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U.S. Meat Goat Situation Report

Dr. Frank Pinkerton[1] and Dr. Ken McMillin[2]
[1]Langston University (retired)
[2]Louisiana State University AgCenter

Preface

This paper provides contextual information undergirding the three papers presented today by Louisiana State University Scientists (goat carcass quality and yield characteristics, consumer preference for goat meat, and goat producer constraints). These presentations report findings from a recently completed three-year USDA-funded research project. My paper also offers commentary on possible exploitation of these research findings by producers, processors, and consumers.

Introduction

Meat goat inventory numbers are compiled annually by the National Agricultural Statistics Service (NASS), a unit of the USDA. From an industry high of 3,118,000 in January 1 2008, total goat numbers fell to 2,811,000 in January 1 2013, a decline of 9.9%. Meat goat numbers declined from 2,590,000 to 2,315,000, a decline of 10.6%. The decline in meat goat numbers from January 2012 to January 2013 in the U.S. was 1.75%, as compared to 4.4% for the previous 12 months (bad droughts in Texas and Oklahoma).

A recent nationwide herd health survey by USDA/APHIS found a total of 124,000 U.S. meat goat operations averaging only 11 breeding age does per herd. The vast majority were smallholder units of less than 30 breeding age females, but there were also numerous operations with over 100 does scattered over many states. Larger herds (over 500 head), typically managed extensively, mostly in areas of low rainfall, are slowly declining in numbers and numbers/ranch. Indeed some Texas, ranch holdings in chronic drought areas are being leased for hunting or, in some cases, simply being abandoned in the face of limited grazing, high costs of supplemental feeding, and the long-term prospect of negative cost-benefits.

Angora goat numbers to a new low of 136,000, down by a third since 2008.This trend will likely continue as numbers of producers and size of enterprises decline even in the face of mohair prices considered 'good' by the remaining players.

Dairy goat numbers peaked in CY 2010 and have remained stable since. Industry sources cite strong demand for goat milk for commercial cheese making and also increased number of farmstead cheese makers. Imported goat cheeses are thought to constitute over half of domestic consumption.

Table 1 shows the two-year changes in meat goat numbers by state, CY 2011-2012. Current state rankings are shown in the 2013 column. Oklahoma numbers may indicate a partial recover from its' CY 2011 sell-off, but Texas continued to lose substantial number in CY 2012, and at this writing, the climate prognosis is pessimistic for CY 2013 in these and other states.

Concerning producer prices, we noted that during CY 2012 that summer prices were somewhat less than in summer CY2011. We also noted that auction prices did not rise as early, or as high, in late 2012 as in the recent past. However, prices for grade #1 slaughter goats under 60 lb rose to well over $2.00/lb by late February 2013 (press-time for this article). Price gaps, as between grades 1 and 2 and also between weight classes, narrowed as demand rose. (With the notable exception of larger, heavier over-conditioned Boer Show wethers that sold, as usual, at substantial discounts due to consumer resistance.

Goat meat supply

Figure 2 shows the continuing decline, but at a reduced rate compared to the past few years, of U.S. slaughter numbers. The 2013 figures were not available at press-time, but they are expected to fall in about the same proportion as the 2013 live goat inventory numbers cited in Figure 1.

Note also in Figure 2 the increase in imported goat meat numbers as a percentage of total domestic consumption (the currently unavailable CY 2012 figure will likely continue this trend). Readers must understand that these percentage figures are derived by comparing the weight of domestic kill (in federal plus state plants) to the weight of frozen imported carcasses (whole, 6 piece-paks, or bone-in cubes).

As always, we urge readers to remember that an unknown (and unknowable) number of domestic goats are killed every year in 'informal circumstances' (not in federal/state plants) and thus are not counted as domestic kill. Accordingly, the reported percentages in Figure 2 are erroneously high (industry observers suggest by 10%, or more). If so, we are meeting about half of current demand.

Put differently, our goat meat market share is perhaps 50%. In the corporate business world, market share is extremely important, but for domestic meat goat producers, not so much. Returns to producer labor, management, and capital depend on the relationship between prices received for their animals and the cost of their production inputs; neither of these seems dependent on market-share ratios.

On the other hand, a continual loss of market share over time might well narrow the current price gap between domestic goat meat and imported goat meat. Currently, consumers say that they prefer domestic over imported goat meat, and they do in fact pay an appreciable premium for domestic product in metro ethnic marketplaces. However, they readily buy imported goat meat when domestic goat meat is inadequately supplied. A scarcity of domestic product might well drive its retail prices upward, but consumer resistance would establish a ceiling at some price point). A more likely scenario is that increasing quantities of imports would lead to increasing prices for imports, thus narrowing the price gap between domestic and imported goat meat. Such competition could even lower domestic producer prices as market share declines further.

Prior LSU research has shown that ethnic taste panelists could not in fact distinguish organoleptic characteristics (flavor, tenderness, juiciness, overall satisfaction) as between imported and domestic goat meat. A second panel (Anglos and Hispanics) also could not distinguish between such characteristics as between imported and domestic grass-fed goats, but Hispanic panelists did prefer grass-fed domestic goats over domestic goats fed supplement grain while on pasture (too fat, over-conditioned).

Should U.S. meat goat producers become sufficiently concerned about the effects of losing market share, they could elect to try to increase domestic supply. There are but five ways to do so. First, they could persuade more landowners to initiate goat production. Secondly, they could expand the size of their herds. Thirdly, they could increase the off-take from the herd via improved management, and fourthly, they might (slowly) increase doe productivity via genetic improvement. A fifth possibility would be to increase the average size of slaughter goats going to auction.

The first four options are theoretically doable, but their likely cost-benefits ratios would be decisive considerations; current ratios do not seem encouraging. Increasing sale weights of kids might or might not be profitable, and in any case would require abnormally higher prices for increased weights (readers are familiar with the historical drop in prices beyond the 80 lb sale category). But, even if such animals were made available, there would be fierce resistance to this change by consumers (and thus packers and retailers) who traditionally prefer 20-30 lb carcasses.

Ethnic consumers seem primarily concerned with carcass meatiness and with goat meat tenderness. The latter trait is thought to be closely associated with 'youthfulness', as indicated by carcass color (pale pink is

preferred) and by weight of carcass (small is better). Neither sex nor breed of goat seem of concern to buyers of market weight kids.

In the past, consumers have preferred to take whole or half carcasses and 'cubes' (bone-in pieces ranging 2-6 inches in size and of variable 'thickness'). Historically, there has been little interest in lamb-like retail cuts of goat meat and only limited interest in goat sausages and patties.

However, among the current LSU research findings about consumer preferences is preliminary evidence of emerging consumer interest in purchasing goat meat in retail cuts (similar to lamb and pork chops and roasts). We speculate that this may be an outgrowth of 'convenience shopping' among mostly younger buyers wanting goat meat, but not wanting the hassle of more arduous preparation and storage of excess product. And we do know from previous observations that consumers tend to shift from whole carcasses to half or quarters (or to cheaper imported cubes) when the cost of whole carcasses becomes financially burdensome (a 65 lb farm goat in Texas selling for $2.25/lb will sell as a 20 lb retail hanging carcass in New York City for about $6.00/lb; this $120 price tag is discouraging for typical ethnic buyers).

Readers should understand the possible significance of substantial change in this nascent pattern of goat meat consumption. Yes, price/lb for retail cuts would go up somewhat due to labor and packaging costs, but the price per purchase would go down (i.e., a three pound hind-leg roast might cost only $21/package as compared to a $100 carcass. And, yes, such retail cuts might require some 're-education' regarding cooking techniques, but young ethnic women are increasingly in the workforce and subject to the same time constraints of competing activities as other 'homemakers'. This being so, convenience becomes the paramount consideration and the way-granny-did-it becomes of ever diminishing concern.

There is more, and of possibly wider industry concern. Large beef packing plants followed the feedlots that earlier moved to the grain producing areas. Finished beef (wholesale and retail cuts) is currently shipped in refrigerated boxes to urban areas for distribution to supermarkets. This reduced transportation costs of edible product to consumers; it 'rationalized' the trade.

