidding | Breeding | Kidding | Breeding | Kidding |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 Jan | 30 May | 03 Mar | 30 Jul | 03 May | 29 Sep | 03 Jul | 29 Nov | 02 Sep | 29 Jan | 02 Nov | 31 Mar |
| 02 Jan | 31 May | 04 Mar | 31 Jul | 04 May | 30 Sep | 04 Jul | 30 Nov | 03 Sep | 30 Jan | 03 Nov | 01 Apr |
| 03 Jan | 01 Jun | 05 Mar | 01 Aug | 05 May | 01 Oct | 05 Jul | 01 Dec | 04 Sep | 31 Jan | 04 Nov | 02 Apr |
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| 25 Jan | 23 Jun | 27 Mar | 23 Aug | 27 May | 23 Oct | 27 Jul | 23 Dec | 26 Sep | 22 Feb | 26 Nov | 24 Apr |
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| 09 Feb | 08 Jul | 11 Apr | 08 Sep | 11 Jun | 07 Nov | 11 Aug | 07 Jan | 11 Oct | 09 Mar | 11 Dec | 08 May |
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| 27 Feb | 26 Jul | 29 Apr | 26 Sep | 29 Jun | 25 Nov | 29 Aug | 25 Jan | 29 Oct | 27 Mar | 29 Dec | 26 May |
| 28 Feb | 27 Jul | 30 Apr | 27 Sep | 30 Jun | 26 Nov | 30 Aug | 26 Jan | 30 Oct | 28 Mar | 30 Dec | 27 May |
| 01 Mar | 28 Jul | 01 May | 28 Sep | 01 Jul | 27 Nov | 31 Aug | 27 Jan | 31 Oct | 29 Mar | 31 Dec | 28 May |
| 02 Mar | 29 Jul | 02 May | 29 Sep | 02 Jul | 28 Nov | 01 Sep | 28 Jan | 01 Nov | 30 Mar | 01 Jan | 30 May |

**Table 3. Breeding Dates vs. Kidding Dates for Goats**

Kidding dates after breeding (149 day gestation)    Prepared by Dr. A. David Scarfe (January 1993)

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Chapter Eight

# NUTRITION

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## Introduction

Some of us who study ruminants have a tendency to emphasize the complex combination of microbiology, physiology, anatomy and biochemistry that go into making goats function. But in the real world, feeding goats is not that difficult.

Think of a watch – obviously far too complicated for most of us to understand – yet we depend on them every day. Like a watch, you don't have to understand every little aspect to know what time it is – or to keep your goats well fed.

By way of introduction, and to establish the principles upon which this chapter is written, consider the following simple guidelines for successful goat feeding:

•*Goats prefer to browse (Table 1).* Goats do better when they eat with their heads up. "Heads-up" foraging means they are following their natural behavior, they have the opportunity to find nutritionally superior plants and plant parts and they are less likely to face a parasite challenge. Production limitations may force managers to graze goats, but they should realize there is a price to pay for turning browsers into grazers.

Table 1

**FORAGE PREFERENCE BY HERBIVORES**

| Forage type | Cattle | Sheep | Goats | Horses |
|---|---|---|---|---|
| **Grasses** (Pastures) | **70%** | **60%** | **20%** | **90%** |
| **Forbs** (Weeds) | **20%** | **30%** | **20%** | **4%** |
| **Browse** (Shrubs) | **10%** | **10%** | **60%** | **6%** |

•*Forage is the foundation.* Successful goat nutrition is almost always based on goats consuming forage. In general, it is as simple as letting goats have "free-choice" access to browse species, improved pasture or hay that is of adequate quality to meet their nutrient needs (except for minerals and occasional concentrate supplementation if forage quality dips).

•*Improve pastures.* Add legumes in February by broadcasting according to guidelines available from Extension and most seed dealers. Strongly consider including sericea lespedeza in the legume selection. Consider rotational grazing. Plan to stockpile fescue for extended fall grazing. Soil test and fertilize according to recommendations.

•*Manage for quality hay.* Harvest at optimal stage of maturity. Forage test to assess quality. Store hay in a barn or cover. Minimize soil contact during storage and feeding.

•*Manage the hay-feeding process*. Use hay feeders to minimize waste when feeding large round bales. Use feeders designed for goats, with the hay off the ground and avoid feeding in muddy conditions. Carefully monitor hay and replenish when goats have eaten “the good part”; i.e., don’t force goats to consume remnants of damaged hay for extended periods, as it may result in loss of body condition and reduced performance. Remove strings from bales as you put them out.

•*If needed, supplement efficiently*. Start by providing quality mineral supplement, free-choice. Base concentrate supplements on forage tests. Quality hay, fed “free-choice,” needs little or no concentrate supplementation with mature goats. Replacement does, does with twins and thin goats may need additional supplementation. Does being fed lower-quality grass hay, crude protein in 7-8 percent range, may benefit from supplemental protein. (High-protein blocks are convenient and may provide the correct amount of protein, but are expensive and intake is often variable; protein meals, by-product feed or pelleted blends work well, but require feed bunks.) In some cases, additional energy is needed. Corn is the classic energy supplement, but feeding corn at levels beyond 0.4 percent of body weight (0.5 pounds with 140 lb doe) may cause some decrease in forage utilization. This fact, plus competitive pricing, has caused many goat producers to consider alternatives such as blended feeds with soy hulls, corn gluten feed or ingredients to replace a portion of the corn.

Commercial blends of these feedstuffs offering similar advantages are available and may be more suitable for many producers. Goats are apparently more sensitive to urea, so avoid commercial blends with urea. Molasses levels routinely used for cattle and sheep rations may cause problems in goats.

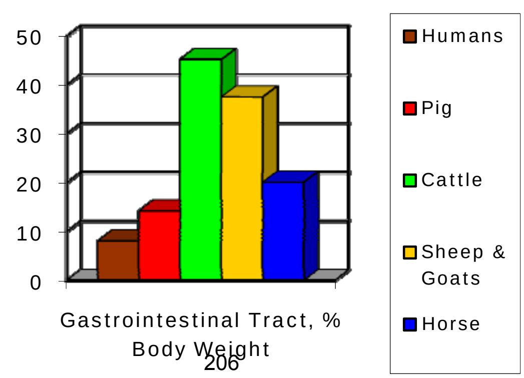
There! This introduction has enough information to allow most goat producers to do a “pretty good job” of feeding goats. But, Master Goat Producers must do better than “pretty good.” That’s why we’ve included additional information to make the graduates of this program “Master Goat Nutritionists” instead of “pretty good” goat feeders.

**Ruminant Digestion**

Maybe you are aware that much of the land in Tennessee is not suitable for row crops. But it is the goat farmer's good fortune that goats are able to use marginal land that would otherwise be of little use. Goats are able to use the forages growing on this land to produce a high-quality source of vitamins, minerals, energy and protein in the form of milk and meat products. This is because goats are ruminant animals, able through the micro-organisms in their digestive system to use these forages, which are of no use to non-ruminants. This, of course, makes the ruminants a very valuable part of our food chain and our economy.

Figure 1 shows the relative capacities of digestive tracts of humans and various animals. Human beings, pigs and chickens are non-ruminants. Cattle, sheep and goats are ruminants. Note that ruminants have larger digestive tracts relative to their size than non-ruminants, including horses (which are classified as cecal digesters).

Figure 1. Relative capacities of the digestive tracts of various species



Ruminants such as cattle, deer, sheep and goats are able to use forages the non-ruminants cannot because of the unique relationship with the micro-organisms in their complex digestive system. These micro-organisms can digest cellulose, which non-ruminants cannot do. We as non-ruminants have a stomach, a small and large intestine. The ruminant digestive system is similar to ours once food reaches the stomach, but it is very different before the food gets to the stomach or abomasum. It is almost as if goats have four stomachs, but it is more accurate to say that there are three compartments prior to the stomach. These compartments (Figure 2) are the rumen, reticulum and omasum, and then there is the stomach or abomasum.

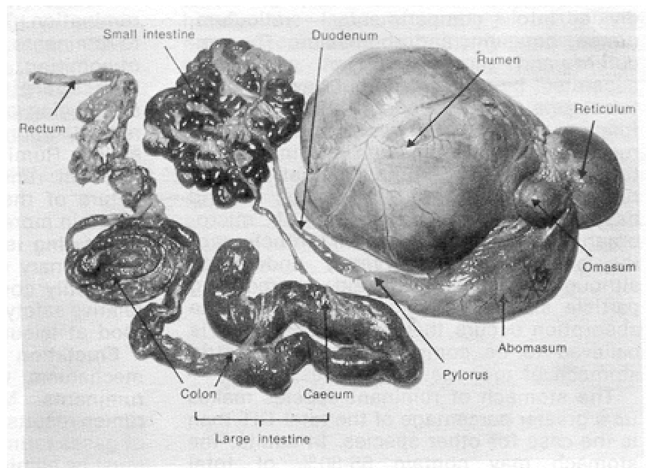



Figure 2. Ruminant digestive tract

Humans use glucose as a main source of energy, but goats use volatile fatty acids (VFAs), such as acetic, propionic, and butyric acid, which are manufactured by the micro-organisms in the rumen. The microbes also convert protein and non-protein nitrogen, such as urea, into a higher quality protein for the goats to use. The VFAs are absorbed and used in a manner similar to the use of glucose in humans. The rumen of an adult goat has a capacity of 3.5 to 5 gallons. It contains millions of papillae or little flat finger-like projections that serve to greatly increase the total interior surface area of the rumen.

Following the rumen is the reticulum, often referred to as the "honey comb." It is here that the more difficult-to-digest foods or non-food items are handled. These include teeth, nails, wire and other hardware picked up during grazing and not broken down by the rumen. Hardware disease is a result of the rumen being punctured by these foreign materials, which may ultimately cause the death of the animal.

Next is the omasum or "many-plies." The omasum has many folds and is responsible for absorption of water out of forages so that they can be properly digested by the stomach and absorbed in the intestines.

**Nutrients Required by the Breeding Herd**

The main objective of a goat nutrition program should be to meet the needs for a specific purpose as economically as possible.

The nutrient requirements of goats vary with the stage of production and age. Younger goats require a higher percentage of energy and protein in their diets than older animals. Lactating does have different feed requirements from dry, pregnant does. Therefore, diets should be specifically formulated to meet the needs of goats based on the variability of the forages, the stage of production of the goats and the season of the year. Temperature can greatly affect the energy and water requirements. Grain mixes can be formulated to provide for nutrient deficiencies in forage.

Goats require five basic nutrients for maintenance (maintaining body temperature, internal functions), work (walking, browsing), growth and reproduction. These nutrients are protein, energy, vitamins, minerals and water.

Many types of forbs, browse, hay and grass grow in Tennessee and the quality of these forages varies greatly. The nutrient content of these feeds depends upon variety, weather conditions, soil fertility, maturity at harvest, harvest procedures and storage conditions. The way to ensure that goats are being properly fed is to know their nutrient requirements and to formulate diets based upon forage analyses from the forage they consume.

Your local Extension agent can provide you with the materials to mail forage samples to the Feed Analysis Lab at the University of Tennessee, where the nutrient value of your forage will be analyzed. Forage testing allows producers to make informed decisions about the need for supplemental feed (amount and type of feed needed).

Soil testing is essential to determine the fertility levels of each soil and to ensure that proper amounts of fertilizer and lime will be added to future crops. Forage testing is also an important way to determine the nutrient quality of the forage.

## Section 1 Nutrients in feeds and goat requirements

All animals require five basic classes of nutrients that you must consider in balancing rations.

**Water -- the most important - must be fresh, clean and always available.** Water functions in the animal to transport nutrients. As a part of the body temperature regulation system, it is a lubricant and is a necessary ingredient in countless chemical reactions in the body.

Water is usually provided to animals in excess of need, so rations are not normally balanced for water. In fact, as is shown in the example that follows, you normally balance rations as if the feeds did not contain any water. This will avoid errors associated with mixing feeds of different water contents.

Many factors affect the water requirement, including the level of dry matter intake, physical form of the diet, physiological status of the animal (they drink more when lactating), temperature and activity. Goats require about one to three gallons of water per day and drink about four times more during the day than the night. Water restriction causes a decrease in feed intake, impairs productivity and increases respiration rate and body temperature.

**Energy** -- Energy is the nutrient provided in the largest quantity by most feeds and serves as fuel for the animal's body. In balancing rations, Total Digestible Nutrients (TDN) is often used as a measure of energy. TDN can be expressed as a percentage of the ration's dry matter or in terms of pounds of TDN required by the animal.

Energy can also be expressed in calories; or, more commonly in livestock, as megacalories (Mcal). Since most diets fed to goats are incompletely digested, several additional terms have been developed to describe energetic efficiency. Digestible Energy (DE) is the energy in the feed minus the energy in the feces. Metabolizable Energy (ME) is the energy of the feed minus the energy lost in feces, urine and gases. Net Energy (NE) is the portion actually used for maintenance (NEm) or production (NEp). The Net Energy for production is often named to reflect the type of production, such as Net Energy for gain (NEgain or NEg).

Most energy in ruminant diets comes from carbohydrates in several forms. Sugars and starches are readily digestible and all animals can utilize sugars and starches. Cellulose, hemicellulose and lignin are less digestible, but the bacteria and other microbes in the goat’s digestive tract can digest these products to some degree and the goat can, in turn, digest the microbes.

Fat (lipids) is another source of energy. Fat has 2.25 times more energy per unit of volume than carbohydrates, but goats can only consume a limited amount of fat (5 percent or less of the total dry matter consumption) or digestive upset may occur.

Excess energy is stored by the body as fat, which is often referred to as “condition.” Condition Scoring (in Chapter 14) is a system for evaluating the amount of fat (or lack of fat) that is stored. It is recommended that producers monitor body condition because this is the best method for assessing the energy nutrition status of the goat herd.

**Protein** -- Protein is a major component of muscle, hair, hooves, skin, internal organs and body chemicals. Immune function depends on immunoglobulins that are composed largely of protein. Protein is composed of smaller compounds called amino acids. However, we typically balance for protein rather than individual amino acids when putting together goat rations. This is because the microbes of the rumen digest much of the dietary protein, changing it into microbial protein that goats digest.

You will often hear protein referred to as "crude protein" when balancing goats rations. Crude protein is a reliable estimate of the protein content of feeds. It is referred to as "crude" because it is not a direct measure of feed protein but an estimate derived by analyzing for nitrogen in the laboratory. Because protein is approximately 16 percent nitrogen, you can estimate crude protein if you know the nitrogen level. For example, if a feed is analyzed to be 2 percent nitrogen, you can figure the percent crude protein (0.02 x 100 / 0.16 = 12.5%). A simpler method is to multiply the amount of nitrogen by 6.25 (2% x 6.25 x 100 = 12.5%).

Another method of expressing protein is the metabolizable protein (MP) system. MP consists of Degradable Intake Protein (DIP) and Undegraded Intake Protein (UIP). UIP is that portion of consumed protein that is not broken down by rumen microbes, often referred to as "bypass" protein. DIP is the portion of the dietary protein used by rumen microbes to meet their nutritional demand for protein.

An advantage of the MP system of describing protein nutrition is that it takes into account how protein is used by both the animal and the microbes that inhabit the animal's gut. The MP system also more accurately describes the differential utilization of various protein fractions for various functions. For example, microbes may utilize inexpensive non-protein nitrogen sources (like urea), while sparing higher-quality protein for use by the animal, resulting in improved efficiency and decreased feed costs. Unfortunately, many of these efficiencies are not easily accomplished under browse - pasture - hay systems common in Tennessee, and goats are suspected to be somewhat more prone to urea toxicity. *It is recommended that urea containing feeds be avoided in goat rations unless or until there is adequate research to assure the safety of this product.*

Protein, unlike energy, is not stored in significant amounts in the body of goats. Therefore, animals must be provided with the required amount of protein each day.

**Vitamins** -- Goats usually have little problem with vitamin nutrition because the rumen microbes synthesize most of the vitamins they require. An exception to this general rule is that the fat-soluble vitamins A, D and E are not synthesized in the rumen and may need to be added if natural sources of vitamins A and E (such as green, leafy hay) are unavailable for an extended period. Another exception is when goats need vitamin therapy after sickness or stress.

Vitamins are needed by the body in very small quantities. The vitamins most likely to be deficient in the diet are A and D. All B and K vitamins are formed by bacteria found in the rumen of the goat and are not considered dietetically essential. Vitamin C is 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 under their skin, or they should receive supplemental vitamin D. Good-quality, sun-cured hays are excellent sources of vitamin D. A deficiency in vitamin D results in poor calcium absorption which leads to rickets, a condition where the bones and joints of young animals grow abnormally.

**Minerals** -- Unlike vitamins, minerals are critical to keep goats healthy and for maintaining breeding soundness. Minerals of most concern when you plan dietary needs are sodium chloride (salt), calcium, phosphorus, magnesium, potassium, sulfur, iodine, copper, cobalt, zinc and selenium. There are other minerals required, but these are seldom lacking in rations. Most Tennessee goat producers provide a free-choice, mineralized salt mixture to avoid a shortage. Salt-mineral mixture may be fed free-choice or mixed into the daily ration (see following section on mineral consumption).

Minerals required by animals can be divided into two groups: Macro-Minerals and Micro-Minerals.

Macro-minerals are needed in relatively larger amounts and are typically measured in percentages. Macro-minerals most commonly discussed in relation to the goat herd are associated with sodium, calcium, phosphorus, magnesium, iron and sulfur.

The sodium and chlorine (salt) are major components in body fluid that control body functions but rarely cause problems because herd minerals always include sodium chloride. It is generally recommended that salt levels in goat mineral mixtures be kept below 10 percent.

Calcium is the most abundant mineral in the animal's body and functions as a structural component of bones and teeth. Calcium is moderate to high in most of the forages goats consume, but low in cereal grains. Calcium deficiency is unlikely unless goats are fed a diet high in cereal grains.

Phosphorus is usually found in conjunction with calcium in bones and teeth and is also found in many of the soft body tissues. Phosphorus is essential for normal reproduction in the animal.

Most forages are relatively high in calcium (grass: less than 0.5%; legumes: more than 1.2%), so calcium is low only if high grain diets are fed, which would be unusual for goats. Low-quality, mature or weathered forages will be deficient in phosphorous, especially for high and average lactating does. The ratio of calcium to phosphorous in the diet is important and should be kept about 2:1.

Table 2

**Mineral Requirements**

| Nutrient | Kids | Dry Docs | Lact Docs |
|---|---|---|---|
| Calcium,% | .55 | .42 | .70 |
| Phosphorus, % | .30 | .24 | .30 |
| Magnesium, % | .16 | .16 | .25 |
| Manganese, ppm | 40 | 40 | 40 |
| Copper, ppm | 10 | 7 - 10 | 15 |
| Zinc, ppm | 50 | 50 | 50 |
| Selenium, ppm | 0.30 | 0.30 | 0.30 |
| Vitamin A, IU/lb | 1000 | 1800 | 1800 |
| Vitamin D, IU/lb | 140 | 450 | 450 |
| Vitamin E, IU/lb | 11 | 10 | 10 |

Magnesium is used in enzymes and transmission of nerve impulses. Deficiencies may result in a grass tetany. 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 percent magnesium.

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.

Copper is a component of many enzymes needed to sustain the life of the animal but 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. Cattle milk replacers should not be fed to nursing kids. Grains are generally lower in copper than forages. Mineral mixes and sweet feed should contain copper sulfate, copper carbonate or chelated copper because these forms of copper are better utilized by the goat than copper oxide.

The exact level of copper to recommend in goat diets is not clear. Not only is the requirement unclear, but there are also several elements that interfere with copper utilization. These “antagonists” include molybdenum, sulfur and iron. The Tennessee Forage Mineral Survey (2001 – 2005), established that sulfur levels in forages are often high enough to make copper less available to goats and other ruminants. Iron levels in both water and forages are high enough to contribute to the antagonistic effect. For these reasons, it is recommended that free-choice minerals contain between 900 to 1000 parts per million (ppm). It is unlikely that higher levels (up to 1500 ppm) will cause problems, but this is not known with certainty.

Selenium is a component in muscle tissue and is implicated in situations where goats do not shed the afterbirth following kidding. Selenium is marginal-to-deficient in all areas of Tennessee and most of the Southeast, and many commercial trace mineralized salts do not contain it. Mineral mixtures that include selenium should be provided to the goat herd at all times. It is particularly important to use a mineral mixture with selenium included since, as with copper (but in a different manner), sulfur is known to interfere with selenium availability.

There are legal limitations on the amount of selenium that may be added to commercially blended mineral mixtures. Sodium selenite is the form that selenium is normally added, but there is some question if this form, provided at or below the legal limit, can provide enough selenium to overcome sulfur antagonism. Newer forms of selenium, derived from yeast, may provide a more nutritionally available form.

Additional minerals usually available in feedstuffs and required in limited amounts include iodine, iron, potassium, cobalt and manganese.

When selecting minerals for the goat herd, it is important to check that all of the above-mentioned minerals are present. When comparing two or more mineral supplements, it is important to look at both the percentage of the mineral present and the recommended level of consumption and the form presented (sulfate vs. oxide). To get a true evaluation between two mineral supplements, multiply the percentage by the consumption to get daily intake (Table 3).

Table 3

**Suggested Levels in Supplement for Goats**

- Phosphorus = 4 - 10 %
- Calcium = 2.0 > P
- Copper = 1000 ppm (up to 1500 in some places if symptoms persist, but part needs to be organic for safety / efficacy)
- Lower NaCl for goats (<10%)
- Magnesium = 2 – 4 % (Higher to prevent tetany)
- Cobalt, Selenium, Iodine, Zinc, Iron, Manganese, Sulfur

**Mineral Consumption by Goat Herd**

It is important to monitor consumption of mineral supplements by the goat herd, especially if mineral-related problems are suspected.

Problems related to mineral consumption may include sudden death of nursing goats (possibly related to magnesium deficiency - grass tetany) or slow breeders (possibly related to copper deficiency, possibly complicated by sulfur, molybdenum or iron excess).

Commercial mineral mixtures typically have suggested consumption rates on the label. If consumption is not within the desired range, problems may occur.

Use the chart on page 11 to monitor consumption of mineral supplements. If consumption is more or less than desired, it may be necessary to discuss the problem with your mineral dealer.

Expect variation in mineral consumption. Goats are noted for being unpredictable in mineral consumption patterns.

Consumption is particularly critical if the supplement is medicated. Medications should typically be delivered at specific levels. Significant variation from recommended consumption my have negative performance effects.

Many factors affect consumption (season, pasture moisture, location of mineral feeder, etc.) Goats with young kids typically consume more. As kids grow, they also consume mineral. It is advisable to make allowances for some variation, and avoid making significant adjustments unless over- or under-consumption is persistent or significantly different than the label recommends.

**Mineral Consumption Record[1]**
**(Number of goats ______)**

| Date | Amount Fed | Calculations and / or Comments |
|---|---|---|
| | | |
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| | | |

[1] Calculate daily consumption per head (in ounces) by adding consumption over a period, dividing by number of days in that period, then dividing by number of head. To convert to ounces, multiply the result by 16.

## Balancing Animal Requirements with Forage and Feeds (ration balancing)

The steps in balancing a ration are as follows:

1. Identify the animals to be fed. Classify the animals according to weight, ge and purpose for which they are being fed (growing, maintenance, lactating).

2. Select nutrient allowances to fit the animal. The nutrient requirements for animals are found in tables such as Table 4. More detailed tables are available at Extension offices.

3. Select feeds and supplements to meet nutrient requirements. In almost all cases the least expensive base feed in Tennessee is home-grown hay and pasture, or locally purchased hay. Supplemental feeds may be home-grown, purchased or both. Supplement ingredients should be selected based on local availability, price, palatability and safety. Table 5 contains some commonly available feeds that meet these requirements along with "book value" analysis. More detailed tables are available at your Extension office.

4. Determine the amounts of each ingredient to use. Start this by testing the base forage upon which the ration is to be based. Use the University of Tennessee Forage and Feed Testing Service (information on this service is available from

Extension agents) or a commercial service. There are several ways to determine the correct proportion of base forage and supplement. One of the most common and easiest is to estimate the amount of available home-grown feed you wish to include in the diet, then figure which nutrients are lacking. This often requires a trial-and-error approach but works for most common rations. A refinement of this approach is a computer program (available from Extension agents) that allows quick calculations to make this method more desirable. More expensive ration-balancing programs are also available.

**An Example of Ration Balancing**

Now, let's actually balance a ration. For this example we will feed a 60-pound wether to gain about 0.44 pounds per day.

Step 1. Identify animal. The animal is identified as a medium-frame, 60-pound wether, gaining 0.44 pounds per day.

Step 2. Select Nutrient Allowances. To do this, look up in Table 4 the nutrient requirements of a 60-pound goat gaining 0.44 pounds per day. These are recorded on the top line of the Ration Balancing Sheet (Example 1, page 13).

Table 4. DAILY NUTRIENT REQUIREMNTS FOR MEAT-PRODUCING GOATS[1,2]

| NUTRIENT | YOUNG GOATS[3] | | DOES (110 lb) | | | | BUCKS (80-120 lb) |
|---|---|---|---|---|---|---|---|
| | Weanling (30 lb) | Yearling (60 lb) | Pregnant | | Lactating | | |
| | | | Early | Late | Avg Milk | High Milk | |
| Dry matter, lb | 2.0 | 3.0 | 4.5 | 4.5 | 4.5 | 5.0 | 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] 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, Oklahoma

[3] Expected weight gain > 0.44 lb / day.

Source of Table: Nutrition of Meat Goats by J-M Luginbuhl and M. H. Poore, North Carolina State

**Example 1. Ration-Balancing Sheet**

| Nutrient Requirements (From Table 4) | Amount Fed (lb) | Dry Matter Intake (lb) | TDN (lb) | Protein (lb) | NEm (Mcal) | NEg (Mcal) | Other |
|---|---|---|---|---|---|---|---|
| | | 3.0 | 1.95 | 0.36 | —— | —— | |
| **Feed Ingredients** | | | | | | | |
| Orchardgrass hay | 2.40 | 2.14 | 1.16 | 0.19 | | | |
| Cracked corn | 0.75 | 0.68 | 0.61 | 0.06 | | | |
| Soybean meal | 0.25 | 0.22 | 0.18 | 0.12 | | | |
| | | | | | | | |
| **Total** | 3.4 | 3.04 | 1.95 | 0.37 | | | |
| **Deficiencies** | 0 | 0 | 0 | 0 | | | |

Step 3. Select feeds and supplements. Orchardgrass hay makes a good example because it is common in Tennessee even though it is highly variable in quality. Orchardgrass is typically more suitable as a forage for yearling goats, so this will be the major feed in the ration. Look up orchardgrass in the Feed Ingredients Table (Table 5).

## Table 5. Feed Ingredients -- Composition of Some Goat Feedstuffs
**(Dry Matter Basis)**

| FEED | Dry Matter (%) | TDN (%) | Crude Protein (%) | NEm (Kcal/Lb) | NEg (Kcal/Lb) | UIP (%CP) |
|---|---|---|---|---|---|---|
| Alfalfa hay (mid-bloom) | 90 | 58 | 17 | | | |
| Orchardgrass hay (Sun cured) | 89 | 54 | 9.1 | | | |
| Corn, shelled | 88 | 90 | 10.1 | 1 | 0.68 | 55.33 |
| Corn silage | 33 | 70 | 8.1 | | | |
| Cottonseed meal | 91 | 76 | 45.2 | | | |
| Distiller's grains with solubles | 92 | 88 | 25.0 | | | |
| Fescue hay (mid- bloom) | 92 | 48 | 9.5 | 0.34 | 0.11 | 17.00 |
| Soybean meal (49%) | 89 | 84 | 54 | 0.94 | 0.64 | 20.00 |
| | | | | | | |

**UIP = Undegraded Intake Protein**
**Source: Nutrient Requirements of Cattle, NRC, 1996.**

For this example, look up shelled corn as an energy source and soybean meal (49% crude protein) as a protein source for balancing the ration.

Step 4. Determine the amounts of each nutrient to use. In general, balance a ration for one kid, then calculate multiples. Most of the goat's daily ration will come from the base feed orchardgrass hay, so list this first under "Feed Ingredients" in Example 1. Intake can be estimated from experience, trial-and-error or from tables. In this example, we will estimate that the goat will eat about 2.4 pounds of hay per day. Record 2.4 under "Amount Fed."

One of the first things to notice on nutrient analysis of orchardgrass hay (Table 5) is that hay is 89 percent dry matter (11 percent moisture). To balance the ration, any feed ingredient is treated as if it had no water. This is called "calculating on a dry-matter basis." Since we are feeding 2.4 pounds of orchardgrass in this example, we are actually feeding 2.14 pounds on a dry-matter basis (2.4 x 89 / 100 = 2.14). Record "2.14" in the "Dry Matter Intake" column in Example 1.

To calculate TDN, find in Table 5 that orchardgrass hay is 54 percent TDN (on a dry matter basis). To find out how many pounds of TDN are in 2.14 pounds of orchardgrass dry matter, simply multiply by 54 percent (2.14 x 54 / 100 = 1.16). Record 1.16 under "TDN."

To calculate protein, look up the crude protein level of orchardgrass in Table 5. The protein percentage is 9.1. The amount of protein provided by 2.14 pounds of orchardgrass hay dry matter is equal to 0.19 pounds (2.14 x 9.1 / 100). This is recorded under "Protein."

The next step is to see what is lacking. By subtracting the nutrients provided by orchardgrass from the nutrient requirements of the kid (Example 1) it is revealed that the base forage lacks 0.86 pounds of dry matter, 0.80 pounds of TDN and 0.17 pounds of protein.

Since cracked corn and soybean meal are available, list them on the Ration Balancing Sheet (Example 1) and perform the same math as we did with the orchardgrass. This may take some trial-and-error attempts, but for this example, enter 0.75 pounds of cracked corn and 0.25 pounds of soybean meal. Record these under the "Amount Fed" column in Example 1.

Calculate the dry matter intake, TDN, protein for cracked corn and soybean meal just as with corn and orchardgrass and record them under the appropriate columns in the Ration Balancing Sheet.

**Table 6. Commonly Used Weight Conversions**

| Feed | lb per Quart | lb per Bushel |
|---|---|---|
| **Barley** | **1.5** | **48** |
| **Brewers' grain (dried)** | **0 .6** | **19** |
| **Corn, shelled** | **1.8** | **56** |
| **Corn, cracked** | **1.6** | **50** |
| **Corn, ground** | **1.4** | **45** |
| **Cottonseed meal** | **1.5** | **48** |
| **Oats** | **1.0** | **32** |
| **Soybean meal** | **1.5** | **48** |
| **Wheat** | **1.9** | **60** |
| **Wheat bran** | **0 .5** | **16** |

**1 lb = 454 grams = 16 oz**
**1 kg = 2.2 lb**
**1 ton = 2,000 lb**

Add the total amount of each nutrient supplied by this ration mixture. Record the totals and compare with the required amount. As you can see in Example 1, this ration has no deficiencies. Therefore, it is concluded that this is a "balanced ration."

In some cases, it may be necessary to further refine the ration. For example, if any nutrient is excessive, adjust the ration by reducing those ingredients that supply the most of the excess nutrient(s). In some cases, it may be necessary to increase a nutrient allowance because of special situations. For example, goats in poor condition may need additional energy, or stressed kids may need additional protein, energy and vitamins.

### Square Method of Formulating Rations

Because the trial-and-error method for balancing rations can be time-consuming for routine use, you can use several aids to formulate rations, including the use of algebraic equations. But one of the simplest and most widely used is the square method. To use the square method, first draw a square (or some such figure) as shown below, then follow the directions as outlined. In this example, the percentage of protein was determined, but the proportion of other nutrients can also be calculated.

1. Draw a square with desired ration protein percent (18) in center.

| | | | |
|---|---|---|---|
| **% protein in supplement** | **38** | | **10** |
| | | **18** | |
| **% protein in corn** | **8** | | $\underline{\mathbf{20}}$<br>**30** |

2. Select feeds to use and place protein percent in upper left corner (38) and lower left corner (8).

3. Subtract diagonally, always subtracting the smaller number from the larger number; 38 - 18 = 20. (Write in lower right corner.) 18 - 8 = 10 (Write in upper right corner.) This means that you will mix 20 parts of corn with 10 parts of protein supplement to get an 18 percent protein ration: (Do you remember fractions? This may be simplified to 2 parts corn: 1 part protein).

4. To convert this to a percentage basis, add the numbers on the right side (10 + 20 = 30) and calculate.

$10 / 30 \times 100 = 33.3\%$ supplement; $20 / 30 \times 100 = 66.7\%$ corn

### Computer Ration Formulation

The availability of desk-top and lap-top computers has resulted in the development of a variety of ration-balancing programs. Some of these are very complex and difficult to use. Others are "least-cost" programs that allow the substitution of various ration ingredients to provide the most economical feed mixture possible. These programs can be very useful, especially for those who plan to balance a large number of rations. Many people who only rarely need a balanced ration prefer to consult someone else. A common method for balancing rations is to provide detailed information to the forage testing service about the animals to be fed and allow the service personnel to balance a ration.

**REMEMBER! No ration-balancing program or nutritionist is perfect. Always observe goats and, if possible, measure performance by weighing and then make adjustments in rations accordingly.**

Keep the following facts in mind when using computer programs:

1. Diets formulated by computer are not magic. They are only as good as the information the programmer used in developing the program. Before using a ration formulated by a computer, have it evaluated by an experienced goat feeder, your county Extension agent or a nutritionist.

2. "Least-cost" rations are most useful to large feeders or feed companies with a variety of feeds from which to choose. Most farmers have a limited variety of available feeds and little use for least-cost programs.

3. Remember, intake affects animal performance. No matter how nutritionally balanced and economical a ration is on paper, the animal must eat it to perform. If intake is below predicted values the ration may have to be adjusted to improve performance.

**Stage of Production**

The first consideration in meeting the goat's nutrient requirements is to feed according to its stage of production. At the end of this chapter, a goat-herd nutrition chart starts with kidding and ends with the birth of the next season's kid. Although this nutritional chart is based on the individual goat, it must be applied to the whole goat herd.

*Post kidding.* This is the most critical period, because the doe initially provides rich colostrum then moves toward peak lactation in a matter of weeks as she is undergoing uterine involution. These processes require additional protein and energy. There is also mobilization of body stores of minerals, most prominantly calcium and phosphorus. Without proper nutrition the does may lose too much condition, which may affect the eventual resumption of cycling. Even under optimum conditions, does are likely to be losing weight during this period, particularly if nursing twins or triplets.

*Dry, non-pregnant.* This is the least critical period. During this phase, the most difficult challenge may be to keep does from becoming over-conditioned (fat).

*Lactating and Pregnant.* This will not apply to herds that kid once a year. On accelerated systems, it is possible does could be pregnant while still lactating (although not at peak lactation). The nutritional need is to maintain lactation so that kid growth is maintained.

*Mid-gestation.* It is important to supply goats with enough energy and natural protein to maintain body flesh, or perhaps slightly increase body flesh if they are going into the fall or winter in a thin body condition.

*Last trimester of pregnancy*. This is when 80 percent of fetal growth occurs. The doe should be gaining weight or the birthweight of the kid(s) may be affected. Poor nutrition during this phase may affect milk production and could easily cause kids to be born with poor disease resistance. Kids with decreased birth weight and compromised immunity do not gain as well and wean at a lower weight.

## Section 2 Feeds and feed additives

Many types of feeds are available for use in goat herds in Tennessee. These can range from very common and well-known feeds like corn or soybean meal, to others that are not as well-known (soybean hulls, wheat midds), but which may be extremely useful in certain situations. Therefore, in this section we will first provide some guidelines on the use of commercially available feeds - based on the presumption that most goat producers will obtain all or part of their supplemental concentrates from commercial sources.

### Understanding the labels on purchased feeds

Feed labels contain valuable information. The purchaser should read the label and understand the information.

Following are the components of the feed label:

**Feed Name** - This may include the product name and brand name and must carefully conform to regulations about appropriateness.

**Medication** - If feed additives (including drugs or other non-nutritive, special-purpose additives) are used, this must be on the label. Directions for use will be included as well as precautions.

**Weight** - The weight of the feed in the bag will be printed.

**Purpose** - This will include the kind of animals for which the feed is intended.

**Guaranteed analysis** - This will include minimum and/or maximum concentrations of nutrients, such as crude protein, crude fat, crude fiber, vitamins and minerals. This is extremely important to producers who want to choose an economical feed that is suited for the job. For example, in some cases, a high-protein supplement is needed, and at other times, a lower-protein feed will work.

**Ingredients** - The feedstuffs that are used to prepare the feed must be listed; however, in some cases, ingredient classes may be used. For example, sometimes generic terms, such as "plant protein byproducts" may be referenced when a variety of products are utilized at different preparation times.

**Company Name and Address** - Must be included on the label. Feed labels should be carefully studied and followed. Do not use feeds in a manner different from label directions. Problems may result from improper feeding. Medicated feeds that are advantageous for one type of animal may be dangerous if used by another type of animal. For example, feeds containing Rumensin® or Bovatec® may be valuable for goats and extremely dangerous if consumed by horses. Mineral mixtures prepared for swine or goats may not be suitable for sheep due to excessive levels of copper.

Feeding animals can be a complicated business and feed labels may not contain enough information to cover all situations. Do not hesitate to ask questions. Feed suppliers are usually willing and able to answer questions relating to correct use of their feeds. Extension agents and veterinarians are also excellent sources of nutritional information.

## Common Byproduct Feeds in Tennessee

Byproduct feeds, also known as commodity feeds or co-product feeds, are feedstuffs that result from the processing and /or manufacture of other products. Some people have regarded these as "left-overs" but their value in animal rations is too great for these feeds to be lightly regarded.

These feedstuffs are available in many forms, such as bagged in small quantities or as part of a commercially mixed complete feed. Others are available only in bulk, typically in truckload quantities. It is as bulk feeds where larger producers find the most economical usage. Some of the commonly used byproduct feeds are listed below.

### Corn Gluten Feed

*Description.* A byproduct of corn processing, it may be either in "wet" form (typically about 45 percent moisture) or dry. The dry form is available as meal or pellets. Crude protein is variable, typically from 16 to 25 percent. Acid detergent fiber is typically in the 10 to 12 percent range while NDF is 44 to 47 percent. TDN is about 80 to 83 percent. Calcium is low (0.02-0.33 percent) and phosphorus is about 1.2 percent. In general, corn gluten feed palatability is good. This feed is typically used when there is a need for a concentrate with low starch, moderate level of digestible fiber and moderately high protein.
*Storage and Feeding*. Wet product requires bunker, bag or pit storage. Dry form generally requires grain bin, but can be purchased as bagged product.
*Limitations***.** Sulfur can sometimes run high enough to be of concern. The wet form will spoil unless properly stored and / or fed in a timely manner. It is typically limited to a maximum of 20 to 40 percent of total ration. Pricing will sometimes dictate limited usage, but may, at times, be very favorable.

### Soybean Hulls

*Description.* The soybean hull is the seed coat removed during oil extraction. It is usually toasted and ground after removal and may be added back to the meal. Soybean meal with 48 percent crude protein does not have the hulls added back after processing, and 44 percent soybean meal contains the hulls. Soybean hulls are high in fiber that is highly digestible by ruminants. Soybean hulls contain 80 percent TDN, 12 to 14 percent crude protein and 14 percent starch. The lower starch level results in a lower rate of fermentation and reduces the problems with acidosis. Demand and prices are usually lower during the summer months.
*Storage and Feeding.* Soybean hulls are light and bulky with a weight of 20 lb/cubic foot. They are usually stored in flat bed storage and loaded with a front-end loader. They are very palatable to goats and are a good feed for newly weaned kids. The protein, calcium and phosphorus is adequate and nearly balanced, making soybean hulls a commodity that can be fed without mixing with other feeds. They can be used as a supplement; they are palatable and their low starch concentration reduces the chance of acidosis and founder. When used as a supplement with forage, soybean hulls have less of a depressing effect on forage intake and digestibility, usually resulting in better gains than when goats are fed similar amount of TDN from grains.
*Limitations.* Soybean hulls can be fed at high levels to growing goats. Storing and handling characteristics may limit their use in some situations.

**Wheat Middlings**

*Description.* Wheat middlings are a byproduct of milling wheat for flour. They are high in TDN (82 percent), protein (18 percent) and phosphorus (1.0 percent). Wheat midds are available from flour mills across the United States and are routinely used in commercial feeds. Their price is often attractive when higher protein content is needed in the ration.

*Storage and Feeding.* Wheat midds are light and bulky with a weight of 20 lb/cubic foot. They are usually stored in flat bed storage and loaded with a front-end loader. Wheat midds are moderately palatable but some animals may not readily consume them unless mixed with other feeds. Pelleting improves their palatability to goats.

*Limitations.* Palatability may limit their use in some situations and levels should be limited to 50 percent of the total dry matter intake. At higher levels of feeding the high phosphorus concentration needs to be balanced by adding calcium. Storage and handling characteristics may limit their use in some situations.

**Molasses**

*Description.* Black strap molasses (mill run, heavy) is a byproduct of the sugar industries in south Florida and Louisiana. Molasses is available various forms, from wet products provided in lick tanks, to molasses added to dry meal feed blends to molasses blocks.

*Limitations.* Molasses is low in protein, and supplemental protein is needed in many situations. It requires specialized storage and feeding equipment, increasing the initial handling and feeding costs. Molasses is typically fairly high in sulfur, which may make it less desirable in areas where excess sulfur may cause problems such as copper deficiency. If sulfur is high in the entire ration, it could lead to polioencephamalacia (see veterinary section). Also, molasses has been linked to scouring, possibly as a result of over-consumption. For these reasons, it is suggested that molasses inclusion be approached with caution and many producers prefer to avoid molasses altogether. Others limit it to 1.0 percent of the ration.

**Whole Cottonseed**

*Description.* Whole cottonseed is a byproduct of cotton production and acreage is expanding in the Southeastern U.S. Whole seed can be fed to ruminants or processed for its oil content, and an increasing proportion has been fed in recent years. Cottonseed is high in TDN (94 percent or higher), crude protein (23 percent) and is a good feed for goats. Supplies are seasonal and prices tend to be lowest in the fall.