Contrarily, there are few goat stocker operations and even fewer feedlot enterprises; accordingly, few such cost-efficient channels exist for goat meat. Indeed, producers typically sell at the closest auction, and goats are then hauled to distant packers located as close as possible to urban consumers. This channel causes weight loss (shrinkage) and adds transportation cost; both costs are passed on to the consumer. It is not rational, but it is real—and will be for many years.

Goat production issues

LSU researchers surveyed hundreds of owners of meat goats across the U.S. to identify their major industry concerns; two seem paramount. The first actually concerns marketing issues. Producers feel that they are at a disadvantage in current marketing channels. They mostly sell at small and distant auctions and thus incur larger costs for transportation and possible price discrimination due to lack of buyers (lesser competition). Other marketing options (brokers, cooperatives, packer-direct, and on-farm direct sales to consumers) are available to a few, or many, producers; some are not. All incur variable costs for moving goats pasture-to-plate.

Goat producers vary widely in the scale and scope of their operations. They also vary widely in their knowledge of goat marketing channels. Goat producers (large- or small-holders) often seem unaware of the scale of their industry as compared to other livestock species and equally unaware of the differences in production, processing, and merchandizing of these species.

Perhaps too few goat owners realize, or accept, that they are producing and marketing a 'minority' species… in many instances far removed from consumers and also not amenable to ameliorative economy-of-scale endeavors prevalent in the beef, pork, and chicken industries. Americans consume, per capita, about 100 lb

of poultry per year, 65 lb of beef, and 60 lb of pork. In contrast, we consume about .9 lb of lamb/mutton and about .3 lb of goat meat (domestic plus imported). Ergo, it is not surprising that marketing opportunities for goat (and sheep) producers are not comparable to mainstream species.

The second primary producer concern focuses generally on the economics of meat goat production. More specifically, goat owners complain of unfavorable returns to their labor, management, and capital. In economic parlance, the cost-benefit ratios for goat farming are not sufficiently positive. In some instances, only break-even returns are achieved; in other instances, losses can be substantial.

In commercial-scale goat production, three management factors determine enterprise profitability. The first is the annual maintenance cost per doe (derived by dividing all production costs by the number of does exposed for breeding).

The second factor is the percentage of kid crop sold. The higher this percentage, the higher the gross income and, presumably, the net income will be. Experience has shown that it is difficult to achieve positive cost-benefit ratios if this figure is much less than 150%. Good managers can achieve about 175% (1.75 kids sold/doe); superior managers of mixed-aged herds can achieve 200% (for every single, there must be triplet). Kid crops sold above 200% are rare in herds kidding once per year.

The third factor is weight of kids at sale time… larger weight equals larger income, and higher market grade of kids usually garner better prices/lb. Caveat: successful producers say numbers of kids sold per doe is, economically speaking, more important than their sale weight which is, in turn, worth more than sale grade.

In small-scale operations, these same factors apply, but owners may also recognize other factors as having non-cash value (brush and weed control, tax abatement, child-rearing opportunities, life-style improvement, etc.). In this accounting, the objective is to lose as little as possible while maximizing family enjoyment. A considerable majority of all goat owners fall into this category. Regarding IRS policy, farm losses are deductible only if the intent is to make a profit; otherwise no deductions are allowed.

The most incorrigible and expensive component in determining annual doe maintenance costs is the charge taken for land use. At current prices, land simply cannot be purchased and paid for with income from commercial goat sales or even from breeding and/or Show stock sales. IRS rules allow one to deduct the costs of interest and of taxes on land purchases, as also depreciation for improvements to the land. In many cases, commercial meat goats may not cover even these costs.

When evaluating opportunities for reducing annual doe maintenance costs and improving net income, it is tempting to simply make no charge for land use. The IRS won't care and you can just say to yourself that the land is being held for investment price appreciation). But, for more accurate farm enterprise analysis, one should charge 'fair rental value' or (if the land is paid for) use 'opportunity-cost' figures (commonly: interest unearned). But, using either figure will significantly reduce net farm income; live with it.

Table 1. Inventory changes, in number and percentage, from 2011 to 2013, in selected states.

Rank	***State***	***2011 head***	***2013 head***	***% change***
1	Texas	950,000	850,000	-10.5
2	Tennessee	115,000	114,000	-0.9
3	Oklahoma	91,000	106,000	+16.5
4	California	100,000	98,500	-1.5
5	Missouri	80,000	82,000	+2.5
6	North Carolina	85,000	70,000	-17.7
7	Kentucky	72,500	69,000	-4.8
8	Virginia	58,000	67,000	+15.5
9	Georgia	71,000	64,200	-9.6
10	Ohio	59,000	62,000	+5.1
11	Florida	55,000	54,000	-1.8
12	Pennsylvania	46,000	43,000	-6.5
13	South Carolina	42,500	43,000	+1.2
14	Alabama	56,500	42,000	-25.7
15	Arkansas	48,000	42,000	-12.5
16	Kansas	40,000	34,000	-15.0

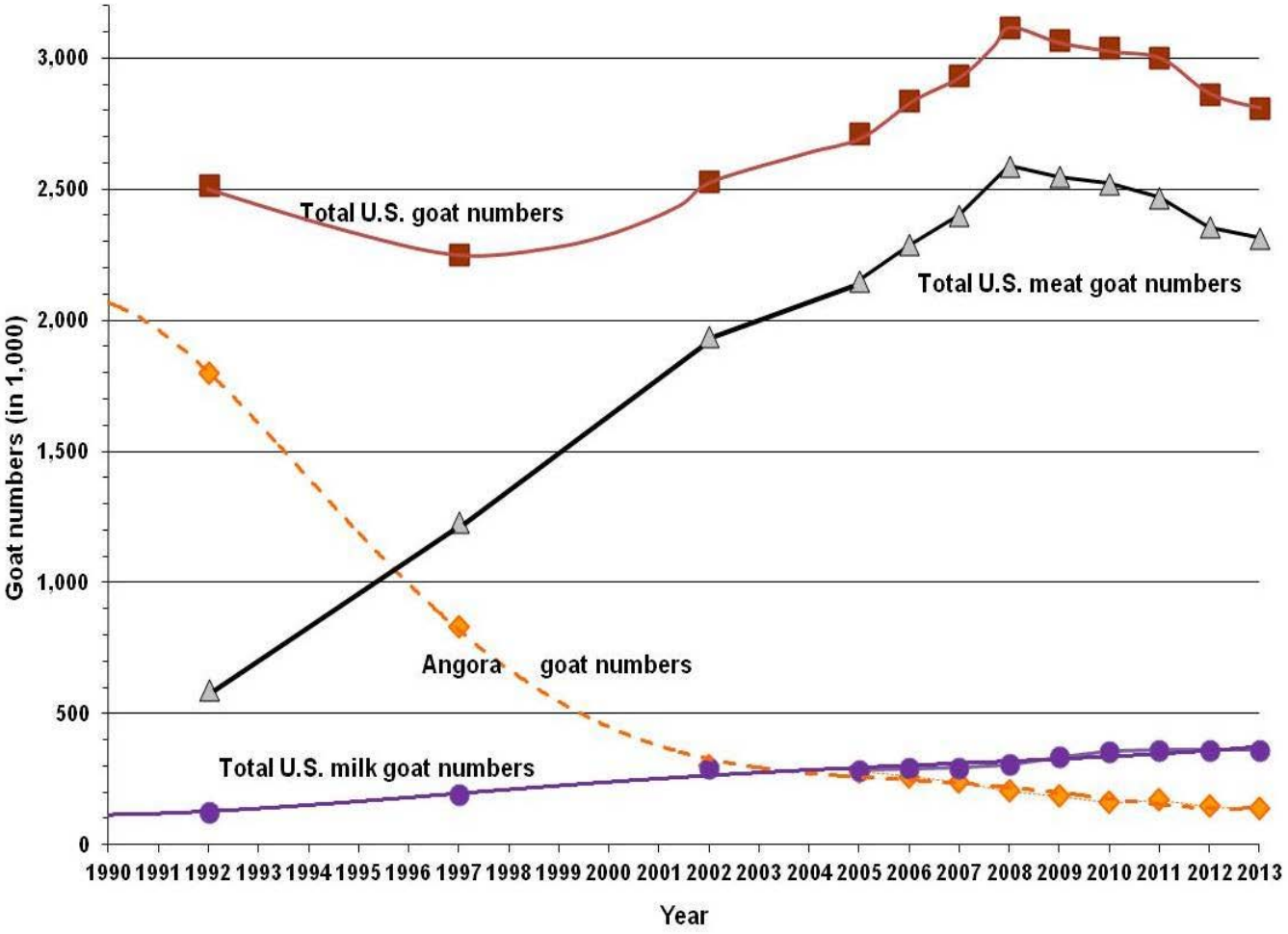

Figure 1. Trends in total goat numbers, meat goats, Angora goats, and milk goats in the U.S.