*Storage and Feeding.* Cottonseed is light with a weight of 20 to 25 lb/cubic foot. It is usually hauled in dump trailers or trucks with a bottom conveyor and can be hauled and stored in peanut drying wagons. Cottonseed must be dry or it will mold during storage. Cottonseed does not need to be processed and can be mixed in diets to be fed in feedbunks. Goats usually will eat cottonseed after they are adapted to it. At first offering, whole seed may need to be mixed with other ingredients, but after adaptation goats usually consume it readily. Feeding cottonseed at a level to meet the supplemental protein needs of growing goats is a common feeding system. Higher levels can be fed if whole seed is priced competitively as an energy supplement.

*Limitations.* High fat content (18 percent or more) and gossypol limit the level of cottonseed that can be fed. Whole cottonseed should be limited to 25 percent of the total dry matter intake of goats. A practical feeding limit would be 0.5 lb/day for a stocker kid and 1 lb/day for a doe.

Gossypol has been shown to reduce reproductive development of does, but the effect on bucks is not known. Gossypol levels will vary in whole cottonseed but feeding the amounts listed above has not resulted in gossypol toxicity problems. Whole cottonseed is sometimes difficult to handle and is likely to “bridge” in storage bins or in self-feeders. Processing (coating, de-linting, grinding / pelleting) may improve handling characteristics.

**Hominy**
*Description.* Hominy is a byproduct of corn processing for human consumption. It contains corn bran, corn germ, and part of the starch. Hominy is higher in energy, protein, fat, and fiber than corn grain. The fat concentration can range from 5 to 12 percent, which will alter the TDN concentration and the maximum levels that can be added to the ration. It is often used in rations as a replacement for corn.
*Storage and Feeding.* Hominy is finely ground and can be stored, handled and fed similarly to ground corn. It is desirable to feed up supplies in one month or less to avoid the stale smell, as with ground corn.
*Limitations.* Hominy has a lower starch level than corn but can be used with the same limitations as corn.

**Feed Additives**

A number of feed additives are available to improve the performance of goats, prevent disease and improve feed / forage efficiency. Lists of currently available feed additives and the guidelines and regulations for their use are constantly changing, so it is better to work with commercial feed dealers to determine which feed additive(s) fit a given situation. Follow manufacturers’ and goat quality assurance guidelines when using feed additives.

## Section 3 Evaluation of the nutritional status of the herd

**Body Condition Scoring**

Visual appearance of goats for body condition provides a useful assessment for determining current and future feeding needs. Body condition can be determined by prominence of skeletal features, evidence of fat deposits and general appearance (see Body Condition Scoring article in Chapter 14).

**Nutritional Evaluation of Goat Herds**

Reproductive success optimum health is linked to the nutritional status of the goat herd. This has been established both scientifically and in practical "on-farm" applications. In most situations, following the guidelines outlined in this chapter will result in success. In certain situations, such as when performance (particularly breeding performance) is below expectations, it may be recommended that a “formal” nutritional evaluation be conducted.

Ideally, the evaluation should occur prior to kidding (60-90 days before parturition would be desirable, for example). In practice, the evaluation could be done at other times (6-8 weeks before breeding; weaning).

In some cases, follow-up analyses will be indicated after the thorough initial nutritional evaluation.

The following nutritionally related items are typically evaluated:

Body Condition - The body condition scoring system in Chapter 14 is the preferred system. Every goat should be scored, but recommendations are generally made based on breeding and yearling group composites.

Forage Analysis - To include moisture, energy, protein and mineral profile. Analyses may be hay or pasture, but pasture samples will be analyzed for minerals only. Separately obtained pasture samples may be tested for fescue fungus.

Blood and Liver Analysis - To assess selenium and copper status (possibly disease titer, as recommended by a veterinarian). Ten percent of the goat herd will be tested (minimum of five head). This test is not definitive, and should be interpreted by a nutritionist only within the context of review of symptoms and forage analysis for mineral.

Fecal Egg Counts - The presence of significant levels of internal parasites may indicate nutritional/physiological status and may be part of the cause of the problem. At least 10 percent of animals should be sampled. It is important that the animals selected be identified, condition scored and be reflective of the nutritional condition of the herd (i.e., do not sample only BCS 6 and 7 goats if the herd contains significant numbers of “thinner” goats). See Chapter 3 for a more thorough discussion.

Water Analysis (optional): This will be done when there is evidence of sulfur, iron or other water contaminants.

**Nutritional Math**

Tennessee goat producers need to find the management solutions to maintain the herd in a productive manner. With this in mind, look over the following "pencil-pushing" guidelines for making feed-related decisions this fall.

**Determining Hay Needs -** The following is a rule-of-thumb method for determining hay needs:

A. Estimate hay available. It is best to base your estimation on accurate weights of several bales. It is common for people to overestimate the weights of their hay bales. Several demonstrations have shown that, on the average, people overestimate the weight of their bales by 200 pounds. If the estimated weight is 1000 pounds, the actual weight is likely to be 800 pounds.

B. Large-package bales stored outside may have substantial losses during storage and feeding. Hay stored under ideal conditions will lose 5 percent; average hay loss is about 15 percent; possible hay loss if bales are unprotected or on the ground can be 30 percent. Adjust your estimate accordingly.

C. Calculate the number of animal units based on the following system:

| | | | |
|---|---|---|---|
| a. 6 Mature goats | = | 1 unit |
| b. 6 Yearling goats | = | 1/2 unit |
| c. 6 Kids | = | 1/4 unit |

D. Figure your need to feed for 100-120 days in the winter in Tennessee (use the lower figure if substantial amounts of stockpiled forage are available; use a higher figure if drought or other conditions cause winter feeding to start earlier in the fall).

E. Figure each animal unit will eat 25 to 30 lbs of hay, assuming average to good-quality hay.

F. Estimate actual hay needs:

**Example**: Multiply animal units x days x amount of forage per day:

| | |
|---|---|
| 29 does and a buck | = 5 units |
| 12 yearlings | = 1 unit |
| 24 kids | = 1 unit |
| Total | = 7 animal units |

7 animal units x 120 days x 25 lbs of hay/day = 21,000 lbs. This totals 10.5 tons of hay.

If loss is 20 percent you can calculate the adjustment by (10.5 / (100 – 20)) x 100 = 13.1 tons (26,250 lbs.).

If bales weigh 80 lbs, calculate bales needed by dividing pounds needed (26,250) by weight per bale (80) to find that 329 bales are needed to feed this herd.

**Comparing the value of feeds -** When comparing feeds for nutritional value, it is best to calculate price corrected for differences in nutrient concentrations. Example: Corn gluten feed (CGF) typically analyzes at approximately 20 percent crude protein. Compared to soybean meal at 48 percent crude protein, if all other factors are equal, the value per pound of protein may be calculated as follows:

**If 48 percent SBM sells at $245/ton:**
**0.48 X 2000 = 960 pounds protein**
**$254/ton / 960 lbs = 25.5 cents/pound of protein**

**If 20 percent CGF sells for $120/ton:**
**0.20 X 2000 = 400 pounds protein**
**$120/ton / 400 lbs = 30 cents/pound of protein**

In this example, correcting for differences in protein concentration shows the more expensive feed may be the more economical source of protein, BUT other factors, such as energy content or physical form, may enhance the value of a particular feed and should be considered in assessing practical value. The best method for comparing the true value of various feeds is to balance "least-cost" rations, but this takes some in-depth calculations, often with a computer.

**How much water is in the feed?** In general, high-moisture feed is expensive to transport, more likely to spoil and more difficult to store, but if problems can be overcome, it may offer an attractive feed alternative. When considering a high-moisture feed, it is best to do some quick calculations to determine the true value of the feed nutrients by:

1. Adding up all costs associated with using the feed, including purchase price, transportation costs, storage costs, etc.
2. Converting to a dry-matter basis to determine the true cost of the feed.

Example: If all costs associated with a 20 percent dry matter feed equaled $40/ton, the actual cost of the feed is $250/ton.

3. Nutritional evaluations should also be made on a dry-matter basis. For example, if a feed was 40 percent dry matter and protein was 8 percent on an as-fed basis, one could calculate protein on a dry matter basis as follows:

| As-Fed Protein Percent | / | Dry Matter Percent | = | Percent Protein on Dry-Matter Basis |
|---|---|---|---|---|
| **8** | **/** | **0.40** | **=** | **20 Percent** |

**Goat Nutrition Definitions:**

**As Fed --** Describes feed as normally fed to animals, including moisture.

**Average Daily Gain (ADG)** -- Weight gain per day; important measure of genetic ability to grow and nutritional adequacy of ration fed.

**Balanced Ration** -- A diet which provides all the necessary nutrients in proper amounts for the most satisfactory production.

**Bushel** -- Unit of feed measure, about 1.25 cubic feet. (1 bushel of shelled corn weighs 56 lbs).

**Concentrate** -- Feed that provides a high level of nutrients per unit of volume: that is, contains a high nutrient density. (Example: Corn is an energy concentrate and soybean meal is a protein concentrate.) These feeds have less than 18 percent fiber.

**Deficiency** -- The lack of adequate levels of one or more nutrients, resulting in decreased production or deficiency disease symptoms.

**Diet** -- What a person or animal normally eats or drinks.

**Dry Matter** -- The portion of feed that is not water. Nutrient concentrations are often expressed on a dry-matter basis so that apparent differences in nutrient concentration caused by the presence of moisture are removed.

**Efficiency of Feed Utilization** -- Amount of feed required per unit of production. (Example: pounds of feed per pound of kid gain).

**Energy** -- The amount of fuel in animal feeds potentially available to the animal for maintenance of body function, production, or work.

**Related Energy Terms:**

**Calorie** – Energy measure (Kilocalorie (Kcal) = 1,000 calories; Megacalorie (Mcal) = 1,000 Kcal).

**Total Digestible Nutrients (TDN)** - An estimate of the energy value of feeds calculated by adding the percentage or amount of digestible carbohydrate, digestible protein and digestible fat (x 2.25).

**Digestible Energy (DE)** - Total feed energy minus energy lost in feces.

**Metabolizable Energy (ME)** - The energy of the feed minus the energy lost in feces, urine and gases.

**Net Energy (NE)** - The portion of energy actually used for maintenance (NEm) or production (NEp).

**Fat** -- Fats are high-energy compounds made up of carbon, hydrogen and oxygen, commonly measured and reported in tables as **EE (Ether Extract)**. Used as an economical feed ingredient to increase feed energy, improve palatability and increase nutritive value. (Often used for both fats and oils, which differ primarily in melting point; fats are solid at room temperature.)

**Fiber, carbohydrates and other associated plant cell wall constituents** -- Substances resistant to mammalian digestion but which may be partially digested by microbes in the gut of species such as ruminants.

**Related Fiber Terms - All of these are laboratory measurements commonly used to describe the fiber component of feeds:**

**CF** - Crude Fiber – An older estimate of fiber, not widely used today.

**ADF** - Acid Detergent Fiber – A newer fiber determination method, based on digesting the feed with acid and measuring the residue.

**NDF** - Neutral Detergent Fiber – An estimate of fiber based on digesting the feed with a milder solution than is used in ADF determination. This estimates the level of the more highly digestible fiber.

**Fill** - The amount of feed and water in the digestive tract.

**Finishing** - Feeding a high rate of concentrate ration to fatten animals for slaughter.

**IU** - International Unit. A standard unit of potency of a biologic agent based on measured animal response.

**Minerals** - Inorganic elements often required in the diets of animals for normal body function.
**Macrominerals:** Minerals required in relatively large amounts by animals. Typically includes calcium, phosphorus, potassium, magnesium, sulfur, sodium and chloride.
**Microminerals:** Often referred to as trace minerals; required in relatively low concentrations in the diet. Includes manganese, copper, zinc, selenium, iron and fluorine.

**Nutrients** - Substances required by animals in the diet for maintaining normal body function. Primary nutrient groups include energy (fats and carbohydrates), proteins, vitamins, minerals and water.

**Palatability** - The acceptability of a feed by animals; affected by taste, odor, texture, temperature, moisture or other factors.

**Protein** - A substance found in many forms in plants and animals; made up of carbon, nitrogen, hydrogen and oxygen, and, sometimes, sulfur or phosphorus. A required nutrient for animals essential for maintenance, growth, lactation and reproduction.

**Related Protein Terms**:
**Amino Acids** - The "building blocks" of protein; nitrogen-containing compounds chemically linked to form protein.
**Crude Protein** - An estimate of total protein in feed derived by analyzing for nitrogen and multiplying the nitrogen concentration by 6.25.
**DIP** - Degradable intake protein.
**MP** - Metabolizable protein.
**Protein Supplements** - A feed used to provide additional protein to overcome or balance protein inadequacy of a base feed. Common ingredients in protein supplements include soybean meal, cottonseed meal, distiller's grains and nonprotein nitrogen (**NPN**; urea is a common form of non-protein nitrogen).
**UIP** - Undegradable intake protein.

**Ration** - The feed fed to an animal for a given period, generally 24 hours.

**Roughage** - Coarse or bulky feed, high in fiber content.

**Ruminant** - A cud-chewing animal having a complex (four-compartment) foregut (stomach) system. The four compartments include the rumen, reticulum contain microorganisms that digest feed-stuffs, including cellulose, for further digestion by the animal. The abomasum has function similar to the stomach of non-ruminants.

**TDN** - Total digestible nutrients.

**Vitamins** - Nutrients required in very small amounts that are needed to maintain proper body function.

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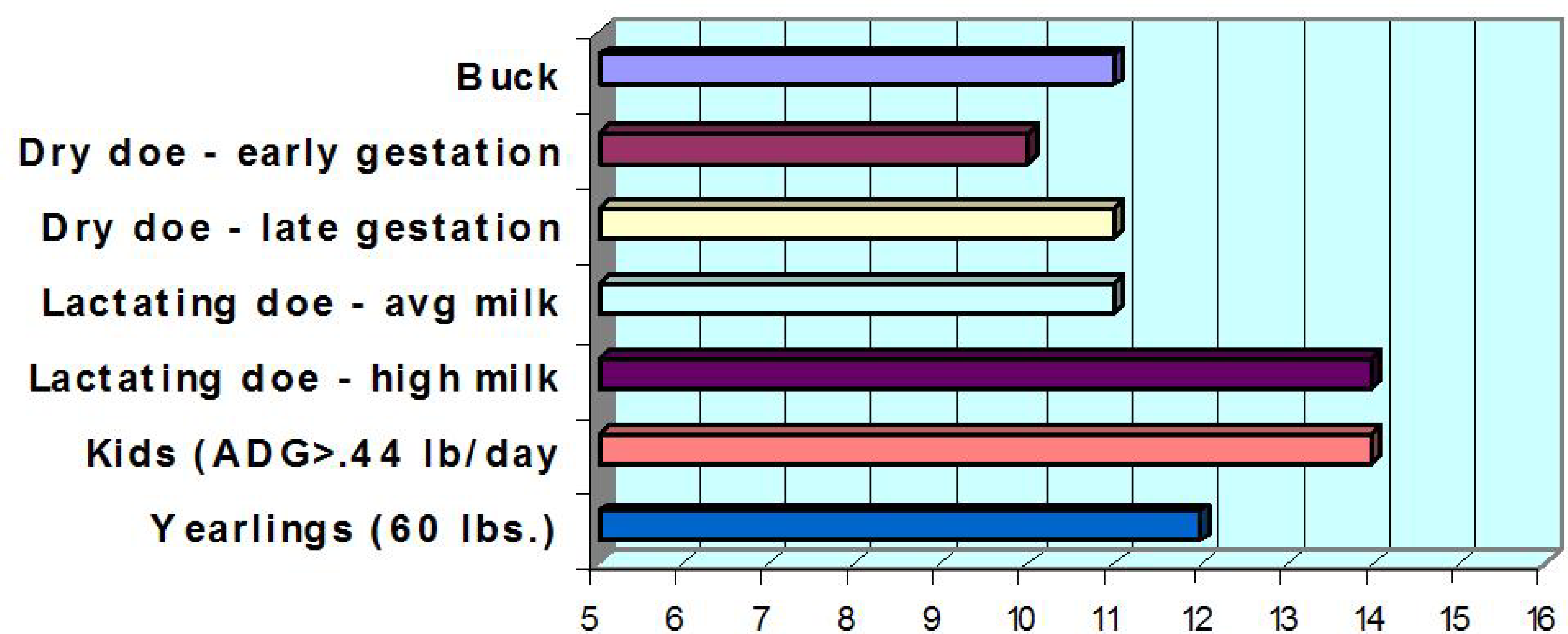
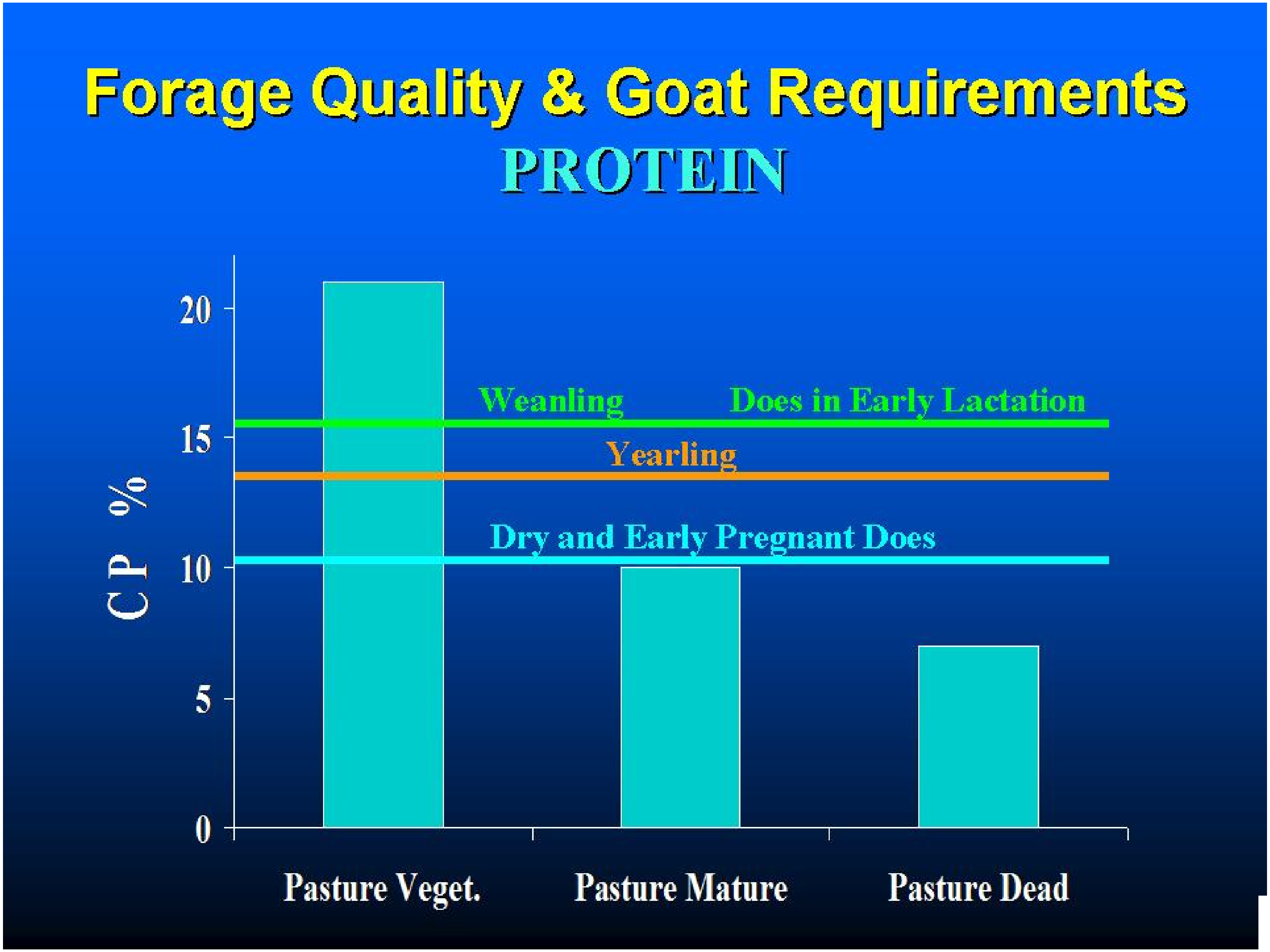
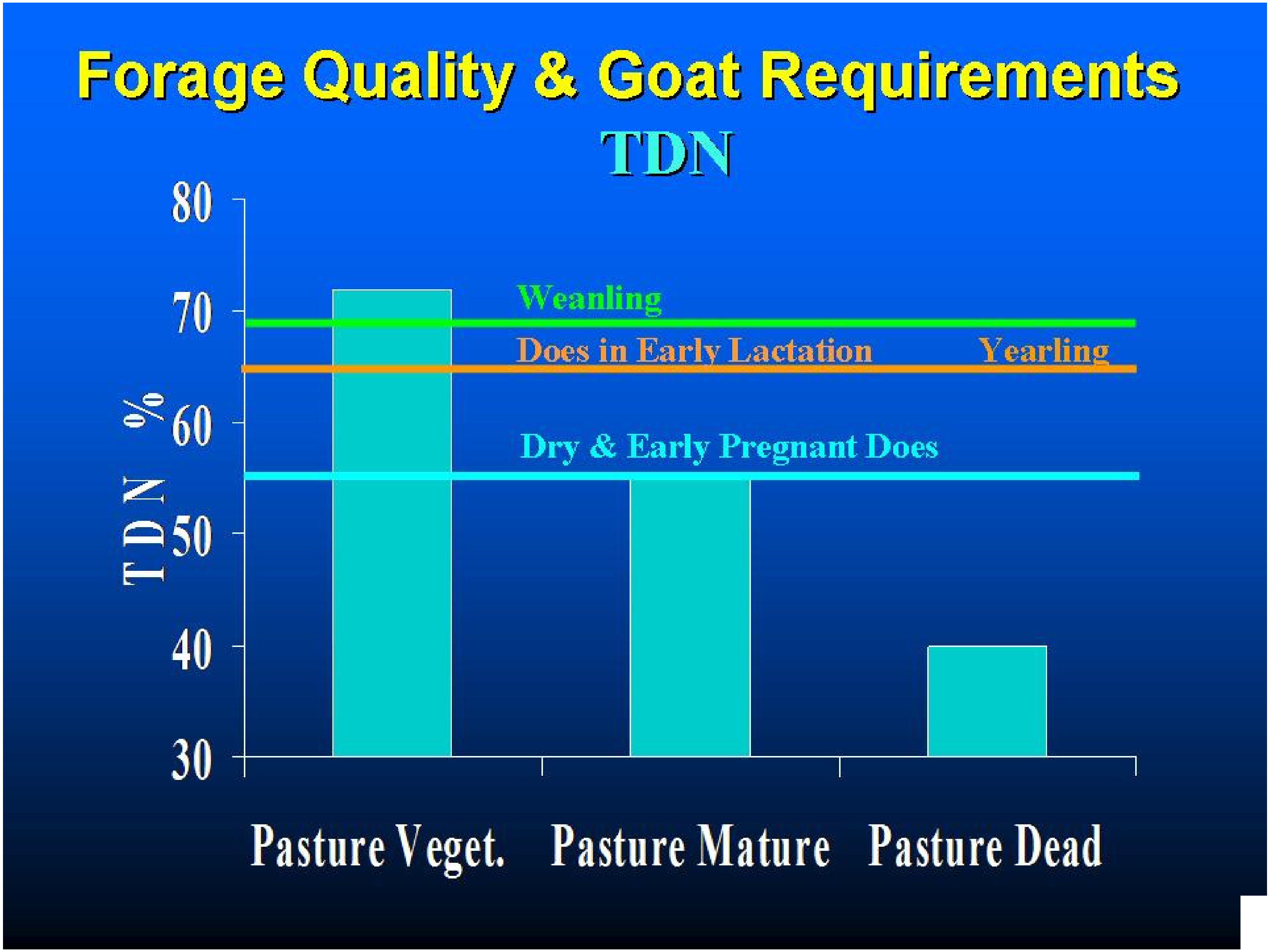
## Protein (CP) requirement for different classes of meat goats




Forage Quality & Goat Requirements
PROTEIN
C P %
20
15
10
5
0
Weanling
Does in Early Lactation
Yearling
Dry and Early Pregnant Does
Pasture Veget.
Pasture Mature
Pasture Dead


Forage Quality & Goat Requirements
TDN
80
70
60
50
40
30
TDN %
Weanling
Does in Early Lactation
Yearling
Dry & Early Pregnant Does
Pasture Veget.
Pasture Mature
Pasture Dead

# Energy and Protein Nutrition of Goats

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On a world basis, goats have provided food and fiber for many people for centuries. This extensive usage of goats to help sustain human life has provided us with many different breeds and biotypes adapted to a variety of environments and production needs. During much of this time goats have survived and produced due to their own selective intake of plant materials or with the aid of caretakers who forced them to consume materials that were not utilized by man or other economically important animals. At times, goats were provided feeds based on scientific data from other species that had improved performance.

The 1981 publication, Nutrient Requirements of Goats (NRC, 1981), was one of the first references to compile known research into a comprehensive document listing the nutritional requirements for goats in various stages of production. This document gained prominence and is still used as a reference for goat nutritional requirements. Two statements in the introduction of this publication illustrate the challenges that existed and still exist when attempting to address the nutritional requirements of goats. “It is increasingly evident that despite similarities to sheep and cattle, goats exhibit significant differences in grazing habits, physical activities, water requirements, feed selection, milk composition, carcass composition, metabolic disorders and parasites,” Also the authors state “this first NRC report must be considered within the limits of available knowledge and refinements are reserved for subsequent editions as the literature of goats improves”.  Continued study of the Nutrient Requirement of Goats (NRC, 1981) establishes that the authors understood the importance of prioritizing the order of establishing nutrient requirements and is illustrated by this statement, “Efficient utilization of nutrients depends on an adequate supply of energy, which is of paramount importance in determining the productivity of goats”.

## *ENERGY*

### *Maintenance*

Citing 10 references, a value of 101.38 kcal ME/kgW$^{0.75}$ (424 kJ) was established as the maintenance energy requirement for goats with no distinction as to age, stage of growth, maturity or biotype (NRC, 1981). As most of you are aware, a subsequent edition of the Nutrient Requirements of Goats was published in 2007.

In a recent publication, Luo et al. (2004) utilized a database which included 80 treatment means representing 466 animals and concluded that BW$^{0.75}$ is an appropriate scaler of goat energy requirements. Utilizing this database, the authors estimated the ME maintenance requirement of goats consuming at or above maintenance to be 431 kJ/kg BW$^{0.75}$. We can see that this expanded database has made only a small increase in the proposed maintenance energy requirement. However, when Luo et al. (2004c) predicted energy requirements for maintenance and gain for preweaning, growing and mature goats by regressing metabolizable energy intake against average daily gain he arrived at different values. ME maintenance requirements were predicted to be 485, 489, 580, 489 and 462 kJ/kg $BW^{0.75}$ for preweaning, growing meat, growing dairy, growing indigenous and mature goats. With this information based on more data and a better understanding that the biotype of the goat to be fed influences their maintenance energy needs, we should have a better opportunity to develop diets to optimize performance.

*Growth*

Dietary energy decisions, when formulating feeding programs for weight gain, have been fairly simple since metabolizable energy required for weight gain was estimated from three experimental values and established at 7.25 kcal ME/g (30.33 kJ) of gain (NRC, 1981) for all rates of gain and with no differentiation as to biotype or growth stage. Luo et al. (2004c) have also predicted the metabolizable energy requirements for gain for the same classes of goats for which they predicted $ME_m$. Their values are 13.4, 23.1, 23.1, 19.8, and 28.5 kJ/g gain for preweaning, growing meat, growing dairy, growing dairy, growing indigenous and mature goats, respectively. These values make it obvious that growth status and biotype are critical inputs when establishing energy inputs to attain a desired level of performance.

*Activity*

"While activity can have a significant influence on the energy requirements of animals there is insufficient data available to make precise estimates of the amount of energy that will be required for any specific amount of activity"( NRC, 1981). NRC applied percentage increases to the ME requirement for basic maintenance to account for the energy costs of activity. For light activity under intensively managed grazing, a 25 % increment above maintenance was suggested. In situations with semiarid range pasture and on slightly hilly land, a 50 % increment was used. For mountainous pastures, or grazing sparsely vegetated grassland increasing the basic ME maintenance by 75 % was suggested. Sahlu et al. (2004) provided a detailed table with diet quality, distance traveled, terrain, and grazing plus walking time to suggest that multiples of the ME requirement for maintenance may range from 0.034 to 0.838. However, they state in the text accompanying this table "there are not presently published data available to assess the accuracy of this simple system".

*Lactation*

Energy requirements for milk production will certainly be more readily applied to dairy goats since production is easily measured, but it is also critical for other biotypes if we are to attain optimum kid weaning weights from these animals. Again, referring to the prominent publication Nutrient Requirements of Goats (NRC 1981) a value of 1246.12 kcal ME/kg (5213.77 kJ) of 4.0 percent fat corrected milk is utilized. This value was felt to be valid for milk with fat ranges from 2.5 to 6.0 percent. Utilizing data from 44 studies with 243 treatment mean observations, Nsahlai et al. (2004b) estimated the requirement and efficiency of use of ME for milk production. Since the value employed for ME maintenance influences the derived value for ME lactation more than one source of estimation was evaluated. When the authors used the recent $ME_m$ derived from estimates of Luo et al. (2004b), dietary ME for milk production was 5224 and 4882 kJ/kg fat corrected milk without and with correction for ME required for excretion of excess nitrogen.

*Pregnancy*

While it is recognized that the later stages of pregnancy require additional energy for fetal growth there is very little data specifically for goats to establish a requirement. NRC (1981) incorporates a value of 0.80 Mcal ME/day as a suggested increase during the last two months of pregnancy. This value includes an additional 20 percent allowance for multiple births. Sahlu et al. (2004) in Table 15 provides estimated daily requirements of ME for pregnancy in ten day increments from 91 to 150. This table further delineates estimates for ME needed based on expected birth weight and one, two or three kids.

## *PROTEIN*

*Maintenance*

Proteins are the principal building blocks of the animal body and, as such, are needed continuously. We are reminded in (NRC, 1981) that "two types of biologically determined protein requirements have been reported. These pertain to minimum and maintenance levels which must not be confused". Citing five publications a mean value of 2.03 g of total protein /kgW$^{0.75}$ was suggested for maintenance in the 1981 NRC text. However, this publication utilized a calorie to protein ratio of one Mcal DE to 32 g total protein when establishing the recommendations in Table 1. More recently Luo et al. (2004b) utilized observations from 73 publications between 1973 and 2003 to determine a requirement for metabolizable protein for maintenance. By regressing metabolizable protein intake against ADG these researchers established a requirement of 3.07g/kgBW$^{0.75}$ for maintenance of all biotypes of growing goats.

*Growth*

Using the calorie: protein ratio described above and the findings from three references, the value of 0.284 grams of total protein per gram gain was used in the Nutrient Requirements of Goats (NRC, 1981) to develop the protein requirements for growth shown in Table 1. Using regression analysis, as they did for the protein requirement for maintenance, Luo et al. (2004c) determined the metabolizable protein requirement for body weight gain to be 0.404 g/g of gain for meat goats and 0.290 g/g of gain for dairy and indigenous biotypes. These researchers further advise that since metabolizable protein intake may not have been more limiting to growth than ME intake that these estimates be considered as maximum requirements rather than averages.

*Activity*

As addressed in the Nutrient Requirements of Goats (NRC 1981), the energy requirements for activity have not been determined experimentally, therefore the levels listed in Table 1 were derived from protein to calorie ratios. Since energy requirements were established by percentage increment increases for the three levels of activity, listed protein requirements for activity follow the same percentage increases. Recent publications reviewed do not address the influence of activity on protein requirement; therefore no additional discussion will be presented.

*Lactation*

Nsahlai et al. (2004a) utilized 173 treatment mean observations of lactating goats to determine metabolizable protein requirements. As a result these researchers suggest the requirement for protein for lactation is 1.45 grams of metabolizable protein per gram of milk protein.

The protein requirement for lactation suggested in the Nutrient Requirements of Goats (NRC, 1981) was based on a digestible crude protein system for dairy cattle (NRC, 1978) due to a lack of adequate data from studies with lactating goats. This method of calculation resulted in a suggested requirement of 72 grams of total crude protein per kilogram of milk (NRC, 1981).

As shown in Table A, additional data has indicated a reduction of over 15 percent in the recommended protein intake for maintenance for mature goats from the 1981 NRC level. However, estimated energy requirements have been increased almost nine percent. These changes can be attributed to a much larger database for calculating the values and also a better understanding of the partitioning of nutrients to various body functions.

Table A. Energy and Protein Requirements of a 70 kg Mature Goat

| | | |
|---|---|---|
| | | |
| | NRC 1981 | 2004 |
| | | |
| ME mJ | 10.26 | 11.18[a] |
| | | |
| Crude Protein (g) | 96.3 [b] | 81.7[c] |

[a] based on Luo et al. (2004b) value of 462 mJ ME/kgW$^{0.75}$
[b] NRC (1981) CP requirement = Mcal DE * 32
[c] Table 7 Sahlu et al. (2004) converted to crude protein utilizing NRC, 1996

The nutrient requirements of growing goats (Table B) show a different trend than those of mature animals. Protein recommendations increase by over 45 % while energy recommendations increase very little. However, it must be remembered that energy requirements are based on minimal activity needed to secure feed and the actual requirement may vary.

| Table B. Energy and Protein Requirements[a] of a 20 kg Growing Kid | | |
|---|---|---|
| | | |
| | NRC 1981 | 2004 |
| | | |
| ME mJ | 5.53 | 5.69[b] |
| | | |
| Crude Protein (g) | 51.76 | 76.5[c] |

[a] 50 g gain
[b] 2004 requirements for energy based on doelings and wethers
[c] metabolizable protein converted to crude protein utilizing NRC, 1996

The 2004 data increases the information available to make decisions concerning expected performance from a wide variety of feeding conditions. It further enhances our understanding of goat biotype influence on energy and protein requirements it also highlights the need to better understand the feeds we are using if we expect growth performance from meat type goats. Recent published and unpublished data establishes this need more dramatically.

Moore et al. (2002) reported in a study evaluating by-product feeds for meat goats that animals with an initial weight of 24.7 kg consuming orchardgrass hay averaged 905 g per day (3.2% BW) of dry matter intake. These animals were fed for 72 days and had an ADG of 33 g. The orchardgrass hay which contained 10.7% crude protein (CP) and 36.8% ADF on a DM basis was supplemented with soybean meal to bring the consumed CP to 12.25%. This is in contrast to a more recent study (Hall, 2005) in which meat-type goats consumed mixed grass hay containing 10.6% CP and 39.9% ADF at 2.5% BW. Their ADG was 109 g.

The 1981 NRC has been an excellent source of information concerning goat nutritional requirements and should not be ignored. However, the tremendous amount of information, based on additional data, available in the 2007 NRC publication should be considered when evaluating or developing new goat feeding programs.

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**Nutrient Management in Mixed Specie Pastures for GOATS**

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Goats are an environmentally adaptive specie of livestock, extremely opportunistic and afford the small limited resource landowner(s) an alternative enterprise. The goat provides food security, high quality protein (for human consumption), biological land enhancement and many 'value-added' products to increase revenue generated on a holistically sustainable rural farm.

Meat goat numbers have been significantly increasing within the US since the early 1990's but goat meat consumption has surpassed available supply, based on ethnic group statistics. The importation of goat meat (30 pound carcass equivalent) surpassed export in 1994. There is no longer an export value for goat meat; the import value has tripled (Pinkerton, Nuti and McMillin). And, according to the 2002 Census, Tennessee is the second leading goat producing state in the US.

Goat production plays a major role in changing farming systems and economic transformation. With the decrease in planted tobacco acreage and income from this traditional crop, the production of goats becomes a natural alternative. Another example is that hog numbers have plummeted drastically since the mid-1980's yet those production facilities are still functional on many farms; the structures and land being readily adapted to meat goat production.

There is a misconception among some newer goat producers in that goats are treated as 'small' cows. Limited experience producers also envision goats eating anything – including low quality forages and poor quality hay – and still expecting the goat to be an economically viable option. In a survey of Tennessee goat producers, the major areas of concern were forages and pasture management (nutrition), internal parasites, health maintenance programs and disease management (Peischel).

The herbivore, through browsing and grazing affects the plant specie grazed, plant part selected, quality of vegetation grazed, frequency of plants grazed, and degree of vegetation removal. Plant growth requirements are sunlight and the ability of the soil to provide moisture, support, protection and nutrients. The water cycle, driven by solar energy, affects vegetation more than any other single environmental factor. There is a continuum between soil, plant(s), animal(s) and the atmosphere. Environmental factors that affect vegetation distribution in relation to pasturelands management are topography, slope, precipitation, wind erosion and soil mineral content. In Tennessee, soil mineral deficiencies include copper, magnesium and zinc (Gill 2004). Important decisions are influenced by the plant community and the factors that influence those communities.

Soil fertility, enhanced by grazing management as it increases the amount of organic matter in the soil and soil nutrients, are recycled by plant roots. Livestock deposit mineral supplements as dung and urine and redistribute nutrients in a grazing system; therefore use good rotation management. Healthy pastures, healthy soil microorganisms - high quality vegetation. The quantity and quality of vegetation produced in a given time is dependent upon the amount of sun energy a plant captures and converts to tissue. Plants need a leaf area to photosynthesize but a canopy cover of more than 30% can decrease vegetation production. As plants are grazed, recovery time is dependent upon soil fertility, season of year, soil moisture content, temperature, degree of defoliation, time of removal, animal specie grazing and residual dry matter.

Residual dry matter is the amount of forage dry matter remaining after a pasture has been grazed. Different plant species vary in recovery time and climate effects recovery time. The correct amount of residual is needed for rapid regrowth yielding higher quality forage so that livestock per acre can be increased as well as animal performance. High residual may also slow recovery rate as sunlight is hard to capture, old leaves are less efficient producers than new leaves, the ratio of non-photosynthetic material to green material and the leaf:stem ratio is stressed. In lightly grazed paddocks with a high residual dry matter, a decreased rate of net photosynthesis available for new growth and the old leaves shade the new ones decreasing production.

Brush, forb and pasture management is based on the physiology of the plants; biodiversity of plant species in a community is vital (Dabaan 1997 and Taylor 2003)).

Livestock used in grazing regimes must be under control - where they need to be, how long they are there and the number of animals present. Caution, do not overgraze the plant and deplete root reserves nor over rest the plants and decrease biodiversity. In grazing management, use of animal behavior and herd effect allows concentrated animal energy input into a small area for a short period of time. Animals of the same physiological condition need to be foraged as a mob and the quality of feed on offer needs to satisfy their physiological requirements or a mineral supplement provided. Social dominance, herd leadership, and fight distance are considered in grazing management as is sex of livestock, age and breed dominance.

**Diet Preference Differences**
(percent of diet)

| **Plant** | **Horse** | **Cattle** | **Sheep** | **Goat** |
|---|---|---|---|---|
| | | | | |
| grass | 90 | 70 | 60 | 20 |
| weeds | 4 | 20 | 30 | 20 |
| browse | 6 | 10 | 10 | 60 |

Genetic heritability of foraging is important in browse, forb, and pasture operations. The goal is to improve herd performance; the economical production traits of goats and their ability to adapt to environmental stress is crucial.

Grazing management utilizing vegetation species diversification (biodiversity), intensive grazing management and brush/forb and pastureland management decrease internal parasite loads (Min 2004). The immune system is stimulated while enhancing land productivity through the use of livestock is a management goal. The cause of the problem must be resolved, not just treatment for the effect!

There are three major groups of internal parasites; nematodes (roundworms), cestodes (tapeworms) and trematodes (flukes) and each expresses itself differently. For example, in wet, temperate environments (Haemonchus contortus), cooler areas (Ostertagia) or heavy rainfall areas (Lungworms and possibly Flukes). Each individual internal parasite has a complex life cycle affected by climatic change, topography, geography and animal specie involved.

Livestock become infected by direct consumption of the infective phase of the larva, skin penetration or maternal transmission. It is therefore important to know the life cycle to get control of the individual parasite problem. From fecal analysis, the major parasites that need to be considered in your specific geographic area (or farm) can be attained. Parasite loads vary by season, higher during warm, humid, moist times and lower during the fall and winter months and by individual goat. Inhibited larval development (delayed egg laying) can occur until the external environment is prime for larval development. In the warm, moist, humid pasture areas, the first larval phase can hatch in a few hours whereas in the dry areas or during low temperatures, hatching is much slower developing or the larva can die. Once the larva hatches to L3 it has become infective and caution is warranted in grazing pastures.

During the cool part of the day, the larva will be at the plant base and as the temperatures rise during the day, so do the larva, up the stem and onto the leaves. Larva can migrate horizontally to 30cm or more and vertically 2cm to 10 cm (although 2cm to 5cm is most common). Larval migration will be more relevant in the early morning with dew, after a rain, or after irrigating. Consider collecting water droplets (dew, rain) and identify larvae. This identification technique gives a 5 to 7 day advantage to make management changes to avoid deworming.

Pasture management is critical in preventing accumulation of infective larvae. Safe areas are needed for goats to graze to avoid consumption of larvae and re-infestation. Most important times for the doe are one month pre-kidding, immediately post-kidding and at weaning for the kids. It can take 12 – 18 months of rest to create a safe grazing area – dependent on climatic conditions. For most farmers, not enough owned acreage is available to pursue that approach and an Integrated Parasite Control Program (IPCP) needs to be established. Or, explore the possibilities of land enhancement, weed abatement, fuels reduction or cutover timberland management on lands owned by neighbors or public lands (Magadlela 1995, Luginbuhl 1999 and 2000).

In the process of developing this program (IPCP), the producer is changing from chemical (dewormers) control to a biologically sound program to minimize the larval challenge created by parasites. It is a dynamic process, always in the state of change. As grazing areas become healthy, dung beetles and earthworms appear along with parasite antagonists (bacteria and fungi).

Suggestions to keep this synergistic process in motion:

A. It is extremely important to maintain a higher body condition score on goats. Nutrition management and resistance to parasitism are synonymous. Dietary protein must be readily available, especially for young growing animals and does during late gestation and early lactation. The phosphorus level in dry matter consumed needs to be increased and mineral elements and vitamins in balance (chelated mineral/vitamin mix on offer with free choice kelp meal). Intake of a mineral mix by the goats will vary based upon body weight, age, class, quality and quantity of forage on offer as well as availability.