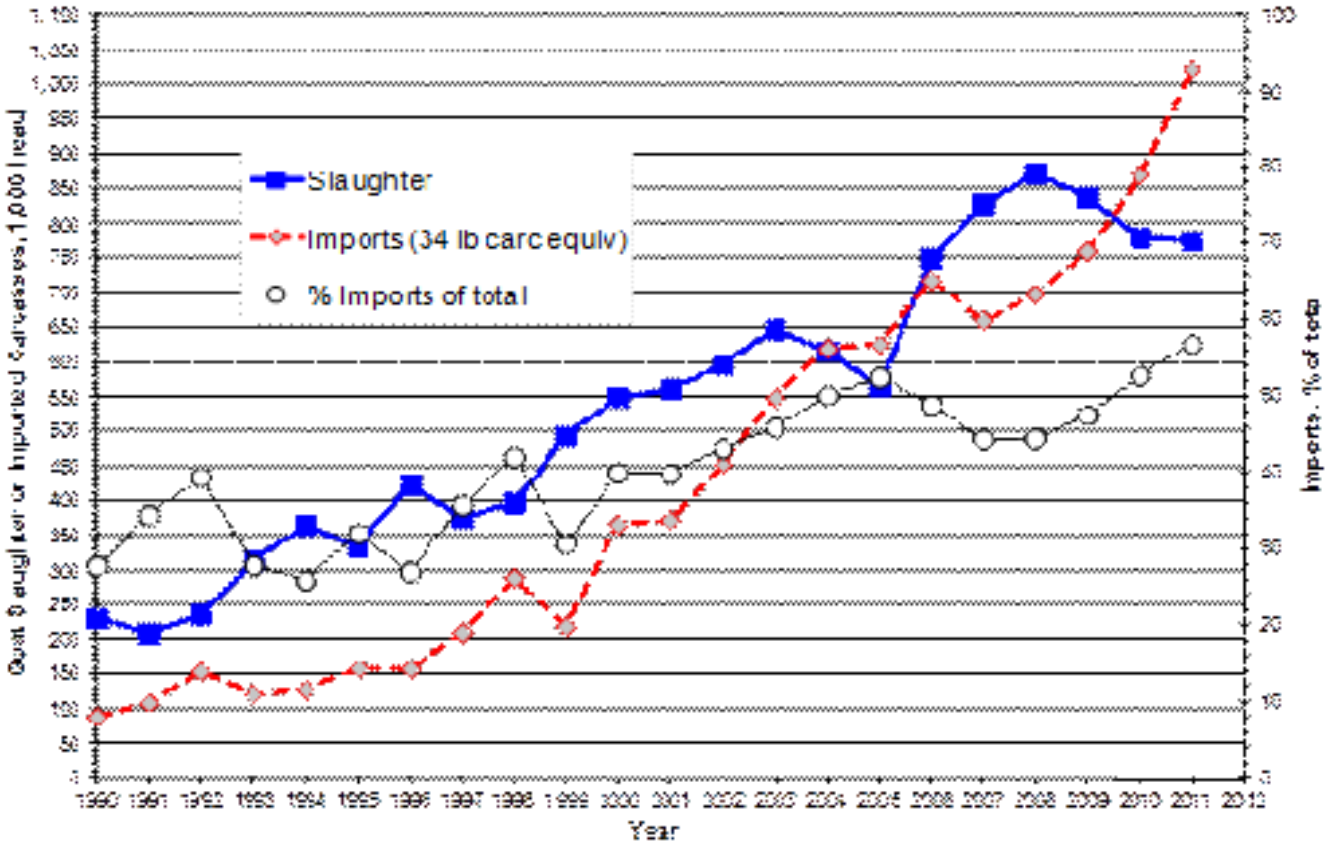

Figure 2. Annual domestic U.S. goat slaughter in head and imports of goat meat as 34-pound carcass equivalents from1996 through 2011 with import as a percentage as total numbers of estimated animals. Note that slaughter values before 2006 are for only federal slaughter while values after 2006 are combined state and federal inspected plant slaughter numbers.

Results of the U.S. Meat Goat Production Survey

Dr. Jeff Gillespie[1], Dr. N. Nyaupane[1], Dr. Ken McMillin[2], and Dr. R. Harrison[1]

[1]Department of Agricultural Economics and Agribusiness

[2]School of Animal Sciences

Agricultural Center, Louisiana State University

Introduction

U.S. meat goat production has increased significantly over the past several decades. There has, however, been limited information available on the production practices used by meat goat producers and the economics associated with using these practices. The objectives of this study are to: (1) determine producers' use of production systems and marketing practices, knowledge of pricing, perceptions of challenges facing the goat industry, goal structure, preferences for breeding stock, and producer demographics; (2) determine types of producers adopting the various production systems, breeding practices, and marketing practices; and (2) determine strategies that lead to economic success in the meat goat industry. This research project is ongoing, as we have not completed all analyses. This paper provides some initial results from the study.

Materials and Methods

A mail survey questionnaire was developed to collect information on meat goat producers' use of various technologies, management practices, and production systems, as well as their perceptions about the industry. A total of 1,600 producer names were identified via an internet search of state goat producer associations, Eatwild.com, and other websites advertising meat goat or goat meat sales. Producers were surveyed during July-September, 2012. A total of 584 returns were received for a 43% return rate. One of the questions on that survey asked respondents if they would be willing to fill out a follow-up survey on costs and returns. That survey is currently ongoing, so the results of that survey are forthcoming. Appropriate statistical procedures are used throughout the study, with the specific statistical procedure used depending upon the question being asked.

Results and Discussion

Farm Descriptor Means. The average farm size of respondents was 200 acres, of which 78% was owned by the producer and 58 acres used for the goat operation. About 14% of these producers' net household income was from the goat operation, while 40% of the producers' net farm income was from the goat operation. Thus, other sources of income generally made up the majority of income for these households. Percentages of farms having each of the following facilities available included: working pen, 74%; breeding pen, 56%; kidding pen, 77%; working chute, 42%; weaning pen, 71%; quarantine pen, 75%; scale, 52%; and sheds/barn, 98%. About 29% of the farms also produced beef cattle, 22% produced field crops, 21% produced horses, 33% produced other livestock / poultry, and 25% had no other enterprises on the farm. The average farm bred 36 does, had 51 kids born alive, and had 72% of does that kidded having twins or triplets.

Goat Breeds and Production Systems Used. Of the breeds of goats used, 75% of the farms used Boer, 32% used Kiko, 10% used Spanish, 32% used mixed goats, and various other specific breeds were each used by <10% of the producers. The majority of producers pastured and rotated their goats (52%), followed by pasturing and not rotating (35%), producing in a dry lot (30%), and finally extensive-range or pasture/

woods where the goats were not handled very much (14%). These percentages sum to >100% because some producers used multiple production systems.

Use of Production Practices. The majority of goats were sold for slaughter or as meat (45%), followed by sales for use as breeding stock or for show (46%). About 73% of the producers castrated the male goats, most using an elastrator. Disbudding and hoof trimming were conducted by 39% and 91%, respectively, of the farms. Artificial insemination and embryo transfer were used by 11% and 7% of the producers, respectively. Various goat pregnancy detection methods were used, though 62% did not check for the pregnancy of does. About 88% of the producers timed breeding of their does such that they would kid only during certain times of the year, with most (56%) doing so in order to facilitate effective market timing. About 34% timed breeding for efficient use of pastures. Producers were asked about their practices when bringing new goats into their herds, with 75% indicating they kept new goats in quarantine for a period of time, but the period of time varied greatly.