B. To provide the above needed nutrition, plant diversity in grazing areas needs to be maximized to provide the quality and quantity needed during both drought (more protein and phosphorus) and during the wetter times of the growing season (more minerals, especially copper and zinc). Depending upon the location of your specific property, there are various approaches used to attain needed nutrition. 1) Tame pastures - planted high quality mixed grass and forb species for goats (a grazing brome/orchard grass, plantain, chicory, perennial sericea lespedeza and birdsfoot trefoil). Plant specie selection is important as different chemicals in plants (condensed tannins) have an effect on internal parasites (Min, 2003) and leaf structure (chicory) makes it difficult for larva to crawl and cling. Pasture rest is based upon death of infective larvae and management strategy for specific plant utilization. 2) Regrowth from haying and silage making - cut higher than 5cm and graze at no less than 10cm in height. 3) Irrigated pasture - irrigate immediately upon removal of the goats, do not return until vegetation is more than 5cm high and give a longer rest period dependent upon individual internal parasite specie. 4) Brush, forbs and shrubs – a goats first love - stay out on browse as long as possible (the higher the head, the lower the level of internal parasites).

C. Diversified specie grazing (cattle, horses, sheep, goats) is important as various internal parasites are not cross specie contaminating. By diversifying, there is plant selection variation among animals so, a vegetative analysis needs to be completed for a grazing area and animal specie used accordingly. The additive grazing effect from mixed specie grazing and increased grazing capacity will depend upon dietary overlap. To maintain an additive effect of both plant and animal species, grazing capacity is based upon the effect of terrain, season, grazing program, stocking rate and weather which affects production and composition. Do not have an animal species overlap of more than 18 to 30 percent or a non-additive dietary affect is obtained. Be careful of animal specie selected as they have the ability to shift diet preference (cattle and sheep) based upon forage availability and during a drought. Goats and sheep in combination are non-additive; whereas goats and cattle, goats and horses, and goats, cattle and horses are an additive effect.

D. Strategic use of anthelmintics to minimize parasite resistance and not compromise the immune system of the goat. DO A FECAL ANALYSIS BEFORE MAKING A DECISION to deworm. If necessary deworm the does 3 weeks pre-kidding and immediately post-kidding and at weaning for the kids. Be sure to have defecation times and an area set aside dependent upon the anthelmintic selected based upon internal parasite identification.

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Chapter Nine
(Part A)

# MEAT GOAT CARCASS MERIT

H. Dwight Loveday

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## Introduction

In beef and lamb, there are the USDA Yield and Quality grades to indicate carcass cutability and lean quality. Cutability is the expected yield of retail cuts from the carcass. The major factor in determining the percent cutability of a carcass is the amount of fat. In meat animals fat is first deposited internally around the organs, then subcutaneously (beneath the skin) and between the muscles (seam fat) and lastly inside the muscles (marbling). In goats, the internal and external fat depots are the most important. Muscling to a lesser degree can influence the percent cutability or expected yield of product.

Lean quality is used to predict the expected meat palatability; that is, the tenderness, juiciness and flavor of the meat. Currently, no USDA quality grade standards exist for goat carcasses; therefore lean quality parameters for other species will be discussed. Generally speaking, because lamb and goats are harvested young, muscle tenderness tends not to be a major problem. However, in mature animals tenderness problems may arise due to changes in the connective tissue structure. As meat animals mature, the lean becomes darker in color and more coarsely textured. Other indicators of mature animals are ossification of growth plates in long bones and ribs that are whiter, flatter in shape. Ideally, goat meat should be dark grayish-pink to red in color, moderately firm and fine textured. Marbling is also a lean quality factor. Marbling enhances the juiciness and flavor of the meat but has little impact on tenderness. Marbling is especially important in beef quality grading. In lamb quality grading where the carcasses are not usually split, flank streaking is used as a lean quality indicator. The greater the flank streaking in and upon the inside flank muscles, the higher the lean quality. Lean texture and firmness is also a meat quality factor. High quality meat should be firm with a velvety, smooth texture.

## Indicators of Goat Carcass Cutability

*<u>Kidney, Pelvic and Heart Fat:</u>* Kidney, pelvic and heart fat is expressed as a percentage of the hot carcass weight (%KPH) (Figure 1). KPH is the first fat deposited to protect the vital organs. Because the KPH fat is not consumable, the greater the %KPH, the lower the percent carcass cutability.

*<u>External Fat:</u>* Goats typically deposit subcutaneous fat first over the ribs and the pocket behind the shoulder. Most goats do not deposit fat over the major back muscles unless they are overly fat. A carcass Subcutaneous Fat Cover Score (Figure 2) has been developed. The scoring system reflects the relative amount of fat over the ribs, shoulder, back and legs. Score 1 is for carcasses minimally covered with fat whereas Score 3 is overly fat with a thick fat covering over the ribs and shoulder and a thin layer of fat over the back.

*<u>Conformation:</u>* Conformation is the relative shape of the carcass; that is carcass thickness in relation to carcass length. Conformation is used as an indicator of the carcass muscle to bone

ratio. At the same fatness, the more muscle, the greater the retail product yields. The USDA has published selection criteria for live goats and carcasses as part of the USDA Institutional Meat Purchase Specifications (IMPS) for Fresh Goat (Series 11) (http://www.ams.usda.gov/1sg/1s-mg.htm)

> Selection No. 1: (Figure 3) live goats and carcasses have superior meat type conformation. They are thickly muscled throughout as evidenced by bulging outside leg muscles, a full (rounded) back strip and a moderately thick outside shoulder.
>
> Selection No. 2: (Figure 4) live goats and carcasses have average meat type conformation. They are moderately muscled throughout as indicated by slightly thick outside leg muscles, a slightly full (flat to slightly shallow) back strip and a slightly thick to slightly thin outside shoulder.
>
> Selection No. 3: (Figure 5) live goats and carcasses have inferior meat type conformation. The carcass is very angular. The legs, back and shoulders are narrow and may have a sunken appearance.

Corresponding carcass selection scores are show in Figure 6. Oman et. al. (1999) proposed a 15 point carcass scoring system with 1 = very thin and angular and 15 = very thick and bulging.

*Carcass Weight:* Carcass weight is related to meat goat type and management practices. Small breed types are ideally harvested at lighter weights than larger breed types. Regardless of breed type, animals that are harvested at weights heavier than their ideal weight will be fatter and lower cutability. Goat carcass weight influences the marketing and fabrication of the carcass.

**Prediction of Goat Carcass Cutability**

Texas A&M University has used two equations for predicting meat goat carcass cutability. The first equation is the lamb cutability equation. This equation uses hot carcass weight, adjusted fat thickness, body wall fat thickness and rib eye area to predict the percentage of boneless, closely trimmed retail cuts [%CTRC= 49.936-(0.0848*Hot Carcass Wt., lbs.)-(4.376*Adj. Fat Thickness, 12th rib, in.)-(3.530*Body Wall Thickness, in.)+(2.456*Rib Eye Area, in.2)]. The second equation was developed for commercial, market type goats. This equation predicts the percentage of semi-boneless, closely trimmed primals (%SBTP) from the leg, sirloin, loin, rack and shoulder by using the measurements of hot carcass weight, rib eye area and body wall thickness [%SBTP= 0.69330-(0.23174*Hot Carcass Wt., lbs.)+(1.96202*Rib Eye Area, in.2)-( 1.57832* Body Wall Thickness, in.)]. The second equation is preferred for meat goat evaluation.

## Indicators of Goat Carcass Quality

*Lean Color:* Because goat carcasses are not normally "ribbed" between the 12th and 13th ribs like beef carcasses, lean color is evaluated on the inner flank muscles. Yearling and older goats will have a greater amount of muscle pigments that result in a darker lean color. Most consumers prefer young kid goats and thus, a light grayish-pink to light reddish-pink color. Lean color scores are A (light grayish pink), B (moderately dark red) and C (dark red) (Figure 7).

Although no guidelines have been established, rib shape and color can be used to identify mature animals. Yearlings and more mature animals will have wider, flatter ribs with less redness. Additionally, the amount of flank streaking could be used to indicate expected palatability.

## Summary

Goat meat is widely consumed throughout the world. As the demand for goat meat in the United States increases, there will be a need to standardize carcass traits and lessen the variation in carcass quality. Through selection, producers will be able to market animals of high muscling with desirable lean color and palatability.

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## Acknowledgements

Pictures courtesy of Dr. Ken McMIllin and the LSU Ag Center.

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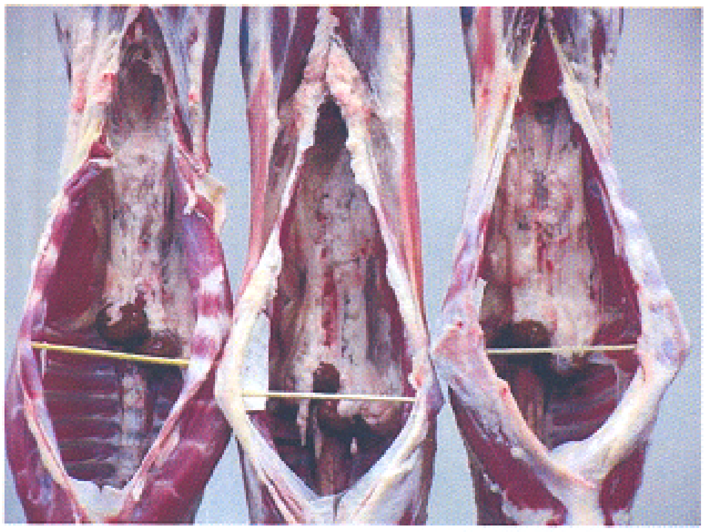
Figure 1. Percentages of kidney, pelvic and heart fat in meat goat carcasses.



1% 2% 3.5%

Figure 2. External (subcutaneous) fat scores for meat goat carcasses.

1 2 3

Score

Figure 3. Example of a Selection 1 meat goat.

Figure 4. Example of a Selection 2 meat goat.

Figure 5. Example of a Selection 3 meat goat.

Figure 6. Examples of selection 1, 2 and 3 meat goat carcasses.

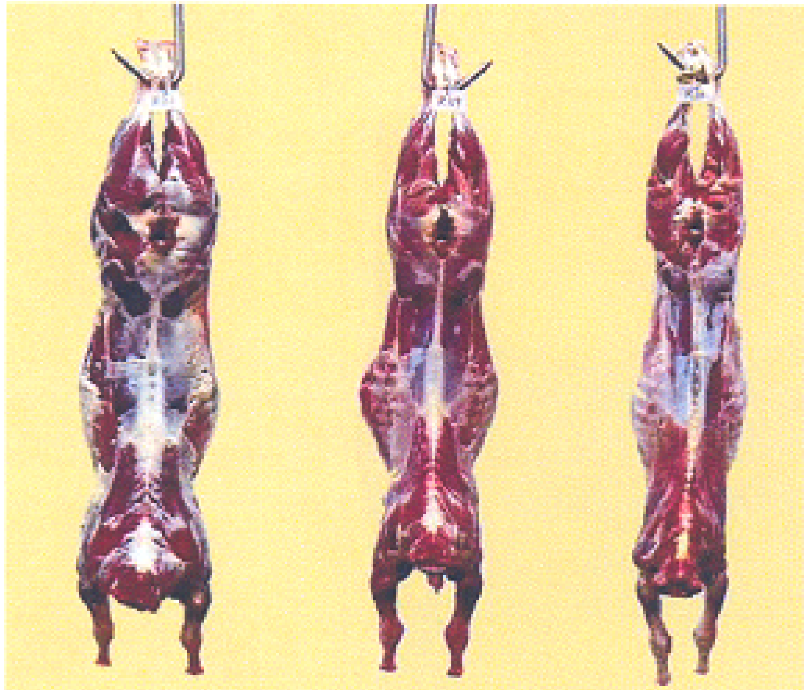
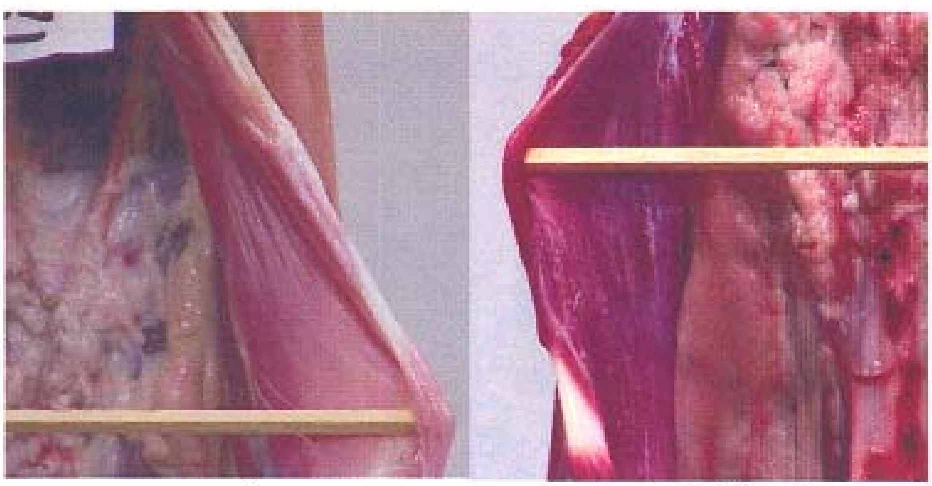


Figure 7. Example of flank color scores.



A B

Chapter Nine
(Part B)

# MEAT GOAT CARCASS FABRICATION

H. Dwight Loveday

## Introduction

Goat is one of the most consumed animals in the world. Hispanics, Asians and groups from the Mediterranean, Far East and Africa consume varying amounts of goat and types of goat meat. Due largely to changing U. S. demographics, goat meat (chevon or cabrito) demand has increased. Most goat meat is consumed near large population centers and is usually purchased in the carcass form. However, in most major retail stores, goat meat is not available in the meat counter. More often, goat is available through direct sales and in specialty stores and ethnic markets.

Goat is a lean meat alternative and is comparable to beef and chicken in nutrients. Goat can be consumed fresh or used as a raw material in value-added meat products such as sausages and meat snacks.

## Goat Carcass Fabrication

Due to a wide variation in goat types (dairy vs. meat or large, medium and small breed types) going to market, there is a wide variation of goats in the marketplace. Live weight may vary from 30 to 100 pounds. Most goats will produce carcass weights that are 45-55 percent of the live weight. Consequently, there are several methods to fabricate (cut) a goat carcass into usable portions. The five cutting styles identified by the USDA Institutional Meat Purchase Specifications (IMPS) for Fresh Goat (Series 11) are discussed here.

Goat carcasses can be divided into a foresaddle and hindsaddle by cutting behind the last rib. For larger carcasses, this generates smaller pieces that are easier to handle and to further divide into primal (major subdivision of the carcass) and retail cuts.

1) ***Platter Style***: (Figure 1) This cutting style is preferred for small type goats that will produce carcasses 20 pounds or less and are not appropriate for further fabrication. The platter style carcass has the rear trotters removed at the hock and the kidney, pelvic and heart fat removed. The carcass is unsplit and the rear legs can be tucked inside the rib cage (thoracic cavity) and the front trotters inserted into the hind legs to display as a center of the table item.

2) ***Roasting Style:*** (Figure 2) This cutting style is for small to medium-sized goats producing carcasses weighing 15-30 pounds. Because of the larger size, the roasting style carcass can be cut into the following cuts:

a. Foreshank: Made by cutting through the elbow joint and the knee.
b. Neck: Made by cutting slightly above where the neck joins the shoulder (4th cervical vertebrae.)
c. Foresaddle, Streamlined: The fore and hindsaddle are separated behind the last rib and through the backbone. The cut is "streamlined" because the foreshank and neck are removed. The foresaddle, streamlined may be double (unsplit) or single (split down backbone).
d. Loin, Rump On, Double: After the fore and hindsaddle is separated, the loin, rump on is made by cutting perpendicular across the leg to the bone immediately behind the hip bone (this is at the "hook" bone near the tail region). In roasting style goats, this cut will only be 2-4 pounds and is generally left double rather than split.
e. Leg Roasting Style: After the loin, rump on is made, a leg section remains. To finish this cut, simply remove the rear trotters at the hock joint.

3) ***Barbeque Style:*** (Figure 3) This cutting style is for medium-sized goats producing carcass weights of 20-40 pounds. As the name implies, the cuts from this carcass-cutting style are well-suited for barbeque pits. Barbeque style cuts include the following:

a. Neck: See Roasting Style.
b. Outside Shoulder: This cut is made by cutting through the web muscle between the breast and arm sections and continuing in the natural muscle seam underneath the shoulder blade bone and exiting past the blade cartilage near the backbone. The trotter should be removed at the knee.
c. Ribs, Fullset: After the neck and outside shoulder are removed, the ribs, fullset are separated from the hindsaddle by cutting behind the last rib and through the backbone. Next, remove the breastbone (sternum) where the cartilage rib tips attach to the breastbone.
d. Breast: This cut results from the fabrication of the ribs, fullset (above). Any heart fat should be removed. Note that a breast cut can be made from any carcass.
e. Loin: The loin is removed from the hindsaddle by cutting in front of the hip bone cartilage. This location can be found by probing the carcass with the knife point. The flank muscles should be removed by cutting at least 0.05 inch but not more than 2 inches from the rib eye muscle on both ends and sides. All kidney and pelvic fat should be removed. The flank trim can be reserved for stew meat or for grinding.
f. Legs: After separating the loin from the hindsaddle, the legs remain. The rear trotters should be removed above the hock joint. Depending on use, the legs may be split into single legs or left as double legs.

4) ***Food Service Style***: (Figure 4) This cutting style is for medium to large sized goats that will yield carcasses weighing 30 pounds or more. Carcasses of this size can produce primal cuts that can be further fabricated into retail cuts desirable for food service or retail markets. Cuts from the Food Service style include:

a. Hindshank: The hindshank is made by removing the rear trotter above the hock and by a cut through the stifle joint (knee).
b. Neck: See Roasting Style.
c. Outside Shoulder: See Barbeque Style.

d. Ribs, Food Service Style, Fullest: After the neck and outside shoulder are removed from the carcass, the ribs, Food Service Style, fullset and back and inside shoulder are separated from the leg and sirloin by a straight cut in front of the hip bone cartilage. The ribs, Food Service Style, fullset contains both the flank and rib sections. The back and ribs, Food Service Style, fullset is separated by straight cut beginning immediately below the backbone on the shoulder end to a point immediately below the loin eye muscle on the sirloin end. The flank can be removed for stew meat or grinding.
e. Inside Shoulder, Squared: The inside shoulder, squared is fabricated from the back strap by simply cutting through the backbone between the 4th and 5th ribs. The shoulder may be a single or double.
f. Back: The back consists of the rib (rack) and loin sections by removing the rib, flank and shoulder sections. All kidney fat should be removed. Backs may be split or left as a double. Also, rib and loin chops may also be fabricated from the back.
g. Breast: Remove the breastbone (sternum) by a straight cut where the cartilage rib tips attach to the breastbone. All heart fat should be removed.
h. Sirloin: The sirloin is cut from the leg section by cutting at or slightly in front of the ball of the leg bone. Flank muscles should be removed. Sirloin chops may be cut from larger sirloins.
i. Leg, Shank-Off, Sirloin-Off, Partially Boneless: This leg section is made by removing the pelvic bone, backbones, tail bones, flank muscles and all cod or udder fat.

5) ***Hotel Style***: (Figure 5) This cutting style is best suited for large sized goats (carcass weights 40 pounds and greater). Hotel Style is very similar to the typical fabrication techniques for lamb. Primal and retail cuts resulting from the Hotel Style are:

a. Foreshank: See Roasting Style
b. Hindshank: See Food Service Style
c. Neck: See Roasting Style
d. Breast: See Food Service Style
e. Shoulder, Square-Cut: Made by cutting between the 4th and 5th ribs of the carcass. The shoulder, square-cut has the foreshank, neck and breast removed. The shoulders may be left as a double, but is much easier to use as a single. Additionally, arm shoulder chops, blade shoulder chops and boneless shoulder roasts can be fabricated from the single square cut shoulders.
f. Rack: After shoulder removal the rack and ribs are separated from the hindsaddle by cutting behind the last rib. The rib section should be removed by a straight cut across the ribs not more than 4 inches from the eye muscle on both the shoulder and loin ends. Racks may be single or double. Single racks can be further cut into rack roasts and rib chops.
g. Ribs, Breast Bones Off: The ribs, breast off result from the fabrication of the foresaddle into the shoulder square-cut and rack (see above). This rib section can be used much like pork spareribs.
h. Loin: The loin is removed from the hindsaddle by cutting in front of the hip bone cartilage. Next the flank muscles are removed by cutting 0.5 inch to not more than 2 inches from the loin eye muscle on both the rack and sirloin ends. The kidneys and kidney fat should be removed. A double loin can be cut in loin double chops. If the loin is split, loin chops can be made.

i. Leg, Shank-Off: This cut remains after the above loin section is removed. Another option is to cut sirloin chops from the leg leaving a shorter, but much easier to carve, leg roast. The leg (with sirloin off) can be fabricated into a semi-boneless leg by removing the pelvic, backbones, tail bones, flank muscles and cod/udder fat. Or, all the bones can be removed making a boneless leg roast.

Table 1 gives the approximate yield of the cuts for the five cutting styles.

Table 1. Approximate cut weights for various cutting styles.

| | Cutting Style | | | | |
|---|---|---|---|---|---|
| Product Name | Platter | Roasting | Barbeque | Food Service | Hotel |
| Preferred Carcass Wt. lbs. | ≤ 20 | 15-30 | 20-40 | 30-40 | ≥40 |
| Foreshank, lbs. | N/A* | 1.0 | N/A* | N/A* | 2.2 |
| Hindshank, lbs. | N/A* | N/A* | N/A* | 1.4 | 1.6 |
| Neck, lbs. | N/A* | 0.8 | 1.2 | 1.5 | 1.7 |
| Foresaddle, Streamlined, lbs. | N/A* | 9.6 | N/A* | N/A* | N/A* |
| Shoulder, Square-Cut, lbs. | N/A* | N/A* | N/A* | N/A* | 10.5 |
| Outside Shoulder, lbs. | N/A* | N/A* | 3.8 | 6.3 | N/A* |
| Inside Shoulder, Squared, lbs. | N/A* | N/A* | N/A* | 2.0 | N/A* |
| Rack, lbs. | N/A* | N/A* | N/A* | N/A* | 6.5 |
| Ribs, Fullset, lbs. | N/A* | N/A* | 7.5 | N/A* | N/A* |
| Ribs, Breast Bones Off, lbs. | N/A* | N/A* | N/A* | N/A* | 6.2 |
| Breast, lbs. | N/A* | 0.5 | 0.5 | 1.0 | 1.0 |
| Ribs, FS Style, Breast On, Fullset, lbs. | N/A* | N/A* | N/A* | 3.7 | N/A* |
| Back, lbs | N/A* | N/A* | N/A* | 5.8 | N/A* |
| Loin, lbs. | N/A* | N/A* | 2.0 | N/A* | 2.8 |
| Loin, Rump On, Double, lbs. | N/A* | 4.0 | N/A* | N/A* | N/A* |
| Sirloin, lbs. | N/A* | N/A* | N/A* | 2.2 | N/A* |
| Legs, lbs. | N/A* | N/A* | 7.5 | N/A* | N/A* |
| Leg, Roasting Style, lbs. | N/A* | 3.0 | N/A* | N/A* | N/A* |
| Leg, Shank Off, lbs. | N/A* | N/A* | N/A* | N/A* | 11.3 |
| Leg, Shank Off, Partially Bnls., lbs. | N/A* | N/A* | N/A* | 6.0 | N/A* |

*N/A: Not typically found with this cutting style

## Summary

Due to variation in breed types, weight and preferences for goat meat, there are several techniques used to fabricate a goat carcasses into useable cuts. For small goats, the carcass remains whole whereas the larger goat carcasses can be cut into primal cuts that can be further divided into typical retail cuts. Food service and retail markets prefer cuts from the larger carcasses. Regardless of cutting style, goat meat (cabrito and chevon) offers a lean, high protein muscle food. Additionally, goat meat can be incorporated into value-added sausage products.

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Figure 1. Platter Style

Figure 2. Roasting Style

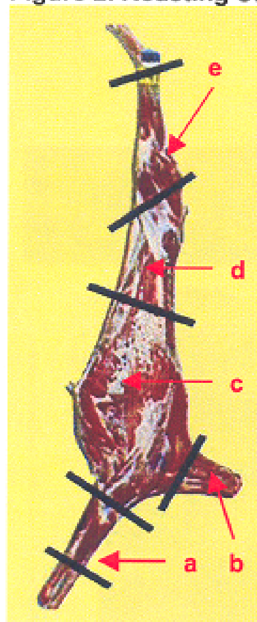



Figure 3. Barbeque Style

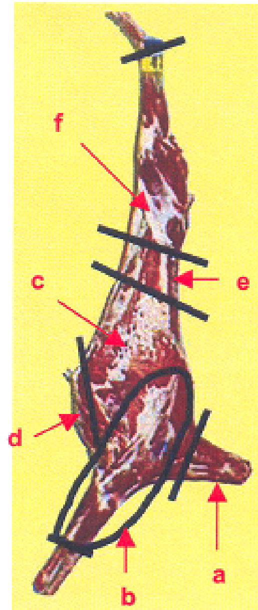



Figure 4. Food Service Style

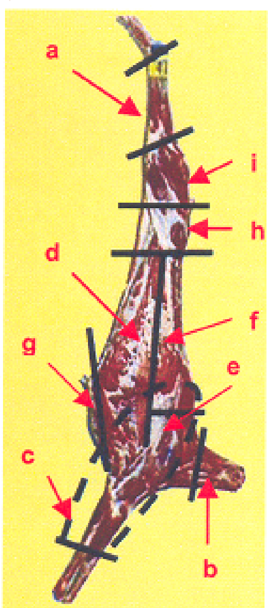
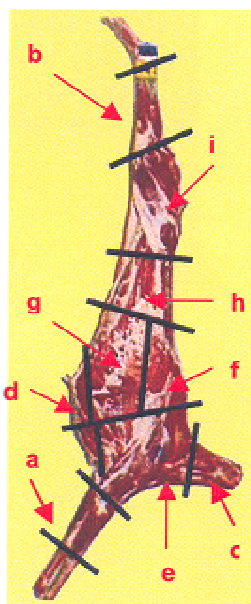



Figure 5. Hotel Style



Chapter Ten

# ENVIRONMENTAL CONCERNS for GOAT PRODUCERS

Greg Brann

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## Why Should a Goat Producer Be Concerned About the Environment?

Today, the public is concerned about maintaining clean water for drinking and recreational uses. If not managed properly, goats on pasture can increase the risk of water pollution. Animal waste removal from a concentrated animal feeding operation must be properly handled and applied to pasture and crops or the potential for water pollution increases. Public concern about an issue often translates into laws and regulations if an industry fails to take voluntary action and does its part to protect the environment.

If not managed properly, some goat production practices will lead to public concern. There are management practices that can help minimize adverse environmental impacts. Alternative water sources, stream-bank protection, rotational grazing, heavy use area protection, minimum pasture grazing height and nutrient management are some of the practices that can improve the environment.

For confined goat operation feedlots, the Tennessee Department of Environment and Conservation has established water quality regulations for farm operations meeting the number of head per farm criteria. The Tennessee Department of Agriculture is the state agency that administers the program. Goat producers with feedlots can obtain the water quality regulations from either of the previously mentioned state agencies.

Locating heavy use areas, feeding areas, confined production areas and other animal facilities away from sensitive areas such as depressions, wells, ponds, surface waters and wetlands will greatly decrease adverse environmental impacts.

Tennessee has more than 100,000 head of goats.

## Heavy Use Areas

When goats congregate around supplemental feeding areas, mineral feeders, shade areas and water troughs, these heavy use areas pose both environmental and production challenges. Goat waste accumulation, loss of vegetation, reduced drainage and increased soil erosion are all reasons to properly manage these areas. The amount of animal waste accumulation in an area is determined by the number of animals and the amount of time the animals are there. Waste accumulation contributes to the spread of diseases and parasites, and results in a concentrated source of nutrients that can run off the pasture or seep into groundwater. The trampling effects of animal hooves on these high-traffic areas can result in loss of vegetation, increase runoff, soil erosion and mudholes. In combination, these factors threaten animal health and soil and water resources. Additionally, muddy areas around commonly used supplemental feeding and watering sites are a management nuisance to producers.

Shade, mineral feeders, hay rings, water troughs and other supplemental feeding areas should be spaced out individually in the pasture to avoid creating single multi-use areas ("camps") frequented by livestock. Site selection should include drainage and proximity to wells and surface water. A site with well-drained soil and approximately a 3 percent slope will reduce mud. Water should be prevented from running onto and especially from crossing heavy use areas. Redirect run-off with diversions, then shape and grade to improve drainage. Resource rotation and attention to placement are effective and inexpensive ways to minimize negative environmental impacts, decrease pasture degradation and prevent large, commonly used loafing areas. Some producers move facilities such as shelter, mineral, hay and water to reduce the impact on heavy use areas. Mobile camps also improve grazing distribution and waste distribution.

Mobile facilities aid in grazing and manure distribution.

Areas frequented by goats should be located downslope from drinking water wells and an adequate distance upslope from surface water bodies. Nutrients and microorganisms from accumulated wastes and the sediment from disturbed areas can run off into surface waters when filtering and buffering areas are not sufficiently wide to trap them. When heavily used areas are located upslope from wells, nutrients and microorganisms are more likely to contaminate groundwater supplies.

If facilities or animals are rotated prior to reducing a stand of vegetation, more permanent structures like rock or concrete will not be needed. A practice known as Heavy Use Area Protection (HUAP) stabilizes agricultural areas that are frequently used by goats. Land that benefits from heavy use area protection includes, but is not limited to, land around water troughs, hay rings, mineral feeders, shade areas and livestock lanes. Heavy use areas are typically protected by:

- grading and leveling the area to provide for surface drainage and prevent ponding of water
- removing loose, wet, organic or other undesirable materials
- placing geotextile cloth over the treatment area, and
- spreading graded aggregate base (GAB) stone to a minimum depth of 6 inches over the treatment area.

Once installed, these areas should be maintained by routine inspection, scraping, proper redistribution of animal wastes and additions of crusher run stone, as needed. These rock areas may also reduce the need for hoof trimming.

Risk of surface water contamination is reduced when sufficient perennial vegetation surrounds heavy use areas. Perennial vegetation minimizes the amount of runoff from the area. Sodseeding cool-season annuals into dormant perennial pastures is also beneficial. The percentage of the ground covered with vegetation, as well as the height of the plants, impacts how much water runs off from an area. Ideally, a 50 to 100 feet buffer zone of perennial vegetation should surround heavily used areas.

## Winter-Feeding Areas

Conditions around winter feeding areas are frequently a problem. The area usually becomes muddy and is void of any vegetation. If the feeding area is on a significant slope, rainfall runoff from the area easily flows into a nearby stream. A buffer zone at least 50 feet wide should be maintained between the winter feeding area and any water body. The feeding site needs to be moved frequently to keep all vegetation from disappearing. Never put the winter feeding site near a stream or in a flood plain.

## Confined-Production Areas

Confined-production areas, including dry-lot feeding and goat-handling areas, should be located downslope of wells and adequately upslope from surface water bodies. Goats like to rest in bare areas but typically avoid water. However, goats can impact stream banks by denuding banks if not managed properly through rotation. Limited grazing can improve herbaceous vegetation due to goats removing browse plants and allowing more light for grass and forbs to grow.

In most situations, a 50- to 100-foot buffer zone of perennial vegetation should be in place around confined production areas to reduce runoff and trap sediment. This distance may vary based on the size and location of the confined production area. The distance should be similar in scale to the size of the confinement area. Increase the width of the filter strip as the slope and drainage area increase.

Similar animal-waste and soil-quality problems can exist when comparing heavy use areas and confined-production areas. These problems are slightly intensified with goat-handling areas but are of particular concern with dry lot feeding areas, due to the high concentration of goats in relatively small land areas over an extended period of time. Typically the best vegetation on these areas is tall fescue, bermudagrass or a combination of the two. Confined areas can also be temporarily placed on undesirable vegetation to remove it.

The animal waste produced in confined production areas has the potential to cause ground water or surface water pollution by leaching or runoff. Solid wastes from confined production areas should be collected regularly to prevent buildup of the material. To minimize the risk of environmental contamination, the wastes should be spread and dragged on areas with at least 90 percent ground cover of perennial vegetation. Percent ground cover can be estimated visually by determining the portion of the soil surface covered by close-growing perennial plants. Perennial vegetation is important, as it acts to retard surface runoff, trap sediment and potentially reduce nutrient movement into surface water throughout the year. As cover percentage decreases, so do the beneficial aspects of the ground cover.

Fencing drainage areas will allow producers to better manage vegetation of stream banks by not allowing overgrazing.

## Streambank Protection

One of the most controversial issues facing goat producers is fencing to exclude goats from streams. Preliminary research results indicate that proper placement of alternative water supplies and shade upslope in the pasture can reduce goat stream use without fencing. Although goats avoid getting their feet in water, they will lounge on streambanks and under tree roots, degrading banks. Rotational use of stream access has been demonstrated to protect vegetation and prevent severe erosion of streambanks. Example: a five-paddock rotation decreases the time of goats in each paddock to 20 percent. If a streambank is part of a grazing paddock, the rotation should occur before the streambank is denuded or impacted; in fact, the rotation should always occur before the first streambank area is impacted. Installed gravel stream crossings that limit goats' access to managed portions of the stream and streambank have also been shown to reduce degradation.

To visually assess the condition of streambanks, first determine the percentage of perennial groundcover existing within a 15-foot distance from the streambank. Also, visually inspect the streambank for manure deposits and noticeable goat trails. Allowing goats continual access to streams and streambanks will likely lead to resource degradation and poor water quality in the immediate area. Consider the voluntary measures of alternative water supply systems and rotational use of the stream and stream crossings if fencing the stream is not in your plan.

## Farm Ponds

Farm ponds are typically constructed with multi-use animal and recreational opportunities in mind. Continuous unmanaged use of farm ponds by goats diminishes the value of the pond for activities such as fishing. The life of the pond is greatly decreased as well. Ponds typically fill in from erosion of the pond edge and wearing down of the embankment from goat trails. A good indicator of environmental risk for farm ponds is the amount of vegetative cover surrounding them.

Farm ponds provide a valuable source of drinking water for goats, but the water can actually be provided by using gravity flow or pump systems and watering troughs. Additionally, watering ramps constructed into the farm pond and fencing can improve water quality and increase the life of the pond. Limiting goat access and maintaining healthy perennial vegetation around the farm pond margin will minimize negative impacts. Bermudgrass is an excellent vegetation for the pond's edge.

## Watering Facilities

Water is often the most limiting factor in implementing grazing systems; however, rotational systems can occur without elaborate water systems. Pipelines can be installed inexpensively by renting a trencher and doing the work yourself. High-density, polyethylene burst-proof pipe can be laid on top of the ground with quick couplers used for temporary troughs. Another option is to install permanent tanks with a heavy use area installed around them. A heavy use area is not needed if the natural material around the water tank is stable enough to control erosion. A large percentage of animal waste nutrients are deposited around watering facilities, so the best alternative is to use portable troughs for improved distribution of nutrients. However, portable troughs should be moved periodically and require more labor.

If the source of water is city water or well water, a double-check valve with an antibackflow device should be installed to prevent water contamination. Contact local water district for type of antibackflow device required.

Ideally place water troughs for optimum forage utilization, animal distribution, manure distribution and future paddock development. Remove balls from ball waters for goat access.

Proper location of a watering facility can increase pasture utilization and improve water quality for the goats, as well as the general water quality in the area. Locate water facilities so fields can be subdivided further in the future. The best location for the watering facility is the center of each field or paddock, so the travel distance of goats is the least. However, if the travel distance is less than the distances listed in Table 10-1, it is more cost-effective to locate the watering facility to serve multiple fields.

**Table 10-1. Recommended Travel Distance to Water***

| | | |
|---|---|---|
| Beef Cows, Stockers | 800' | Typically herds water as a group if travel distance is greater than 800 feet. |
| Goats and Sheep | 1320' | |

* *NRCS Technical Guide*

Water facilities should be designed to supply goats' daily water requirements (Table 10-2). If goats water as individuals, the refill time of the trough can be up to four hours. However, if the whole herd waters together, refill time should be one hour. Smaller troughs also require a quick refill time so goats don't turn over the trough.

| Table 10-2. Daily Water Requirements[*] | |
|---|---|
| Lactating Dairy[2] | 25 - 30 gals |
| Dry Beef Cow, Heifers | 10 - 15 gals |
| Beef Cows, Lactating | 10 - 20 gals |
| Stockers | 7 - 13 gals |
| Goats and Sheep[1] | 0.5 - 2.0 gals |
| [1] During periods of high temperature, goats may drink 50 percent more water.<br>[2] Consider water availability during confinement time. | |

[*] *NRCS Technical Guide*

## Wetlands

Wetland areas supporting population of threatened and/or endangered species should be excluded from goat use. Changing management from total exclusion to unrestricted use of wetland increases the potential for adverse environmental impacts. Managing goats access to wetland areas, i.e. proper timing to use forage during periods of a seasonal low water table without causing miring or allowing significant loafing, provides producers an opportunity to use this forage resource without significant risk to the environment. In contrast, allowing goats unlimited access to wetland areas can significantly decrease plant resources that would otherwise stabilize the wetland area and filter runoff. Additionally, manure deposition in wetland areas and miring of the soil due to heavy goat traffic can negatively impact water quality.

## Nutrient Management

A nutrient management plan should be developed to provide guidelines for applying nutrients from commercial fertilizer and animal wastes to meet plant nutrient requirements. Nutrient management plans identify the acreage, location and crops on which nutrients are applied. Nutrient management plans are based on realistic crop production potential, soil test analysis recommendations for nutrient requirements and actual nutrient content of animal wastes. Wastes should be analyzed, since published values for waste content are only guidelines and actual content can vary greatly. Assistance in developing a nutrient management plan can be obtained at the Natural Resources Conservation Service or UT Agricultural Extension Service offices.

Annual soil testing provides the most accurate information for developing a nutrient management plan, especially when animal wastes are commonly applied. Phosphorus can quickly increase from low to high levels with the addition of animal wastes, based on the nitrogen requirements of the crop. Animal wastes applied to meet crop nitrogen requirements typically contain much more phosphorus than plants can use during a single growing season.

To reduce nutrient runoff and leaching, apply nutrients to forage crops according to their season of growth. Runoff-producing rainfall, typically greater than 0.5 inches, occurring soon after nutrient application can result in substantial nutrient loss from the field. Timing of nutrient application is critical for plant use and environmental protection.

Poor nutrient application timing can result in environmental pollution and a reduction in nutrient availability for the forage crop.

Once the correct nutrient application rate is determined by nutrient management planning, applicators are responsible for calibrating their equipment to insure the correct amount of nutrients are distributed evenly over the field. Maintaining accurate records of nutrient applications is a good management practice for all producers. Where significant amounts of animal waste are generated from confined production areas, be sure to keep records of the amount of nutrients produced and how they are distributed.

Animal wastes should not be applied within 100 feet of sensitive areas such as wells, surface waters or sinkholes. Harvesting vegetation helps prevent nutrient buildup. Grazing recycles approximately 70 percent or more of the nutrients. Manure distribution can be a benefit to reduce the need for additional nutrients, but can create a nutrient disposal problem. Also, if manure is deposited in sensitive areas, water quality problems can occur. Goat manure is best tested to determine nutrient content but typically nutrient content is 16-6-14/100 lb goat/yr. A goat produces 4 pounds of manure per day which equals 0.06 cu ft/day.

## Pasture Management

Long-term persistence of forage species is increased when minimum grazing heights are maintained. Minimum grazing heights vary by forage species, with prostrate, creeping species sustaining closer grazing than upright, bunch-type species. Once defoliated, forages need time to accumulate energy reserves and initiate new growth before being grazed again. When management allows a rest period, by either rotational stocking or reduced grazing pressure, pasture plants tend to maintain more vigorous growth. Continuous close grazing weakens the stand, exposes the soil surface to sunlight and the eroding forces of rainfall and increases the opportunity for weeds to invade. For more information about pasture management, see Chapters 4 and 8.

Goats forage preference is in the following order: woody browse, forbs including lespedeza's, grass followed by clovers. If diverse forage species are not available goats will forage on what ever is available.

## Dead Animal Disposal

All goat producers are faced with the problem of disposing of dead animals. Ground water and surface water can be contaminated with disease-causing bacteria and excess nitrates from improper disposal of dead animals.

Many years ago, goat producers could have a dead animal picked up and taken to a rendering plant. This practice is no longer available to most Tennessee goat producers.

Burial should be the method of choice for disposing of goat carcasses. The dead animals should be buried within 24 hours of death. The burial pit should be from 4 to 6 feet in a moderately well-drained to excessively well-drained soil. Avoid wetlands, floodplains or along a stream bank. At least 100 feet of distance should be maintained between the burial pit and any well. The dead animals should be covered with at least 30 inches of soil. Cover animal initially with coating of hydrated lime to hold animal and reduce predators.

Remember, improper disposal of dead animals can cause water contamination problems as well as predator problems.

## Technical and Financial Assistance

The goats in most Tennessee goat operations are spread out over the farm, not in confined areas such as feedlots. Therefore, management of the waste produced by the animals in these operations is not as important a concern as is management of animal waste produced in more confined systems, such as poultry, swine or dairy. If environmental issues are a primary concern, goat producers should contact their local Agricultural Extension Service, Natural Resources Conservation Service or Soil Conservation District office for individual site-specific assistance. Cost-share assistance to install best management practices varies from county to county and year to year. Programs such as the Federal Environmental Quality Incentives Program; Tennessee Department of Agriculture Agricultural Resources Fund; and other federal, state and local funds are typically available at varying levels on an annual basis. Most of these funds are available on a competitive basis, and interested producers should check with their local offices on the status of these programs in their county.

Be aware that all vegetation provides protective cover for the soil, rotate livestock before removing or destroying vegetative cover especially on sensitive areas. Goats prefer resting areas void of vegetation.

## Assessment of Farm Management Practices and Environmental Concerns

The self-assessment outlined in Table 10-3 will allow goat producers to evaluate the soundness of goat production practices as related to environmental concerns. The management practices range from a "low risk" to a "high risk" practice for water quality issues. If management practices fall into the moderate-high or high risk category, give serious consideration to changing the management practices.

**Table 10-3. Self-Evaluation of Goat Production Practices.**

| | Low Risk (L) | Moderate-Low Risk (ML) | Moderate-High Risk (MH) | High Risk (H) | Self-Assessment |
|---|---|---|---|---|---|
| ***Location of Facilities*** | | | | | |
| **Location of Animal-Handling Facilities** | Handling facilities are greater than 100 feet away from water bodies and have little or no chance of discharging into streams. | Handling facilities are greater than 50 feet away from water bodies and have no direct discharge route into streams. | Handling facilities/corrals are from 10 to 50 feet away from water bodies, but have a potential to discharge into streams. | Handling facilities/corrals have waterway and/or a direct discharge path into streams. | |
| **Location of Animal-Feeding Areas** | Feeding areas are 200 feet or more away from water bodies and fecal material is dispersed over the pasture. Discharges into streams are not likely. | Feeding areas are less than 200 feet from water bodies but slope of the feeding area may cause discharge from catastrophic rainfall events into streams. | Feeding areas are near riparian areas where animals have access to a portion of the water body for drinking and wastes are likely to discharge into streams. | Feeding areas are in stream areas where the animals have full access to the surface waters and animal wastes can easily be discharged into streams. | |
| **Location of Water Sources** | Stream access points and/or alternative water sources are developed and used by the animals all of the time. | Stream access points are developed but there are no alternative watering facilities. | Animals primarily drink directly from streams with minimal development of alternative water sources or access points. | Animals are required to drink directly from streams with no developed access points. | |
| ***Heavy Use Areas*** | | | | | |
| **General Location** | Heavy use areas located at least 100 ft. downslope from water well; 100 ft. from surface water. | Heavy use areas located 50 to 100 ft. downslope from water well; 100 ft. from surface water. | Heavy use areas located upslope and at least 100 ft. from water well; 50 ft. away from surface water. | Heavy use areas located up slope and within 100 ft. of water well; within 25 ft. of surface water. | |

| Table 10-3. Self-Evaluation of Goat Production Practices. | | | | | |
|---|---|---|---|---|---|
| | **Low Risk (L)** | **Moderate-Low Risk (ML)** | **Moderate-High Risk (MH)** | **High Risk (H)** | **Self-Assessment** |
| **Runoff** | No runoff from area, 50 to 100 ft. of perennial vegetation surrounds area. | Runoff managed with diversions; 25 to 50 ft. of perennial vegetation surrounds area. | No runoff management; 25 to 50 ft. of perennial vegetation surrounds area. | No runoff management; less than 25 ft. of perennial vegetation surrounds area. | |
| **Maintenance** | Annual inspection of area; immediate inspection after major storm events; scrape, replace stone and remove organic matter, if needed. | Area is inspected every one to two years; scrape, replace stone and remove organic matter, if needed. | Area is inspected every two to three years; organic matter is allowed to build up; maintenance is minimum. | Area is not routinely inspected; no scraping or replacement of stone; organic matter is not removed. | |
| ***Confined Production Areas*** | | | | | |
| **General Location** | Confined production areas located at least 100 ft. downslope from waterwell; 100 ft. from surface water. | Confined production areas located 50 to 100 ft. downslope from waterwell; 100 ft. from surface water. | Confined production areas located upslope and at least 100 ft. from waterwell; 50 ft. away from surface water. | Confined production areas located up slope and within 100 ft. of waterwell; within 25 ft. of surface water. | |
| **Lot Runoff and Management** | No runoff from area; 50 to 100 ft. of perennial vegetation surrounds lot or area. | Runoff managed with diversion; 25 to 50 ft. of perennial vegetation surrounds lot or area. | No runoff management; 25 to 50 ft. of perennial vegetation surrounds lot or area. | No runoff management; less than 25 ft. of perennial vegetation surrounds lot or area. | |
| **Solid-Animal-Waste Handling** | Solid wastes are collected weekly and redistributed to areas with greater than 90 percent ground cover using nutrient management guidelines; solid waste is distributed evenly and dragged. | Solid wastes are collected every one to four weeks and redistributed to areas with 75 to 90 percent ground cover using nutrient management guidelines; solid waste is distributed evenly. | Solid wastes are allowed to accumulate for greater than four weeks and are redistributed to areas with 60 to 75 percent ground cover; nutrient management guidelines are not used. | Solid wastes are allowed to accumulate for greater than four weeks and are redistributed to areas with less than 60 percent ground cover; nutrient management guidelines are not used. | |
| ***Feeding Areas*** | | | | | |

| Table 10-3. Self-Evaluation of Goat Production Practices. | | | | | |
|---|---|---|---|---|---|
| | **Low Risk (L)** | **Moderate-Low Risk (ML)** | **Moderate-High Risk (MH)** | **High Risk (H)** | **Self-Assessment** |
| **Water Source for Goats** | Water tanks are available and are located far enough away from the water body to eliminate direct discharge, and they are used more than 90 percent of the time by livestock over the water body itself. | Water sources are available, but they are located near the water body. | There are designed access points to water bodies available for livestock to use. | There is uncontrolled access to the water body. Goats have access to full reach of surface water. | |
| **Feeding Areas and Water Bodies** | Supplemental feed is located 1000 ft. or more from the water body to encourage animals to use more of the pasture and to avoid direct discharge into the water body. Areas are moved at least weekly throughout the feeding season. | Supplemental feed is located greater than 300 feet from the water body. Feeding areas are relocated every two to three weeks, but sites are used every year. | Supplemental feed is located between 100 and 200 feet of the water body. Two to three feeding sites are used alternately throughout the feeding season. | Supplemental feed is located less than 100 feet from the water body along with shelter. The feeding area is the same location every year and/or located within 50 feet of a water body. | |
| **Manure Concentration** | Goats are fed over a large enough area so livestock act as the distribution mechanism with no manure buildup noticeable one month into the growing season. | Goats are fed over a large enough area that manure concentration is distributed or manure is removed and mechanically spread or harrowed, and feeding sites are not noticeable one month into the growing season. | Goats are not encouraged to use the whole pasture, so manure tends to be concentrated in small areas near water or shelter. Harrowing of feeding site is done each spring. | Goats are fed in small areas, so manure concentration is high and no distribution of manure is done during non-feeding season. | |
| **Slope of Feeding Area** | Shallow slope (<5%) | Moderate slope (5-10%) | Fairly steep (10-15%) | Steep slope (>15%) | |
| **Flooding Potential** | Winter feeding area is not in the stream 100-year flood plain. | Winter feeding area is in the stream 25-year flood plain. | Winter feeding area is in the stream 10-year flood plain. | Winter feeding area is in the stream's normal 2-year flood plain. | |

| Table 10-3. Self-Evaluation of Goat Production Practices. | | | | | |
|---|---|---|---|---|---|
| | **Low Risk (L)** | **Moderate-Low Risk (ML)** | **Moderate-High Risk (MH)** | **High Risk (H)** | **Self-Assessment** |
| **Surface Water Runoff** | No potential upslope runoff water passes through the feeding site. | Upslope runoff water is diverted away from the winter area so feeding area runoff is managed separately. | Runoff water from feeding area is partially diverted away from the water body, but no diversions are used to manage feeding area run-in. | Upslope runoff water runs directly through the feeding and bedding areas into a water body. | |
| **Water Well Location** | All water wells are more than 200 feet from feeding area and are upslope. | A water well is located between 100 and 200 feet of the feeding area. | A water well is located within 100 feet of the feeding area or is downslope from the feeding area. | A water well is located in or next to the winter feeding area. | |
| **Buffer Zones and Water Bodies** | There is a perennial vegetated buffer zone at least 50 feet wide. | There is a perennial vegetation of 30 feet or more between feeding area and water bodies. | There is residual annual vegetation cover of 30 feet between feeding area and water bodies. | There is no buffer zone between the feeding area and water bodies. | |
| **Revegetation of Feeding Area** | Manure is distributed and not noticeable one month into the growing season. | Manure is well distributed and not noticeable at the end of the growing season. | Manure is distributed by mechanical harrowing and feeding site may be vegetated but is still noticeable at the end of the growing season. | There is no distribution of manure, and very little grass grows on the feeding site. | |
| ***Streambanks, Ditches and Adjoining Areas*** | | | | | |
| **Condition of Vegetative Strip Along Streambank or Ditch** | 90 percent ground cover with perennial species within 15 ft. of streambank; a minimum number of goat trails and manure deposits exist. | 75-90 percent ground cover with perennial species within 15 ft. of streambank; numerous goat trails and manure deposits are evident. | 60-75 percent ground cover with perennial species within 15 ft. of streambank; some signs of streambank erosion are evident and numerous manure deposits exist. | Less than 60 percent ground cover with perennial species within 15 ft. of streambank; streambank erosion is very evident and numerous manure deposits exist. | |

| Table 10-3. Self-Evaluation of Goat Production Practices. | | | | | |
|---|---|---|---|---|---|
| | **Low Risk (L)** | **Moderate-Low Risk (ML)** | **Moderate-High Risk (MH)** | **High Risk (H)** | **Self-Assessment** |
| **Goat Access to Streambank or Ditch Areas** | Goat access is limited to designated areas by rotational use, alternative water supply sources are provided, or livestock are excluded by fencing; condition of streambanks with animal access is frequently inspected. | Goats are allowed seasonal access at designated areas; condition of streambanks with animal access is inspected. | Goats are allowed continual access at designated areas; condition of streambanks with animal access is not routinely inspected. | Goats are allowed unlimited access throughout the year; condition of streambanks with animal access is not routinely inspected. | |
| ***Farm Ponds*** | | | | | |
| **Condition of Vegetative Strip Along Margins of Farm Pond** | 90 percent ground cover of perennial species within a 30 ft. radius of the pond margin; a minimum number of goat trails and manure deposits exist. | 75-90 percent ground cover of perennial species within a 30 ft. radius of the pond margin; numerous goat trails and manure deposits are evident. | 60-75 percent ground cover of perennial species within a 30 ft. radius of the pond margin; some signs of bank erosion are evident and numerous manure deposits exist. | Less than 60 percent ground cover of perennial species within a 30 ft. radius of the pond margin; bank erosion is very evident and numerous manure deposits exist. | |
| **Goat Access to Farm Ponds** | Goats are excluded from a farm pond; drinking water is supplied by gravity flow or pump systems, or other water-supply systems. | Goats are prevented from loafing in a farm pond; watering ramps are used for drinking water or rotational stocking minimizes use of a farm pond. | Goats are allowed seasonal access to a farm pond for drinking water and loafing. | Goats are allowed unlimited access to a farm pond. | |
| ***Wetlands*** | | | | | |
| **Goat Access to Wetland Areas** | Goats are excluded from wetland areas. | Goats are allowed managed access to wetland areas during periods of seasonal low-water table. | Goats are allowed managed access during periods of seasonal high-water table. | Goats are allowed unlimited access to wetland areas. | |
| ***Nutrient Management*** | | | | | |
| **Soil Testing** | Yearly. | Every two years. | Every three years. | Less frequently than every three years. | |

| Table 10-3. Self-Evaluation of Goat Production Practices. | | | | | |
|---|---|---|---|---|---|
| | **Low Risk (L)** | **Moderate-Low Risk (ML)** | **Moderate-High Risk (MH)** | **High Risk (H)** | **Self-Assessment** |
| **Nutrient Analysis, Application Timing and Crop Budget** | Nutrients are applied based on realistic crop production potential and according to seasonal plant growth; animal wastes are analyzed for nutrient content; equipment is routinely calibrated. | Nutrients are applied based on realistic crop production potential and according to seasonal plant growth; nutrients from animal wastes are estimated using table values; equipment calibrated periodically. | Nutrients are applied in excess of crop production requirements and not according to seasonal plant growth; animal wastes are estimated using table values; equipment is not calibrated. | Nutrients are applied at disposal rates that exceed crop production potential; nutrient applications are made without regard to seasonal plant growth; equipment is not calibrated. | |
| **Record Keeping** | Good records of on-farm applications and nutrient production and distribution are kept. | Minimal records of on-farm applications and nutrient production and distribution are kept. | Minimal record keeping of on-farm applications; no records of wastes leaving the farm. | No nutrient management records are kept. | |
| **Location of Waste Application in Relation to Water Sources** | All application areas are more than 100 feet from wells, surface-water sources or sinkholes; application occurs on vigorous stands of vegetation with at least 4 to 6 inches of growth and a minimum of 90 percent ground cover. | Most application areas are more than 100 feet from wells, surface-water sources or sinkholes; application occurs on stands of vegetation with 2 to 4 inches of growth with 75 to 90 percent ground cover. | Several application areas are less than 100 feet from wells, surface-water sources or sinkholes; application occurs on weakened stands of vegetation with less than 2 inches of growth with 60 to 75 percent ground cover. | Application areas are frequently less than 100 feet from wells, surface-water sources or sinkholes; application occurs on weak stands of vegetation with less than 2 inches of growth with less than 60 percent ground cover. | |
| ***Pasture Management*** | | | | | |

| **Table 10-3. Self-Evaluation of Goat Production Practices.** | | | | | |
|---|---|---|---|---|---|
| | **Low Risk (L)** | **Moderate-Low Risk (ML)** | **Moderate-High Risk (MH)** | **High Risk (H)** | **Self-Assessment** |
| **Condition of Pastures** | A minimum average plant height of 3 inches for warm-season and 4 inches for cool-season improved perennial forages is maintained; supplemental hay requirements are minimal and occur less than 25 percent of the year (90 days). | An average plant height of 2 inches for warm-season and 3 inches for cool-season improved perennial forages is maintained with not more than 20 percent of pastures grazed lower than heights listed above; supplemental hay use is significant and occurs 25 to 40 percent of the year. | Pastures are grazed to within 1 inch of the soil surface for warm-season and 2 inches of the soil surface for cool-season improved perennial forages; feeding hay is necessary 40 to 50 percent of the year. | Pastures are grazed to within 1 inch of the soil surface for warm-season and 2 inches of the soil surface for cool-season improved perennial forages; feeding hay is necessary more than 50 percent of the year (180 days). | |
| **Weed Invasion** | Invasion of weedy species is minimal; a healthy stand of forage species is maintained; weeds comprise less than 5 percent of the pasture. | Weeds comprise 5 to 15 percent of the pasture; periodic weed control measures are taken. | Weeds comprise 15 to 30 percent of the pasture; weed control measures are not routinely taken. | No weed control, forage stand is suppressed due to weed invasion; weeds comprise more than 30 percent of the pasture. | |
| ***Disposing of Dead Animals*** | | | | | |
| **Burial Site** | Dead animals buried outside of flood plains and wetlands, not within 100 feet of a private water well and not within 100 feet of surface water. | | | Dead animals buried in flood plains or wetlands or within 100 feet of a private water well or surface water. | |

| Table 10-3. Self-Evaluation of Goat Production Practices. | | | | | |
|---|---|---|---|---|---|
| | **Low Risk (L)** | **Moderate-Low Risk (ML)** | **Moderate-High Risk (MH)** | **High Risk (H)** | **Self-Assessment** |
| **Burial Process** | Dead animals immediately covered with 6 inches of soil, eventually covered with 30 inches of soil; burial pit less than 6 feet deep; groundwater does not enter the burial pit. | | | Dead animals not immediately covered with 6 inches of soil or permanently covered with soil at least 30 inches deep; burial pit less than 6 feet deep; or groundwater enters burial pit. | |

* A portion of this self-evaluation was adapted for use from the Georgia Farm-A-Syst Beef Production Assessment System written by Holli A. Kuykendall and Mark A. McCann.

## References

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Lane, Clyde. 1991. **Preventing Water Contamination from Beef Cattle**. PB 1426. The University of Tennessee Agricultural Extension Service.

U.S. Department of Agriculture, Natural Resources Conservation Service, Section IV, Tennessee Field Office Technical Guide, Dates of Standards and Specifications range from 1972-2000 and are updated periodically.

## Sources of Information

**Local county offices:**

- UT Agricultural Extension Service
- Natural Resources Conservation Service
- Farm Service Agency
- Soil Conservation District

**State and federal offices:**

- UT Agricultural Extension Service
  2621 Morgan Circle
  Knoxville, TN 37996
- Farm Service Agency
  US Courthouse Room 579
  801 Broadway
  Nashville, TN 37203
- Natural Resources Conservation Service
  US Courthouse Room 675
  801 Broadway
  Nashville, TN 37203
- Tennessee Department of Agriculture
  Water Resources
  P.O. Box 40627
  Nashville, TN 37204
- Tennessee Department of Environment & Conservation
  L & C Tower
  401 Church Street
  Nashville, TN 37243

- U.S. Environmental Protection Agency
  Atlanta Federal Center
  100 Alabama St., SW
  Atlanta, GA  30303-3104

## Internet Sites of Interest

**UT Agricultural Extension Service**
http://www.utextension.utk.edu

**UT Agricultural Experiment Station**
http://www.taes.utk.edu

**UT Animal Science Department**
http://animalscience.ag.utk.edu

**UT Biosystems Engineering and Environmental Science Department**
http://bioengr.ag.utk.edu

**Farmstead Assessment System**
http://www.uwex.edu/farmasyst

**Tennessee Department of Agriculture**
http://www.state.tn.us/agriculture/index.html

**Tennessee Department of Environment and Conservation**
www.state.tn.us/environment

**U.S. Environmental Protection Agency**
http://www.epa.gov

**USDA Farm Service Agency**
http://www.fsa.usda.gov/tn

**USDA Natural Resources Conservation Service**
http://www.tn.nrcs.usda.gov

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# Environmental Factors Affect Nutrient Requirements for Goats

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Goats are an environmentally adaptive specie of livestock, extremely opportunistic and afford the small limited resource landowner(s) an alternative enterprise. The goat provides food security, high quality protein (for human consumption), biological land enhancement and many “value-added” products to increase revenue generated on a holistically sustainable rural farm.

The herbivore, through browsing and grazing, affects the plant specie grazed, plant part selected, quality of vegetation grazed, frequency of plants grazed, and degree of vegetation removal. Plant growth requirements are sunlight and the ability of the soil to provide moisture, support, protection and nutrients. The water cycle, driven by solar energy, affects vegetation more than any other single environmental factor. There is a continuum between soil, plant(s), animal(s) and the atmosphere.

In Tennessee, the major soil mineral deficiencies have been identified as copper, magnesium and zinc (Gill 2004). Unless a high quality, loose, free choice mineral is provided, side effects can manifest as reproductive failure (copper) and foot rot (zinc).

Environmental factors that affect vegetation distribution in relation to pasturelands management are topography, slope, precipitation, wind erosion and soil mineral content. Brush, forb and pasture management is based on the physiology of the plants; biodiversity of plant species in a community is vital (Dabaan 1997 and Taylor 2003).

Genetic heritability of foraging is important in browse, forb and pasture operations. The goal is to improve herd performance; therefore the economical production traits of goats and their ability to adapt to environmental stress is crucial. Environmental stress can be heat/cold, weather (precipitation/humidity), nutrient density and quality of feed on offer, predation, traveling distance, topography, etc. Stress can represent major economic losses with a decrease in reproductive performance of both the male and female, inability to maintain a moderate body condition score, decrease in growth rate, increased incidences of internal parasitism and a suppressed immune system. Several factors affecting the degree of stress on the animals are breed, physiological state, age, sex of goats, social dominance and fight/flight distance.

The major response of goats to heat stress is evaporation; ruminants also try to maintain thermoneutral regulation through respiration. This increased respiration rate decreases feed intake and rumination time. Metabolism rate is altered as ruminant do store heat, therefore they will seek shade. Their endocrine system is affected as is the electrolyte balance of sodium / potassium.

(McDowell 1985) states that the major effects of thermal stress are: feed consumption, environment by forage quality interrelationships, digestion and metabolism and requirements of specific nutrients. Feed intake is decreased as temperature and humidity increases. This helps maintain body heat balance by minimizing heat generation from ruminal fermentation. But, essential nutrients are consumed and metabolized in smaller quantities. It may be necessary to offer a nutrient dense supplement at this time because forages are maturing, increasing in cell wall content and decreasing in digestibility. Energy and protein utilization are decreased, sodium/potassium/calcium/magnesium/chloride are lost due to skin secretions and vitamin A appears to be the vitamin depleted rapidly during thermal stress.

Heat stress delays puberty in both males and females, lowers semen quality and conception rates, adversely affects fetal growth, affects birth weight and weaning weights (Bearden and Fuquay 1997, Eloy 2004) and causes abortions (Pugh 2002). Body condition is lost as appetite is suppressed during heat stress. Changes that can be made in management to minimize the loss of body condition are: provide natural or artificial shade, a high quality forage diet and cool, fresh water on offer. Water consumption increases as ambient temperature rises.

Stress management is critical to improving the profitability of the farm. Minimizing stress enhances the immune system to achieve profitable health. These management practices can include the physical handling of the stock, well constructed working facilities, animal welfare, an understanding of animal behavior (Wells 2006, Peischel 2003) and practices to avoid nutritional deficiencies (Hart 2006).

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Chapter Eleven

# FENCING FOR GOATS

Greg Brann

Goats are not as hard as most people think to control with fencing, especially if a good forage base is available. Each type of fence has benefits and short comings. Goats tend to go under a fence more than jump it. It is often best to use permanent fencing on the perimeter and use portable, temporary electric fencing for cross-fencing, allocating grazing as needed.

Consider livestock management, handling, watering, shade, feeding and resource impacts when locating fences. Determine paddock size needed before cross fencing is installed. Locate a watering facility so fields can be cross-fenced with water accessibility. Even if cross fencing is not done, proper placement of water is important. Recommended travel distance to water for goats is 1320 feet or less.

The following formula estimates paddock size so producers have an idea of the area needed for a certain number and size of animal on a specific forage base.

$$\textbf{Acres/Paddock} = \frac{\text{(No. Animals) x (Animal Wt.) x (Intake Rate in \% Body Weight) x (Days on Paddock)}}{\text{(Inches of Forage) X (Pounds Per Acre Inch) X (\% Grazing Efficiency)}}$$

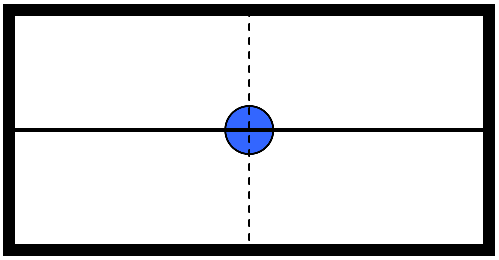
(See Tables 4, 5 and 6 for factors in equation, page 8 and 9).

**Example:** Given 20 does weighing 100 pounds, rotated once a week on a good pasture (tall fescue) 8 inches tall

$$\textbf{Acres/Paddock} = \frac{\text{(20 Animals) x (100 Animal Wt.) x (0.03 Intake Rate in \% Body Weight) x (7 Days on Paddock)}}{\text{(8 Inches of forage) X (300 Pounds Per Acre Inch) X (0.50\{\% Grazing Efficiency\})}}$$

$$\textbf{Acres/Paddock} = \frac{\text{420 lb animal demand / 7 days}}{\text{1200 lb forage available}} = \text{0.35 acres/paddock}$$

Where applicable clear a right-of-way to facilitate fence construction and fence maintenance. Consider placing fences with the landscape, so little interference occurs if land use changes or land is in a rotation with hay or crops. When planning and constructing a fence on steep slopes, consider soil erosion potential from livestock trailing. When possible, use natural terrain to reduce concentrated flow from causing trail erosion. Consider placing permanent fences approximately 300 feet apart allowing for easy, temporary cross-fencing. Due to manageability, it is not recommended to use permanent cross fencing on any field smaller than 10 acres. In general if small fields are cross-fenced, fence in the long direction of the field.



---------------- Temporary fence

Permanent fence (Placing the fence in the long direction of the field allows the same land use as a big field)

If possible, it is best to centrally locate water for optimum utilization of forage, improved manure distribution and cross-fencing alternatives in the future. A water hose or high density polyethylene pipe would also provide flexibility in providing water to small paddocks.

PERMANENT FENCING

**Table 1**
**Permanent Fencing**

| Type Fence | Typical Wire Spacing | Typical Type of Wire | Maximum Distance Between Pull Assemblies | Maximum Line Post Spacing | Maximum Line Post Length (L) and Depth (D) |
|---|---|---|---|---|---|
| Woven Wire (w. w.) | >=32" High Woven + 1 or 2 Barbed Wires 42" High (Woven 32, 1st barb 37, 2nd barb 42) | 12.5 Top and Bottom with 14.5 Gauge for Other or High Tensile Woven Wire | <= 330' Apart 4" Horizontal Brace 6" Brace and Corner Posts, 7' L | 14' Apart Conventional woven wire 25' Apart High Tensile woven wire | Wood 6' L, 24" D Steel 5.5' L, 18" D |
| High Tensile Electric | 5 or More Wires, 42" High (wire spacing from the ground 8, 16, 24, 32 , 42) | 12.5 Gauge 170,000 psi | <= 4,000' Apart 4" Horizontal Brace 6" Brace and Corner Posts, 7' L | 75' Apart or 150' with Stays on 50' Spacing | Wood 6' L, 24" D Steel, High-Density Wood, Fiberglass 5.5' L, 18" D |

**<u>Non-electric</u>**

A. Woven wire
   2" x 4" no climb
   4" mesh
   6" mesh
   12" mesh

Woven wire is a reliable but expensive form of fencing. Place woven wire on the inside of posts. No-climb horse fence or 4-inch mesh work well for goats. The 6-inch mesh is sometimes called goat killer wire, because goats with horns often get their heads hung in it. The 12-inch mesh wire works well for mature goats, because they typically can get their heads out of 12-inch mesh wire. Kids can get out of 12-inch mesh fence.

Goats tend to walk beside non-electric wire rubbing their side, stretching the wire, lowering the integrity of the fence and shortening the fence life expectancy. It is recommended to place an offset electric wire approximately 12-inches off the ground and 6-inches or more away from the non-electric fence. The offset wire will stop goats from rubbing on the fence and provide an electric charge for cross-fencing.

Top wire above woven wire is recommended to bring the height up to 42 inches and protect woven wire. Barb wire is typically used and can be placed 2 inches to 4 inches apart. High-tensile electric can also be used above woven wire; it should be 6 or more inches above non-electric wire because induction can lower voltage. Barb wire should not be electrified.

Barb wire, non-electric high tensile and board fence are not typically recommended; however, they can be used if two offset high-tensile electric wires are run at approximately 8 inches and 18 inches. Offset wires should be 6 inches or more from the original fence.

**<u>Electric fencing:</u>**
Goats have small feet and aren't grounded as well as cattle. However, goats are very sensitive to electricity and respect electric fences once they are properly broken to them. The recommended voltage for control of goats is a minimum of 4,000, preferably higher voltage.

**Training goats to respect electric fencing:**
Place goats in a small secure pen (less than 100 sq. ft. per animal) constructed of non-electric fence such as woven wire. Place offset electric wires 8 inches and 16 inches off the ground. Offset wires should be 6 to 10 inches from the non-electric fence. Leave animals in the area for five or more days before turning into bigger paddocks. It is recommended to turn into incrementally larger paddocks.

**Grounding electric fencing:**
Proper grounding is the most common problem with electric fences. A ground rod should be installed at electric company's transformer pole (primary ground) and another ground rod installed at the electrical circuit breaker box (secondary ground). Contact the electric company for service if electric company grounds do not already exist. Grounding systems should be separated by 25 feet or more. For the energizer install a minimum of three ground rods six feet long. If soil depth is shallow place ground rods at an angle or install more ground rods so equivalent grounding is achieved. Test voltage of ground rods; if 500 or more volts are present at the ground rod, add additional ground rods. Ground rods should be a minimum of 10 feet apart.

**Lightning protection:**
For lightening protection, plug the energizer into a surge protector and install an induction loop (lightning choke) with a lightning arrestor or spark gap attached to a ground rod system with at least one more ground rod than the energizer has. Ground rods of the lightening ground should be 65 feet or more from other ground systems.

Install cutout switches on different electric fence lines or paddocks to manage voltage and allow easier maintenance. Short finders are a valuable tool for hard-to-find shorts. It is recommended to start at the far end of the fence line and test amperage with short finder. Short finders point in the direction of the short.

**Volts and Joules**
Volts are a measure of the potential for moving electrical energy, while joules are a measure of energy. A joule measurement by itself simply gives an idea of the amount of energy delivered, but not the peak voltage or amperage. Coupled with the joule rating, you need to know the type and length of pulse delivered. Also, the type of loading will influence the ultimate amperage delivered. In general one joule will charge six miles of single wire or one mile (5280') of 6-strand fence. Additional joules help when vegetation reduces charge. If a high-powered energizer is used on a small acreage, stray voltage can be a problem. Some energizers have a terminal for smaller acreages.

**Making comparison of energizers**
A uniform rating system has been developed for fence energizers through a committee of the American Society of Agricultural Engineers (ASAE). However, most energizer manufacturers do not currently place the total rating system information on their product. Until the standard is commonly adopted, you should look for a UL-certified energizer with the low-impedance design. Different companies rate joules at the energizer, while other companies rate joules at the end of the fence. Consider the length of fence, number of electrified "hot" wires, weed growth and future expansion.

High Tensile Electric Fencing: Recommended Wire Spacing

| **Table 2**<br>**High Tensile Electric Fence: Recommended Wire Spacing** | | |
|---|---|---|
| Wires | Animal Type | Wire Spacing From the Ground (Inches) |
| 3 | Cattle,<br>Sheep, Goats | 8, 16, 28 |
| 4 | Cattle, Sheep, Goats | 8, 16, 24, 32 |
| 5 | Cattle, Horses,<br>Sheep, Goats | 8, 14, 22, 32, 42 |
| 6-8 | Predator Control | 6, 12, 18, 26, 34, 44, 56, 68 |
| If jumping is a problem, recommended fence height is a minimum of 48”. Typically best to electrify all wires to reduce shorts. In dry conditions if every other wire is grounded, the shock is improved. | | |

## Bracing

Bracing is one of the most important components of a fence. All wires are dependent on the brace assembly. The extent of bracing needed depends on number of wires, soil stability, soil depth and materials used. Bracing works best if end post leans 2 to 4 inches away from the direction of pull. To improve the integrity and life of the fence, tie off wires at corners and major dips. Driven posts are typically 70 percent tighter than posts set in an augured hole and tamped in.

Types of braces recommended:

- H brace – standard. Good for all types of fence where post depth is 36 inches or more or 30 inches in concrete.
- Double H brace – shallow or wet soils where post depth is between 24 and 30 inches
- Floating brace – good for all fences where post are 36 inches deep or 30 inches in concrete. Materials include 6 inch post with 4 inch leaning brace with 12.5 gauge wire and tensioner from end of brace to bottom of the post.
- When tying to trees use a 6 inch lag eye bolt, 5/16inches diameter. Only attach to trees that will live 20 or more years and are low-quality timber specimens.

**Gates or Gaps**
Panel gates are typically best. Electric gaps can also be constructed using recommended wire spacing, connecting horizontal wires with a vertical wire every 10 feet or so. Three electric handles are typically needed. Running the top wire of the gap through a ½-inch diameter plastic conduit approximately 4 feet long increases visibility and allows the producer to cross the gap without opening. Electric bungee gates work well, but a connector wire needs to be placed in pipe under the gate opening or above the gate.

## WORKING FACILITIES

The main components of a working facility are a crowding pen, an alley, sorting gate, an optional head gate, footbath, scales, tilt table and loading chute. Some producers do very well with just a solid-sided crowding pen approximately 8 feet square. An alley or raceway is very handy for deworming with a drench. The alley should be 10 feet or longer, 12 inches wide, solid-sided and 42 to 48 inches high. Some companies offer alleys with drop down sides. For large-horned goats, sides of the alley may need to be tapered to 24 inches at the top. If the alley is too wide, animals will turn around.

**Goat behavior in the working facility:**
Due to goat's strong herding instinct, it is hard to sort goats in open pens, therefore, best to sort through an alley. Goats need to see 2-3 animals in front of them to improve the flow up the alley. A tub also aids in getting animals to move into the alley. Some goats will go low to avoid being caught and a few will jump but this is less common. Goats in general do not go up ramps to the headgate well. These ramps should be solid and 12 inches wide.

## TEMPORARY ELECTRIC FENCING

**Table 3**
**Temporary Electric Fencing**

| Type Fence | Typical Wire Spacing | Typical Type of Wire | Maximum Distance Between Pull Assemblies | Maximum Line Post Spacing | Maximum Line Post Length (L) and Depth (D) |
|---|---|---|---|---|---|
| Light gauge galvanized | 8, 16, 28 | 17-gauge wire | Single steel post can be used; tie off every 330’ | 40’ (step in post recommended) | 35” (L) 4” (D) |
| Electro-netting (good predator control) | 48” high | Polywire mesh | Ends need stable post, hand pull ~50 lbs tension, Brace can be built with plastic post insulators interlocked & one post leaning in direction of pull | Line post built into the fence | 30” (L) 4” (D) |
| Polywire | 8, 16, 28 | (9 strand stainless steel recommended). White is the most visible. | Ends need stable post, hand pull ~50 lbs tension, Brace can be built with plastic post insulators interlocked & one post leaning in direction of pull. | 40’ (step in post recommended) | 35” (L) 4” (D) |

A fence height less than 42 inches may not control goats that jump. If jumping is a problem, fence height should be 48 inches or higher. If a temporary fence stays in one location over a year consider replacing it with a permanent fence.

| Table 4<br><br>Animal Intake, Rotation and Number of Paddocks | | |
|---|---|---|
| **Daily Forage Intake (% of Body Wt.)** | **Recommended Rotation Days** | **Number of Paddocks** |
| 2.5 – 3.5% | 1 – 3 days | 6 - 45 |
| 2 – 3% | 3 – 7 days | 3 – 16 |
| 3.5 – 4 % | 3 – 7 days | 3 - 16 |

| Table 5<br>Grazing Efficiency | | |
|---|---|---|
| **Number of Paddocks** | **Approx. Days on each Paddock** | **Grazing Efficiency includes maintaining minimum stubble** |
| Continuous | ------- | 40% or less<br>or (80% over-grazed, low yield) |
| 4 to 6 paddocks | 7 to 9 days | 40 to 55% |
| 8 to 10 paddocks | 4 days | 55 to 65% |
| 24 to 45 paddocks | 1 day or less | 70 to 80% |
| Hay | ------- | 70 to 80% |

**Table 6**

**Recommended Grazing Heights and Rest Periods**
**(Ultimately the rotation is not based on days but grazing or browse height.**
**Consider all forage up to a height of 5 feet.)**

| **Forage Type** | **Typical Pounds/ ac. in.** | **Begin Grazing Height, Inches** | **End Grazing Height, Inches*** | **Rest Time Days** |
|---|---|---|---|---|
| Tall fescue, orchardgrass & legume, annual ryegrass, or small grains | 200 - 400 | 8” | 4” | 14 to 45 |
| Bermudagrass, crabgrass | 200 - 500 | 5 to 8” | 3” | 14 to 45 |
| Alfalfa | 150 - 300 | 12 to 15” | 3” | 24 to 32 |
| Sudangrass, pearl millet | 100 - 300 | 12 to 18” | 8” | 14 to 30 |
| Native warm season grasses | 100 - 300 | 12 to 18” | 8” | 30 to 50 |
| Browse: limited research is available on sustaining browse vegetation | Browse production is typically 2000 – 4000 lbs/yr Consider available forage up to 5 feet (to sustain browse remove no more than half of leaf area) | | | 45 or more days |

*Due to parasites and other diseases, it is recommended that goats not graze below a height of 5”.

## Author

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Tennessee

# Determine paddock size needed before cross fencing and water are installed.

**Minimum Acres per Paddock with a minimum of 5 paddocks**
**(Do not use this table for stocking rate)**

| **Rotation Frequency[1]** | **Grazing Efficiency[2]** | **Head/ Herd** | **10** | **20** | **40** | **50** | **75** | **100** | **125** | **150** | **200** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **-------------------------Acres----------------------------** | | | | | | | | |
| 3.5 | 65% | ------ | 0.1 | 0.2 | 0.4 | 0.5 | 0.8 | 1.1 | 1.3 | 1.6 | 2.2 |
| 7 | 50% | ------ | 0.3 | 0.6 | 1.1 | 1.4 | 2.1 | 2.8 | 3.5 | 4.2 | 5.6 |
| 14 | 35% | ------ | 0.8 | 1.6 | 3.2 | 4.0 | 6.0 | 8.0 | 10.0 | 12.0 | 16.0 |

Variables in calculating acres can vary substantially. This table assumes 8 inches of growth at turn in and forage weighing 250 pounds per acre inch. Livestock numbers are based on 100 -pound animals with a kid up to 45 pounds. Consumption rate is based on an average of 4.0 percent of body weight consumed per day throughout the year. If livestock weigh more or less than 100 pounds just multiply by a factor (i.e. For 90 lb multiply by 0.9, for 130 lb use 1.3).

Knowing acres per paddock is extremely useful in determining the correct location of fence and water. Even if cross fencing is not done proper placement of water is important. Consider placing permanent fences approximately 300 feet apart allows for easy temporary cross fencing.

For more specific determination enter data in use the following formula.

$$\textbf{Acres/Paddock} = \frac{\text{(No. Animals) x (Animal Wt.) x (Intake Rate in \% Body Weight) x (Days on Paddock)}}{\text{(Inches of forage) X (Pounds Per Acre Inch) X (\% Grazing Efficiency)}}$$

See footnotes at end of fencing section for factors in equation

Footnote 1:

| ***Rotation Frequency*** | | | |
|---|---|---|---|
| **Livestock** | **Daily Forage Intake (% of Body Wt.)** | **Recommended Rotation Days** | **Number of Paddocks** |
| Beef cows, dry dairy, swine, or horse | 2 – 3% | 3 – 7 days | 3 – 16 |
| Sheep, goats | 3.5 – 4 % | 3 – 7 days | 3 - 16 |

Footnote 2

| **Grazing Efficiency** | | |
|---|---|---|
| **Number of Paddocks** | **Approx. Days on each Paddock** | **Grazing Efficiency includes maintaining minimum stubble** |
| Continuous | ------- | 40% or less<br>or (80% over grazed, low yield) |
| 4 to 6 paddocks | 7 to 9 days | 40 to 55% |
| 8 to 10 paddocks | 4 day | 55 to 65% |
| 24 to 45 paddocks | 1 day or less | 70 to 80% |
| Hay | ------- | 70 to 80% |

Footnote 3

| |
|---|
| *Recommended Travel Distance to Water for Beef Cows, Stockers, Horses, Sheep or Goats is 800' on rolling or steep terrain and 1320' on flatter land* |

| **Recommended Grazing Heights and Rest Periods (Ultimately the rotation is not based on days but grazing height)** | | | |
|---|---|---|---|
| **Forage Type** | **Begin Grazing Height, Inches** | **End Grazing Height, Inches*** | **Rest Time Days** |
| T. fescue, orchardgrass & legume, An. ryegrass, or small grains | 8" | **4"** | 14 to 45 |
| Bermudagrass, Crabgrass | 5 to 8" | **3"** | 14 to 45 |
| Alfalfa | 12 to 15" | **3"** | 24 to 32 |
| Sudangrass, Pearl millet | 12 to 18" | **8"** | 14 to 30 |
| Native Warm Season Grasses | 12 to 18" | **8"** | 30 to 50 |
| ***Due to parasites and desired intake it is recommended that goats not graze below a height of 5".** | | | |

Chapter Eleven

# GOAT STRUCTURES and EQUIPMENT

Shaun Jackson

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## Structures

Careful consideration should be given when deciding which type of structures to include on the farmstead. Barns and other farm structures come in all shapes and sizes, and there is also a wide variation in costs associated with erecting these structures. While building plans can be easily changed on paper (with little or no cost), once construction has begun they are often difficult and costly to change. Each county has different zoning laws and some require building permits before any type of construction can begin. Producers should contact their appropriate local government officials for information regarding zoning and building regulations.

One major point to consider when planning structures for a meat goat operation is whether or not structures or fabricated shelters are needed. Goats adapt readily and can endure a variety of weather conditions. In areas with heavy plant cover, such as forests in a silvopasture system, adequate cover and protection may be present. However, in areas without natural cover and in climates with extreme weather conditions, supplemental shelter should be provided. Shelter may also be necessary during kidding and until young goats are environmentally adapted.

Personal preferences and goals should be taken into consideration when planning to create or modify a farmstead. While one producer may enjoy being close to his or her goats at all times, others may wish to move farm facilities away from the home. Think carefully about orientation of existing buildings, trees and power lines; prevailing winds; soil drainage; slope of the land; access to roads and driveways; and access to water and electricity. While one producer may take a “keep it simple” approach, others may want more elaborate or extravagant facilities. The key is to select a design that you can live with and afford. Complete a detailed cost analysis before construction begins to determine the most cost-effective approach while meeting housing and shelter requirements.

The type of operation is a determining factor when planning farm structures. Will the operation consist of strictly meat goats? Will dairy and/or fiber goats be included? Is agritourism in your farm business plan? Although this publication is primarily geared toward meat goat operations, the above-mentioned considerations will be briefly discussed. A dairy operation will need to include provisions for milking and milk storage. Fiber goats require an area for shearing and fiber collection, grading, sorting and storage. If a producer decides to include agritourism, facilities should be safe and comfortable for guests visiting the farm. This can increase the cost of structures significantly. However, the potential for greater profits also increases.

When planning strictly meat goat facilities, simplicity is best. A small, low, wooden structure with open access to the outside environment works well in most cases. These structures can be constructed at low cost and will provide adequate shelter for meat goats while allowing access to browse and/or pastures. The front (open side) should face opposite of the prevailing winds in the area. This provides greater protection for the goats from high winds and rain, as well as improving the structure's durability. Fifteen to 20 square feet per mature dairy goat should be provided (Porter, 2000). The front of the structure should be 5-6 feet tall and the back should be 3-4 feet tall (McKinney, 2000). These dimensions will allow for an adequate slope on the roof for rain drainage. A gutter placed at the end of the back slope will prevent erosion along the back of the structure. These small buildings may be either anchored in the ground (permanent structure) or placed on skids or wheels, so they can be moved from paddock to paddock.

Another type of portable building is the hoop building made from welded livestock panels. These shelters are relatively simple and inexpensive to construct. Hoop buildings consist of two or more livestock panels arched to form a Quonset-shaped structure. The structure is then covered with a tarpaulin or other weatherproof material to provide protection from the elements. The major advantages to hoop buildings are that they are relatively inexpensive to construct, they can be easily moved and they can be disassembled and used for other purposes.


Moveable shelters are important in goat production, especially when rotational grazing/browsing systems are utilized. Rotational grazing/browsing is recommended for not only improvement in available pastures, but for goat health reasons. Goats that are regularly rotated have less health problems associated with internal parasites and typically have fewer foot problems.  It is both expensive and impractical to build a structure for each paddock. In some cases, old equipment such as silage and cotton wagons can be converted into moveable shelters for goats. Before such conversions are made, equipment should be thoroughly inspected to ensure that the goats or humans working with them will not be injured. Loose flooring or protruding metal parts can be potentially hazardous.