Marketing Practices. Of marketing practices used, 79% sold direct to consumers and 65% used live auctions. Marketing practices used by ≤15% each included sales to dealers, brokers, or meat packers; selling goat meat; selling goats via wholesale or retail businesses; using market pooling; and using cooperatives. Those selling direct to consumers tended to have farmed longer and sold lower percentages of animals for slaughter or as meat. Those using live auctions were less likely to hold college degrees, were less likely to be retired, and sold higher percentages of animals for slaughter or as meat. Types of producers using the other marketing outlets were also examined. Of the 11% selling goat meat, most sold direct to consumer, followed by farmers' markets, restaurants, and finally grocery stores. Of the 23% of respondents targeting goat production to specific holiday markets, 78% targeted Easter, followed by Ramadan, Christmas / New Year, Hispanic holidays, and finally various other holidays.

Perceptions of Challenges Facing the Goat Industry. Eleven challenges to the goat industry were provided to goat producers, with their perceptions as to their agreement that the challenge was negatively impacting goat producers in their areas queried. Challenges that elicited modal responses of "strong agreement" that the challenge was negatively impacting producers in their areas included the high cost of goat production, lack of a clear marketing system for goats, lack of a goat meat processor close by, internal parasites, and insufficient government support for the industry. Challenges that elicited modal responses of "somewhat agree" that the challenges were negatively impacting producers in their areas included lack of steady demand for goat meat and pasture management problems. Challenges that elicited modal responses of "neutral" that the challenges were negatively impacting producers in their areas included lack of a grading system for goats, diseases, predators, and a surplus supply of foreign goat meat product. Analysis was further conducted to determine the types of producers likely to indicate stronger agreement with each of the challenges.

Reasons for Entering Goat Production. Goat producers were asked, "To what extent do you agree or disagree that your selection of a goat enterprise as opposed to other agricultural enterprises is because of the following reasons?", with 14 statements for which they were to indicate their agreement or disagreement. Based upon the means, the most important reason was, "I enjoy working with goats." Tied for second were, "I can raise goats on a relatively small acreage" and "Goat production fits well into my land management plan." Fourth was, "Goat grazing preferences are different from other species." Fifth was "My family can be involved in the goat enterprise." Others of note were, "Goat production is profitable," which ranked 12th, and "Low cost to purchase and raise goats," which ranked 13th.

Further Research to Be Conducted

As mentioned earlier, this is an ongoing project. Some additional research we are conducting includes: (1) analyzing the types of producers adopting various technologies, management practices, and production

systems; (2) determining the relatively profitability of farms adopting various technologies, management practices, and production systems; (3) analyzing price differentials for auctions for Selections 1, 2, and 3 goats and farmers' awareness of the differentials; (4) analyzing the goal structures of goat producers; (5) analyzing producers' preferences for breeding stock by industry segment, as well as producers' willingness to pay for various breeding stock attributes; (6) determining costs and returns of U.S. goat production; and (7) determining scale efficiency of U.S. goat production.

Acknowledgements

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Consumers' Preference for Goat Meat in the United States

Dr. R. Harrison[1], Dr. J. Hill[1], Dr. Jeff Gillespie[1], and Dr. Ken McMillin[2]

[1]Department of Agricultural Economics and Agribusiness

[2]School of Animal Sciences

Agricultural Center, Louisiana State University

Introduction

The numbers of meat goats in the U.S. have slightly declined in recent years while the tonnages of imported frozen goat meat from Australian and New Zealand have increased (Pinkerton and McMillin, 2012a, b). Previous survey research of Muslim goat meat consumers (Fisher et al., 2009; Ibrahim et al., 2008; and Worley et al., 2004) indicated preference for Halal meat, particularly during religious holidays, with some consumers preferring fresh goat meat and to slaughter goats themselves. Males older than 41 years of age, non-Caucasian, and non-Catholic individuals were found more likely to consume goat meat in studies of consumers in Southern areas of the U.S. (Knight et al., 2006; Nelson et al, 2004; McLean-Meyinsse, 2003). Increased numbers of immigrants, more emphasis on local production, and consumer awareness of natural and organic food choices have increased opportunities for small-scale farmers. There is a lack of knowledge about goat meat consumers, which limits strategic planning by individual goat producers and collectively, the meat goat industry. This survey was designed to sample national representative populations of goat meat eaters and the general U.S. to determine goat meat preferences and opinions for at-home consumption.

Materials and Methods

A survey questionnaire was developed to ask questions about the frequency, occasions, and form of goat meat consumption; query preferences and attitudes about goat meat and live goats; provide choices between characteristics of type of cut, color, source, and price of goat meat and age, sex, slaughter method, and price of live goats to determine relative differences in through conjoint analysis; and give socioeconomic and demographic data on respondents. An internet company obtained data from 2000 general respondents and 2000 goat meat eaters from their representative national sample populations. Goat meat eaters were designated as individuals 18 years of age and older who had eaten goat meat in the past year,

Results and Discussion

The demographics of the general population respondents were average of 48.4 years of age, 58.8% female, 85% white, 7% black, 4% Asian, 7.1% Hispanic, 4.4% Asian descent, 5.2% African descent, 31.4% from South region. 24.3% West region, 19.7% Northeast region, and 24.7% Midwest region. Of the general population respondents, 12.8% had eaten goat meat in the past year, with the majority (86.7%) purchasing goat meat cuts, 3.9% purchasing live goats, and 9.4$% purchasing both. Most of the general population respondents (87.2%) had not eaten goat meat in the past year and 76% of those had never eaten goat meat. Responses to the question of "Why have you never eaten goat meat?" indicated that 43.2% had never heard of eating goat meat, 41.7% did not have goat meat available in their grocery or meat shop, 10.2% consider goats as pets not intended for consumption, 3.6% had been told by others that it is not tasty, 3.6% considered goat meat too expensive compared with other meats, and 1.2% thought that only low class people eat goat meat. Of the general population, 0.2% considered themselves vegan and 0.1% as vegetarian.

A follow-up question gave choices as to occasions when individuals who had never eaten goat meat were likely to try goat meat. 34.8% indicated that they might try goat meat at a grocery store providing samples of cooked goat meat, 34.7% as part of a meal served at a friend's home, 31.4% as an appealing menu item served in an ethnic restaurant, and 29% at a social gathering which included goat meat as part of the meal. Only 2.9% indicated that they would never try goat meat under any circumstance. The reasons for not eating goat meat regularly if goat meat had been tried were not available in my grocery or meat shop 51.7%, just not part of my culture 33%, don't know how to cook goat meat 25.7%, didn't like the taste 18.5% and too expensive compared with other meats 11.4%. 63.1% would be willing to eat goat meat more often as an appealing item at an ethnic restaurant and 61.9% at a social gathering with goat meat as part of the meal, 29.6% as part of a recipe in a food magazine and 22.6% as part of a recipe seen on a cooking show, but 7.7% would never eat goat meat again under any circumstance.

The demographics of the respondents indicating that they had eaten goat meat 1 to 2 times in the past year were average of 41.5 years of age, 59% male, 65.4% white, 12.9% black, 12% Asian, 15.6% Hispanic, 12.1% Asian descent, 8% African descent, 33.9% from South region. 26.3% West region, 20.4% Northeast region, and 19.5% Midwest region. The goat meat eating respondents purchased goat meat cuts (85.8%) while 5% purchased live goats and 9.2$% purchased both. The demographics, except for male:female ratios and slight ethnic differences, of the goat meat eating population matched those of the respondents in the general population.

Of goat meat eaters, 59.4% consume goat meat on no specific occasion, with consumption on special occasions or other holidays 30.7%, Easter 15.1%, Ramadan 5.6%, and Christmas 14.1%. Goat meat consumption by goat eaters in a restaurant were stratified with 39.5% responding 0 to 26% of the time and 38% responding 76 of 100% of the time. Conjoint analysis allows comparison of different levels of variables that represent realistic combinations of choices that consumers might make. The levels for meat choices were whole carcass, half carcass, chops, and cubes for cuts; light pink, medium red, and dark red for meat color; fresh domestic, frozen domestic, and frozen import for meat source; and $3.89, $5.39, and $6.89 per pound for price of goat meat. Relative importance of the attributes were cut 68%, source 15%, price 14%, and color 3%. The levels for purchase of live goats were intact male, castrated male, and female for gender; less than one year, one year, and two years for age; slaughtered by buyer, farmer, or commercial for slaughter choice; and $75, $130, and $195 per head for live goat price. Slaughter type (33%) and goat age (32%) were more important than goat sex (18%) and price (17%) to goat eaters who purchased live goats.

Goat eating consumers who purchased meat preferred chops and cubes over whole and half carcasses. The attribute color was found not to be very important to consumers' choices. Consumers valued fresh domestic over frozen domestic or frozen imported goat meat. Non-white goat consumers preferred half carcasses, imported meat, and darker color of goat meat. Consumers of goat meat once per month or more frequently preferred purchasing whole or half carcasses, as did Hispanic respondents. Goat eaters who purchased live goats preferred purchasing goats of less than one year of age with slaughter by the farmer rather than by themselves or in a commercial plant. Hispanics preferred one or two year old goats.

Conclusions

The demographics of goat eaters and general population of the respondents surveyed were similar, with about the same proportions of goat eaters purchasing meat and live goats from each survey group. Only 2.9% of respondents who had never eaten goat meat would never try it under any circumstances, 18.5% did not like the taste of goat meat, and 7.7% who had eaten goat meat would never eat goat meat under any circumstances. Goat meat color was less important to consumer consuming goat meat than cut, source, and price of goat meat. Slaughter method and goat age were more important to goat meat eaters purchasing live

goats than price and goat sex. The results of the survey indicate that many marketing niches exist for goat meat and live goat sales for meat goat producers to exploit.

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Live Animal and Carcass Measurements of Meat Goats: A USDA National Institute of Food and Agriculture Project

Dr. Ken McMillin[1], Dr. J. Gregorie[1], Dr. K. Braden[2],
Dr. R. Cope[2], and Dr. Frank Pinkerton[3]

[1]School of Animal Sciences, Agricultural Center, Louisiana State University

[2]Department of Agriculture, Angelo State University

[3]Langston University (retired)

Introduction

The meat goat industry was the most rapidly growing livestock category in the U.S. in the early 2000s, but numbers of meat goats in the U.S. have slightly declined since 2008 while the tonnages of imported frozen goat meat from Australian and New Zealand have continued to increase (Pinkerton and McMillin, 2013, 2012). The meat goat industry is highly unstructured compared with other livestock industries and the few studies about market structure have not linked production practices with live goat characteristics and consumer surveys have not been related to goat meat characteristics. Specific information has been needed about each segment in the goat meat industry so that potential common market and product linkages can be identified and relative product values in each segment can be distinguished. A group of investigators submitted a proposal to the USDA National Institute for Food and Agriculture grant program in 2009 that was not funded. Additional investigators from Texas, Georgia, and Alabama were added and the project was funded in 2010. The project purpose is to identify production practices and product traits at each segment of the meat goat industry to increase the net economic benefits and productivity of meat goat producers. The research objectives are to determine purchase and consumption patterns for goat meat through a national survey of consumers; to evaluate live, carcass, and meat traits of kid and yearling goats representative of meat goats being marketed in the U.S.; and to survey producers on production and marketing practices needed to increase net margins and productivity within the next 5 years. This information from the multistate investigation will allow cohesion in communication among the production, processing, and retail market sectors and integrate research and outreach activities the information to goat producer and industry audiences.

Materials and Methods

Kid, yearling, and aged doe meat goats of different conformation, sex, and breed groups (n=725) that were representative of the goats currently being marketed in the major goat producing states were selected from auction markets and private goat producers in Texas, Georgia, Louisiana, Kentucky, Tennessee, Missouri, and California. There were 453 known Spanish and Boer purebred or crossbred goats, 73 kid goats with Savanna breeding, 42 Nubian or Nubian crossbred goats, 39 aged Boer crossbred does, 58 Kiko and Kiko crossbred kid goats, and 60 goats purchased at Texas auctions. Goats were transported to university (LSU, Angelo State University, Fort Valley State University) meat laboratories or commercial slaughter facilities for live linear measurements (Figure 1), evaluation of live conformation, and weighing before humane slaughter. After 24 hours of cooler chilling, carcasses were evaluated by trained personnel for cold carcass weight, carcass conformation, circumference measurements of the rear legs and chest, flank color score, external

Figure 1. Linear dimensions of chine length, loin length, rump length, heart girth, barrel circumference, height at withers, height at hip, chest depth, chest width, and shoulder width measured on live goats.

fat score and kidney, heart, and pelvic fat (McMillin and Pinkerton, 2008). One side of each carcasses was fabricated into shank, hind leg, fore arm, shoulder, rib, and back primal cuts (Figure 2) before manual deboning to obtain lean muscles from the hind leg, fore leg, shoulder, and back. The Semimembranosus muscle was vacuum packaged and frozen for determination of proximate composition (moisture, fat, protein, ash %) and evaluation by trained sensory panels at Southern University Agricultural Research and Extension Center. The data from each of the three project segments will be collated and analyzed to determine the

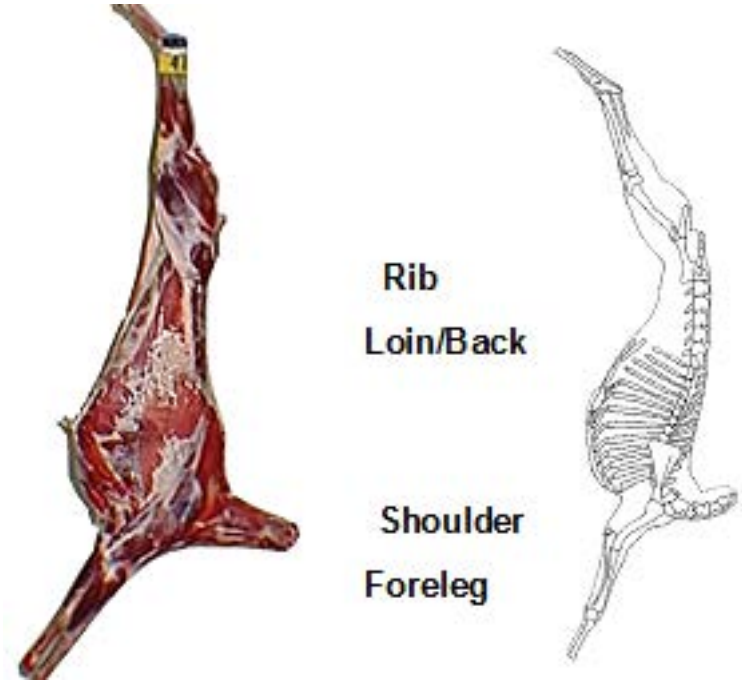

Figure 2. Standardized meat cut locations for shank, leg, back, rib, neck, shoulder, fore leg primal cuts of meat goat carcasses

specific statistical relationships between producer, consumer, and meat identifiers. The relationships of the trained sensory evaluations to the traits identified as important by goat meat consumers will be determined.

Results and Discussion

Goat meat consumers have expressed interest in purchasing smaller portions of goat than carcasses or half carcasses and desire to consider meatiness in their purchase decisions. Yield grades estimate amounts of lean meat based on accurate evaluation of the relative ratios of lean, fat, and bone tissues. Kid goats deposit minimal fat covering over the Longissimus dorsi, which is often too small in meat goats that average 29 kg (64 pounds) with 14 kg (31 pound) carcasses in commercial slaughter (NASS, 2012), to accurately measure for estimation of carcass muscling. Carcasses were evaluated for external fat amounts over the ribs and behind the shoulder. Goats in the project ranged from barely distinguishable fat covering the body to fat scores above 3, indicating a large amount of fat covering the side of the carcass. Relative amount of muscling was estimated by conformation score, with goats representing conformation scores from 150 down to 330 being evaluated. Dressing percentages usually were around 48%, but varied by as much as 5 to 7% above or below depending upon the type and source of the goat. There were minimal differences in primal cut percentages and lean meat yields from carcasses of kid goats, necessitating additional studies of other factors influencing lean meat yields of meat goats.

Conclusions

Goats have different patterns of fat deposition and muscle development than other livestock meat species, necessitating measurements other than LEA and backfat thickness to provide muscling and fat estimations on live goats and carcasses. The live animal, carcass, and muscle composition traits that contribute to tenderness, juiciness, and flavor of goat meat are being determined on the samples of Semimembranosus muscles from the same goat population samples. Quality or estimated palatability must be defined with terms and traits that can be objectively measured to facilitate communication, product transactions, and trust in the meat chain. Development of suitable live animal and carcass evaluation standards will facilitate advancement of marketing and logistical technologies to benefit the meat goat industry.