During the summer, heat may become an issue in goat production. Excessive heat and exposure to constant, direct sunlight can be detrimental to production, especially in paddocks without adequate shade cover. Shade cloth is an inexpensive way to provide shade to goats under these circumstances.

Some producers may wish to construct a permanent barn specifically for goats, especially if there are no existing agricultural structures on the farmstead. This can be costly in both time and money. Typically, the larger and more elaborate the barn, the higher the cost. However, when not in use for goat housing, such structures can be used for equipment and hay storage or as a maintenance shop. Items such as medicines or pesticides stored on the farm should be kept out of reach of children and unauthorized persons at all times.

Goat shelters should be considered a place for the animals to escape rain, heat and other environmental conditions, not a place for them to live. Total confinement systems are not recommended for goats. Goats thrive in an outdoor environment where they can browse on vegetation. Total confinement livestock systems for goats cause decreased thriftiness and lead to a general decline in health. Additionally, there is no known market for goats raised in total confinement systems.

If permanent structures are being considered, building location is extremely important. Questions to be answered before selecting a site:

- Which direction do the prevailing winds blow? The wind can carry odors to unintended areas and may cause damage if the largest wall is directly facing the wind. Proper orientation can help alleviate this problem.

- How well-drained is the soil on the proposed site? Poor drainage leads to flooding problems. Another problem caused by excess water near shelters is foot problems. Excessive moisture encourages bacterial growth and causes goats' hooves to become soft. This combination can be disastrous, especially if ailments such as foot rot have been present in the herd.

- Is the proposed site on a steep slope, or at the bottom or top of a hill? Barns located at the bottom of hills or on a slope are subject to problems with water runoff during heavy rains.

- How close is the proposed site to trees, power lines, homes or other buildings? Will the buildings be arranged in such a way as to provide easy access for goats, equipment and humans? Should extreme weather or a fire occur, building arrangement and proximity become important factors in minimizing damage.

- Will the proposed site allow for future expansion?

- Is there a road or driveway that provides access to the proposed site? A solid roadbed is recommended for equipment and other vehicles. In areas without a roadbed, equipment tends to sink during wet weather, causing the equipment to "get stuck" as well as contributing to soil erosion. A solid road will make things easier during the building process and once the barn is in operation when transporting materials and animals and when removal of manure is necessary.

- Does the proposed site have access to water, utilities and other services?

Planning a barn should not be entered into lightly. A list of building plans is available through UT Extension: http://bioengr.ag.utk.edu/Extension/ExtProg/Structures/ or by visiting your local UT Extension office. Although building plans are relatively straightforward, some producers may wish to hire a contractor to complete the work. This significantly increases the cost of the building. However, in many cases contractors guarantee their work, are bonded and can accomplish the task in a shorter amount of time.

A special note should be made regarding treated materials. If a producer is certified organic or is seeking organic certification, some treated lumber and other building materials will not pass organic certification. Before purchasing treated materials, check to see if they are allowable under organic certification rules. Bored goats tend to stand around, chew and rub on wood. This can lead to toxicity problems if goats ingest the treated materials. Wood also harbors disease and is often difficult to clean and disinfect. Producers with these concerns should consider using metal materials such as “T” posts, welded stock panels and combination wire pipe panels. Again, cost and ease of use of materials should be considered.

## Equipment

Equipment is considered to be all types of feeders, waterers, corrals and working facilities that are useful to meat goat producers. Specifically hay, grain and mineral feeders; waterers and water delivery systems; corrals; and working facilities will be discussed. Various types of equipment are available for purchase or other designs can be built. Producers should select equipment that is easy to use and serves their purpose. Keep sanitation and cleanliness in mind when choosing equipment. Plastic and metal materials are easier to clean and disinfect than wood. Clean and disinfect equipment periodically to prevent the spread and harboring of disease. Disinfection is a must when equipment is rotated between different groups of animals, even if they are from the same herd.

### Hay, Grain and Mineral Feeders

Feed is the largest cost in any livestock operation. Therefore, feeders (hay, grain and mineral) that minimize waste are preferred. The more feed that is wasted, the less profitable the goat enterprise will be. The best feed or mineral in the world becomes barnyard litter the moment it touches the ground, because goats do not like to eat off the ground. When selecting feeders, a producer should ask the following questions:

- Will my goats waste feed with this feeder? Carefully examine the design. If a goat grasps feed or mineral from the feeder, will the excess fall to the ground?

- Will all of my goats have easy access to the feed or mineral? If feeders are too crowded, the more aggressive goats (and horned goats) will get most of the feed, while the more timid or weaker ones may be left out. Providing plenty of feeding space helps to reduce this problem.

- Will my goats damage the feeder? Feeders should be constructed of sturdy materials. Bored goats tend to want to “play” with objects in their pasture or paddock. Be sure your feeders are strong enough to handle a goat attack.

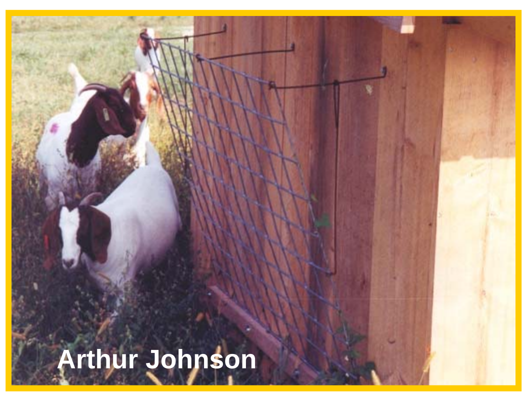
- Can my goats get on top of the feeder? If they can, they are likely to cause damage to the feeder or injure themselves. Also, if they can get into the hay feeder they will tend to use their feed as bedding, which leads to increased waste and incidence of disease.

- Is the feeder easy to clean and disinfect? As previously stated, sanitation is essential to control the spread of disease. Metal and plastic are easier to clean than wood.

- Can the feeder be used by the goats? Is it too restrictive (i.e., can goats not get their head through an opening) or is the feed going to be too far for them to reach? Remember, if your goats cannot actually eat their feed or mineral, it does them no good.

- Can the feeder be easily moved? In rotational browsing systems where goats are moved often, this is an important consideration. The easier the feeders can be moved, the better.

It is important to select feeders that both you and your goats can live with. Below are some examples of feeders that people have used with success.

## Water Delivery Systems

Water is the most important nutrient for goats. In fact, goats can live much longer without food than water. In addition to just having water, the water that is supplied should be clean and potable. Waterers come in all shapes and sizes. Everything from small pails to 200-gallon tanks can be used to deliver water to goats. Allowing goats to drink from streams and ponds is not a recommended practice, especially when the quality of water is unknown. Allowing livestock to roam in streams leads to degradation of water quality downstream and contributes to soil erosion.

There are two main types of watering systems for goats: automatic and non-automatic. In automatic watering systems, water is delivered automatically through floats and valves and the water level is maintained at a minimum. In non-automatic watering systems, water must be placed in the container. There are advantages and disadvantages to each of these types of watering systems. The main advantage of automatic waterers is that fresh water is constantly supplied to the animals with minimal effort. Disadvantages include potentially expensive installation and risk of water line breakage or water pump malfunction. The main advantage to non-automatic watering systems is cost. While these systems are typically less expensive, more labor is involved as the water must be transported to the waterer. This can be accomplished by hauling, piping or carrying the water.

UT Extension has two excellent publications on livestock watering systems; "*Solar Powered Livestock Watering Systems*" (PB 1640) and "*Alternative Livestock Watering Systems*" (PB 1641). Both may be obtained at your local UT Extension Office or downloaded at http://www.utextension.utk.edu/publications/animals/default.asp

## Corrals and Working Facilities

Corrals and working facilities are needed for performing functions such as treating sick animals, vaccinations, hoof trimming, catching, weighing and loading (Schoenian, 1999). In operations with a small number of goats, welded livestock panels can be used to create a circular corral in which the goats can be caught. A major advantage to using this type of corral is that it is relatively inexpensive and can be assembled and disassembled quickly. In larger operations, a more complex handling system may be warranted.

Working facilities for goats should be a minimum of 4.5 feet tall. Many goat-working facilities consist of a holding pen, chute, head-catch and loading ramp. Facilities may also include a footbath for the goats and an area for handlers to disinfect themselves before and after working the goats.

While most of the equipment mentioned in this section can be built, there are some companies that specialize in goat-handling equipment. As a general rule, purchased equipment is much more expensive than handmade equipment. However, purchased equipment is usually of high-quality construction and easier to move and may pay for itself in the long run (Schoenian, 1999).

## RESOURCES

Caprine Supply
P. O. Box Y
De Soto, KS 66018
Phone: 913-585-1191 Fax: 913-585-1140
https://www.caprinesupply.com/

Hoegger Supply Company
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Chapter Twelve

# PREDATORS and PREDATION

John Ferrell and Randy Huskey

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### What is Predation?

Predation (a mode of life in which food is primarily obtained by killing and consuming other animals) is a purely natural phenomenon, but it is a problem when the predator becomes too abundant or humans harbor individuals of a particular specie of prey. Most species of farm or ranch livestock have at times been subject to predation. In the United States, poultry and swine are largely produced in confinement and are thus protected. This is not the case with grazing ruminants and it is generally recognized that in commercial production of ruminants for meat and fiber production, confinement rearing is not an option.

To the livestock producer, the most serious predator is the one causing trouble at a specific time and place. In the United States, those species that may cause trouble are bear (grizzly or black), mountain lions, wolf, domestic dog, wild or feral swine, coyote, bobcat, lynx, fox and raptores, such as the golden eagle or black vulture. Overall, the greatest threat to the U.S. livestock industry has been considered to be the coyote, due to their wide distribution throughout most of the country. However, wild and feral swine are rapidly spreading throughout much of the United States and are becoming a serious threat.

It is reasonably established that in monetary terms, the greatest total loss due to predation is that suffered by the beef cattle industry due to their greater value, larger numbers and wider distribution. However, when expressed as a function of the value of the industry, sheep and goat producers suffer far greater loss. It traditionally has been these industries that have born much of the burden of maintaining predation management programs. Predation is one of the chief reasons cited by producers when they leave sheep and goat production, be it by wild or domesticated animals. Expressions or evaluations of predator damage usually relate to the numbers or value of livestock killed by predators, but there are serious limitations to the use of this approach alone, because it does not consider full costs associated with predators.

An analogy can be made that the value of livestock killed by predators represents “the tip of the iceberg” relative to the actual cost of predation. One of the substantial “other costs” is that of control efforts, whether conducted by government or by the individual producer. Producer efforts may include personal attempts to remove predators or altered-management practices to evade losses (night confinement, improved fencing, early weaning, choice of grazing area, etc.). The National Agricultural Statistics Service (NASS) uses producer-driven surveys to determine goat losses and (Table 1.) shows the latest numbers reported on causes of death for goats by predators (2).

| (Table 1.) **Loss of Goats by Predators, Diseases, Known Causes and Unknown Causes** (Total Value, 2004) | | | |
|---|---|---|---|
| | | | |
| | Losses | | Total Value |
| Item | **Goats** *(Head)* | Kids *(Head)* | All Goat Losses *(1,000 Dollars)* |
| Predators | 40,000 | 115,000 | 15,965 |
| Diseases and Other Known Causes | 60,000 | 120,000 | 18,540 |
| Unknown Causes | 29,200 | 51,000 | 8,261 |
| Total | 129,20 0 | 286,000 | 42,766 |
| Goat value per head is based on a two-year straight average, using Texas data, of the value of all goats reported in the January 1 Sheep and Goat Survey from 2004 to 2005. (Table 1.) Derived from Nass Publication Sheep and Goat Death Loss Released May 6, 2005. | | | |

In many cases, animal losses due to predation may be over- or under-estimated. Many times the actual cause of death is unknown; however, such losses do occur. Many times it takes a lot of work to identify the exact cause of losses unless the producer visually identifies the culprit. Predation is a more serious problem for the livestock industry than most people realize unless they are involved. Because predator species do not respect property or political boundaries, it is important that control efforts be conducted on regional basis.  Later in this chapter we will discuss predatory animals and their control methods.

## The Predators

When we think of predators we think of things such as the big bad wolf, but many producers may loose livestock to animals they would never consider as  predators. Animals and even insects cause predation losses to the livestock industry each year. Predators to be discussed include coyotes, feral dogs, vultures, feral swine, black bears and fire ants.

**Coyotes**

Wildlife require food, cover and water to survive. When these three habitat elements are abundant, the dependent species will flourish. Population levels will increase until they are limited by predators, parasites and/or disease and a lack of habitat. In nature, a local population will usually grow to a peak and then limiting factors will combine and cause it to collapse. Somewhere in between the peak and collapse, there is a point where the available habitat will support a specific number of individuals in perpetuity. That population density is called the "carrying capacity" and is associated with a given area. Carrying capacities can be increased when there is an absence of limiting factors and the available habitat is enhanced. Sometimes the increased population levels cause conflicts with other land uses, i.e., Canada geese in urban areas, white-tailed deer in ecologically sensitive areas and the eastern coyote in areas of livestock production.

The eastern coyote is not subject to predation, and infestations of parasites and disease are minimal. Hunting and trapping can be effective in limiting population growth; however, in many areas these activities are restricted by landowners. The major factor that limits coyote populations is the availability of suitable habitat. As coyotes are very adaptable, they are able to exist in a wide range of territories and in some cases, thrive in urban settings. When coyotes exceed the carrying capacity in an area and have depleted their natural food supply, they have to find something else to eat. In agricultural areas, coyotes adapt and learn that livestock is food. They then teach their young to kill lambs and calves to survive. With their newfound food supply, coyotes are able to increase the carrying capacity of their habitat. (3)

**Identification**

In body form and size, the coyote (*Canis latrans*) resembles a small collie dog, with erect pointed ears, slender muzzle and a bushy tail. Coyotes are predominantly brownish gray with a light gray to cream-colored belly (Figure 1, page 19). Color varies greatly, however, from nearly black to red or nearly white in some individuals and local populations. Most have dark or black guard hairs over their back and tail. In western states, typical adult males weigh from 25 to 45 pounds (11 to 16 kg) and females from 22 to 35 pounds (10 to 14 kg). In the east, many coyotes are larger than their western counterparts, with males averaging about 45 pounds (14 kg) and females about 30 pounds (13 kg). Coyote-dog and coyote-wolf hybrids exist in some areas and may vary greatly from typical coyotes in size, color and appearance. Also, coyotes in the New England states may differ in color from typical western coyotes. Many are black, and some are reddish (Figure 2, page19). These colorations may partially be due to past hybridization with dogs and wolves. (4)

**Habitat**

Many references indicate that coyotes were originally found in relatively open habitats, particularly the grassland and sparsely wooded areas of the western United States. Whether or not this was true, coyotes have adapted to and now exist in virtually every type of habitat, arctic to tropic, in North America. Coyotes live in deserts, swamps, tundra, grasslands, brush and dense forests, from below sea level to high mountain ranges, and at all intermediate altitudes. High densities of coyotes also appear in the suburbs of all major US cities.(4)

## Food Habits

Coyotes often include many items in their diet. Rabbits and rodents top the list of their dietary components; carrion, ungulates (usually fawns), insects (such as grasshoppers), livestock and poultry are also consumed. Coyotes readily eat fruits such as watermelons, berries and other vegetative matter when they are available. In some areas, coyotes feed on human refuse at dump sites and take pets (cats and small dogs). Coyotes are opportunistic and generally take prey that is the easiest to secure. Among larger wild animals, coyotes tend to kill young and inexperienced animals, as well as old, sick or weakened individuals. With domestic animals, coyotes are capable of catching and killing healthy, young, and in some instances, adult prey.

Prey selection is based on opportunity and a myriad of behavioral cues. Strong, healthy lambs are often taken from a flock by a coyote, even though smaller weaker lambs are also present. Usually, the stronger lamb is on the periphery and is more active, making it more prone to attack than a weaker lamb that is at the center of the flock and relatively immobile.

Coyote predation on livestock is generally more severe during early spring and summer than in winter for two reasons. First, sheep and cows are usually under more intensive management during winter, either in feedlots or in pastures that are close to human activity, thus reducing the opportunity for coyotes to take livestock. Second, predators bear young in the spring and raise them through the summer, a process that demands increased nutritional input, for both the whelping, nursing mother and the growing young. This increased demand corresponds to the time when young sheep or beef calves are on pastures or rangeland and are most vulnerable to attack. Coyote predation also may increase during fall when young coyotes disperse from their home ranges and establish new territories. (4)

## General Biology / Behavior

Coyotes are most active at night and during early morning hours (especially where human activity occurs), and during hot summer weather. Where there is minimal human interference and during cool weather, they may be active throughout the day. Coyotes bed in sheltered areas, but do not generally use dens except when raising young. They may seek shelter underground during severe weather or when closely pursued. Their physical abilities include good eyesight and hearing and a keen sense of smell. Documented recoveries from severe injuries are indicative of coyote's physical endurance. Although not as fleet as greyhound dogs, coyotes have been measured at speeds of up to 40 miles per hour (64 km/hr) and can sustain slower speeds for several miles (km).

Distemper, hepatitis, parvo virus and mange (caused by parasitic mites) are among the most common coyote diseases. Rabies and tularemia also occur and may be transmitted to other animals and humans. Coyotes harbor numerous parasites including mites, ticks, fleas, worms and flukes. Mortality is highest during the first year of life, and few survive for more than 10 to 12 years in the wild. Human activity is often the greatest single cause of coyote mortality.

Coyotes usually breed in February and March, producing litters about 9 weeks (60 to 63 days) later in April and May. Females sometimes breed during the winter following their birth, particularly if food is plentiful. Average litter size is five to seven pups, although up to 13 in a litter has been reported. More than one litter may be found in a single den; at times these may be from females mated to a single male. As noted earlier, coyotes are capable of hybridizing with dogs and wolves, but reproductive desynchronize and behaviors generally make it unlikely. Hybrids are fertile, although their breeding seasons do not usually correspond to those of coyotes.

Coyote dens are found in steep banks, rock crevices, sinkholes and underbrush, as well as in open areas. Usually their dens are in areas selected for protective concealment. Den sites are typically located less than a mile (km) from water, but may occasionally be much farther away. Coyotes will often dig out and enlarge holes dug by smaller burrowing animals. Dens vary from a few feet (1 m) to 50 feet (15 m) and may have several openings. Both adult male and female coyotes hunt and bring food to their young for several weeks. Other adults associated with the denning pair may also help in feeding and caring for the young. Coyotes commonly hunt as singles or pairs; extensive travel is common in their hunting forays. They will hunt in the same area regularly, however, if food is plentiful. They occasionally bury food remains for later use. Pups begin emerging from their den by 3 weeks of age, and within two months they follow adults to large prey or carrion. Pups normally are weaned by 6 weeks of age and frequently are moved to larger quarters such as dense brush patches and/or sinkholes along water courses. The adults and pups usually remain together until late summer or fall when pups become independent. Occasionally pups are found in groups until the breeding season begins. Coyotes are successful at surviving and even flourishing in the presence of people because of their adaptable behavior and social system. They typically display increased reproduction and immigration in response to human-induced population reduction. (4)

**Identifying coyote predation**

In attacks on adult sheep and goats, coyotes typically bite the throat just behind the jaw and below the ear, although repeated bites made while shifting their hold may obscure the initial tooth punctures. Death commonly results from suffocation and shock; blood loss is usually a secondary cause of death. On small prey, such as young lambs and kids, coyotes may kill by biting the head, neck or back, causing massive tissue and bone damage. Young lambs, kids and pigs may be carried away by coyotes and disappear without a trace. Bloody soil and vegetation, missing animals or females searching for their young may be the only evidence that a problem exists. Some coyotes kill by attacking the flanks or hind-quarters, causing shock and loss of blood. This is quite common on calves, but is less common with sheep and goats. It does seem to occur more often in sheep during winter months, possibly because of the heavy fleece during this period. Death of the calf and severe injuries to the genital organs and hindquarters of cows are characteristic when coyotes attack cows giving birth. This is more common with heifers (young cows having their first calf) than with older cows. It is also quite common in some areas to see calves bobtailed by coyote attacks.

Young coyotes are more likely to kill in a manner not typical of that which is expected, but some coyotes consistently kill in an atypical manner. Coyotes, like other animals, are individuals and each may have unique food habits and behavior depending on circumstances. (5) For pictures of coyote predation visit (http://texnat.tamu.edu/ranchref/predator/coyote/p-coyote.htm).

## Control Methods

In Tennessee the hunting and trapping season on coyotes is open year round; refer to a Tennessee Wildlife Resources Agency (TWRA) Hunting Guide for more information and up-to-date information.

## Traps and Snares

Trapping coyotes is one of the most effective control methods available. Number 3 Leg-hold traps are the most common and the most versatile control tool. An advantage of using leg-hold traps is that non-target species may be released after capture. A disadvantage of using leg-hold traps is they may be difficult to maintain during periods of bad weather, snow, freezing temperatures and rain may render leg-holds inoperable. Snares are effective tools when placed on trails or placed where coyotes pass through or under fences (Figure 3, page 20) for differentiating coyote tracks). Snares consist of a flexible wire cable and a locking mechanism - as an animal passes through the loop of the snare the lock closes on the animals neck. Snares may be equipped with a deer stop which will allow the release of non-target animals.

Trapping is an art that requires a lot of experience and time to effectively learn. One may contact the TWRA or USDA/Wildlife Services for technical support as the TWRA permits nuisance wildlife control operators. These individuals perform a variety of wildlife control work. The nuisance wildlife control operator (NWCO) is a private individual or company and therefore charges a fee for services. A list of currently permitted NWCO's is available by calling a TWRA office. One may also contact a local trapper by calling one of the Tennessee trapping associations for a list of trappers that may be willing to assist. Live traps are not effective for control of coyote predation.

## Hunting

Shooting can be an effective control tool. Use of predator calls will help lure in weary coyotes. One advantage of shooting coyotes is that offending animals can be selected and control measures can be taken during specific damage situations. Dogs may be used to chase coyotes, a method that is effective for locating den sites.

## Frightening Devices

Scare devices such as propane cannons, sirens and strobe lights may be effective control methods. No permits or license is required to use these devices on coyotes. Scare devices may be purchased from a wildlife control supply company. These devices should only be used occasionally and not on a long term basis. Coyotes will become acclimated to the scare device if used at the same location and when used for long periods.

## Feral Dogs

Many homeowners who have pets consider their family pets as loving animals, but when running loose, they can cause horrific losses to livestock producers. In 1983, the Journal of Range Management July 36(4) published a paper based on a survey of sheep producers of Ohio. The paper showed that no geographic region of the state was immune from losses of sheep due to dog predation and time of year did not effect losses. Many other studies indicate that domestic dogs were the culprits of these losses and most were well fed and groomed.

Most attacks occur at night or early morning hours. Many dogs trapped in studies have been traced back to homes and were considered to be loving family pets. The animals that were not eaten indicate the dogs killed merely for the fun of it. Domestic dogs do not normally kill for food and their attacks usually lead to indiscriminate mutilation of prey. When they do feed, they tend to leave torn, ragged tissue and splintered bones, much like coyotes do. (6)

As a rule, domestic dogs feed very little on their prey. Some individual dogs, including pets, have the instinctive ability to kill effectively, whether or not they feed, and some become adept through repeated killing. True feral dogs are more likely to kill for food. Feral dogs and coydogs are also more likely to kill in a manner similar to coyotes, possibly as a result of experience in killing for food. (7)

**Identifying Predation**

Both domestic and feral dogs often range in packs and do extensive damage once they begin to attack livestock. Dog packs often harass livestock and persist in chasing injured animals, often for several hours. Careful searching where this occurs often reveals many attack sites with tracks, hair or wool and pieces of skin widely scattered. Fences damaged by livestock attempting to escape, exhaustion, injuries, weight loss, loss of young and abortion are some common consequences of such attacks. Sheep and goats are especially vulnerable. They may drown in streams or reservoirs while trying to escape, or they may "pile up" and suffocate in fence corners, gullies and sheds. Many more may be injured or killed in this manner than from dog bites. (7)

**Keys to dog and coyote predation**

- Coyotes tend to kill quickly, at night or early dawn, by biting sheep on the throat just behind the jaw and under the ears.
- Coyotes will generally kill only one or two animals close to areas with plenty of cover to allow the coyotes to escape.
- Coyotes eat their kill by first feeding on the abdominal cavity.
- Coyotes are probably responsible if lambs or small animals are missing, because coyotes will take smaller animals back to their den, especially when feeding their pups.
- Dogs will attack at any time of the day or night.
- Dogs are usually poor predators and their attacks last much longer affecting more of the flock, so the animals are more nervous and confused after the attack.
- Dogs usually attack sheep or other livestock for the chase, not for food.
- Dog attacks usually cause more slashing and ripping wounds, the mutilation of legs, ears, tails and hindquarters - on both the dead and surviving animals.(8)

**Control Methods**

Many jurisdictions have animal control officers that may assist landowners with feral dog control. Contact your local sheriff department or police department for assistance with feral animals.

**Fencing**

Well maintained net wire fences will preclude most feral dogs from reaching livestock. Occasionally dogs will persist in digging under wire fences. Placing a strand of electrically charged wire along the bottom and one strand around the top of a wire fence will increase the effectiveness of the net fence. This will stop dogs from both digging under and climbing over net fences.

### Trapping

Trapping is an effective method to control feral dogs. A number 1 ½, 2, or 3 soft catch leg-hold trap is a versatile tool available to the trapper. Snares are another good tool available to the trapper and may be placed on trails or in areas where animals crawl under fences. Large cage type traps (live traps) are very effective at catching feral dogs. The cage trap is easier to learn how to use than a snare or leg-hold trap but the cost of cage traps may be prohibitive.

Trapping is an art that requires a lot of experience and time to effectively learn. Contact the TWRA or USDA/Wildlife Services for technical support. The TWRA permits nuisance wildlife control operators; these individuals perform a variety of wildlife control work. The nuisance wildlife control operator (NWCO) is a private individual or company and therefore charges a fee for services. A list of currently permitted NWCO's is available by calling a TWRA office.

### Vultures

There are two species of vultures common in North America, the turkey vulture (*Cathartes aura*) and black vulture (*Coragyps atratus*). In many localities in the United States, vultures are called "buzzards." The turkey vulture specializes in locating and eating carrion. Black vultures also subsist principally on carrion but at times this species is predatory. Thus, for livestock producers, the black vulture is the species of concern. Black vultures have a 1.3 to 1.5m wing span and weigh about 2 kg. Adult and juvenile black vultures have a dark grey head and black body; the underside of the wings is dark grey to black with a white patch at the end of each wing, and relatively short tail feathers. In flight, black vultures have the appearance of large bats. The mode of flight differs between black and turkey vultures due to different wing lengths supporting about the same body mass. Turkey vultures flap the wings a few times and glide when at low altitudes; whereas black vultures flap frequently, interspersed with brief glide when at low altitudes unless a strong wind blows. At high altitudes, both vultures fly primarily by gliding and riding thermal wind currents. While soaring or gliding, turkey vultures generally hold their wings at a steeper angle than do black vultures.

Black vultures have been reported to live to 25 years of age. The range of the black vulture includes south-central Arizona, the southern and eastern two-thirds of Texas, and the entire southeastern United States. The black vulture has a very broad diet. Unlike most other vultures, it will subdue, capture and eat live prey, including birds, skunks and opossums, turtle hatchlings, fish and livestock. The black vulture does not depend upon smell to find food. Instead, it frequently locates food by sight, and sometimes by following turkey vultures. When a turkey vulture finds a carcass, black vultures often arrive in large numbers and dominate or displace the turkey vulture at the site. Black vultures roost communally and appear to have a well-developed social structure with long-term, family- based relationships. Communal vulture roosts are important foraging tools used by black vultures and information regarding the locations of food resources can be transferred among birds roosting together.(9)

## Vulture Predation

The black vulture being the main culprit in livestock predation may be due to it's widely adaptable diet and its aggressive behavior. Data compiled from USDA Wildlife Services reports suggest that attacks on domestic animals from black vultures have increased since 1997. Turkey vultures rarely attack livestock; such reports often represent a misidentification of a black vulture attack. Initial damage by black vultures is usually at the eyes and nose, navel and anal area of newborn and sick livestock. They blind the animals by pecking out the eyes, even if they do not kill them. Generally, vultures attack in large numbers, maybe 20 or more per attack. Vulture predation is hard to
pinpoint, because it may be difficult to determine if the animal was dead before the vulture arrived. Many vultures become aware of easy meals and damage occurs because these defenseless animals make easy targets. ( 9) Predation photos can be viewed at http://texnat.tamu.edu/ranchref/predator/birds/p-birds.htm

## Control

Many producers have reported harassment as a means of control. This includes firing guns to scare off vultures, roost destruction, trapping and relocating animals. Relocating problem animals did not reduce the attack and loss of livestock, but merely changed the location of the damage, because the animals had become adept at killing.

Cultural practices show the best results in interrupting predation from vultures. Producers should remove dead animals and dispose of them properly. Remove any food source that attracts vultures and locate kidding areas in closed sheds or close to areas with high human visibility. (9)

Vultures are protected by the Migratory Bird Treaty Act, which is administered by the U.S. Fish and Wildlife Service. Vultures may be harassed without federal permits, but they can only be killed after obtaining a Migratory Bird Depredation Permit from the U.S. Fish and Wildlife Service. Contact the USDA/WS (phone number, end of chapter).

## Feral Swine

Wild pigs (*Sus scrofa,*) include both feral hogs (domestic swine that have escaped captivity) and wild boar, native to Eurasia but introduced to North America to interbreed with feral hogs. In Tennessee, feral swine are defined as any wild hog found in Tennessee, except those found on Catoosa, South Cherokee, Cove Mountain and Foothills Wildlife Management Areas. Feral hogs are considered big game but are not required to be tagged or checked in at big game checking stations.

Like domestic hogs, they may be any color. Their size and conformation depend on the breed, degree of hybridization with wild boar, and level of nutrition during their growing period. Wild boar have longer legs and larger heads with longer snouts than feral hogs. The color of young boar is generally reddish brown with black longitudinal "watermelon"stripes. As the young develop, the stripes begin to disappear and the red changes to brown and finally to black. Both the male feral hog and wild boar have continuously growing tusks. Wild boar and feral hogs hybridize freely; therefore, the term wild pig is appropriate as a generic term for these animals. (10)

## Swine Predation

Hogs in some areas, domestic or wild hogs (Russian boar, domestic hogs gone wild and their crosses) prey on livestock. This occurs more often during droughts or other periods when mast (acorns, etc.) and other foods are scarce. Hogs will also feed readily on carrion, but some hogs become highly efficient predators. Hog predation on livestock usually occurs on lambing or calving grounds, perhaps partially because of the prevalence of afterbirth. Occasionally, adult animals giving birth are fed upon and killed by hogs. Young and small animals are often entirely consumed by hogs and the only evidence may be tracks and blood where feeding occurred. Missing young and their mothers with full udders may indicate such predation, particularly where this is frequent and no other causes for loss can be found. Hogs feed on carcasses much like bears do, although they are not as proficient in skinning them out. They may consume some parts that bears do not, such as the rumen and its contents. Since hogs commonly root up soil and vegetation, their presence is usually evident and their tracks, Figure 6, page 20) are distinctive. (11)

## Control

Fencing is generally not practical except in small areas around yards and gardens. Heavy wire and posts must be used, but if hogs are persistent exclusion is almost impossible. Electric fencing on the outside of the mesh may be of some help, but it is difficult to maintain over large areas. Electric fencing has been used effectively in many areas of the country. (10)

Hunting is an effective feral hog control method. On privately owned lands in Tennessee, the feral hog season is open year round, except in-holdings on Catoosa and South Cherokee where the season is open concurrently with the statewide deer seasons. Here the use of dogs is prohibited. There is no bag limit and either sex may be harvested.

Shooting feral hogs at night and chasing feral hogs with dogs are also effective control measures. However, a permit must first be obtained by contacting a Tennessee Wildlife Resources Agency office (phone numbers at end of chapter).

Trapping feral hogs using large cage type traps is a very good control method. In order to trap feral hogs in Tennessee one must first obtain a big game depredation permit from TWRA (phone numbers. Page 18). There are several limiting factors associated with large cage traps. The traps are heavy, hard to transport and they can be quite expensive. Trapping feral hogs with snares may be effective. Snares may be placed along well worn feral hog trails. You may contact the Tennessee Wildlife Resources Agency or the United States Department of Agriculture Wildlife Services for further technical support. Trapping feral hogs is an effective control measure, however, the time it takes to learn the correct trapping methods and the expense of some traps may not be worth the effort.

## Black Bear

The black bear is approximately 5 feet long and varies in weight from 125 to 400 pounds. It has small eyes, rounded ears, a long snout, a large body and a short tail. The shaggy hair varies in color from white through chocolate brown, cinnamon brown and blonde to black; most black bears are black or a darker shade of brown (Figure 4, page 19).

While black bears are capable of standing and walking on their hind legs, the usual posture is on all fours. The black bear's characteristic shuffle results from walking flat-footed, with the hind legs slightly longer than the front legs. Each paw has five strong, non-retractable claws used for tearing, digging and climbing. One blow from a powerful front paw is enough to kill an adult deer. But in spite of their size and strength, black bears are surprisingly agile and careful in their movements. Although much of its historical habitat has been destroyed by axe, plow and bulldozer, the highly intelligent black bear has adapted and survived.

Black bears are opportunistic feeders, making use of just about any available food source. While they prefer berries, nuts, grass and other plants, they also eat carrion, small animals and fish. When fall approaches, black bears must eat large amounts of food to gain enough weight to sustain them through their winter hibernation, when they must survive on their reserves of body fat. During periods of relatively warm weather, they may awaken and take short excursions outside.

Black bears reach breeding maturity at about 4 or 5 years of age and breed every two to three years. Black bears breed in the spring, usually in May and June, but the embryos do not begin to develop until the mother dens in the fall to hibernate through the winter months. However, if food is scarce and the mother has not gained enough fat to sustain herself during hibernation as well as produce cubs, the embryos do not implant (develop). Black bear cubs are generally born in January or February. The blind cubs weigh about 3/4 of a pound or less at birth, and twins are most common. By spring thaw, when the bears start leaving their dens, the cubs are fur-balls of energy, inquisitive and playful. They are weaned between July and September of their first year and stay with the mother through the first full winter. They are usually independent by the second winter. Cub survival is totally dependent on the skill of the mother in teaching her cubs what to eat, where and how to forage (find food), where and when to den and where to seek shelter from heat or danger.

Except for breeding and raising young, black bears are generally solitary animals. They try to avoid humans and are considered non-aggressive except when injured, protecting their young or protecting themselves. Daily movements are influenced greatly by temperature and food availability. Bears usually feed in the cool of the evening or early morning. During the heat of the day, they will seek shade in dense underbrush. Home ranges are determined by food types, abundance and availability, and can be as small as 1 square mile or as great as 100 square mile. Rugged terrain and dense shrubs provide escape cover and den sites for black bears. Black bears also seek den sites under fallen trees, in hollow trees or caves, or in previously occupied dens. They are excellent tree climbers, and will use trees to escape from danger. When possible, black bears will choose streams with dense bankside shrubbery as travel corridors to and from food sources. (12)

**Bear Predation**

Few black bears learn to kill livestock, but the behavior, once developed, usually persists. The severity of black bear predation makes solving the problem very important to the individuals who suffer the losses. If bears are suspect, look for deep tooth marks (about ½ inch [1.3 cm] in diameter) on the neck directly behind the ears. On large animals, look for large claw marks (1/2 inch [1.3 cm] between individual marks) on the shoulders and sides. Bear predation must be distinguished from coyote or dog attacks. Coyotes typically attack the throat region. Dogs chase their prey, often slashing the hind legs and mutilating the animal. Tooth marks on the back of the neck are not usually found on coyote and dog kills. Claw marks, are less prominent on coyote or dog kills, if present at all.

Different types of livestock behave differently when attacked by bears. Sheep tend to bunch up when approached. Often three or more will be killed in a small area. Cattle have a tendency to scatter when a bear approaches. Kills usually consist of single animals. Hogs can evade bear in the open and are more often killed when confined. Horses are rarely killed by bears, but they do get clawed on the sides. After an animal is killed, black bears will typically open the body cavity and remove the internal organs. The liver and other vital organs are eaten first, followed by the hindquarters. Udders of lactating females are also preferred. When a bear makes a kill, it usually returns to the site at dusk. Bears prefer to feed alone. If an animal is killed in the open, the bear may drag it into the woods or brush and cover the remains with leaves, grass, soil and forest debris. The bear will periodically return to this cache site to feed on the decomposing carcass. Ninety percent of all incidents were likely associated with habituated, food-conditioned bears. (10)

**Control**

Trapping black bears is a very effective control method. Large culvert traps are used to trap and remove problematic bears. In order to trap and move a bear in Tennessee one must first obtain a big game depredation control permit. Call the TWRA office near you for assistance in obtaining a depredation permit.

Shooting black bears and chasing with dogs is an effective control method, however, bears are considered a big game species in Tennessee and therefore have established hunting seasons in the fall. Refer to the Tennessee Hunting Guide for hunting season dates and regulations. If shooting or chasing with dogs is a desired control method and bear hunting season is not open, one must obtain a big game depredation control permit from the TWRA office nearest you.

Exclusion fences may be an effective control tool. An electric fence is more effective at preventing a bear from entering a livestock foraging area or night camping site.

Pyrotechnic devices may be an effective control measure and purchased from animal control supply companies. By emitting loud sounds and flashes, these devices scare animals. These devices may be used without obtaining a permit from TWRA. Some bears become habituated to humans and associate them with a food source. These individuals become difficult to deter with pyrotechnic devices.

**Fire Ants**

Like many other ants, imported fire ant colonies live in mounds of soil that may be more than 18 inches high. Mounds are often found in open, sunny areas (Figure 5, page 19). Periodically, winged reproductive male and female ants leave colonies on mating flights. Mated females (queens) can fly or be carried by winds for miles. When they land, they start new colonies. There may be hundreds of thousands of worker ants (sterile female ants capable of stinging) in a mature colony. There are both single-queen (monogyne) and multiple-queen (polygyne) colonies. Worker ants from multiple-queen colonies are not territorial and move freely from mound to mound. The opposite is true of workers from single queen colonies. This allows polygyne colonies to build many more mounds per acre. The single-queen form may build 40 to 80 colonies per acre, while the multiple-queen form can build 200 to 800 or more mounds per acre. Most of the quarantined counties in Tennessee have single-queen imported fire ant colonies. Fire ants disperse naturally through mating flights, or mass movement of colonies. Shipments of hay, nursery stock, soil and other items from an infested area may relocate entire colonies or nests. (13) As of 2005, 41 Tennessee counties are quarantined for, or have established populations of, imported fire ants (http://fireants.utk.edu , http://www.state.tn.us/agriculture/regulate/plants/ifa.html).

When disturbed, fire ant workers may rush out and bite and sting. Most people react with a pustule at each sting site, but a small percentage of people have a more severe reaction requiring immediate medical attention. In addition to the medical concern, fire ants change our behavior and reduce our recreational activities if populations are unmanageable. Other impacts in the urban environment include reduced property values, shorting of electrical equipment and damaged lawns and areas along walkways. They affect agriculture by: reducing hay yield because of raised cutter bars or dulled and broken equipment due to contact with the mounds, clipping germinating seedlings, tunneling through tuberous or ground crops, tending sucking pest insects and protecting them from natural enemies, deterring hand labor and damaging irrigation equipment.

Imported fire ant foragers can rapidly recruit other ants to food and moisture resources. Newborn livestock and wildlife, birds hatching from eggs, and confined animals are particularly vulnerable to attack by imported fire ants. Reported cases of injury are uncommon. During the hot summer months, the frequency of livestock injury and deaths increases rapidly because the ants are starved for food and moisture. For this reason, scheduling breeding programs to avoid birthing during hot summer months can help prevent this problem. When birthing is scheduled for the summer months, placing females in a designated birthing pasture that has been treated to reduce fire ant populations may be justifiable and cost effective. The ants are not recognized to harm mature animals other than ostriches and emus that, reportedly, can go into shock when stung. A recent estimate puts annual damage and repair costs attributed to imported fire ants in the U.S. at over $6 billion even though they only infest about 320 million acres in all or parts of 13 states and 1 territory. (14)

**Damage Assessment and Control Decisions**

A fire ant damage assessment is needed to determine where and when to treat. Ranchers can make two common mistakes when estimating fire ant losses and deciding on treatments. First, they may not include every loss caused by fire ants that takes money out of their pockets. Dead and injured goats and infested hay bales are obvious losses. However, a shorted-out air conditioner or the cost of treating mounds around the children's swing set also should be included, even though they are not directly related to the business part of the ranch. Survey results show that electrical damage and pesticide expenditures are the two most common types of losses.

The second mistake involves treatment options. Fire ant "eradication" is not technically or economically feasible. Still, when many ranchers think of fire ant treatments they think of treating large expanses of land to try to kill all ants. At a minimum of about $15 per acre per year, treating large areas is not usually economical, although some methods can cut large-area treatment costs by up to half. What many ranchers fail to realize is that most fire ant problems occur on fairly small areas that can be treated rather easily and at a modest cost.

Fire ants damage livestock in many ways, but determining that ants actually caused the damage may be hard to get a handle on. Damage may include hundreds of stings, death to small, immobile, young livestock animals, or reduced forage utilization. Producers need to be aware of such issues in a livestock operation.

Worksheets on determining fire ant damage to hay or livestock production can be found at, http://fireants.utk.edu/Webpages/Agricultcontrolpage.htm or http://www.aces.edu/pubs/docs/A/ANR-1248/ANR-1248.pdf

If your loss per acre for hay production is:

**More than $15,** you can probably make money by treating for fire ants.
**Less than $15 but more than $6**, you may still be able to make money using alternative/nonchemical methods.
**Less than $6**, fire ant treatment would not be justified.

If loss for livestock production per acre is:
**More than $15,** you can probably make money by treating the entire place.
**Less than $15,** pinpoint where these losses occur and only treat those areas.