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Acknowledgements

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Meat Goat Herd Health Procedures and Prevention

Dr. Lionel Dawson
Oklahoma State University

Introduction

The goal of a herd health program is to improve the goat herd's productivity through general husbandry, nutrition, parasite control, vaccination, and environmental management. An understanding of various management practices and common diseases on the farm is necessary to accomplish this goal. An effective herd health program is an essential part of a successful goat management program. Good feeding and breeding will not result in maximum production if goats are not kept in good health. Conversely, good nutrition and herd management will greatly reduce the complexity and cost of the herd health program.

Herd health programs are always described in very general terms and then modified to fit individual herds. The exact makeup of any program depends on the herd size, purpose of having the herd, and the production goals of the owner. For the most part, goats are managed as small groups of five to a hundred animals per herd. There are relatively very few large commercial goat herds with numbers above 500 head in the United States. Large herds may have problems associated with high density of animals and continuous turn over. Small herds tend to have higher nonproductive/productive ratios than do larger herds. This is because small herd owners often keep animals that would normally be culled in large commercial herds. Often, the net result is the maintenance of animals with chronic illnesses that may serve as reservoirs of disease.

Since each herd is different, each owner should work with his/her veterinarian to create an individual herd health plan. Keep good records for each animal regarding medications, vaccinations, dewormers, diseases, breeding, culling etc., and use this information to plan your herd health program. Preventive medicine is usually less expensive than treating the disease as the highest economic returns are realized when disease problems are at a minimum. Many diseases have similar symptoms and a producer should work with a veterinarian familiar with common goat diseases. A veterinarian familiar with goats has the training and experience needed to provide diagnosis and recommend animal health products used in goats to treat these conditions.

Common Herd Health Procedures

In the normal course of herd health management it will be necessary to perform different herd health procedures. Some of these procedures are performed to collect information on an animal's condition that can be relayed to a veterinarian. Others are needed in the course of disease prevention or treatment. A producer should only attempt those procedures in which they feel comfortable and sufficiently proficient so that no harm can come to the animal. If there is any doubt, consult a veterinarian. The most common procedures done by producers are listed below with a brief explanation of correct methods.

Taking temperature – rectally

The first procedure usually performed on an animal suspected to be ill is to take its temperature. In goats, this is performed rectally. Either a digital or mercury thermometer can be used. Plastic digital thermometers do not break and may be considered as safer to use than a mercury thermometer. A small amount of lubricant may be put on the thermometer and it should be inserted with a twisting motion. A normal goat's temperature should be 103 - 104ºF (39 - 40ºC).

Pulse or heart rate

There are several places on the goat where the pulse or heartbeat can be felt and measured. Heartbeat can be felt by placing one's fingertips between the ribs behind the elbow. Pulse can be measured using the femoral artery on the inside of the rear leg roughly ⅓ of the way down. Pulse may also be detected by placing the index and middle fingers on the artery located below and slightly inside of the jaw roughly two-thirds to the rear of the muzzle. A normal range is 70 to 90 beats per minute.

Respiration

Respiration is detected by watching movement of the flank or chest. A normal range is 12 to 20 per minute.

Rumen movements

Adequate rumen function is essential for a goat's health. One sign of adequate function is regular ruminal movement. This can be detected by placing the hand on the left flank of the animal. If the rumen feels soft and water-filled this should be noted and reported to your veterinarian. Rumen contractions should be easily felt and should occur 1-2 times per minute.

Checking mucous membranes

Paleness of the mucous membranes in the mouth (gums), vagina and prepuce can be an indicator that the animal is in hypovolemic shock, meaning that there is a decrease in the blood volume circulating in the animal. The color of the conjunctiva around the eyes can be an indicator of anemia that could be caused by a heavy internal parasite burden. Roll down the lower eyelid to look at the color. A pale, whitish color indicates anemia. This color can be scored using the FAMACHA system which is described in the section on Parasites of Goats. Remember that irritation of any type causes membranes to turn red. This means that an anemic goat with pinkeye may still have red membranes.

Drenching and dosing

Drenching or dosing an animal entails the oral administration of a liquid. The obvious goal of this procedure is to ensure that the animal swallows the full amount given. Grasp the animal under the jaw to raise its head. Raising the head of the animal will assist in ensuring the liquid is swallowed. A finger or thumb can be put into the mouth where there are no teeth (goats lack canine teeth as do all ruminants) to assist in opening the mouth for the drenching equipment. Generally a bottle with a tube over the end or a drenching gun is used. Liquids should be given slowly to allow time for the animal to swallow. Dewormers must be given using appropriate drenching equipment ensuring that they are given over the back of the tongue and swallowed.

Tubing an animal

In some cases it may be necessary to pass a tube down the mouth directly into the stomach in order to administer a large volume of a liquid. This could also be used to feed a young animal incapable of nursing or to either sample rumen contents or insert rumen contents into an animal having severe digestive problems. The size of the tube passed should be appropriate for the animal's size. Generally, a ½ to ¾ inch (1 to 2 cm) diameter tube should be used for adult goats. A short metal or PVC pipe (speculum) larger in diameter than the tube to be inserted is placed in the mouth to prevent the goat from biting or chewing the plastic tube. Some people prefer to use a "Harp" speculum instead. The hard-sided tube or speculum is inserted into the mouth of the goat and holds their mouth open while you pass the tube. The plastic tube is then passed down the throat and into the stomach. Administer liquids slowly. Have a veterinarian or person trained in this technique instruct you before attempting it the first time.

The procedure for tubing a neonatal kid is similar to that for adult animals with a few distinctions. For kids, one does not need to use a PVC tube or speculum. The size tube used is smaller for baby goats (12 to 14 French or roughly ¼ inch inner diameter). The tube should be flexible without any hard edges to harm the kid's mouth or throat. Hold the kid's mouth open and pass the tube gently over the hump or base of the tongue at the back of the mouth and into the stomach.

There are some precautions to take in tubing an animal to ensure that liquids are not inadvertently administered into the lung. The first precaution is to always hold the goat's head in its normal flexed position. If you extend the head and throat, your tube has a straight shot down the trachea. When doing this, preferably have the goat standing. As the tube is inserted, watch and feel the throat area. The tube needs to enter the esophagus and not the trachea or windpipe. The esophagus is a smooth, flexible tube leading to the stomach and one can feel or see the stomach tube sliding downwards. The trachea is a rigid tube and the stomach tube can neither be seen nor felt from outside the animal. When the tube is in the esophagus, feel the bottom of the neck. You should feel "two tubes." One will be the trachea and the other will be the rigid tube inside the esophagus.

Another check can be done while midway down the trachea/esophagus is to suck on the end of the tube. If you are in the esophagus, it will collapse on the tube and you will create a vacuum. Alternatively, blow in the tube and you will see a bolus of air go down the esophagus. If using a stethoscope applied to the goat's rumen on the left side of the body, you will hear air bubbling. Sucking on the tube while it is in the rigid walled trachea will not create a vacuum. One can also check for the smell of rumen fluid to ensure correct placement. To ensure proper depth of penetration, place the tube along the outside of the animal stretching from the mouth to the last rib, a point that would be inside the stomach, and put a mark on the tube. Use this as a guide when inserting the tube. Never rely on the goat coughing as a guide to proper tube placement. It is not a reliable test.

Bolus administration - "Balling"

A "balling gun" is used to administration tablets or boluses to an animal. A balling gun has a holder for the tablet in the end and a plunger to expel the tablet into the throat. Large boluses should be lubricated with vegetable or mineral oil for easier swallowing. Pass the balling gun over the hump of the tongue and press the plunger while holding and tilting the goat's head upwards. Ensure the tablet is swallowed by holding the mouth shut. Stroking the throat can also elicit a swallowing reflex.

Be very gentle in placing the balling gun into the mouth and expelling the pill. The tissues of the throat are very delicate and pills and guns have sharp edges. This can result in serious damage to your goat or minimally a goat with a very sore throat that will not eat. Newer model balling guns have soft plastic heads that reduce the potential for injury.

Paste administration

Dewormers, rumen pastes, and the like may come in a tube and are given through the use of an instrument resembling a caulking gun. Hold the animal as described for "balling," insert the end of the tube into the mouth and squeeze the handle the correct number of "clicks" to deliver an appropriate dose. Again, holding the goat's mouth shut will assist in swallowing.

Giving injections

Administering drugs via injection is a common herd health procedure routinely practiced by almost all producers. Following proper guidelines for each type of injection and using proper equipment will ensure that injections are done correctly and inflict minimum stress on an animal. Proper sanitation will ensure that you don't inject bacteria into your goat and cause an infection. Dirty needles and syringes should never be

used. Using needles and syringes on multiple animals can transmit disease. After making six to ten injections with a needle it will be dull and should be changed and disposed of properly.

Needle selection

Proper injection technique includes selection of an appropriate size syringe and needle. Syringes should have volume markers that would ensure administration of the correct amount of drug. Needle gauge should be considered as it relates to injection type and thickness or viscosity of drug. In general, 18 to 20 gauge needles (as gauge number increases, needle diameter decreases) are sufficient.

Proper injection sites

Live animals are considered unprocessed food, especially if those goats are intended for slaughter and later used in the food chain. Injection site lesions should be a major product quality concern for goat producers raising goats for meat. Injection-site defects are lesions or scars found in cuts of meat that result from tissue irritation caused by the administration of intramuscular or sometimes subcutaneous injections. In addition to the scarred tissue, tenderness of the meat is also significantly reduced in the affected area surrounding the site. Proper injection sites are described for each type of injection described.

Common injection methods

The three most common injection methods are subcutaneous (SQ, under the skin), intramuscular (IM, in the muscle), and intravenous (IV, into a blood vessel, usually the jugular vein). Subcutaneous injections are the easiest to give and intravenous the most difficult. Whenever a drug or vaccine lists SQ as an option for injection use the SQ route. Only experienced personnel should attempt to give an intravenous injection and professional assistance should be used in most instances. Intravenous injections provide the fastest absorption of a drug by the animal while subcutaneous the slowest.

Subcutaneous injections

To inject subcutaneously, pull up a pinch of skin making a tent. Insert the needle into the tent taking care not to pierce through the other side. Depress the plunger slowly. Injecting with the needle pointing towards the ground will lessen the likelihood of the material leaking out of the hole left by the needle. Massage the injected area. If administering large amounts of a drug, over 3 milliliters (ml or cc), it is best to divide the dose among two or more sites not giving more than 2 or 3 cc per site. The preferred site for SQ injections is the skin just behind the elbow, although they can also be given in the triangular area in front of the shoulders between the top and bottom of the shoulder blade and corner of the jaw. Vaccines often cause swellings or "knots" and a knot behind the elbow indicates an injection site whereas a knot in the neck in front of the shoulder could possibly be confused with a caseous lymphadenitis abscess.

Intramuscular

An intramuscular injection calls for the needle to be inserted into a muscle. Intramuscular injections are commonly given in the triangular area of the neck, in front of the shoulder. Do not give intramuscular injections in the loin or hind leg of goats that are used for meat purposes to prevent injection site blemishes from occurring that lowers the value of the meat. Volume given in the muscle should not be more than 3 ml per site.

After inserting the needle, pull back on the plunger slightly to make sure a blood vessel has not been penetrated. Administer the drug slowly. If a blood vessel has been pierced, the needle can be withdrawn slightly, repositioned, and checked again. Never give an injection near the spine to prevent accidentally causing nerve damage.

Intravenous

An intravenous injection requires skill to locate a vein, usually the jugular vein in the neck, insert the needle, and ensure that the needle remains in the vessel while the drug is given. Prior to attempting this, it is best to receive training from a veterinarian. Animals may react quickly to drugs given in this fashion due to rapid absorption. Very few drugs need to be given intravenously; however, blood samples often need to be collected and the technique is the same. The easiest approach is to have someone straddle the goat to hold it securely. The holder will elevate the goat's head up and to the side. If you have clippers, clip all of the hair off the bottom third of the neck. Feel for the trachea on the neck and move towards the top of the neck. The area between the trachea and the muscles of the neck is the "jugular groove" and is where the jugular vein lies. Put pressure at the bottom of the groove and you will see the groove swell from your finger up to the jaw of the goat. The vein is now filled with blood. Using an 18 to 20 gauge needle, direct it at an angle of 45 degrees then stab through the skin. Pull back on your syringe and see if there is blood present. If not, adjust the depth (deeper or more shallow) or move up or down the side of the groove until blood is obtained.

When you are injecting drugs IV, it is important to ensure that all of the drug enters the vein. Give the drug slowly. The jugular vein will take the administered drug straight to the heart and at high concentrations many drugs can cause problems with the heart. IV drugs given around the vein instead of in the vein can cause an irritation or inflammation of the vein.

Minor Surgical Procedures

Castration

Males not wanted as replacement bucks should be castrated. Castration can be done by various mean as early as between 2 to 4 weeks of age. There are several methods of castration and the method selected will depend upon the age of the animal. The most common methods are elastrator band, Burdizzo® or other clamp, or surgical methods. General sanitation and vaccination precautions should be followed. Additional information on castration procedures can be found in the Meat Goat Management section.

Some producers may delay castration until bucks are 2 to 3 months of age. This may lessen the incidence of urinary calculi or bladder stones (see the Goat Diseases section) in animals on a high grain or concentrate diet. Also, remember that intact bucks have high levels of testosterone which acts as a growth promotant and stimulates the production of lean muscle mass. Many goat meat consumers that eat young goats do not care if the meat comes from intact or castrated males. There are some ethnic markets that actually prefer meat from mature bucks. Know the market in your area. The point being that if it is not necessary to castrate goats for marketing purposes, then don't. However for breeding purposes realize that some bucks are fertile and ready to breed by 3 months of age and unwanted males should be castrated or separated from fertile females. In most climates photoperiod effects keep this from being a practical problem until kids are 9 to 12 months of age. In general, castration at an early age is the normal practice to reduce shock to the animal. Older animals should receive some type of anesthesia prior to castration and a veterinarian consulted.

Dehorning

Most meat goat producers will elect not to dehorn their goats. If the decision is made to raise goats without horns then kids should be disbudded in the first two weeks of life. Buck kid horns grow faster than doe horns. Some large single buck kids should be disbudded within the first week after birth. Disbudding a buck kid is the true test of proficiency of the person doing the dehorning and many fail, judging by the number of scurs seen on adult bucks. If you try to disbud a buck kid whose horn base is wider than a regular disbudding iron, you will get regrowth of the horn in a crown outside the burned area. If you try to disbud a small kid with a wide calf dehorner, you may get regrowth of the horn from the center of the ring. If one person is

doing the job, a disbudding box offers the best and safest restraining device. Approximate dimensions are given the accompanying illustration.

The use of a local anesthetic is commonly advocated; however, the actual technique is not easy and the baby goat will scream while being held in preparation for a ring block or a cornual nerve block. One week old kids are small animals and cannot be given large doses of lidocaine or toxicity will result. A one week old kid should get no more then 1 cc total of lidocaine. One technique used is to dilute the lidocaine with distilled water allowing a larger volume to be injected into the locations shown below. Have a veterinarian administer the anesthetic or train you in the procedure.

Veterinarians typically use systemic anesthetics to anesthetize the goat for dehorning. The commonly used drugs are xylazine (Rompun) and ketamine (Vetalar). These can only be administered by a veterinarian.

The disbudding equipment most commonly used is an electric-heated metal rod with a hollowed-out end. Newer cordless, butane gas powered dehorners are available. Some disbudding irons have problems in maintaining a constant temperature, and it is extremely important to match temperature and time. Under-burning of the horn bud will result in scurs while over-burning will lead to brain damage or death. The horn buds can generally be felt in young kids to ensure proper location to burn. After the disbudding iron is hot, apply it firmly over the horn area and rock it around slowly for 3.5 to 4 seconds. Remove the iron and repeat if necessary and do the other side. Evaluate the success of the procedure by its appearance. The goal is to have the area look like "chrome tanned leather." Black color represents burned hair and is indicative of inadequate burning. Clipping the site prior to burning will eliminate the problem of burned hair. Scent glands are located near the base of the horn and descenting could be done at the same time if desired. Inject the kids with 150 IU tetanus antitoxin. Although the risk of tetanus after disbudding is not great, it is a good practice to administer tetanus antitoxin.