**Control Methods**

**Non-chemical**: Non-chemical or cultural control methods can reduce losses while maintaining a stable ant population that will help suppress other pests (lone star ticks, filth breeding flies, etc.) and deter the multiple queen form. Non-chemical methods include:

1. Scheduling goat breeding programs to ensure that kidding occurs during cooler weather when fire ants are less active (soil temp below 65 degrees F).
2. Using disc-type cutter equipment designed to withstand the impact of fire ant mounds to reduce equipment damage.
3. Using mechanized balers and bale movers to reduce human contact with infested bales. Tightly bound bales may be more difficult for fire ant colonies to infest than loose bales.
4. Removing hay bales from the field immediately to prevent ants from infesting them, particularly when rain is expected.
5. Storing bales off the ground or in an area treated for ants. (Note: The Quarantine prohibits the shipment of hay from infested to uninfested counties without certificates. If hay is from a quarantined county, it must be inspected, determined to be free of IFA and accompanied by a permit, prior to movement. Hay must have been stored off the ground to be shipped. If hay was stacked, as long as it was not the bottom tier of hay, it would be considered as stacked off the ground. Call your Tennessee Department of Agriculture inspector to discuss certification requirements. During fair time, county Extension agents may be allowed to inspect hay to be moved to fairs).

**Chemical Control:** Chemical treatment can suppress fire ants in pastureland for about $15 per acre. Chemical treatments do not eradicate fire ants, and the treatments need to be repeated periodically. There are a limited number of fire ant control products labeled for use in pastures. In the Two-Step Method, fire ant bait is broadcast once or twice a year. These treatments can kill up to 90 percent of the colonies within several weeks to several months. Hydramethylnon bait, such as AmdroPro®, takes three to six weeks and the effects last for months or until ants re-infest the treated area. Insect growth regulator baits containing s-methoprene (Extinguish®) or pyriproxyfen (Esteem) may require several months to work but may suppress ants for more than a year. A hopper blend of 0.75 lbs AmdroPro and 0.75 lbs of Extinguish can be applied per acre. Theoretically, the blend may give a quicker kill (provided by Amdro) and a longer residual (provided by the IGR insect growth regulator, methoprene). The second step in the Two-Step Method is to treat individual mounds that are a particular nuisance. Products containing carbaryl or Sevin® are registered as fire ant mound drenches for pastures. Once the broadcast bait treatment has taken effect, few individual mounds should need to be treated. Suggested bait application guidelines can be found in the references listed below. Always read and follow the instructions on the product's label. (15)

**Biological:** There is great hope that in the future fire ant populations will be suppressed through the release of natural enemies from their native habitats in South America. One parasitoid being investigated is a phorid fly that develops inside the head of ants. In theory, adult phorid flies looking for worker fire ant hosts suppress ant foraging and allow native ant species to compete more successfully with fire ants. The phorid fly *Pseudacteon curvatus* was established in over 34 Tennessee counties in 2005. (13) For more information on fire ants and their management, see ***Imported Fire Ants in Tennessee*** at http://fireants.utk.edu/

PRECAUTIONARY STATEMENT

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

## Summary

Most producers may need to consider using many different management tools when dealing with livestock predation. A management system may include many of the following management practices. All management techniques have advantages and disadvantages. Some will work for one producer, while others will work for another. Because every livestock operation is different, not all of these management suggestions are practical for everyone. It is important for producers to combine the management techniques best suited to their operations with the most effective predator control methods for their circumstances.

## Fencing

Specially constructed woven (mesh) wire or electric fencing can be a useful tool in a management strategy for deterring predators. Fencing is most successful if it is strung before the predator has established a pattern of movement. If coyotes have been feeding on livestock in a pasture, the construction of a fence will probably not deter them, since they already recognize the livestock as a food source. See fencing (Chapter 11) for details.

## Record Keeping

When livestock predation has occurred, the use of accurately kept records helps speed the response to a predator problem. In addition, knowing the exact number and location of the losses can help establish the predation pattern and identify problem areas on the farm or ranch.

## Night Confinement

Because many predators, including the coyote, are usually active between dusk and dawn, penning livestock in predator-proof pens at night should reduce losses. In addition, some predators are reluctant to approach any place where humans are present. Livestock will learn to come to the secure pens when they are regularly penned at night. Additional labor and maintenance of facilities may be required.

## Kidding in sheds or secure lots

Kidding in sheds or secure lots can reduce losses to predators. Shed kidding allows the producer greater access to the doe to assist with kidding and will also provide the opportunity for kidding earlier in the season. The main disadvantages of shed kidding are the initial cost of the shed, the additional labor needed and an increased incidence of disease. The costs will vary depending on the accessibility of lambing facilities and feed, plus the availability of additional labor.

## Removal of all dead livestock

Dead animals attract coyotes and other scavenging predators. Unless the dead animals are removed, the predators will become accustomed to the taste of livestock. Coyotes may depend on dead animals to remain in livestock-raising areas. One Canadian study indicates that on farms that promptly removed dead livestock, predator losses were lower than on farms where dead livestock were not removed. (7)

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## Web - Resources

http://www.aphis.usda.gov/ws/
http://www.sheep101.info/predators.html
http://www.ext.vt.edu/pubs/livestock/410-030/410-030.html#L5
http://www.aphis.usda.gov/lpa/pubs/factsheets.html
http://www.sheepandgoat.com/predator.html
http://www.sheepandgoat.com/predator.html
http://www.texnat.tamu.edu/ranchref/predator/b-1429-1.htm
http://texnat.tamu.edu/ranchref/predator/birds/p-birds.htm

### Phone Numbers

United States Department of Agriculture/Wildlife Services (USDA/WS)
1-866-487-3297

Tennessee Wildlife Resources Agency (TWRA)
In east Tennessee call (423)587-7037
On the Cumberland Plateau call (931)484-9571
In middle Tennessee call (615)781-6622
In west Tennessee call (731)423-5725

Trapping Associations
West Tennessee Furtakers (901)476-5953
Tennessee Fur Harvesters (615)883-3696
Tennessee Freetrappers (615)672-8546

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Figure 1

Figure 2

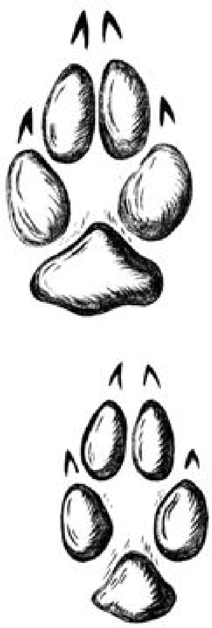
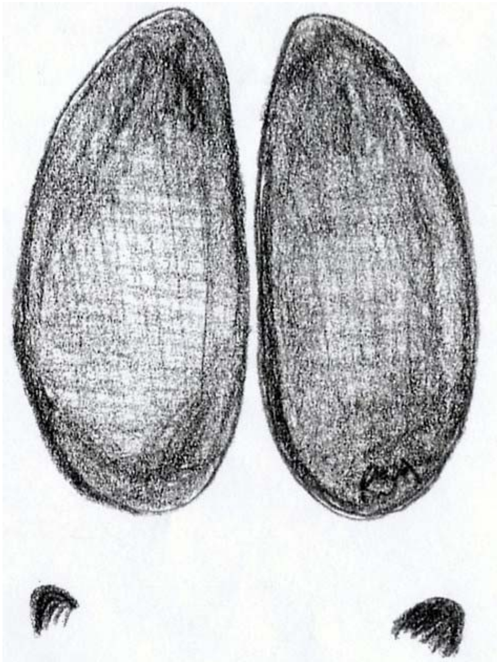


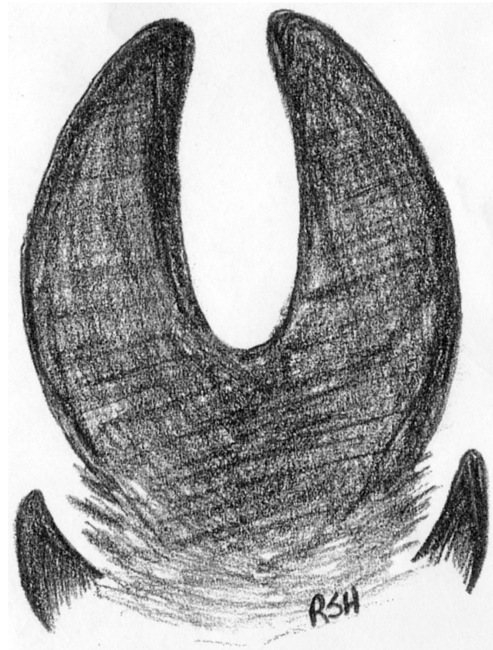
Figure 3

Figure 4

Figure 5



**Feral Boar Tracks**



**Wild Boar Tracks**

**Figure 6**

# THE LIVESTOCK GUARDIAN DOG

**An Peischel, PhD**
**Goats Unlimited**
**Ashland City, Tennessee**

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I recently had an individual call and want to discuss the training of livestock guardian dogs. For a while I listened and at the same time, thinking to myself - train ?? - I don't "train", I facilitate success. Everything I do beginning with the selection of breeding stock, whelping, exposure to different classes of goats and topography, to a range of different predators, the situation is managed so each individual pup is given every chance to succeed. Every experience for a pup has to be positive, the pup needs to feel in control, and their intense natural instinct to guard needs to be self-expressed.......then, the big day comes when they are sent miles away to guard the goats by themselves; they're on their own. My dogs have never let me down, I sleep peacefully. Goats Unlimited has been fortunate to never have lost a goat to predation with the use of livestock guardian dogs.

Goats Unlimited is located in rolling hardwood hills situated in the northern middle section of Tennessee. Our major predators are coyotes and domestic pack dogs. We do land cleaning and enhancement, restoration of marginal lands and riparian areas and weed abatement with our Kiko meat goats. Our type of business puts the dogs in situations where they could be guarding in a neighborhood type setting with people around or in densely forested areas where they will rarely encounter a human. There are also weather, topographic and vegetation extremes that the livestock guardians learn to survive in.

<u>Breeding Stock: The Pyrenean Mountain Dog and the Akbash</u>

The dogs used for breeding purposes are selected from ranches/farms that are using dogs as livestock guardians. Both the dam and sire of the dogs selected have to be guarding and the physical conditions (terrain, predator type, weather) very similar to ours. The dogs must be physically sound, structurally correct and representative of the breed standard.

The breeds we have selected as livestock guardians are the Pyrenean Mountain Dog and the Akbash. Each breed was selected for specific breed characteristic traits that fit our management program. As you begin the journey of "success facilitation", never lose sight of the fact, and remember that these dogs are nocturnal - so are the predators.

The Pyrenean is mentioned in documents hundreds of years old owing its origin to the plateau of Tibet. It started as one of the Mastiff family and came into Europe overland with the Aryan hordes. Remaining isolated in the Pyrenees Mountains (between France and Spain) for centuries, they guarded the flocks on the high and isolated mountain slopes. They have a natural guarding instinct, protecting with their very lives those placed in their protection. Pyreneans are large and powerful, have great stamina and a coat providing protection from foe and climatic elements. Their air of quiet confidence and tolerance makes the Pyrenean an ideal fit for our management requirements.

The Pyrenean is well suited to the neighborhood land cleaning, restoration and weed abatement projects as project size can vary from 20 to 160 acres. They are more people tolerant, therefore, less aggressive toward humans. For our conditions, their coat protects them from the winter rain, hail and occasional snow. The dogs are expected to find their own shelter and protect themselves from the elements.

The Akbash originated in western Turkey centuries ago for the guarding of sheep. White in color, their shorter length double coat is shed annually. They have a fleet appearance built for speed and stamina (long legs, muscular, strong) with keen eye sight and hearing. They are ideal for forest/brush and rangeland operations. Akbash are more aggressive to predators, have a strong maternal and guarding instinct and a forceful independent nature in their guardian behavior.

The Akbash was chosen to cross with the Great Pyrenean in an effort to reduce the dense coat of the Pyrenean. The hair coat of the cross is much shorter and has proven advantageous in hot, humid climates. The cross is exceptionally athletic like the Akbash yet the personality and the bone structure of the Pyrenean has been maintained. The crossbred guardians have the same black pigmentation around the eyes, nose and mouth as do the originating breeds.

Whelping and Feeding

We do not breed our guardians until they have proven successful as livestock guardians in their own right, have OFA's (Orthopedic Foundation for Animals) confirming no evidence of hip dysplasia and are at least 2 years of age. Once the dogs are bred, they are maintained on a higher plane of nutrition (27% crude protein and 18% fat) with a vitamin/mineral (especially readily absorbable calcium and phosphorus) supplement given daily. The bred females are used for guarding on acreage close to homebase so they can be monitored daily as whelping day approaches. Approximately 8 days before whelping, they receive a parvovirus and 7-way vaccination. They are whelped out in the brush with the goats. It is up to the bitch to provide a "safe" area for her pups and to guard them. I check them from a distance with binoculars, leaving everything up to the dam. Pyrenean and Akbash pups are born in litters of 5 to 10 with an average birth weight between 1.5 and 2.5 pounds. After whelping, the female receives added nutrition; a cooked meal once daily (cooked meat, a gravy bullion base with suet, supplemental vitamins and minerals, goat milk, and rice). The dog consumes all she wants of this mixture and a high quality dry dog food is provided in a self-feeder free choice.

The pups will be twice their birth weight by day 5 - they grow exceptionally fast and need high levels of nutrients for the rapid long bone growth that occurs. Their eyes begin opening about 12-14 days of age and they are immediately started on warm goat milk. A liquid mineral/vitamin supplement is added to the milk of which the pups can drink all they want - offered 3 times in a 24 hour period. At three weeks of age, the pups start eating cooked food - mashed rice, puppy chow soaked in goat milk, vitamin/mineral supplement. By the time they are 5 weeks old they are chewing on dry dog food but still receiving a cooked meal a day with cooked meat. Once they are 6 weeks old, they are consuming dry food daily and an evening meal of dry food soaked in goat milk with cooked meat. Because this breed of dog experiences rapid bone growth, it is vitally important to provide a balance of calcium, phosphorus and vitamin D3 until about 18 months of age. Between three and six months of age they may grow from 30 to 100 pounds.

Preventative Health Care

At 2 days of age, both the front (single) and rear (double) dewclaws are removed from the Pyrenean pups. The pups receive a parvo virus vaccination at 5 weeks of age, a 7-way vaccination (canine distemper, adenovirus type 2, coronavirus, parainfluenza, parvovirus and leptospira bacterin) at 8, 12, 16 and at 20 weeks of age another parvo virus vaccination. At 12 and 16 weeks of age they receive lyme vaccine and at 16 weeks they are vaccinated against rabies. They begin a life long monthly heartworm prevention program at 3 months of age. Males are neutered at 4 to 5 months of age and females spayed before first heat, about 6 to 7 months of age. All of the dogs, upon reaching one year of age, are on an annual vaccination program for 7-way, lyme and rabies.

Guarding Management

The pups are born within the same time frame as kidding (March/April and October/November) so during any year several litters of guardian pups are born. When pups open their eyes there are many "kid" eyes staring back at them, checking them over. The kids are cautious around the pups and are tolerant when the pups start waddling around, interrupting the kids' nap time. Kidding takes place in solar powered electric fencing (5 to 6 strand polywire or electronetting) so the pups learn at a very early age where they are to stay. They have a great respect for the electric fence - it only takes one time of contact and their memory is imprinted forever.

The pups need to be COMPLETELY bonded with the goats for them to be successful guardians. I do not pet the pups nor do I let anyone else pet them. They are handled when receiving vaccinations or heartworm medication. The pups will come around and "check in" when someone goes into the pasture to check the goats. The pups' presence is acknowledged with a quick "pat" on the head and they are encouraged to "get back to the goats". Once they are completely bonded, then an extended head pat and neck rub, which is an acknowledgement to them, is given. They are usually about 6 to 8 months old when this begins to happen. However, each pup is an individual, maturing at a different rate than littermates, so take care that they are totally bonded before befriending. And remember, the guardians are for the goats.

Weaning the Pups

Once the pups are 6 weeks old, the extra supplemental meal fed to the bitch is eliminated and she eats dry food only. This initiates the "milk" drying off process. The pups are encouraged to eat more food fed in individual pans and the self-weaning has begun. By the time they are 8 weeks old, they have weaned themselves. We leave the bitch with the pups if self-weaning has been successful. This allows the pups to travel with their mother and start learning the ropes of becoming a successful guardian. Should self-weaning not succeed, the bitch is removed from the pasture, and an older, neutered male is placed with the pups as "teacher/mentor". The pups stay with the kids to weaning; weaning the kids at 3 months of age.

It is now time to introduce the herding dogs (Border Collie, New Zealand Heading dog and Huntaway). The guardian pups are still in the "apprehensive, curious" phase of development so they more readily accept the working dogs. As the goats are moved to different areas to clean brush and browse, the pups are mustered with the goats by the herding dogs. The pups learn to travel with the mob and to not challenge the herding dogs.

The weanoffs are separated into two groups; the doelings (disbudded) and the wethers/bucklings (horned). At weaning, the pups and their "teacher" go with the doeling weanoffs. The pups will stay with the doelings until they are approximately as tall as the doelings. It is important to keep the pups with a group of goats that are just slightly larger than the pups are. This prevents the pups trying to "play" with the goats. When they try to become too aggressive or assertive, the goats are large enough to convince the pups they do not want to proceed with bad actions. Once the pups reach a point where they need to be removed from the doeling mob, they are taken to the wethers/buckling group along with their "teacher". It is also at this time when they learn to eat from self-feeders.

The wethers/buckling mob is physically larger and the bucklings less tolerant of "playful" pups; they straighten the pups out right away. It is at this point in “facilitation time” that the litter of pups is separated. Only 2 pups are kept together with an older (mentor) guardian. When the 2 pups are almost as tall as the goats, they are moved to either a doe mob, or in with a group of yearling bucks. These mobs are each being guarded by a minimum of three experienced dogs. They will stay with this size of goat until they are a year old. But, they will be exchanged every few weeks so that all the pups will be with other mature guardians and other pups. Do not keep the same two pups together. I prefer to only have one pup with other guardians but sometimes we have as many as 10 to 12 pups at a time and it makes logistics difficult. I like my dogs to be able to work together with any dog they may be placed with in the future. They have to be adaptive in acceptance to all livestock guardians and all classes of goats.

Evaluating the Maturing Dog

Up to this point, the maturing dogs have been in an area that has coyotes and domestic pack dogs as predators. They will be in this setting as yearlings. Between one and two years of age the guardians will participate in at least three kiddings. They are observed for their active guardianship of the young kids and does. Their personalities and temperaments are critically assessed. This is a major turning point in time when any guardian not "passing the test" will be culled. At about two years of age, they go into densely forested areas to guard and now in their guarding career will be faced with the possibility of encountering bear. Here they are guarding in higher elevation vegetation; lots of dense brush, blackberries, downed timber (or harvested area) and trees. Guarding in the mountains will round out their guarding experiences and I now consider them mature, experienced livestock guardians. The goats they are guarding under these vegetative conditions are mature wethers and mature does.

It takes time and a sincere effort to facilitate the success of a livestock guardian dog. They will save you many dollars and heartaches. A mature, experienced guardian is irreplaceable and commands respect. Goats Unlimited would not be successful without them. And it is to the "livestock guardian dog" that I am grateful.

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Chapter 13

# Low-Stress Handling
# and
# Behavior of Browsing Goats

An Peischel

Physiological and psychological effects of STRESS on the goats has a major impact on production performance and health. It is therefore critical to have a basic understanding of goat behavior (social, nutritional, environmental, etc.) so as to enhance the welfare and well-being of the goats. The stockman needs to be observant, patient and understand that individual or small mob dynamics do not necessarily work with large commercial mobs; therefore use caution when drawing conclusions. Sit out in the brush with a waterproof notebook and a ham and cheese on rye - !! observing !!

When using goats for ladder fuel reduction, fire breaking, weed abatement, riparian area restoration…….there are basic behavioral patterns that can be used to enhance utilization of the goats, manage vegetation to avoid erosion or to curtail problems before they arise.

The selection of environmentally adapted goats with the goats in good physical condition is conducive to success. Before placing goats into a new fenced area allow the livestock guardian dogs to check out the area first. When the dogs complete their rounds, let the goats in. Once in the new area, the goats will circle the fence line, check out the vegetation and then begin browsing.

In plant selection goats eat from the tip of the plant toward the base, selecting the highest quality the first time around. They eat the seed heads from grasses and forbs and select flowers of thistles and some brush species. Mobile lips and bipedal capabilities afford them the ability to select young buds, create a 6 to 8 foot browse line and knock down vegetation high in cellulose and lignin.

When browsing, goats are always on the move – nibbling on one plant while on the lookout for the next selection. They consume vegetation from the outside perimeter toward the center of an area, cautious not to put themselves in a situation they cannot see out of. This behavior relates back to the predator/prey concept they have evolved with. Goats will turn, face an attacker and become aggressive. When herding on foot or with herding dogs, be cautious with the amount of pressure exerted as it forces them into the attack mode and they will attempt to escape. If an escape happens, let the individual(s) return to the mob on their own accord. The goat is social (bonded to the mob), wants to be part of a group and does not want to be out there by itself. The stockman needs to know why the individual(s) left the mob and correct the situation immediately so as to not encourage others to escape. Be conscious in rolling/hilly terrain to move goats up hill, not down hill. They naturally select the highest spot geographically for afternoon naps and night camps - it affords safety without obstruction.

Be sure the goats are trained to electric fence before expecting them to respect the fence. Take into consideration when using "fencing" that browsing behavior, time spent browsing, rumination time, lounging time and flow pattern of motion will change. Water needs to be provided in smaller troughs with a high rate of recharge. Goats will drink one gallon or more a day if high quality water is provided. This consumption helps keep the rumen microflora colonized increasing digestion of cellulose. If you are in a situation where night corralling is to be used, it is important to have on offer a supplement as intake will be decreased and body condition score will decline.

Goats have minimal subcutaneous fat and are susceptible to climatic changes of wet and cold. They will seek shelter during inclement weather so be sure a brush canopy, trees or rock outcroppings are accessible. If not, be responsible and creative with portable shelter. Older goats can manage about 48 hours of extreme weather but younger animals can succumb to death in about 12 hours. They cope with heat and humidity quite well but on occasion change browsing patterns and time of browsing (including plant selection) as the temperature soars.

Goats are opportunistic, agile (jump, dig holes, squeeze), curious and capricious. There is a dominance structure within the mob and they will form small familial "groups" within the larger social structure of the mob itself. This is very crucial for young animals as bonding teaches browse selection, establish browsing territories, encourages various athletic habits and increases survival rate.

Sensory capacity of the goat comprises smell, taste, sound (above the range of human hearing), vision (peripheral vision), vocalization, body language, touch and group size.

During kidding, important behavioral aspects to consider are predator-prey response concept, your body language and bonding (maternal labeling) necessary for survival. Eye contact is disturbing to a doe concealing herself and kids in the undergrowth. When approaching under these circumstances, do not look at the doe, use peripheral vision (and do not wear sunglasses!). Approach in a slow yet continuous motion. Be conscious of your body profile - you are less invasive sideways. Always approach from your "disadvantage" point. In other words, let the doe have the high point and look down on you approaching. Don't make her look up as that challenges her fright/flight pattern. Bonding between dam and kid is the key to survival in the brush. They develop a communication system alerting each other to approaching danger. To enhance this bond, do not move the does and kids into a new area until they are at least 7 days old.

Time and patience is a virtue. Goats can be taught to adapt to change: herding on horseback or bicycle, loading readily into a stock trailer, decrease of social interacting space and the ability to cope with an individual stress for a short period of time. Temperament is not only a heritable trait (25%), but can be enhanced by imprinting at birth and the creative insight of the herdsman. Give the goat time to assess the situation as they do make calculated decisions.

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## *UNDERSTANDING ANIMAL BEHAVIOR AND NATURAL RESOURCE MANAGEMENT*

(Introduction, Social Structure, Physical Features, Environment, and Food)


## INTRODUCTION:

This assessment tool is designed to help understand animal:

- Movements
- Eating preferences
- Location preferences
- Overall activities

The principles listed here can make a difference in how you manage your land and animals or how you advise others to do so. These principles can make a difference in animal performance, natural resource conditions, and farm or ranch profitability. Tailor this information to benefit your operation and resources.

First of all, slow down and observe animals. Your work is completed faster and the job is of a higher quality when you slow down. Once animal behavior is understood, resource management strategies can be developed in harmony with them. Some types of behavior are genetically determined or instinctive; others are learned behaviors shaped by environment and consequences. This document will focus on learned behavior.

Learned behavior is developed in response to animal experiences, or consequences. Positive consequences encourage a behavior, and negative consequences discourage a behavior. An animal's behavior is related to its environment, including kinds, age, number of other animals present, availability of food and other resources, terrain, climate and its interaction with people. When environment changes, behavior also changes. Understanding how our actions can result in certain animal behavior is important to properly manage and sustain natural resources. Properly managing animals will:

- decrease stress on you and the animal,
- reduce injury,
- increase longevity of structures such as fences, corrals, barns, and heavy use areas,
- and improve overall animal performance.

## SOCIAL STRUCTURE:

*Bud Williams Class*

**Moving animals –**

- *Identify lead animals* -
  Observe first animals through the gate and/or first animal to respond to your management. These animals can assist you with the movement and placement of the other animals.

- *Observe last animals through the gate* -
  The last animal through the gate may be sick, hurt, old, or just plain slow

- *Moving animals from one area to another* -
  Train animals to move as a group using a reward such as fresh grass or a small amount of feed supplement. Animals that do not respond to training over a short period should be moved out of the herd or sold. Many times the stubborn individual or "hard head" can adversely influence others.

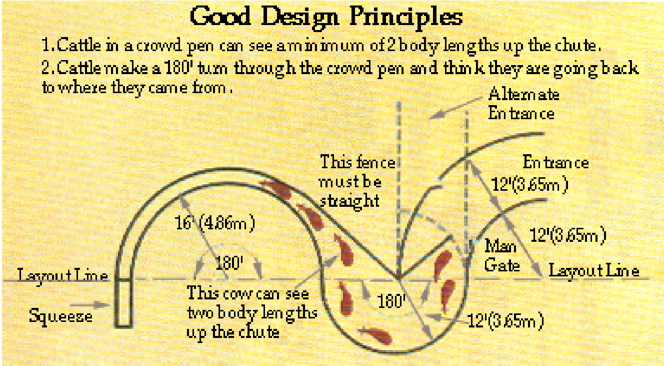
- *Placing and Settling animals*-
  - Slow down and speak in a normal voice.
  - Designate one person to call the animals and another to keep the group together.
  - Operate on the edge of the flight zone when herding animals. As you move toward the animal the flight zone is the distance you are from the animal when it begins to move. Location of the flight zone will vary considerably. Move in and out of the flight zone to apply and release pressure. Do not constantly apply pressure. Removing pressure is a positive consequence. Slight movement by the handler can make a big difference in animal reaction.

*Bud Williams Demonstration*

- Get individuals to herd-up by slowly riding or walking in a broad zig- zagging movement back and forth on the edge of the flight zone.
- When moving livestock, position yourself so the animal can see you or the animal will turn or spin around because it cannot see you.
- Direct the lead animals, not the animals in the back.
- Riding in the opposite direction of herd movement increases herd speed.
- Riding parallel, in the same direction as the herd slows movement.
- Movement draws movement. Other animals tend to join those already moving.
- A horse or a 4-wheeler moves faster than a cow, so slow down and do not apply excessive pressure.

- *Settle animals after moving them to a new area* -
  Allowing animals to start grazing prior to leaving them settles and calms them so they are more likely to stay in the area they are placed. When necessary apply only enough pressure to keep animals in the desired area.

SOCIAL STRUCTURE (continued)




*Temple Grandin Corral Design*

**Handling Animals -**

- *Layout of corral –*
  Crowd pens should be on level ground and only be filled half full. Width of a V-shaped chute is 18-inches at bottom and 32-inches at a height of 5-feet, or 28-inches wide for a straight chute. Crowd pens work best if animals can see 2 to 3 body lengths up the single file chute before it curves. Animals go around the curve thinking they are going back where they came from.

- *Moving animals easily through the chute -*

*Walk through the chute at the animal eye-level watching and listening for distractions. Animals have a wide angle of vision, and they are easily frightened by shadows or movement outside the chute. Noise should be kept to a minimum because animals have sensitive hearing. Cattle, pigs, goats, and sheep are herd animals, so isolation of a single individual should be avoided. Animals which have frequent gentle contact with people will be less stressed during handling than animals which have had previous aversive treatment (negative consequences).*

- *Tools to use in persuading animals to move -*
  Electric prods or loud noise should be used only as a last resort. Walking on the outside of the chute toward the animals in the chute will often cause the animals to run up the chute trying to escape. After getting the desired group to move up the chute, step away from the chute. Another alternative is use of rattle sticks or a plastic bag on the end of a stick.

## PHYSICAL FEATURES

*photo by Greg Brann*

### Topography-

- *Rough topography makes it difficult for animals to easily see each other and respond to your management -*
  - Tools such as a bull horn or loud feed wagon may help in calling animals.
  - Animals typically prefer to move across the slope and up and down the edge of drainage-ways.
  - See Structure section for locating facilities.

Soil- ***not every soil is suited to every landuse***

- ***Be aware of resource limitations –***

  **Match vegetation to soil, climate, animal nutritional needs and management. Organic matter can be improved through proper management of forage and manure deposition. Overgrazing and trailing can quickly destroy soil and future production.**

- *Concerning shallow, poorly drained soils or very droughty soils-*
  It may be best to use areas with these soils in only certain seasons or use lighter animals that make less impact on the soil. Time when soils can be used most extensively:

  - Shallow soils in fall and early winter
  - Poorly drained soils in summer and fall
  - Very droughty soils in winter and spring
  - Deep well drained soils all seasons

  Drainageways –

  Drainageways are susceptible to erosion - Plan fences and placement of facilities so animals are less prone to travel or excessively trample drainage-ways. Long, sloped trails are prone to erosion and can be direct conduits to water areas. Runoff can be controlled with diversions on small watersheds.

PHYSICAL FEATURES (continued)

*photo by Adam Daugherty*

**Structures-**

Carefull considerations should be given to the placement of fixed structures such as barns, fences, corrals, feeding areas, shelters, shelterbelts, and cross fences. They can be relocated but typically at high cost.

- *Consider these points when sighting structures*-
  Areas frequented by high concentrations of livestock typically need to be located in a well drained area away from drainage ways. Trailing can be anticipated between feed areas and watering points. Locate fences and facilities to avoid trailing in areas prone to erosion or other sensitive areas. A good rotation or rest period reduces trailing problems

- *Addressing runoff water* -
  It is important in high rainfall areas to direct runoff water away from problem areas in order to reduce mud. Use guttering, grassed waterways, rock, prescribed grazing or use exclusion to manage runoff.

- *Addressing heavy use areas* -
  As animals turn to leave a facility, such as a water trough or feed area, soil tends to dig out. These areas can be protected with deep gravel and geo-textile, concrete or other stable material.

- *Consider placement of gates* -
  Gates located so animals enter straight or up to a 45-degree angle turn will reduce wear of the gate area. Fences up and down hills that cross small drainage ways will help reduce runoff down trails.

- *Lane or trail transition* –
  When lanes transition from soil or rock to concrete, a hole commonly occurs. A pile of lime for animals to cross at the end of the concrete prevents the hole and stone bruises. Animals lose big rock in lime. Replace lime pile as needed.

# ENVIRONMENT


Climate-

- ***Select animals adapted to your climate and vegetation -***
  Observe grazing time, panting, hair coat length, etc.

- *Consider animal comfort -*

**Climate is fixed. However, the micro-climate can be modified.**

Shade and increased vegetative cover can lower temperatures in hot months. Windbreaks can reduce the chill effect in winter. Misting can be used to cool confinement animals. Misting works best in an arid environment. As little as a ten-foot difference in elevation can cause a dramatic temperature shift.

- *Thermal Neutral Zone for different species*
  Cattle are most comfortable if temperature is between 59$^{o}$F and 79$^{o}$F. Intake is decreased when temperature is above 79$^{o}$F, intake increases when temp is below 59$^{o}$F. Intake is reduced when the animal is wet and temperature is below 59$^{o}$F. Energy requirements are increased as wind speed increases, particularly when the animal is wet and cold. Intake is reduced further when temperatures are not substantially cooler in early morning relative to temperatures at sun down especially if no shade is available.

**Aspect or exposure-**

- *The effect of landscape exposure on vegetation can be managed*
  North and east exposures typically have less evaporation so they hold moisture longer and respond best to use in the summer and fall. Flat deep bottomlands hold the most moisture for summer and fall. South and west exposures typically warm up first in the spring.

ENVIRONMENT (continued)

**Water-**

The area grazed is typically in a radius from the watering point. If all water sources are strategically located and access is controlled with fence, herding, or valves, the animals foraging location can be somewhat controlled.

- *Observe the distance animals effectively graze from the water* -
  Evaluate utilization incrementally from the water point to decide the need for additional water.

- *Evaluate water quality* -
  Dissolved solids, algae, urine and feces, sediment, temperature, and chemistry (i.e. Sulfur, Nitrate) all affect water quality and water consumption.

- *The following diseases have the potential of being transmitted through water:* Anthrax, black leg, foot rot, tuberculosis, leptospirosis, samonellosis, brucellosis, foot-and-mouth disease, coccidiosis, and erysipelis. Additionally, blue-green algae is toxic to all classes of livestock.

*photo by Greg Brann*

**Landcover-**

Landcover should be suited to meet the demands of animal behavior.

- *Evaluate landcover* -
  Excessive trailing and denuded areas signal a lack of water, overstocking, overgrazing, and possibly the need for another vegetative type.

- *Observe animal grazing periods* -

Cattle normally graze for six to eleven hours per day, in two major periods, just before dusk and just after dawn, with shorter periods during the day or at night. If not, toxins may be affecting the animal's activity (i.e. animals that graze endophyte-infected tall fescue often stand in ponds for hours).

ENVIRONMENT (continued)

- *Observe animals for normal rumination* -

Adequate rumination indicates a balance of fiber and nutrients in the diet. After a grazing period, the ruminant animal rests and ruminates, regurgitating the forage, chewing, mixing it with saliva, and swallowing it again. Rumination time ranges from five to nine hours daily. Maximum time spent ruminating is 9 hours. Mature ruminants are more efficient at ruminating than young animals.

- *Observe animals for normal shedding in the spring* -

Failure to shed normally could indicate a mineral imbalance like a copper deficiency or the effect of grazing endophyte-infected tall fescue.

- *Moving animals to new locations* -

Animals often suffer more from malnutrition, reduced intake, predation, and over-ingestion of toxic plants when moved to unfamiliar environments.

*photo by Greg Brann*

**Conditioning animals-**

- *Conditioning animals to adapt to new environments* -
  - Animals make better transitions from familiar to unfamiliar environments if they are moved to areas where the foods and terrain are similar to what they have experienced.
  - As a rule, animals with no experience with the foods or habitats in a new location make the transition better when they are moved from resource-poor environments – (where plants are scarce, dispersed over rough country, low in nutrients, and high in toxins) - to resource-rich environments (where nutritious plants are abundant) than vice-versa.
  - When introducing animals to a new location, it can be helpful to mix experienced and naive animals together. This does not work when animals forage with companions instead of strangers.

**Conditioning animals (continued)-**

- Prior to moving animals, introduce them to foods they will eat in new environments, or provide them with familiar foods when they first arrive in new areas.

- Animals in poor body condition are more likely to consume toxic plants and become sick.

- *Mothers Know Best!*

It only takes 1 hour per day with its mother for 5 days to condition an offspring to eat foods in the future. Even three years later with no additional exposure to wheat, intake of wheat is nearly 10x higher for lambs that are exposed to wheat with their mothers than if inexperienced lambs are exposed alone.

- *Weaning* -

Consider creep grazing calves prior to weaning then confine cows and calves to their respective sides of the fence at weaning.

- *Electric Fence* -

If you plan to control new animals with electric fencing confine them to a small area fenced with electric fence to condition animals to respect electric fence.

*photo by USDA/NRCS*

**Excretion -**

Cattle, sheep, and goats normally defecate 10 to 18 times and urinate 6 to 11 times daily. Losses differ for various nutrients. Under continuous stocking, excretion concentrates nutrients on only about 20 percent of the pasture. It also reduces the amount of grazable forage due to cattle avoiding dung and urine patches. Stock camps (water, shade, salt areas) further concentrate the excreta. Locating water, salt, and shade in separate areas can reduce the problem.

**Execretion (continued)-**

- *Mixed species grazing* -
  Cattle, sheep, and goats do not avoid grazing around each others' manure, and animals consume different plant species so they do not strongly compete for forage.

- *Reduce animal waste accumulation and cost of manure handling and storage*-
  When gathering dairy cows, allow them to stand a minute prior to moving them to the milk parlor. This will allow a high percentage of excreta to drop on the pasture and not in the lane or parlor.

*photo by USDA/NRCS*

**Wildlife Interaction -**

- *Livestock production can benefit wildlife* -
  - Livestock can be used as a soil disturbance tool to initiate plant diversity, to remove excess growth, and to keep vegetation in a higher quality state.
  - Rotational grazing improves cover for wildlife by creating varying vegetative structure in different paddocks.
  - Wildlife are always the first grazers, which means they get the highest quality vegetation. Wildlife have access to the area 100% of the time where as livestock are rotated in and out. (i.e. 5 paddock system: livestock are in any one paddock only 20% of the time)

- *Wildlife nuisance* -
  Animals such as coyotes, turkey vultures, and dogs can become a nuisance, especially after improper animal disposal. Coyotes may reduce varmint populations; however, they may also feed on small and young livestock.

## FOOD
**(Forage and Feed)**

**Each class of livestock has general nutritional requirements. However, these requirements can vary widely from individual to individual.**

*Photo by Utah State Univ.*

- *Different species of animals have different grazing preferences-*
  Most operations have one species of animal and one or two classes within that species. The species and class of animal can be changed if needed to better fit the environment of your operation. (i.e. Wet soils that pug in the winter may be better suited to having feeder cattle in the dry season versus cow/calf operation year round). Another scenario is operations with thin soils that only produce in one season could be managed to have a high density of animals present during that one season.

  While experience plays a vital role in shaping an animal's preferences for foods, the physiology of the animal also influences preference. In general, sheep and goats are better able to detoxify the toxins in plants and tend to eat a wider variety of plant species compared to cattle or horses.

**MIXED PASTURE**

| Animal Species | Type of Diet (%eaten) | | |
|---|---|---|---|
| | Grasses | Broadleaf weeds and legumes | Browse [1] |
| Cattle | 65 –75 | 20 – 30 | 5 – 10 |
| Horses | 70 – 80 | 15 – 25 | 0 – 5 |
| Sheep | 45 – 55 | 30 – 40 | 10 - 20 |
| Goats | 20 – 30 | 10 – 30 | 40 – 60 |
| White-tail deer | 10 – 30 | 30 – 50 | 30 – 50 |
| Elk, red, and fallow deer | 30 – 60 | 40 – 50 | 10 - 30 |

[1] Shrubs or trees.

SOURCE: D. Forbes and G.W. Evers, Texas A&M Univ.; D.I, Bransby, Auburn Univ.; M.A. McCann, Virginia Tech Univ.; and W>R> Getz, Fort Valley State Univ. IN Southern Forages 3rd Edition

FOOD (continued)-

- *Select livestock from an area with similar vegetation* -

The foods and forages animals eat when they are young have a profound effect on their dietary preferences when they are mature. Select replacement animals from areas with vegetation similar to that on your farm or ranch.

*photo by Greg Brann*

- *Forage mixtures or mono-cultures* -

Planting mixtures of forages rather than monocultures enables animals to meet their own unique dietary requirements, and potentially increase productivity. Blocks of different forages improve animal utilization within a pasture rather than mixed plantings. However block plantings are more difficult to manage.

- *Consider providing animals a choice of energy and protein sources* -

Animals have requirements for protein and energy but the ratio of these two nutrients in the diet is also important.

- A common way to express energy is as total digestable nutrients (TDN)[ENERGY] Total Digestible Nutrients (TDN) to [PROTEIN] Crude Protein (CP) ratio (TDN:CP) of 7 (i.e. 60/8.6 = 7) is ideal.
- Cattle will benefit from additional protein when grazing forages with TDN:CP above 8 (i.e. 60/7.5 = 8).
- Cattle grazing forages with a TDN:CP ratio below 5 (i.e. 60/12 = 5) have improved performance when supplemented with energy.
- Offering animals choices in the feedlot and on pasture will enable animals to keep a constant ratio of energy to protein in their diet and improve feed efficiency.

- *Toxic Plants* -

All plants contain toxins. Unpalatable plants are either low in nutrients, high in toxins, or both. Toxins normally do not cause illness and death. Instead, they limit how much of a plant an animal can eat. Detoxifying plant toxins requires additional nutrients in the diet.

FOOD (continued)-

- *Palatability* -

  Palatability is the interrelationship between flavor and postingestive feedback from nutrients and toxins, determined by an animal's physiological condition, a food's chemical characteristics, and an animal's experiences with the food.

*photo by Jenny Adkins*

- *Introducing animals to endophyte-infected pastures* -

  Toxic alkaloids that occur in endophyte-infected grasses cause food aversions in ruminants. Eating small amounts of infected grass causes a mild aversion in ruminants, and naive animals will learn to regulate intake of the grass. But if naive animals ingest large amounts of the endopyhte, they will suffer severe illness and may permanently decrease intake of the grass.

  When introducing naive animals to endophyte-infected pastures, don't turn hungry animals onto infected pastures. Restricting access to infected pastures for the first week or two after arrival, or filling them up with hay prior to turning them onto to endophyte-infected pastures, may prevent over-ingestion of the endophyte and permanent reductions in intake.

  Offer animals a variety of foods and make sure that they are on a good plane of nutrition when they eat endophyte-infected plants. The sequence in which foods are eaten can affect preference for foods with toxins. Animals can eat more plants that contain toxins without suffering aversive effects if they also consume nutrients sufficient for detoxification compared with animals eating diets low in nutrients.

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Stockmanship, A powerful tool for grazing lands management, Steve Cote

# Carbohydrate Reserves: What You Learned May Be Wrong

For many years, managers have used the carbohydrate reserve theory to decide when grazing should occur to maintain healthy plants. This theory states that the soluble carbohydrates stored in the roots and crowns of plants indicate plant health and ability to regrow following grazing. According to the theory, during the early vegetative stage of plant growth, carbohydrate "reserves" are low, so plants should not be grazed. During late vegetative and early reproductive stages of growth, carbohydrate "reserves" are higher, and plants can better tolerate grazing (see figure 1). Over the years, a great deal of research has been conducted to produce carbohydrate concentration curves for grasses, forbs, and shrubs, as illustrated below.

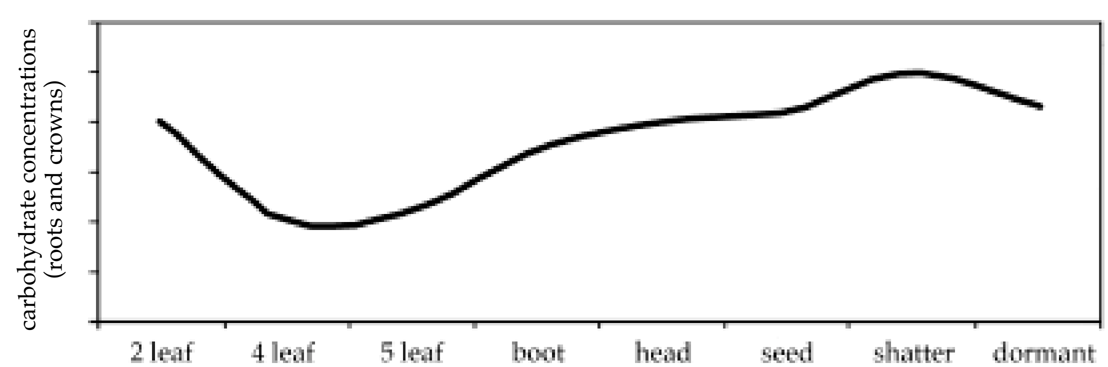
Unfortunately, carbohydrate reserves in plant tissue are poor indicators of a plant's ability to tolerate grazing for several reasons:

1. Carbohydrates are typically measured as concentrations that change only a small amount over the year, but fluctuate widely during the day.

2. Concentrations do not reflect the total amount of carbohydrate available for regrowth following grazing. To accurately measure the total pools of carbohydrate available for regrowth, the concentration of carbohydrates in different plant tissues - roots, crowns, leaves, stems - must be multiplied by the amount of biomass in each of those tissues. Most studies analyzed only the roots and crowns of plants, but stems in grasses and twigs in shrubs are also important storage sites for soluble carbohydrates.

3. Carbohydrate reserves, whether expressed as concentrations or as total pools, are not correlated with the ability of a plant to regrow after it has been grazed. Nor are the rate and amount a plant can regrow in the absence of light - regrowth that depends entirely on stored reserves - correlated with either the concentration or the total amount of carbohy-

**Figure 1. Carbohydrate concentration curve for grasses, forbs and shrubs.**

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drate reserves stored in the roots or crowns of the plant.

4. The carbohydrate reserve stored by bunchgrasses is small - equal to about 1 to 2 days of photosynthesis by a bunchgrass during the summer.

So, what factors are important for a plant to tolerate grazing?

**Plant morphology.** Differences in morphology enable some plants to better tolerate grazing.

1. Grass, forb, and shrub species that produce and maintain many viable axillary buds tolerate grazing because they have the potential to regrow following grazing.

2. Grass, forb, and shrub species that protect meristems (growing points) have the potential to regrow quickly following grazing, thus reducing the amount of nutrients and water needed to regrow. Some grasses and forbs do not elevate apical meristems until late in the growing season, thereby protecting meristems from grazing.

3. Grasses that develop tillers at different times during the grazing season tolerate grazing better than plants that do not, because not all tillers can be grazed at the same time.

**Plant physiology.** Differences in physiology enable some plants to tolerate grazing better than others.

1. The ability to regrow quickly following grazing is important because it enables plants to quickly reestablish leaf tissue that creates energy through photosynthesis. Plants that regrow quickly often have increased photosynthetic rates in regrowth and remaining foliage.

2. A superior ability to compete for resources - water and nutrients - needed to quickly regrow enables some plants to tolerate grazing better than others.

3. In some plants, grazing stimulates absorption of nutrients like phosphorus, which enables those species to tolerate grazing better than others. However, in many species, removal of leaves and stems decreases nutrient absorption because of a decrease in the root surface area.

4. Plants that quickly move resources among shoots or from roots to shoots tolerate grazing better than plants that do not. This enables rapid adjustment of carbon and nutrient distribution among plant parts, which enhances competitive ability and survival.

So, what does this mean for managers? Based on carbohydrate reserve theory, grazing was delayed until forage reached the boot stage of growth, which is the most detrimental time to graze plants in arid regions. When plants are grazed during the boot stage, apical and intercalary meristems responsible for plant growth are removed and regrowth must occur from axillary buds at the base of the plant, a slow process that requires moisture and nutrients at a time when those resources are dwindling. Conversely, grazing during the boot stage in wetter regions stimulates tillering from axillary buds in grasses and forbs, resulting in the production of nutritious forage.

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# Behavior Depends on Consequences

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Every time you let your dog out of the house, it's the same scenario. He stays by your side for a few minutes, until you get busy working. The next thing you know he's down the street. When you yell at him to come home, he runs the other way. Finally, you track him down, give him a couple of swats, and throw him in the kennel. On your way back to the house, you notice your neighbor's dog. He rarely leaves the yard. When his dog strays, a quick whistle and he's back, greeted with praise. What a great dog, you think to yourself. How did I get such a worthless mutt?

Your dog probably isn't worthless but your training methods may be. All animals behave as they do based on the consequences of their behavior. Every behavior has a consequence, and the likelihood of a behavior continuing depends on the consequences of that behavior. Consequences fall into one of two categories - reinforcement or punishment. Understanding how consequences influence behavior is the key to changing behavior.

**Reinforcement.** Consequences that increase the likelihood of a specific behavior reoccurring are called reinforcement. They can be either positive or negative. Creatures seek positive reinforcers. When a hungry animal searches for a nutritious food, or a thirsty animal walks to water, or a hot animal seeks shade, they do so because food, water, and shade are positive reinforcers - they are things the animal wants and needs. Conversely, animals avoid negative reinforcers. When a hungry animal searches for a nutritious food, or a thirsty animal walks to water, or a hot animal seeks shade, they do so to get relief from aversive stimuli - hunger, thirst, heat. The difference between positive and negative reinforcers is the difference between "want to" and "have to" and that distinction is huge in both animal and human systems. All creatures perform best when they want to rather than when they have to.

**Punishment.** Consequences that decrease the likelihood of a behavior reoccurring are called punishment, and they also can be positive or negative. Positive punishment is the presentation of an aversive stimulus. When livestock get shocked for touching an electric fence, they stop touching the fence. When employees are harassed for making suggestions, they stop proposing new ways to do business. Negative punishment is the removal of a positive reinforcer. When a goat eats a plant that was once nutritious but is no longer, or when a ewe walks away each time her lamb attempts to nurse during weaning, both the goat and the lamb decrease rates of responding (eating the plant, nursing) because a positive reinforcer (nutrients, milk) has been removed. Punishment - positive or negative - decreases rates of responding.

**Negative can be counter-productive.** There is a growing movement away from reliance on punishment and negative reinforcement. Both arouse anger and fear in animals. If strongly aversive stimuli are used, these emotions slow learning and may lead to results opposite those intended. A submissive dog may attack its owner if beaten. A child may become unduly shy and nervous if parental punishment is too severe. Punishment by withdrawing a positive reinforcer produces characteristic forms of

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emotional reaction - disappointment or depression - in people. Withdrawal of strong reinforcers may produce serious emotional reactions, the most obvious example being the death of a loved one. People who are close to us provide many positive reinforcers. When they die, those reinforcers are suddenly withdrawn. The same is true when animals are moved from familiar to unfamiliar environments. All the positive reinforcers they have come to know are suddenly removed. No wonder they wander for miles, become malnourished and ill, and don't reproduce. Performance is poor, and stress is high, because all the familiar positive reinforcers have been removed.

**Positive is better.** Behavior is better shaped by positive reinforcement than by negative reinforcement and punishment. While coercion can quickly change behavior, its long-term negative consequences - stress and the desire to escape the circumstance and avoid anything remotely related - far outweigh its short-term benefits. People who work for a boss who continually threatens to fire them unless they shape up (negative reinforcement) are much less productive than people who work for someone who appreciates their efforts (positive reinforcement). Coercion causes stress, which reduces performance and profits. Livestock can be forced to move through chutes and in feedlots with hotshots, but it may cause other unwanted behaviors like jumping and kicking. Livestock move readily in properly designed systems when they are worked gently and rewarded, for instance with grain, for moving through chutes and in feedlots. It is less stressful on animals and on people.

**Combination is best.** A combination of positive reinforcement and punishment or negative reinforcement may be the most effective way to change animal behavior. For example, when moving cattle out of riparian areas, it is ineffective for a rider on horseback to simply scatter cattle out of the bottoms (negative reinforcement) because they will quickly return. If, however, the rider moves the cows as a social group to a new area with water and palatable forage (positive reinforcers), they are more likely to stay. The trick to moving is to keep something interesting in front of them, making sure each step is toward the destination, and letting cattle move because they want to go, never aware they are being driven. Through punishment, animals can be trained to avoid a palatable plants like trees with high agronomic value or poisonous plants if the first few times they eat the plant they are given a dose of a toxin (positive punishment) that makes them sick. Nevertheless, the aversion will not persist unless animals have access to other nutritious foods (positive reinforcement). For training to be most effective, it's not enough to simply discourage unwanted behavior. Animals need to be encouraged to replace unwanted behaviors with desirable behaviors.

**Upshot.** So why does your dog run off but your neighbor's dog stays home? You don't pay attention to your dog (negative punishment), until he runs away. Then, when he returns or is captured, you beat him (positive punishment). No wonder he doesn't want to be around you. Your neighbor understands that dogs are social animals, so he spends time petting, playing, and interacting with his dog (positive reinforcement). Your neighbor uses positive reinforcement when training his dog and rarely has to correct his dog's behavior. When he does, punishment is immediate, consistent and leaves no doubt with the dog that the behavior should not be repeated. Your neighbor understands that behavior depends on its consequences.

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# Learning What to Eat and What to Avoid

Young herbivores learn which foods are harmful and which are safe through interactions with their mothers. Throughout life, they learn about the consequences of eating through postingestive feedback they experience after eating foods. But how can they do this in a world where toxin and nutrient levels of forages change daily and seasonally? How can they possibly learn and remember all the plants that grow in pastures and on rangelands? How can they survive when we move them to new pastures with unfamiliar foods?

Several factors that enable herbivores to determine which foods to eat (palatable, nutritious, safe) and which to avoid (unpalatable, toxic, low in nutrients). By understanding these factors, livestock producers can preserve weight gain and productivity even when moving their animals to new locations, or introducing them to new feeds.

**Herbivores don't eat that many foods.** When we look at a rangeland or pasture we often see tens or hundreds of plant species but in reality only a few plants make up the bulk of an animal's diet in a meal. In one study a pasture contained 100 plant species but 5 species made up 65% of the diet. The remainder of the diet was made up of 7 species or more depending on the animal but each of these plants made up less than 10% of the diet. In general, 3 to 5 species make up the bulk of the diet and the remainder of the diet is made up of plants eaten in small quantities.

**Mom provides a framework.** A young animal first learns about which foods to eat and which to avoid by foraging with its mother. By the time the animal has to forage on its own, it is already familiar with a number of plants that are nutritious and safe to eat. Thus, an animal divides its foraging world into two food groups, familiar and novel. Animals learn through trial and error about novel foods based on the postingestive consequences of the novel foods they eat.

**Novelty.** Herbivores sample novel foods cautiously. If the consequences of eating the food are positive—feedback from needed nutrients—the animal will increase intake of the new food. If consequences are negative—illness from toxins or lack of feedback because the food is low in nutrients—the animal will decrease intake of the food.

When eating a meal of several foods, novelty is the key to figuring out which foods are harmful and which are nutritious. When animals eat a meal of several familiar foods and a novel food and then experience illness, they subsequently avoid the toxic novel food. Conversely, when animals suffering from a nutritional deficiency recover after eating a meal of several familiar foods and a novel food, they learn to prefer the nutritious novel food.

Herbivores also reduce intake of familiar foods when the flavor of the food changes. Changes in flavor may occur when forages grow on different sites or as the plant matures. If the change in flavor results in illness, the animal avoids the food in the future. If, however, the change in flavor results in positive consequences then the animal will continue to eat the food.

**Prior illness.** Herbivores continuously sample foods, even foods that made them ill. If an animal gets sick after eating a meal of several familiar safe foods and food that caused illness in the past, subsequently it will avoid the food that caused illness. Animals are able to remember which foods previously made them sick for a long time. For example, ewes given lithium chloride, a compound that causes food aversions, after eating a meal of caragena and Russian olive, subsequently avoided caragena but not Russian olive because they had been made sick on caragena two years earlier.

**Generalization.** Animals use past experiences with familiar foods to make foraging decisions about new foods. If new foods have flavors similar to foods that made the animal ill in the past, it is less likely to eat these foods. Conversely, if new foods have flavors similar to familiar nutritious foods animals ingest those foods more readily. Adding familiar flavors coupled with nutrients, such as molasses, can also increase intake of novel foods. For example, cattle increased intake of novel, weedy plants such as Canada thistle, spotted knapweed and leafy spurge after the plants were sprayed with molasses. Cattle continued to eat the plants even when they were no longer sprayed with molasses.

**Amount and timing.** If the foods an animal eats during a meal are equally unfamiliar and the animal experiences illness, how does the body determine which food to avoid? Animals pair feedback—positive or negative—with the food they ate in the greatest amount provided both foods are equally new. Animals also form aversions to or preferences for foods when food ingestion is quickly followed by either illness or positive postingestive signals provided the foods are equally familiar to the animal. For example, when lambs were fed two foods that were both somewhat familiar, lambs formed an aversion to the food they ate just before getting sick.

Research suggests sheep must eat a threshold amount of a novel food in order to discriminate among foods. For example, when lambs fed a maintenance diet adequate in nutrients were offered two novel foods for only 20 minutes per day, they preferred the less nutritious of two foods, presumably because it was most familiar. However, the lambs quickly learned to prefer the most nutritious novel food when the two novel foods were the only foods offered. Thus, lambs discriminated between the two foods based on the amount of food eaten and their nutritional state. Collectively, factors such as these influence palatability as food abundance, nutritional quality, and toxicity change daily and seasonally.

**Salience.** At one time researchers thought animals formed aversions to certain strong flavors more readily that others. They referred to these flavors as salient. Bitter, for example, was thought to be a salient flavor because many toxic compounds are bitter. Further study indicated that the response the scientists observed was simply due to novelty. When animals are reared on bland foods and get sick after eating a meal of several foods, one of which has a strong novel flavor, they form an aversion to the food with the strongest flavor. If, however, they are reared on foods with strong flavors and get sick after eating a meal of foods with strong familiar flavors and a novel bland food, they form an aversion to the bland food. Thus animals associate illness with novelty not necessarily with strong flavors.

**Conclusions.** A few simple rules can make a complex process like foraging relatively simple. Animals depend on the availability of familiar foods to make correct foraging decisions. When animals are moved to new foraging locations that contain only novel foods, it is more difficult for them to select safe nutritious foods and to avoid toxic foods. Understanding how animals discern safe from harmful foods is important information managers can use to help animals make transitions to new locations or train animals to eat new foods.

### Additional Reading

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# Grazing Response Index: A Simple, Effective Method to Evaluate Plant Responses to Grazing

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Monitoring gathers information about how rangelands respond to management over time. This information can be used to make changes in management. A good monitoring program provides information on maintaining or improving a resource while producing products like pounds of meat, clean water, and wildlife habitat.

When monitoring rangelands, managers routinely measure forage utilization or the amount of forage eaten. Unfortunately, monitoring utilization alone ignores other factors important to rangeland condition such as, how long animals graze, when they graze and growing conditions.

Recently, Colorado State University's Range Extension and Integrated Resource Management Programs developed the Grazing Response Index (GRI) to help managers evaluate the effects of grazing on rangelands.

**What is GRI?** GRI assesses the effects of grazing on plants during the current year and aids in planning grazing for the next year. GRI uses three factors related to plant health to evaluate impacts of grazing—*frequency* and *intensity* of defoliation (grazing), and *opportunity* for the plant to recover.

**Frequency.** Frequency is the number of times plants are grazed during a grazing period and depends on how long plants are exposed to grazing animals. Grazing the same area over an extended period of time allows animals to select the most preferred plants to their detriment. Grazing plants three or more times during a growing season reduces productivity and weakens them.

To estimate of how many times plants could be grazed during a grazing period, divide the number of days in the grazing period by 7, up to 10 if plant growth is slower. In late spring and early summer, 7 to 10 is the number of days it takes for plants to grow enough to be grazed again. Seven is more conservative, because it produces the highest probable number of times plants could be grazed.

| Number of Times Grazed | Days | Value |
|---|---|---|
| 1 | ≤ 7 | +1 |
| 2 | 7-14 | 0 |
| 3 or more | > 14 | -1 |

A value of +1 indicates that plants grazed less than twice would respond positively to grazing. A 0 value indicates that plants grazed about two times would be neutral to grazing—being neither depressed nor enhanced. A -1 value indicates the plants have been grazed 3 or more times and is excessive. Continuing to graze at this frequency would negatively impact plants.

**Intensity.** Intensity is the amount of leaf removed during the grazing period. Intensity is described using three levels of defoliation - light, moderate and heavy. Plants regrow more quickly if they are left with more leaf area. Generally, leaving 50% or more of the leaf material provides enough leaf area for plants to meet needs and doesn't inhibit plant regrowth.

| Grazing Level | % Utilized | Value |
|---|---|---|
| Light | < 40% | +1 |
| Moderate | 41-55% | 0 |
| Heavy | > 56% | -1 |

Light use, +1, promotes positive plant response because most of the leaf material remains. Moderate use, 0, enables the plant to maintain itself and its current status in the community. Heavy use, -1, would cause plants to decline in health, if this level of defoliation continues over several years. Placing cages in representative areas helps determine percent utilization during the grazing period. Cages must be moved each year.

**Opportunity.** Opportunity is the amount of time plants have to grow before grazing or to regrow and recover after grazing and is critical to maintaining plants. A grazing program should allow plants full growth of leaves before grazing or allow for full recovery after grazing for plants to thrive. Full growth or recovery enables plants to meet requirements during the growing period and allows plants to recover even if they are used relatively heavily or frequently.

Of the three factors used in the GRI, opportunity is most important for long-term health and vigor of plants. The opportunity for plants to grow or regrow is dependent on soil moisture and nutrients, temperature and leaf area. Since this factor is so important in sustaining healthy plants, the rankings are doubled.

| Opportunity to Recover | Value |
|---|---|
| Full recovery | +2 |
| Partial recovery | +1 |
| Some recovery | 0 |
| Little recovery | -1 |
| No recovery | -2 |

Determining opportunity is a judgment call based on the appearance of vegetation at the end of the growing season. If plants appear ungrazed or barely grazed or plants had full opportunity for growth before grazing, use a value of +2. If plants were grazed, but regrew fairly well after grazing then give a rating of +1. If an area was heavily used, with no opportunity to grow or regrow assign a -2.

Even though opportunity is based upon appearance of the vegetation at the end of the growing season, some general guidelines can help determine the rating. For example, an area that is used season-long can be expected to rate -2 (no chance for regrowth). An area with 2 pastures may provide some chance for growth or regrowth resulting in a rating of 0 or -1. An allotment with multiple pastures used and rested at different times of the year will usually receive ratings of +1 or +2.

**Overall Rating—GRI.** The overall rating of the expected response to grazing is the sum of frequency, intensity and opportunity. A *positive* value indicates the management is *beneficial* to the health, structure and vigor of the plants. A *negative* value indicates that management is *harmful.* A *zero* rating is *neutral.*

Recovery after grazing is based on a plant's ability to produce enough leaf surface area to regrow. GRI links mechanisms that control plant response to grazing. It uses three variables that can be managed—*length of grazing period, stocking rate and season of use.* If the frequency index indicates plant response is likely to be negative, shortening the length of the grazing period will improve plant response. If the intensity index is high on most pastures on the ranch, the stocking rate is too high. Since opportunity is based on plant growth or regrowth, it is influenced by season of use.

Contributed by Dr. Roy Roath, Forest, Range and Watershed Stewardship Dept. Colorado State University.

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# Nutrients Influence Palatability

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Greg Baer, a cattle producer in Missouri, planted a pasture of clovers and alfalfa that was high in protein. He believed his cattle would really gain weight on this pasture from heaven. But to Greg's dismay his cattle gained poorly and at times preferred to eat moldy hay and mature endophyte-infected tall fescue growing on the ditch banks rather than the nutritious pasture. Why did Greg's cattle behave this way?

**Release of energy and protein.** Animals form preferences for foods with high levels of energy and protein especially if they release quickly during digestion. For example, lambs showed a stronger preference for a flavor when eating the flavor was immediately followed by a dose of energy compared with lambs that consumed the flavor and received the dose of energy an hour later. Likewise, herbivores may prefer immature orchard grass to more mature orchard grass even though both grasses contain similar amounts of digestible energy because the nutrients in immature orchard grass are released more quickly than in more mature orchard grass.

Ruminants also form strong preferences for foods that contain energy and protein that are released at similar rates during digestion. An excess of protein relative to energy can result in ammonia toxicity, whereas an excess of energy relative to protein can cause acidosis. Both states can cause food aversions. For example, in one study lambs preferred a diet of beet pulp and alfalfa to a diet of barley and alfalfa because energy in beet pulp and protein in alfalfa are released at similar rates whereas energy in barley is released more rapidly than protein in alfalfa.

**Interaction of energy and protein.** The concentration of energy and protein in foods are important in diet selection but their interaction is also important. Given a choice, sheep and cattle maintain constant ratios of energy to protein in their diets to meet their needs for maintenance, growth, pregnancy, and internal parasite infestations. They avoid diets too high or too low in protein relative to available energy.

Preferences for protein and energy are influenced by what was just eaten. For example, people given flavored, medium- and low-calorie snacks prefer the flavor paired with low-calorie snacks right after eating but not when they are hungry. Likewise, lambs prefer foods high in energy after eating food high in protein and vice versa. For instance, given a choice of alfalfa pellets (high protein) and barley (high energy), lambs prefer alfalfa pellets after eating barley and they prefer barley after eating alfalfa pellets.

**Minerals.** Minerals also influence food preferences. Diets deficient in minerals cause food aversions. For example, a phosphorus deficiency in cattle, sheep, and goats depresses intake by 10 to 50%. The degree to which food intake is affected depends on the severity of the deficiency. Excess minerals also cause animals to avoid foods. A primary symptom of excessive minerals in the diet is a depression in food intake. Thus, the amount of minerals in foods —excess, adequate, deficient—influences food intake and preference.

**Nutrients can be aversive.** Normally, animals form preferences for foods high in nutrients but diets too high in nutrients or diets that are not nutritionally balanced can cause ruminants to limit intake. Ruminants suffer from acidosis when they eat too much grain or when they are not given time to adapt to diets high in grain. Likewise, forages too high in readily digestible protein can lead to ammonia toxicity and those too high in energy can also cause acidosis.

A dietary imbalance likely caused Greg Baer's cattle to perform poorly. As Greg came to realize, when it comes to nutrients, ruminants can get too much of a good thing. His pasture likely provided cattle with a diet with too much protein relative to energy. When he planted strips of grass in the pasture, cattle performance increased and their strange feeding behaviors stopped.

**Correcting deficits.** There is no evidence animals eat to prevent deficiencies. However, animals form aversions to diets deficient in nutrients, and that causes them to begin sampling new foods. If they find a food that corrects the deficiency, they form a preference for that food. For example, in the Netherlands, cattle grazing phosphorus-deficient forage ate dead rabbits—bones, fur and all, whereas cattle on phosphorus-adequate forage refused to eat dead rabbits. Likewise, goats browsing nitrogen-poor blackbrush acquired a preference for woodrat houses because chambers inside the houses contain urine-soaked (nitrogen-rich) vegetation that helped them correct their nitrogen deficiency. Goats that ate woodrat houses lost an average of 12% of body weight, whereas goats that did not eat woodrat houses lost 20% of body weight while browsing blackbrush for 90 days during winter.

**Implications.** Understanding that ruminants can balance their diets enables managers to improve efficiency by allowing animals to select their own diets. For example, a producer in Louisiana plants turnips in his ryegrass pasture to help his cattle meet their needs. Turnips are a good source of energy that complements the ryegrass which is high in protein. Cattle don't just eat the tops, they learn to pull turnips out of the ground and eat them. Planting pastures with several plant species that vary in energy and protein content, rather than a single species, allows individual animals to meet their unique needs for nutrients and improves animal performance.

Maintaining plant diversity, grasses, forbs and shrubs, on rangelands can help both domestic and wild animals meet their nutritional needs throughout the year. For example, in fall and winter, shrubs provide needed protein that complements the energy in standing dead grasses and forbs. In addition, animals that have access to a variety of plants eat more and can avoid over-ingestion of toxins compared with animals forced to eat a monoculture or a limited number of plant species.

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**Chapter 14**

# BODY CONDITION SCORING

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Body Condition Scoring (BCS) is an important monitoring criteria when utilizing goats for land enhancement (restoration, rejuvenation, weed abatement, fire mitigation, etc.). Scoring will initiate herd management decisions focused on production options to improve performance (physiological status of the individuals and the mob), limit the health problems associated with improper nutrition and increase profits by allowing selective browsing/grazing based upon the quality and quantity of vegetation required by the goats. All of the above total a decrease in production costs.

When using goats in a "working or production" situation, BCS is a measure of body energy reserves and a change in body condition will reflect a shift in energy balance. The nutrition levels required for performance have to be matched to the nutritional requirements of the goats to attain the desired outcome. Forage and browse resources need to be used efficiently/effectively to sustain biodiversity of successional vegetation communities. The environment, climate and topography will also affect the body condition of the goats as will reproductive performance.

When using the goats in a breeding program, BCS will be a critical monitoring tool to use as a measure for reproductive performance. A higher body condition at kidding and early lactation will increase the chances of re-cycling, increase the ovulation rate and conception in the early part of the breeding season with less breeding days, therefore concentrating the kidding season (advantageous to niche and direct marketing). If adequate energy is available for mobilization at parturition, milk production will be higher and maintained longer. Thin does will likely be late kidders, have delayed recycling and breeding, and an increased probability of abortion. Should they kid, they will have less kids, weaker kids and lower milk production.

Research has shown that visual appraisal can accurately measure body condition. For the most consistent results, palpating along with visual assessment will help measure the adequacy of the nutritional program by evaluating the body reserves. Goats have very little subcutaneous fat. Fat is stored in the omentum and perirenal tissues. Body condition will measure the lipid and protein reserves that will be available to use in late gestation, early lactation, during environmental adversity, etc. It will contribute to making decisions faster about changing a nutrition regime because if one lingers, high production losses and loss of income are possible. It can be very costly to regain body status, therefore avoid extreme fluctuations in body condition scores.

Body weight is a function of breed, body conformation, frame size and mature size, stage of gestation and stage of lactation. The frame, at a point in physiological time, will remain constant but weight will change based on deposition of fat and muscle. Both depend on the nutritional and physiological status of the goat. Do not include the fetus or associated fluids when evaluating weight changes. Becareful when culling on BCS at weaning as there is a negative relationship between body condition and milkability.

By physically palpating and feeling the goat, at both the lumbar and sternal areas, you will develop your "eye" for body condition assessment. Using lumbar values will reflect body protein deposition where as sternal scores will more accurately assess the proportion of adipose tissue. Table 1 is included as a guideline for gauging (monitoring) the ribs, either side of the spine, shoulders, tailhead, pins, hooks, loin edge, backbone (longissimus dorsi muscle) and sternum.

The times to BCS goats are the last three weeks of gestation, 6 weeks into lactation, cautiously at weaning and before breeding. This will help in managing mobs by sorting them into feeding groups (pasture/brush/rangeland mobs) by age and body condition; allowing yearlings to be managed separately from older does and validating replacement selection. Younger goats that have never kidded will have less individual variation in a mob whereas the older does will exhibit more variation due to environmental influences and individual genetic makeup for productivity. If a supplement is needed, whole corn can be a choice for energy and whole cottonseed or soybean meal for protein.

It is best to maintain goats between a score of 4 through 6 (moderate). This eliminates the flux of extremes and the associated recovery costs. These goats will consistently perform to optimum production. A drop in body condition should be gradual and regained rather rapidly. This group will be flushed at 5 to attain a 6 at breeding and kid at 5 or 6. They should not drop below a 4 by the end of lactation. If you are using this group of breeding females on a land enhancement project, they have to be monitored extremely closely as they can lose condition rapidly. There is an economic and production advantage to using wethers for "work" projects. Wethers can be maintained at a BCS of 4 on most vegetation restoration projects. When stressed nutritionally and body condition drops to 3, it takes 4 to 6 weeks with a supplement (or changing to higher quality vegetation) to return them to a 4.

Thin goats (score of 1 through 3) have poor reproductive success, lower twinning rates, decreased weaning rates, increased chance of internal parasite load and are lethargic with no desire to travel any distance. Severely restricted nutrition of the doe will greatly depress the weaning weight of the kids. Therefore, under adverse management and environmental conditions, kid performance can be enhanced by managing the nutritional level of the kids separately.

Fat goats (score of 7 through 9) will be more prone to pregnancy toxemia, fatty liver syndrome, kidding difficulties, lower conception rate, impaired immune response, less athletic and energetic for browsing/brushing and traveling long distances over rough terrain.

The range of scale (1 through 9) can have an accumulated effect in loss of body weight by about 45 percent; therefore, each numerical score would represent about a 5 percent loss in body weight.

Table 1. **Body Condition Score**

| Condition | Score | Comments |
|---|---|---|
| severely emaciated, extremely poor | 1 (thin) | Close to death/starvation evident; outline of ribs visible and spinal processes distinct and prominent with severe depressions; physically weak; shoulder, loin and hindquarters atrophied in appearance; skin adhered to bone |
| extremely thin, poor | 2 (thin) | Not as weak nor as emaciated as (1); skin in direct contact with bone; prominent 'V' shaped cavity under tail; outline of of spine and ribs are still visible; bony surface of the sternum protruding |
| very thin, frame visible | 3 (thin) | Wasting in appearance; ribs visible; individual spinal processes evident and depressions obvious (rib, hips) and sunken between pins and hooks; sternum is prominent |
| slightly thin | 4 (moderate) | Spinous processes (dorsal/transverse) are prominent and sharp; thin flesh covering between hooks and pins; some ribs visible; definite depression between hooks |
| frame covered, balanced | 5 (moderate) | Spinous processes smooth; transverse processes have smooth concave curve; hooks and pins smooth; muscle becoming obvious; sternum can be palpated |
| slightly fleshy smooth cover | 6 (moderate) | Spinous processes rounded; spinous to transverse processes smooth sloped; hooks and pins covered; slight depression between hooks and pins |
| frame not visible, fleshy | 7 (fat) | No spinous processes noticeable, ribs not visible, hooks and pins rounded with some cover; flat between hooks; palpation of sternum difficult |
| obese | 8 (fat) | Edge of transverse processes barely noticeable, tail-head cavity filling with fat |
| extremely obese, severely over-conditioned | 9 (fat) | Spinous processes buried in fat; between hooks and pins rounded; between hooks rounded; tail-head cavity exhibits fat filled folds |

## Anatomical Reference Points for Evaluating the Body Condition of Goats

Anatomical Reference Points for Evaluating the Body Condition of Goats

Figure 1. Typical Vertebra *

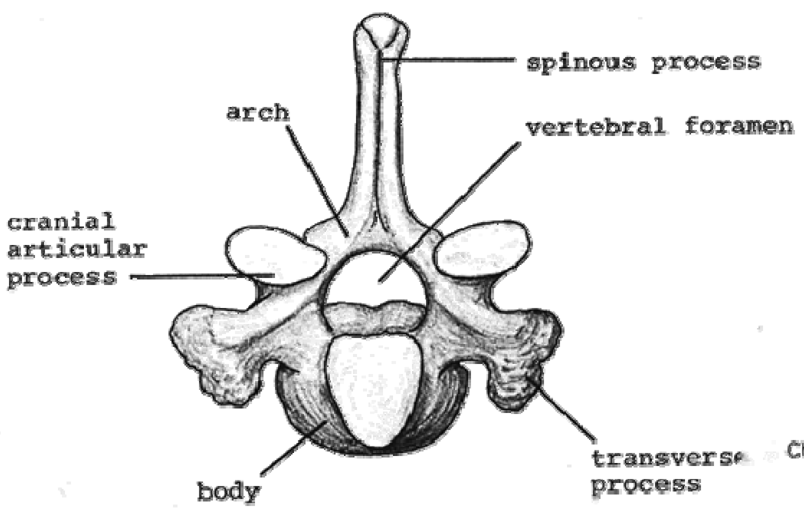



Figure 2. The Back **

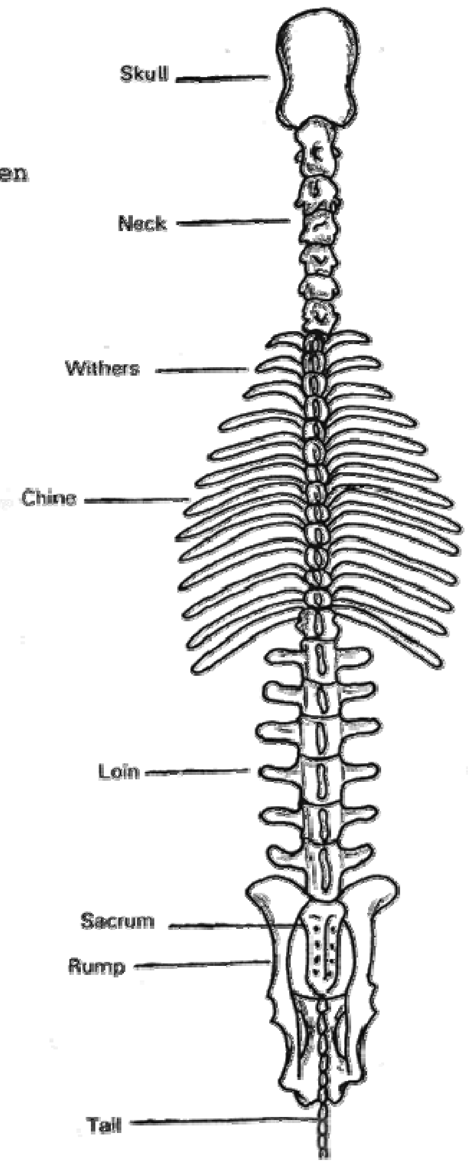
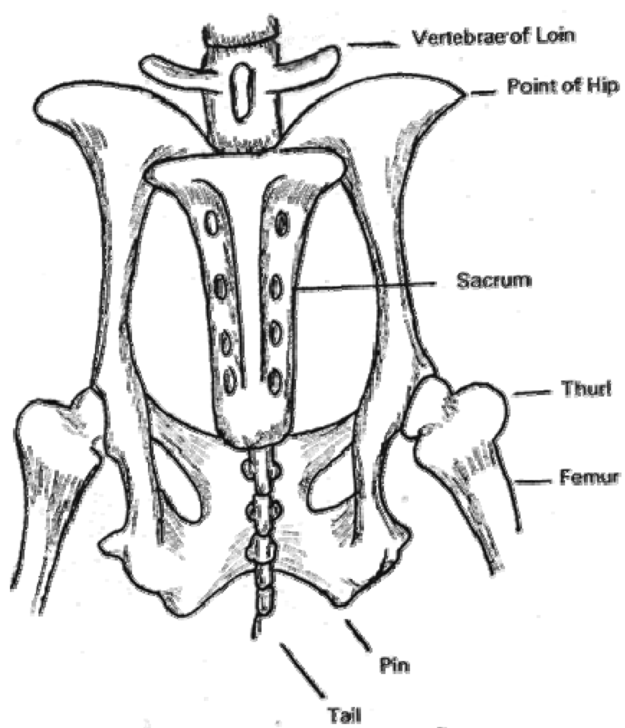



Figure 3. Pelvis – View from the Top ***



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| TABLE 1. | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| DATE | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| MOB identification: | | | | | | Physical condition: | | | | | | | |
| CLASS of Goat: | | | | | | Nutritional status: | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Temperature: High: | | Low: | | | | Management: | | | | | | | |
| Rainfall: | | | | | | Stress level: | | | | | | | |
| Forage available | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Sample number | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
| | | | | | | | | | | | | | |
| Parasite identification: | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Coccidia | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Common tapeworm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Threadworm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Bankrupt worm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Thread-necked strongyle | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | |

# JULIAN DATE CALENDAR (perpetual)

| DAY | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | DAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 32 | 60 | 91 | 121 | 152 | 182 | 213 | 244 | 274 | 305 | 335 | 1 |
| 2 | 2 | 33 | 61 | 92 | 122 | 153 | 183 | 214 | 245 | 275 | 306 | 336 | 2 |
| 3 | 3 | 34 | 62 | 93 | 123 | 154 | 184 | 215 | 246 | 276 | 307 | 337 | 3 |
| 4 | 4 | 35 | 63 | 94 | 124 | 155 | 185 | 216 | 247 | 277 | 308 | 338 | 4 |
| 5 | 5 | 36 | 64 | 95 | 125 | 156 | 186 | 217 | 248 | 278 | 309 | 339 | 5 |
| 6 | 6 | 37 | 65 | 96 | 126 | 157 | 187 | 218 | 249 | 279 | 310 | 340 | 6 |
| 7 | 7 | 38 | 66 | 97 | 127 | 158 | 188 | 219 | 250 | 280 | 311 | 341 | 7 |
| 8 | 8 | 39 | 67 | 98 | 128 | 159 | 189 | 220 | 251 | 281 | 312 | 342 | 8 |
| 9 | 9 | 40 | 68 | 99 | 129 | 160 | 190 | 221 | 252 | 282 | 313 | 343 | 9 |
| 10 | 10 | 41 | 69 | 100 | 130 | 161 | 191 | 222 | 253 | 283 | 314 | 344 | 10 |
| 11 | 11 | 42 | 70 | 101 | 131 | 162 | 192 | 223 | 254 | 284 | 315 | 345 | 11 |
| 12 | 12 | 43 | 71 | 102 | 132 | 163 | 193 | 224 | 255 | 285 | 316 | 346 | 12 |
| 13 | 13 | 44 | 72 | 103 | 133 | 164 | 194 | 225 | 256 | 286 | 317 | 347 | 13 |
| 14 | 14 | 45 | 73 | 104 | 134 | 165 | 195 | 226 | 257 | 287 | 318 | 348 | 14 |
| 15 | 15 | 46 | 74 | 105 | 135 | 166 | 196 | 227 | 258 | 288 | 319 | 349 | 15 |
| 16 | 16 | 47 | 75 | 106 | 136 | 167 | 197 | 228 | 259 | 289 | 320 | 350 | 16 |
| 17 | 17 | 48 | 76 | 107 | 137 | 168 | 198 | 229 | 260 | 290 | 321 | 351 | 17 |
| 18 | 18 | 49 | 77 | 108 | 138 | 169 | 199 | 230 | 261 | 291 | 322 | 352 | 18 |
| 19 | 19 | 50 | 78 | 109 | 139 | 170 | 200 | 231 | 262 | 292 | 323 | 353 | 19 |
| 20 | 20 | 51 | 79 | 110 | 140 | 171 | 201 | 232 | 263 | 293 | 324 | 354 | 20 |
| 21 | 21 | 52 | 80 | 111 | 141 | 172 | 202 | 233 | 264 | 294 | 325 | 355 | 21 |
| 22 | 22 | 53 | 81 | 112 | 142 | 173 | 203 | 234 | 265 | 295 | 326 | 356 | 22 |
| 23 | 23 | 54 | 82 | 113 | 143 | 174 | 204 | 235 | 266 | 296 | 327 | 357 | 23 |
| 24 | 24 | 55 | 83 | 114 | 144 | 175 | 205 | 236 | 267 | 297 | 328 | 358 | 24 |
| 25 | 25 | 56 | 84 | 115 | 145 | 176 | 206 | 237 | 268 | 298 | 329 | 359 | 25 |
| 26 | 26 | 57 | 85 | 116 | 146 | 177 | 207 | 238 | 269 | 299 | 330 | 360 | 26 |
| 27 | 27 | 58 | 86 | 117 | 147 | 178 | 208 | 239 | 270 | 300 | 331 | 361 | 27 |
| 28 | 28 | 59 | 87 | 118 | 148 | 179 | 209 | 240 | 271 | 301 | 332 | 262 | 28 |
| 29 | 29 | | 88 | 119 | 149 | 180 | 210 | 241 | 272 | 302 | 333 | 363 | 29 |
| 30 | 30 | | 89 | 120 | 150 | 181 | 211 | 242 | 273 | 303 | 334 | 364 | 30 |
| 31 | 31 | | 90 | | 151 | | 212 | 243 | | 304 | | 365 | 31 |

***REMEMBER TO ADD AN EXTRA DAY FOR LEAP YEAR***

# Understanding the Essence of Goat Meat in Human Nutrition

## (Healthy Heart Choice for the Producers)

Leslie Speller-Henderson

It is a fact; goat producers are very concerned about the health and condition of their animals. Producers build an operation to ensure adequate nutrition and exercise for their goats in order to have healthy animals and end products of meat, milk and/or offspring. In contrast, goat producers do not give the same awareness to their own health - the condition of their bodies and internal organs.

According to Stock (2004), a lot of time and money is spent looking after the outward appearance. However, Stock (2004) illustrates that time should be taken to think about the heart's health and its day-to-day maintenance given the fundamental importance to human well-being that is challenged by personal actions and lack of accountability. Stock (2004) noted that the trend in the US is an increasing number of people to be overweight. For all intents and purposes, individual behavior and lifestyle choices influence the development and course of chronic disease conditions such as overweight or obesity, diabetes, heart disease and stroke. Specifically, Stock (2004) points out that the choices of eating and drinking food products high in fat, sugars, and salts and engaging in less exercise; combined with stress, smoking and excessive drinking undoubtedly adds extra strain on human bodies and hearts. So, if goat farmers are like the rest of the country, where poor diet and sedentary lifestyle have been linked to the major causes of overweight and obesity in addition to morbidity and mortality due to chronic diseases (Dietary Guidelines for Americans [DGA 2005], 2005); then, it is time to give attention to the human side of health. If a goat farmer's health is compromised, then who will take care of the goats? Encouraging individuals to adopt healthy habits and practices may reduce the burden of chronic diseases (DHHS 2003).

Essentially, people need to eat smaller portions, be more active and make wiser choices within and among food groups of grains, vegetables, fruits, milk, meat and beans (DGA 2005). More detailed, the cornerstone of federal nutrition policy and education recommends that when selecting and preparing meat, to make choices that are lean, low-fat or fat-free and from a variety of protein sources. This statement was designed with goat producers in mind. The new USDA Food Guidance System – MyPyramid - takes the message further by emphasizing, "Go lean on protein – choose low-fat or lean meats; bake it, broil it or grill it." (USDA -MyPyramid 2005).

Using this message, the logical next step is to incorporate lean goat meat (chevon/cabrito) into your meal plan. Goat meat is a good source of protein and is leaner, higher in iron and lower in calories and cholesterol than beef, pork and even skinless poultry.

| Meat Comparison (100 grams or 3.5 ounce portion, roasted) | | | | |
|---|---|---|---|---|
| Nutrient | Chevon (Goat) | Beef (Eye of round, choice) | Pork | Poultry (Skinless) |
| Calories | 143 | 166 | 173 | 167 |
| Protein (g) | 27 | 28.6 | 27.8 | 25 |
| Total fat (g) | 3 | 4.9 | 6.1 | 6.6 |
| Saturated fat (g) | 0.9 | 1.75 | 2.14 | 1.8 |
| Cholesterol (mg) | 75 | 54 | 79 | 75 |
| Iron (mg) | 3.7 | 2.37 | 1.45 | 1.2 |

Source: USDA National Nutrient Database for Standard Reference, 2006.

Research has indicated that goat meat has a balanced proportion of saturated to unsaturated fatty acids and it is a rich source of conjugated linoleic acid (CLA). CLA is a fatty acid found in ruminants that over the past two decades, has been associated with a reduction in cancer, heart disease, onset of diabetes and accumulation of body fat (Solaiman 2005). Specifically, Daley, Harrison, Abbott, Doyle, Nader and Larson (2006) noted that animals eating a forage-only diet can significantly alter the lipid composition of the final meat product while reducing the overall fat content.

In addition, several studies report that forage-fed meat contains elevated concentrations of beta-carotene (a fat-soluble antioxidant and a subunit of Vitamin A) and alpha tocopherol (Vitamin E – fat-soluble vitamin), as well as higher concentrations of omega-3 (n-3) fatty acids (essential polyunsaturated fatty acids-EFA) and CLA (isomer of linoleic acid- an omega-6 (n-6) EFA). All of these substances are reported to have favorable effects on human health. Simply stated, food products from grass-fed ruminants (e.g., goat, lamb and beef) are good sources of fat-soluble essential nutrients and contain much more CLA than those from grain-fed animals (Wikipedia 2006).

A detailed analysis of essential fatty acids and conjugated linoleic acids composition by diets:

| Essential Fatty Acids (EFA) Composition by Diet (g/100g fatty acid) (Daley, et al. 2006) | | | | | |
|---|---|---|---|---|---|
| Essential Fatty Acids | Treatment | | | | |
| | Grass silage + 4 kg grain | 1 kg hay + 8 kg grain | 6 kg grass (DM basis) + 5 kg grain | 12 kg grass (DM basis) + 2.5 kg grain | 22 kg grass (DM) |
| omega 6 (n-6) fatty acids | 2.96 | 3.21 | 3.12 | 3.04 | 3.14 |
| omega 3 (n-3) fatty acids | .91[y] | .84[y] | 1.13[x] | 1.25[wx] | 1.36[w] |
| n6:n3 ratio | 3.61[w] | 4.15[w] | 2.86[x] | 2.47[x] | 2.33[x] |

[w, x, y, z] Means within rows with common superscripts are not significantly different (P>.05) Daley, et al. 2006.
Dry Matter (DM)

| Mean Essential Fatty Acids (EFAs) by Ruminant Diet(Daley et al. 2006) | | |
|---|---|---|
| EFA by diet (as % of total fatty acids) | Grass-fed | Grain-fed |
| n-6 fatty acids | 5.66[a] | 3.92[a] |
| n-3 fatty acids | 2.90[b] | 0.64[c] |
| n6:n3 ratio | 1.95[d] | 6.38[e] |

[a, b, c, d, e] Means within rows with common superscripts are not significantly different (P>.01) Daley et al. 2006.

| Mean Conjugated Linoleic Acid by Diet (g/100g or g/3.5 oz.) (Daley et al. 2006) | | | |
|---|---|---|---|
| Study | Feedlot/Grain | Forage-fed | Amount Increased |
| French, 2000 | .37a | 1.08b | 2.92X |
| Duckett, 1993 | .82c | 2.2d | 2.69X |
| Rule, 2002 | .26e | .41f | 2.04X |
| Realini, 2004 | .25g | .52h | 2.12X |
| Poulson, 2004 | .25i | .46i | 1.84X |

[a, b, c, d, e, f, g, h, i] Means within row with common superscripts are….. Daley et al. 2006.

According to Daley, et al. the amount of total fat found in a serving of meat is highly dependent upon the feeding regime and to some extent the genetics of the animal, as well as the actual cut or area where the cut is located. In general, grass-fed ruminants are slaughtered at lighter weights than grain-fed, producing leaner/lower fat meat product overall (Daley, et al. 2006).

Throughout the world goat is one of the most widely consumed meats, although its consumption in the U.S. has generally been limited to specific ethnic groups. However, the consumption will probably increase as more and more people are introduced to its excellent qualities as a grass-fed ruminant. Adopting this meat into American diets would provide variety in the form of a low-fat meat selection (Empire State Meat Goat Producers Association [ESMGPA], 2005).

Delicious chevon recipes are waiting to be tried, but because of its low-fat content, goat meat loses moisture and toughens quickly if cooked at high temperatures and under dry conditions. Goat meat is usually cooked slowly to moderately and is often marinated first or cooked in a sauce. One easy marinade is to soak the meat in beer or vinegar and a 1/4 cup of lemon or lime juice. If you eat meat and have never tried goat meat, we urge you to try it!! ENJOY!! (ESMGPA 2005).

## GOAT MEAT RECIPES

### Goat Stew

(from the farmhouse kitchen at Pone Creek Caverns)

This recipe is based on two pounds of lean goat meat that will be cooked for 8 hours in a crock pot (or other type of slow cooker) – 1 hour on high and 7 hours on low.

2 pounds goat meat cubed or ground
Sesame oil
2 Tablespoons sesame seeds
½ teaspoon fresh cracked pepper
2 large onions, cut-up
4 potatoes, cubed
6 large carrots, cut-up
1 cup peas, frozen
1 can Cream of Mushroom soup
8 shiitake mushrooms, diced
5 extra large bay leaves
1 tablespoon freshly minced Italian herbs (oregano, majoram, thyme, sage)
½ package Onion soup mix

Brown the meat rapidly in hot sesame oil with the sesame seeds and fresh cracked pepper. Put browned meat in crock-pot with all other ingredients, cook 1 hour on high and 7 hours on low. This is great served over steamed brown or Minnesota wild rice or a bed of butter noodles.

## Goat Chili

(from the farmhouse kitchen at Pone Creek Caverns)

2 pounds lean goat meat (burger, shank or rib meat)
2 tablespoons Sesame oil
1 teaspoon fresh cracked black pepper
2 large onions cut-up
4 cloves garlic, minced
¼ teaspoon ginger
1 tablespoon Virgin olive oil
3 cans kidney beans (or soaked beans)
2 cans stewed tomatoes
1 tablespoon Italian herb mix (freshly minced oregano, majoram, thyme, sage)
1 heaping teaspoon cumin seed or 1 teaspoon ground cumin
2 tablespoons chili powder (mild, medium or hot)

In a pan rapidly brown meat in sesame oil with black pepper; in another pan, sauté onions, garlic and ginger in olive oil. Combine meat and sauté vegetables in crock-pot with remaining ingredients, cook on high for 1 hour and turn down to low and cook for 7 hours. Goat chili is great served Hawaiian style over steamed rice with shredded cheese and diced onions. Include a side of Kim Chee.

## Curry Goat

(www.jamaican-recipes.com/currygoat.html)

3 pounds Goat Meat (cut up in bite size pieces)
1 Large Onion (chopped)
2 cloves Garlic (chopped)
1 Scotch Bonnet Pepper (chopped and seeded)
4 oz. Jamaican Curry Powder
1 oz. Cooking Oil
1 oz. Ground Black Pepper
2 tbsp. Salt
4 sprig. Thyme
1/2 oz. Vinegar
6 Pimento Seeds (Allspice)

Wash goat meat with vinegar and water. Rub in all the season with goat meat and let sit in the refrigerator for 1 hour. Remove meat from refrigerator and remove seasoning from the meat.

In a saucepan, heat oil on high until it smells. Add 1 oz. curry powder to hot oil. Stir curry powder in oil until the color starts to change. Put meat in the saucepan, stir the meat in the hot oil for two minutes; be careful not to burn the meat. Add 1 oz. water to the pot, keep stirring until the meat looks like the muscles are tightening up. Turn down the heat to medium and add 2 cups of water to the meat in the saucepan. Cover the pot, let stew simmer for 20 minutes. Check on the meat in the pot, stir again and add water to cover the meat.

Simmer for another 20 minutes, check to see if the meat is medium soft. If so, add the seasoning you removed earlier into the pot. Let the stew simmer for another 15 minutes on a slightly lower heat (between medium and low).

(Optional) You can add potatoes to the pot the same time you add the seasoning. You can also add bread crumbs to thicken. **Note :** Although this is a stew, it should not be dominated by watery type gravy. You should make this stew cook until most of the water is evaporated, and let the fat from the goat flavor the stew.

It takes practice and trial and error sometimes to get a perfect Curry Goat, so don't give up on your first try.

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**Chapter 15**

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## VETERINARY and HEALTH SUPPLIERS

Caprine Supply – (800)-646-7736
Hoeggars Supply – (800)-221-4628
AgTech – (800)-367-4016 (AI, semen collection)
Omaha Vaccine Company – (800)-367-4444
Wiggins – (800)-600-0716
Valley Vet Supply – (800)-468-0059
Washington State University - (509)-335-9696 (CAE testing and other misc. diseases)
University of Idaho- (208)-885-7081 (toxicology, mineral tests, etc.)
Pipestone Veterinary Supply – 1-800-658-2523
KARD Diagnostics, Nashville, TN – (615)-837-5125

## FENCING and EQUIPMENT SUPPLIERS

Shaul's Manufacturing – (530)-695-8185
Sydell- (800)-842-1369
Nasco – (800)-558-9595
LiveWire – (800)-272-9045, "E" Street, Marysville, CA., 95915
Premier – (800)-282-6631
Kencove – (800)-536-2683
FarmTek – 800-327-6835
QC Supply – 800-433-6340

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ON the WEB

Clemson University – www.clemson.edu/agronomy.goats/handbook/doc.html
www.ranchmanagement.com
www.stockmanship.com
www.behave.net

## Web Resources for Goat Producers

List Created by Geoff Benson, ARE, NCSU

### General information and links to goat publications on the internet:

1 – NCSU Animal Science Meat Goats web page
http://www.cals.ncsu.edu/an_sci/extension/animal/meatgoat/ahgoats_index.html
2 – Clemson University Meat Goat Production handbook
http://www.clemson.edu/agronomy/goats/handbook/
3 – University of Maryland, Maryland Small Ruminant Page
http://sheepandgoat.com/
4 – University of Missouri, Missouri Alternatives Center
http://agebb.missouri.edu/mac/links/linkview2.asp?catnum=113&alpha=G
5 – ATTRA resources for small ruminants
http://www.attra.org/attra-pub/PDF/ruminantresources.pdf
6 – Feasibility of Goat Production in West Virginia: A Handbook for Beginners, Doolarie Singh-Knights
http://www.caf.wvu.edu/avs/sheep/Research%20Highlights/Goat%20production%20bulletin.pdf
7 – Meat Goat Production: Elements Essential for Long-Term Success, Rick Machen, PhD, Texas A&M
http://uvalde.tamu.edu/staff/Machen6.htm

### Goat Enterprise Budgets:

1 – South Carolina meat goat budget http://cherokee.agecon.clemson.edu/goat.pdf
2 – Ohio State University meat goat budget http://ohioline.osu.edu/as-fact/pdf/0014.pdf
3 – Kentucky meat goat budget www.uky.edu/Ag/AgEcon/pubs/software/GoatBudgets.xls
4 – University of Wisconsin dairy goat budget
http://www.cias.wisc.edu/archives/2004/06/18/dairy_goat_enterprise_budget/index.php
5 – Penn State dairy goat budget http://pubs.cas.psu.edu/FreePubs/pdfs/ua260.pdf

### Farm Enterprise Budgets:

1 – Clemson's BudSys is a Microsoft Excel® computer application for farm enterprise budget development. It is comprised of several budget templates that can be customized.
http://cherokee.agecon.clemson.edu/budgets/BusSys_Download.htm
2 – National Ag Risk Education Library Budget Section
http://www.agrisk.umn.edu/Budgets
3 – Searchable database of enterprise budgets and budget software
http://www.agecon.okstate.edu/survey_new/indexNew.asp
4 – NCSU Enterprise Budgets
http://www.ag-econ.ncsu.edu/extension/Ag_budgets.html
5 – VPI Enterprise Budgets
http://www.ext.vt.edu/cgi-bin/WebObjects/Docs.woa/wa/getcat?cat=ir-fbmm-bu

**Machinery Costs:**

1 - Suggested Procedures for Estimating Farm Machinery Costs for Extension Audiences by W.F. Lazarus and R. Selley http://agecon.lib.umn.edu/cgi-bin/pdf_view.pl?paperid=3765&ftype=.pdf http://www.apec.umn.edu/faculty/wlazarus/machinery.html

2 – Machinery Cost Calculator at University of TN http://economics.ag.utk.edu/mcc.html

**Labor and Personnel Management:**

1 - Ag Help Wanted: Guidelines for Managing Agricultural Labor http://aghelpwanted.org
2 – Bernie Erven at Ohio State http://aede.osu.edu/people/erven.1/HRM/index.htm
3 – Farm Personnel Management publication from University of Missouri, NCR329 http://muextension.missouri.edu/xplor/regpubs/ncr329.htm
4 – Agricultural Personnel Management Program University of California. Explore all the links on this site and Billikoph's Labor Management pages are useful http://are.berkeley.edu/APMP/
5 – USDA Office of the Chief Economist – Agricultural Labor Affairs. Subscribe to their newsletter at the bottom of the homepage; good sources of information on H2-A workers. http://www.usda.gov/oce/oce/labor-affairs/affairs.htm
6 – Immigration and Naturalization Service http://www.immigration.gov/graphics/index.htm
7 – AgCareers – job listing for the US http://www.farms.com/careers/
8 – Cornell University's PRO-DAIRY Program, Human Resource Management http://www.ansci.cornell.edu/prodairy/hrm.html

**Business Record Keeping:**

The following software packages are listed because information is available about farm applications and use. There are many other useful software packages available.
1 - **Quickbooks™:** The QuickBooks Farm Accounting Cookbook™. To order, call their toll-free sales line (800-545-5380) or print out order form, mail/fax completed order to Flagship Technologies, Inc. http://www.goflagship.com/products/cbkhome.htm
2 – QuickBooks teaching materials from Alan Barefield, University of Tennessee http://economics.ag.utk.edu/pubsbusiness.html
3 - **Quicken™:** http://www.Quicken.com
4 – Quicken software http://www.intuit.com/products_services/personal_finance/
5 – Quicken materials from Damona Doye, at Oklahoma State U http://agecon.okstate.edu/quicken/

**Farm Business Management:**

1 – University of Minnesota, Center for Farm & Financial Management http://www.cffm.umn.edu/
2 – Iowa State Univ. Extension, Ag Decision Maker http://www.extension.iastate.edu/agdm/main.htm
3 – University of Illinois, Farm Decision Outreach Central (FARM.DOC) http://www.web.aces.uiuc.edu/farm.doc/
4 – Kansas State University http://agmanager.info/
5 – Spreadsheet Templates for Farm and Ranch Management http://www.montana.edu/wwwextec/

6 – The Farm Business Management Information Network for BC (FBMInet-BC) is an information technology project funded by the Canada/BC Farm Business Management Program http://fbminet.ca/bc/index.htm

7 – Cornell University Small Farms http://media.cce.cornell.edu/hosts/agfoodcommunity/afs_temp2.cfm?topicID=28

8 – Selecting New Enterprises for Your Farm http://www.uky.edu/Ag/AgEcon/publications/ext2000-13.pdf

NOTE: If there is a ‘space’ in any of the website addresses, use the “underline” key when typing in the search request.

**Master Meat Goat Producer**
**Marketing, Management & Planning**
(circle best answer)

1. Marketing is…
    a. Selling a product to generate revenue
    b. Advertising
    c. Planning and executing the idea of a product, its price and the promotion and distribution of that product to satisfy the needs of customers
    d. None of the above

2. Marketing allows you to analyze and determine…
    a. If a potentially profitable market exists
    b. The identity of a target market
    c. Strategies to reach the target market
    d. All of the above

3. True/False Tennessee is reported to have the second highest inventory of meat goats in the United States.

4. True/False The United States imports significantly more goat meat than it exports.

5. True/False The majority of people who consume goat meat in the U.S. are middle-class Caucasians.

6. True/False All consumers of goat meat prefer the same product and processing characteristics.

7. The largest and fastest growing ethnic group in Tennessee that is a potential target market for goats and goat meat is…
    a. Muslims
    b. Caribbean Islanders
    c. Hispanics
    d. Greeks
    e. None of the above

8. Which of the following is the best market channel for meat goat producers?
    a. Meat goat producer markets through the local auction
    b. Meat goat producer markets the live animal to the individual consumer
    c. Meat goat producer markets goat meat to the individual consumer
    d. It depends on the producers goals and objectives, the needs of the target customer and where the customer can be reached

9. True/False A meat goat producer can influence the price received for their product based on the type and quality of product produced, timing of product availability and market channel chosen.

10. Promotion can be accomplished through which of the following methods…
    a. Advertising
    b. Publicity
    c. Building a reputation for quality and ethical business practices
    d. All of the above
    e. Both a and b

11. True/False Direct-marketing goat meat involves additional regulatory and risk considerations.

12. If selling goat meat directly to consumers, a producer must…
    a. Have the product harvested, processed and packaged in a custom exempt facility
    b. Obtain a retail permit from the Tennessee Department of Agriculture
    c. Have the product harvested, processed and packaged in a USDA-Inspected facility
    d. Both a and b
    e. Both b and c

13. Farm goals should be…
    a. Specific, Maintainable, Attainable, Relevant, Timed
    b. Specific, Measurable, Attainable, Rewarding, Timed
    c. Suitable, Measurable, Attainable, Relevant, Timed
    d. Specific, Measurable, Attainable, Rewarding, Tenacious

14. Which of the following is not a leading cause of business failure?
    a. Insufficient business/enterprise planning
    b. Family pressure on time and money
    c. Lack of market awareness
    d. Government regulations

15. The leading source of start-up capital for a new business is…
    a. Government agencies
    b. Friends and relatives
    c. Personal resources
    d. Commercial lending institutions

16. True/False A farm record system should be designed primarily for completing income tax forms.

17. True/False Enterprise records can help a farm manager determine which farm enterprisesare profitable.

18. Which of the following is a type of risk faced by farm managers?
    a. Production
    b. Casualty loss
    c. Human
    d. Market
    e. All of the above

19. True/False Short-run or annual plans are beneficial when implementing changes from a present farming system into a new long-run plan.

20. When planning, profitability can be defined as…
    a. Financial growth and security
    b. Ability to generate net income
    c. Providing cash when needed
    d. Paying a large income tax bill

21. Variable costs for meat goat production …
    a. Include interest and depreciation
    b. Are always larger than fixed costs
    c. Cannot be changed in the short run
    d. Are expended only if meat goats are produced

22. Higher average daily gains when finishing feeder kids…
    a. Will always lead to higher profits
    b. Will increase profits/decrease losses if other expenses remain constant
    c. Get the animal too fat
    d. Will not be dependent on feed quality

23. Herd performance measures…
    a. Evaluate the efficiency of the doe herd
    b. Track progress of the herd over time
    c. Indicate potential problems
    d. Assist in establishing goals for the operation
    e. All of the above

24. True/False Goat herds with the largest weaning weights will always be the most profitable.

**Master Meat Goat Producer**
**Chapter 3 – Health**
**Exam Questions**

1. Biosecurity, a series of management procedures to keep the risk of disease from occurring on a farm (premises), is a number one producer priority.   True or False

2. Normal physical parameters for mature goats:
   a). Rectal temperature - _________°F
   b). Ruminations - __________ per minute
   c). Pulse - _____________ beats per minute
   d). Respiration - ____________ breaths per minute

3. Internal parasitism has been noted by producers in Tennessee to be the number one health problem.   True or False

4. To help minimize internal parasitism:
   a). Practice pasture rotation, keeping grass-type vegetation at least 5" tall
   b). FAMACHA test on a regular basis
   c). Perform fecal analysis weekly
   d). Strategically deworm only when necessary
   e). All of the above

5. The FAMACHA eye test is specific for the internal parasite ___________________.

6. Caprine arthritis encephalitis can be neurological and/or arthritic.  True or False

7. Footrot, foot scald and foot abscesses are:
   a). Caused by different bacterial agents
   b). Only occur during wet weather
   c). Can be cured with a zinc sulfate or copper sulfate foot bath
   d). Minimized through genetic selection and strict culling
   e). a and d

8. Listeriosis, a bacterial disease and meningeal worm migration cause neurological damage, intense stress and both are difficult to treat.  True or False

9. Coccidiosis can be prevented by:
   a). Not overcrowding the goats and avoiding dark, damp barns with old bedding
   b). Cleanliness is a major factor (no feeding on the ground or in dirty troughs)
   c). Maintaining a functional immune system
   d). All of the above

10. Nutrition and stress play a major role in a goats healthy immune system and their ability to stay disease free. True or False

11. Sustainable parasite management for goats encompasses the animal itself, the soil, weather and forages. True or False

12. Always isolate new purchases and maintain tight biosecurity with the animal and the people involved. True or False

**MASTER GOAT PRODUCER TRAINING**

**Forage Considerations for the Goat Herd**

Review Quiz Name________________________

Multiple Choice. Circle the most correct answer. (2 points each)

1. A legume forage that is tolerant of very low soil pH is:

a) alfalfa b) yaupon

c) crimson clover d) annual lespedeza

2. A warm-season grass used for hay and pasture that is primarily established by sprigging:

a) bermudagrass b) tall fescue c) orchardgrass d) Kentucky bluegrass

3. This soil fertility practice can improve root growth and nutrient availability to forages.

a) N fertilization b) P fertilization c) Liming d) Potassium fertilization

4 You planted sericea lespedeza in August. Good rains followed and you obtain an excellent seedling stand. The next spring in May almost none of the lespedeza regrows. What is the best possible explanation?

a) insect damage b) winter kill

c) dry seedbed d) Poor seedling vigor e) All of these

5. A forage plant that needs to be re-seeded each year is called a(n):

a) perennial b) biennial c) forb d) grass e) annual f) None of these

6. A plant that comes back each year from vegetative plant parts is termed a(n):

a) perennial b) biennial c) annual d) forb

7. Ruminant animals are capable of digesting cellulosic fiber contained in the vegetative growth of forage crops because:

a) they ruminate b) microbes living in the rumen can digest cellulose

c) protozoans living in the abomasum can digest lignin d) they can form protein from urea

e) All of these e) None of these

**Master Meat Goat Producer**
**Chapter 5 – Silvopasture**
**Exam Questions**

1). Silvopastoralism is an agroforestry practice that intentionally integrates ______, ______ and _______ into a structural practice of planned interactions.

2). The above planned interactions are managed intensively on an environmentally sustainable basis to simultaneously produce:

- a). trees and wood products including high quality sawlogs
- b). high quality forage
- c). livestock
- d). a and b
- e). all of the above

3). Environmental issues that are becoming increasingly important design elements of silvopastoral practices are:

- a). biodiversity / wildlife habitat
- b). soil stabilization / watercatchment characteristics
- c). a and b
- d). pollution abatement / carbon sequestration
- e). all of the above

4). In planning a silvopastoral system, three major components are _________ considerations, ____________ selection and ___________ / ______________.

5). In selecting the forage crop and tree component, marketability, high quality, fast growing, deep rooted and drought tolerant species are considered. True or False

6). The forage component should be a ______________ crop that is:

- a). adapted for livestock grazing
- b). productive under partial shade and moisture stress
- c). responds well to intensive management and tolerant of heavy use
- d). a and b
- e). all of the above

7). Livestock selected for the silvopasture system are ___________, __________ and _______________.

8). Design and establishment of silvopastures encompasses tree pattern and spacing, utilization of light and shade and optimizing growing space for forage in pasture production. True or False

9). In the grazing and forage management portion of a silvopasture system, _______ is the most important nutrient for livestock. The amount required is based upon the ______ of livestock used and their __________ __________ _________. As this changes, daily water intake increases.

10). In managing livestock in a silvopastoral system, portable solar powered electric fencing is a major consideration. The most important factor in this type of fencing regime is the portable tread-in poly posts. True or False

**Master Goat Producer**
**Genetic Questions**

1. An animal's Phenotype is a result of its______________and the ______________ it is provided, to express that trait.

2. Examples of an animal's environment might be:
   a. weather
   b. sickness
   c. age of doe
   d. nutrition
   e. all of the above

3. Name one Growth Trait: ______________________.

4. A crossbred kid has a 53 pound 90 day weaning weight. The average 90 day weaning weight of the parents was 50 pounds. Heterosis for the weaning weight would be:

   a. 6 %
   b. 8%
   c. 10%

5. The greatest response to hybrid vigor is in traits that are:
   a. lowly heritable
   b. moderate heritable
   c. highly heritable

6. During Meiosis, what percent of each parents genes are transferred to the offspring?
   a. 25%
   b. 50%
   c. 87.5%

7. An animal has an adjusted 90 day weaning weight of 55 pounds in a kid crop that averages 50 pounds. This animals 90 day weight herd ration be:
   a. 95
   b. 105
   c. 110
   d. 120

8. The percentage increase of performance over the average of the two parental breeds is _______________.

9. The goat has how many pairs of chromosomes?
   a. 23
   b. 30
   c. 39
   d. 27

10. Which trait has the most economic impact on goat production?
    a. Product
    b. Production
    c. Reproduction

**Master Meat Goat Producer**
**Chapter 7 – Reproduction**
**Exam Questions**

1). Reproduction, the most important factor determining profitability of a meat goat operation. Therefore, optimize __________________, ___________ and _________.

2). Male reproductive organ(s) functions are:
- a). Scrotum - __________________________________.
- b). Vas Deferens - _____________________________.
- c). Seminal vesicles - ____________________________.
- d). Prostate gland - ______________________________.

3). Seminal fluid provides medium for sperm _________, ____________ and ________ needed for sperm cell motility and survival within the female reproductive tract.

4). Normal seminal volume during ejaculation for a buck is ______________ml, with a concentration of __________ billion sperm cells per ml.

5). Female reproductive organ(s) functions are:
- a). Ovaries - _____________________________________.
- b). Oviducts - ____________________________________.
- c). Uterus - ________________________________________.
- d). Cervix - ________________________________________.

6). Age at puberty of the female is ____ months, with an estrous cycle length of _____days and a gestation length of ____________days.

7). Age at puberty of the male is _____ months, with the average breeding age of _____ months, and a daily sperm production of ______ billion.

8). Bucks are affected by high temperatures greater than 100° in that they have a _____ Sperm concentration, _________ sperm motility, and a___________ number of dead and abnormal cells.

8). Nutrition, the environment and genetics greatly affect reproduction. True or False.

9). Elevated temperatures above 90° degrees affects reproduction in the female by _____ embryo survival, ________ fetal development and the inability to _________ normal body temperature causing a state of heat stress.

10). Seasonality of breeders is considered _______________ when they are in anestrus during the fall.

11). Libido in a buck can be affected by physical condition, genetics, environmental temperatures, disease and parasites. True or False.

**Master Goat Producer Program**
**Nutrition Section Questions**
**Chapter 8**

1. The type of forage preferred by goats is ___browse ___grass or ___clovers.

2. The first consideration in meeting a doe's nutrient requirements is her:
    a. Breed composition
    b. Disposition or temperament
    c. Stage of production
    d. None of the above

3. (True or False) As a forage matures, the amount of total digestible energy contained in the forage increases.

4. Which of the following is a not a volatile fatty acid? ___Propionic ___methionine ___Acetic

4. What is the measure of energy most often used when balancing goat rations?
    a. Digestible Energy (DE)
    b. Crude Protein (CP)
    c. Total Digestible Nutrients (TDN)
    d. Net Energy (NE)

5. The body condition scoring (BCS) system is a numerical scale ranging from ___ to ___; in which ___ is the thinnest and ___ is the fattest. The system is used to assess the ________ ________ of goats.

6. Name two of the 4 parts of the goat stomach_________________________________.

7. (Increase or Decrease) As acid detergent fiber (ADF) increases in forage, what will happen to the forage digestibility?

8. Which of the following is NOT a sign of copper deficiency?
    a. Decreased immune function
    b. Sudden death
    c. Rough or discolored hair coat
    d. Increased reproductive failure

9. Feeding ________ beyond 0.4% of body weight can greatly reduce forage utilization. Give one example of a feedstuff that can increase forage utilization. ___________

10. Which of the following is (are) included on the feed label?
    a. Company name and address
    b. Medication
    c. Ingredients
    d. Guaranteed analysis
    e. All of the above
    f. None of the above

11. (True or False) Calcium is the most abundant mineral in the body.

12. Which of the following commodity feeds is highest in protein? ___ rice hulls ___ corn ___corn gluten feed

13. What percent of soybean meal (48% crude protein) and corn (8% crude protein) would be needed to prepare a supplement that contained 12% crude protein?

## QUIZ
## Meat Goat Carcass Merit

Directions: Circle the best answer.

1. Carcass merit is the evaluation of
   a. cutability b. quality
   c. both cutability and quality d. none of the above

2. Carcass cutability is
   a. eating satisfaction b. dressing percentage
   c. yield of usable meat d. all of the above

3. Carcass quality is
   a. eating satisfaction b. dressing percentage
   c. yield of usable meat d. all of the above

4. The major factor in determining carcass cutability is
   a. lean color b. fatness
   c. marbling d. muscling

5. The two major factors in determining the fatness of a meat goat carcass is
   a. fat at $12^{th}$ rib and %KPH
   b. fat over the major back muscles and %KPH
   c. fat deposition over the ribs and %KPH
   d. internal fat

6. In evaluating goat carcasses, the major factor used in determining carcass muscling is
   a. conformation score b. rib eye area
   c. flank color d. fat over back muscles

7. Meat goats that have superior conformation as indicated by being thickly muscled throughout is a
   a. Prime carcass b. Selection 1
   c. Selection 2 d. Selection 3

8. The general preferred carcass weight is
   a. less than 15 pounds b. 15-20 pounds
   c. 35-40 pounds d. over 60 pounds

9. Flank lean color is an indicator of
   a. carcass maturity b. marbling
   c. carcass fatness d. all of the above

10. What factor in addition to live weight does the USDA use in reporting market prices?
    a. fat thickness b. quality grade
    c. Selection score c. subcutaneous fat score

**QUIZ**
**Meat Goat Carcass Fabrication**

Directions: Circle the best answer.

11. What is the name give to “goat Meat”?
    a. cabrito  b. chevon
    c. either a or b  d. none of the above

12. A primal cut is
    a. a high priced cut from the back  b. cuts from the front of the goat
    c. cuts from the rear of the goat  d. a major division of the carcass

13. What is the typical dressing percentage for a meat goat
    a. 48%  b. 58%
    c. 62%  d. 72%

14. IMPS (Institutional Meat Purchasing Specifications) is a USDA document that
    a. sets forth grade standards for meat goats
    b. describes cuts for foodservice and retail marketing
    c. describes the cooking recommendations for meat goats
    d. all of the above

15. Hindsaddle refers to which portion of the goat carcass?
    a. back region  b. rear leg
    c. front leg  d. rear half of carcass

16. List the 5 meat goat cutting styles described in IMPS
    a. ______________________________
    b. ______________________________
    c. ______________________________
    d. ______________________________
    e. ______________________________

17. Which two cutting styles can be further processed into retail cuts?
    a. ______________________________
    b. ______________________________

18. On the attached diagram ( on back), identify the primal or sub-primal cut by placing the number in the blank
    a. _____ foreshank  e. _____ rack
    b. _____ sirloin  f. _____ shoulder
    c. _____ leg  g. _____ loin
    d. _____ breast  h. _____ neckG

Name ______________________________

**Chapter 10**
**Environmental Concerns for Goat Producers**
**Evaluation**

**Test Questions**

1. Depending upon environmental temperature, a lactating doe will consume approximately ________ gallons of water per day.
   A 1 - 2
   B 4 - 5
   C 5 - 6
   D 6 - 7

2. Healthy goats should not have to travel more than _______ feet to a water source.
   A 600
   B 800
   C 1320
   D 2000

3. Watering facilities and heavy use areas are best located ______
   A on road for easy access
   B Central to paddocks and on a rise
   C Near shade
   D Close to all other facilities

4. Dead animals should be buried in a pit and covered with at least ________ inches of soil in a moderately-well drained soil.
   A 10
   B 20
   C 30
   D 40

5. A feeding area that has less then ________ percent slope is considered to be low-risk.
   A 5
   B 7
   C 9
   D 10

6. A low-risk vegetated buffer zone along a stream should be ________ feet wide.
   A 15
   B 30
   C 40
   D 50

7. Goats watering from a pond where a watering ramp is used is considered ________ risk.
   A low
   B moderate-low
   C moderate-high
   D high

8. A water well located within 100 feet of a winter feeding area is considered a ________ risk situation.
   A low
   B moderate-low
   C moderate-high
   D high

9. Goats required to drink directly from streams with no developed access points is considered a ________ risk situation.
   A low
   B moderate-low
   C moderate-high
   D high

10. Confined goat production areas should be at least ________ feet downslope from a water well.
   A 25
   B 50
   C 75
   D 100

## STRUCTURES and EQUIPMENT EXAM
## Chapter 11

1. True or False It is easy to change barn plans at any state of completion.

2. True or False Total confinement is recommended for meat goats.

3. True or False During warm weather goats can take advantage of dense natural cover for shelter.

4. True or False If you live out in the country, you don’t need to worry about building permits.

5. True or False It is not wise to place a permanent structure on land with poor drainage.

6. True or False You should not worry about disinfecting equipment that is moved between groups of goats on the same farm.

7. True or False Corrals and sides should be a minimum of 5 feet tall.

8. True or False Water is the most important nutrient.

9. Which of the following represents the largest expense in a livestock operation?

    a. dewormer
    b. barns
    c. feed
    d. pasture renovations

10. If the best feed in the world falls to the ground:

    a. It will still be consumed by the goats
    b. It becomes expensive barnyard litter
    c. It is a good omen if Mercury is in retrograde
    d. None of the above

Name ______________________________

**Chapter 11**
**Fencing for Goat Producers**
**Evaluation**

**Test Questions**

11. Which of the following types of fencing are not recommended for goats?
    A High tensile electric
    B Woven wire
    C No climb wire
    D Barbed wire

12. Goats that get out tend to _______ a fence.
    A jump
    B go under
    C through
    D ram

13. A minimum of ______ ground rods are needed on electrified fences.
    A 1
    B 2
    C 3
    D 5

14. An energizer should have a minimum of 1 joule per _______miles of electric fencing.
    A 2
    B 4
    C 6
    D 8

15. It is best to not attach fences to trees however in insistences where trees are used as end post it is best done using _______.
    A Boards around the tree
    B Dead trees
    C Lag eye bolts
    D Trees at least 10” diameter

16. A common problem with fencing across streams is______.
    A Poor connection of vertical chains
    B Debris being caught
    C Stream channel stability
    D All of the above

17. Woven wire fence is best when constructed with _________.
    A Augered post
    B Offset electric wire
    C Hand tools
    D None of the above

18. Temporary polywire to control goats should be a minimum of ________ wires.
    A 2
    B 3
    C 4
    D 5

19. Which type of fence is often called goat killer wire by producers?
    A High tensile electric
    B Barbed wire
    C Woven wire 6” mesh
    D Woven wire 12” mesh

20. If electric and non-electric wire are run together what is the minimum distance that the wires should be spaced apart?
    A 2”
    B 4”
    C 6”
    D 8”

**MASTER GOAT PREDATION EXAM**
**Chapter 12**

1. Predation is not a natural phenomenon. T or F

2. Which livestock industry in monetary terms has suffered the greatest loss due to predation?
   a. beef  b. goat/sheep  c. swine  d. poultry

3. When animal losses are expressed as a function of value which industry has suffered the greatest losses?
   a. goat/sheep  b. beef  c. swine  d. poultry

4. The sheep and goat industry have had the burden of maintaining predation management programs?
   T or F

5. What practices are actual costs goat producers accrue because of predation?
   a. night confinement  b. predator control  c. lost performance  d. all of the above

6. Identifying the exact cause of predation is the most difficult part of predation control. T or F

7. Many dogs trapped in predation studies were traced back to homes? T or F

8. Goats killed by dogs that have been fed upon resemble coyote predation. T or F

9. Coyote diets include which of the following:
   a. livestock  b. small dogs  c. rodents  d. all of the above

10. Trapping and snaring coyotes are viable control measures. T or F+

11. The black vulture in Tennessee has been known to prey on newborn livestock. T or F

12. The diet of black vultures includes which animals.
   a. birds  b. skunks  c. newborn animals  d. all of the above

13. Disposal of dead animals is effective for control of vulture predation. T or F

14. Sometimes the only evidence left at the scene of swine predation on goats would be a bloody spot on vegetation. T or F

15. Fire ants can build 40 – 80 live mounds per area. T or F

16. Fire ants can kill wild animals and domesticated livestock with multiple stings. T or F

17. Farmers should consider eradicating fire ants from their property. T or F

18. Producers should not schedule goats to kid in cool weather as a non-chemical control to fire ants. T or F

19. Good sanitation is not a good way to control predation. T or F

20. The Texas two-step method utilizes two treatment options to help control fire ants. T or F

**Master Meat Goat Producer**
**Chapter 13 – Behavior**
**Exam Questions**

1). Physiological and psychological effects of STRESS on goats has a major impact on production performance, health and the overall welfare and well-being of the goats. True or False

2). In plant selection, goats are capable of:
- a). selecting individual plant species, plant parts and plant quality
- b). creating a 6 to 8 foot browse line
- c). selecting vegetation with higher cellulose and lignin content
- d). all of the above
- e). a and b

3). Goats are very conscious of their surroundings as they evolved:
- a). as a predator/prey specie
- b). socially and bond together for protection
- c). conscious of physical pressure from predators and the environment

4). In a browsing pattern (situation) with a mob of goats, they will select about ____ % brush, _____ % forbs and _____ % grass species.

5). During kidding, __________, _________ and __________ are taken into consideration when approaching a doe concealing herself and kids in the undergrowth.

6). Temperament is a heritable characteristic trait (_______ %) and can be enhanced by ________________ at birth.

7). Behavior depends on consequences and reinforcement of those behaviors can be either positive or negative. True or False

8). Learning what vegetation to select and what to avoid is a learned behavior by young:
- a). when foraging with its mother
- b). at weaning when placed in a situation with experienced foragers
- c). a and b
- d). feeding to satiety

9). Nutrients can influence palatability, intake and preference, for example, a phosphorus deficiency depresses intake by _____ to _____ %.

10). Grazing Response Index (GRI) uses three factors related to plant health to evaluate impacts of grazing/browsing - ___________ and _________ of defoliation (grazing), and ______________ for the plant to recover.

11). Learned behavior consequences, low-stress management, genetic selection and environmental adaptation are factors used to compliment physical features such as topography, soil, water infiltration and percolation and climate.  True or False

**TENNESSEE MASTER GOAT PRODUCER**
**End of Program Evaluation**

______________________________
**Date**

______________________________
**County**

We hope that the Master Goat Producer educational program has been beneficial to you and your goat operation and ask you that you take a few minutes to complete this survey.

1. As a result of participating in the Master Goat producer program, I plan on making changes to my goat operation in the following areas (please check all that apply).

   ___Marketing
   ___Business and Financial Planning Management
   ___Health and Biosecurity
   ___Forages
   ___Agroforestry and Silvopasture
   ___Genetics and Breeding
   ___Reproduction
   ___Nutrition
   ___Carcass Merit and Carcass Fabrication
   ___Environment
   ___Facilities, Fencing and Equipment
   ___Predators and Predation
   ___Behavior
   ___Production Management
   ___Evaluation Resources and References

2. Please list the three primary production, management or marketing practices that you will adopt or change as a result of your participation in the Master Goat Producer program?

   1) ______________________________________________

   ______________________________________________

   2) ______________________________________________

   ______________________________________________

   3) ______________________________________________

   ______________________________________________

3. After completing the Master Goat Producer program, we hope that you will be able to make changes to your goat operation that will result in economic benefits. Please indicate the dollar amount benefit that you feel the changes you plan to make in your goat operation will have (please check only one box).

   None _____
   $100-$1,000 ______
   $1,001-$2,000 ______
   $2,001-$3,000 ______
   $3,001-$4,000 ______
   $4,001-$5,000 ______
   $5,001-$6,000 ______
   $6,001-$7,000 ______
   $7,001-$8,000 ______
   $8,001-$9,000 ______
   $9,001-$10,000 ______
   $10,001-or more ______

4. What is your overall impression/evaluation of the Master Goat Producer program?

   ________________________________________________________________

   ________________________________________________________________

5. Do you consider the cost of this program too high____ too low ___ just right ___?

6. Would you recommend the Master Goat Producer program to other producers?

   Yes _____ No ______

7. What can be done (please be specific) to improve the Master Goat Producer program?

   ________________________________________________________________

   ________________________________________________________________

   ________________________________________________________________

8. List and rank other topics that you would like to have taught in future "advanced" Master Goat Producer educational programs.

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

**"MASTER GOAT PRODUCER" AGENT TRAINING**

**Middle Tennessee Research and Education Center**
**Spring Hill, Tennessee**

1. What was the best part of the training?

2. What was the worst part of the training?

3. What are the three primary things you learned?

4. On a scale of 1 to 10 (where 10 is extremely likely and 1 indicates no interest whatsoever), how interested are you in developing/hosting a Master Goat Producer course in your county/area?

No Interest
Extremely Likely
1---------2--------3--------4--------5--------6--------7--------8--------9--------10

5. Would you suggest this training to others? ______ Yes _______ No

6. How could the training be improved?

7. Please utilize the space below and the back of the form to provide any additional comments or input that you think would be helpful to the training organizers.