An alternate disbudding method is the use of a caustic paste. The hair around the horn bud should be clipped and the paste applied. A ring of petroleum jelly around the horn bud may help prevent the paste from burning other skin tissue. Caustic paste sounds more benign than burning horn tissue; however, the paste has a bad habit of causing chemical burns on other parts of the goat or on his/her pen mates. To use caustic paste, make sure the kid is kept by itself so that it doesn't rub the chemical on the udder of its mother or the faces of its friends (not practical with most meat goat kids) and that it is kept out of the rain so that rain water doesn't wash the chemical into the goat's eyes.

Lancing abscesses

Goats get a variety of swellings or "knots" at various locations on their bodies. Some of these are cysts (fluid filled structures) and some of these are abscesses (puss filled structures). There is a disease of goats called caseous lymphadenitis (CL) that causes abscesses in the lymph nodes of goats. See the section on Meat Goat Herd Health - Common Diseases for more details.

One way of speeding the healing of an abscessed goat and of containing all of the infectious material from the abscesses is to lance it. This is usually a very simple and safe procedure. The first thing to do is be patient. Wait until the abscess comes to a "head." This is when the abscess is attached to the skin and the hair has begun to come off at the top of the abscess. The center of the abscess will soften. At this point, there are no vital blood vessels or other structures between the puss in the abscess and the outside of the goat.

Since pus is infectious to other animals and humans, wear gloves when performing this procedure. Remove any remaining hair from the region. Scrub the area with disinfectant soap (Betadine Scrub®) and restrain the goat. If this is done correctly it is not a painful procedure for the goat. Take a pinch of skin in the center of the abscess with your gloved hand or a surgical tool (such as a towel clamp) and stab a scalpel or sharp, sterilized knife blade deeply into the abscess and cut out a circle of skin. Just slashing the abscess

Recommended needle sizes and lengths used in goats			
Age	Gauge	Needle length	
		Intramuscular injection	Subcutaneous injection
< 4 weeks old	20	½ inch	½ inch
4 to 16 weeks	20	⅝ to ¾ inch	½ inch
4 to 6 months	20	1 inch	½ inch
> 6 months	18 to 20	1 inch	½ inch

may allow the cut to seal over before the abscess has healed from the inside out. There will be some white, or greenish white, odorless puss come out of hole created in the abscess. Catch it in a disposable bag and dispose of it where other goats can't get into it. Caseous lymphadenitis is a contagious disease. It is also a zoonotic disease, meaning it can be transmitted to humans, so wear gloves and sanitize your hands and equipment used after this procedure.

After lancing the abscess flush the area with diluted Betadine Solution® (10:1, 10 parts water to 1 part solution) to flush out any residual puss or bacteria. Make sure you keep the goat away from other goats until the lesion has completely healed.

Normal Range for Goat Physiological Parameters

Temperature, rectal	103–104° F (39–40° C)
Heart rate	70–90 beats per minute
Respiration	12–20 per minute
Rumen movements	1–2 per minute
Puberty	4–10 months
Estrous cycle	21 days
Estrus (standing heat)	12–48 hours
Gestation	150 days

Extra-Label Drug Use

There are few drugs for use in goats that have Food and Drug Administration (FDA) approval. Administering any drug not specifically labeled for use in goats or any product, either prescription or over the counter, that is not used as directed on the label is considered "Extra-label" or "off-label" drug use. Only veterinarians may prescribe or use products "off-label" or "Extra-label" provided they have a valid veterinarian - client - patient relationship (VCPR) with the producer.

The issue of "extra label" use also applies to feed medications not approved for use in goats. While extra-label use of medications in or on animal feed is prohibited, in 2001 the FDA provided guidance on extra-label use of medicated feeds in minor species such as goats. In brief, extra-label use of medicated feed in minor species is limited to treatment of animals whose health is suffering or is threatened or whose death may result from failure to treat. If medicated feed is to be used in a food producing minor species, the product used must be approved for use in a food producing major species. The FDA discourages use of medicated feed in an extra-label manner for improving rates of weight gain, feed efficiency, or other production purposes.

Most goat producers are unaware that they do NOT have "extra-label" drug use privileges. Only veterinarians who have established a VCPR with a particular client may prescribe or use drugs in an extra-label

manner on that client's animals if the animal health is threatened and suffering or death may result from failure to treat. To establish a VCPR, the veterinarian should have visited the farm, and have a thorough knowledge of the management of these animals, or has recently seen the animal to be treated. Once a VCPR has been established, the veterinarian may use drugs in an extra-label manner provided that the client has agreed to follow his or her recommendations.

Three conditions of extra-label drug use:

1. The veterinarian has examined the animal(s) in question recently and has made a diagnosis and a determination that products with proper labeling will not work in this instance.
2. The client has been instructed by the veterinarian in the proper use and administration of the product, a withdrawal period has been determined, and the client is willing to follow the instructions given by the veterinarian.
3. The veterinarian is available to respond to any adverse reaction or follow up examination and treatment that may occur to the animal due to the administration of the drug or failure of the drug to work.

FDA criteria for Using Pharmaceuticals Extra-Label

The FDA has also established five criteria that must be met before any drug may be used in a food-producing animal in a manner different from that product's label.

1. The veterinarian must first examine the animal and assumes responsibility for making clinical decisions regarding the health and treatment of the animal within the guidelines of a VCPR. Often a goat owner will not have the animal examined by a veterinarian, but will telephone a veterinarian, who may never have visited the farm, with a list of symptoms and ask for a recommended treatment. This does not qualify as VCPR!
2. The second criterion requires that the veterinarian determine there is no marketed drug specifically labeled to treat the diagnosed condition, or that the recommended dosage on the label for that product is clinically ineffective. Since there are few drugs labeled for use in goats, it is not difficult to determine whether or not there is a legally licensed product available.
3. The third criterion requires that the individual animals to be treated are clearly identified, and that accurate records be maintained regarding the treatment of those specific individuals. If there is no permanent identification such as an ear tag, notch, or tattoo, the owner must make some effort to identify the treated animals with a visible temporary mark by using temporary tags or paint. If possible, these animals should be isolated. Records on animals and treatment must be kept for future reference to avoid any drug residues in the meat or milk.
4. The fourth criterion requires that a significantly extended time period be assigned for drug withdrawal prior to marketing meat or milk from treated animals. The owner must keep accurate records of the treatment, namely the person treating this animal, date, route of administration, product used and a proper withdrawal period. Proper withdrawal period can be obtained from your veterinarian. Veterinarians can access drug information at the Food Animal Residue Avoidance Databank, http://www.farad/org.
5. Many goat owners casually treat their animals and do not keep proper records of animals treated, drugs used, or proper withdrawal period for that product. If no information is available to establish a withdrawal time, then the treated animal or animal products such as milk and meat are permanently barred from the human food chain. This is to prevent illegal drug residues in products for human consumption. Although there are no drug residue test kits marketed specifically for goat meat, owners should be aware that drug residue testing is conducted on milk and meat produced for human consumption.

6. The last criterion details the information that must be listed on the drug dispensed for extra-label use. The label should include the name and address of the veterinarian, the established name of the drug(s), and the specific directions for use including: dosage, routes of administration, frequency of treatment, duration of therapy, cautionary statements, and the withdrawal time for any food that might be derived from the treated animal.

Ten Drug Use Tips

The following drug use tips can help ensure the proper administration of drugs and adherence to proper withdrawal times. All producers should restrict access to drugs to prevent indiscriminate or improper use. Remember that animal health products can be human health hazards.

1. Read the label carefully – labeling directions change frequently.
2. Use drugs only in animal species listed on the label or follow the "extra label" directions of a veterinarian.
3. Use the proper dose for the size of animal to be treated – overdosing can cause illegal residues.
4. Calculate pre-slaughter drug withdrawal times accurately – determine pre-slaughter withdrawal and milk discard times from the latest drug administration.
5. Use the correct route of administration – giving drugs incorrectly can lead to drug ineffectiveness, adverse reactions, illegal residues, and possible animal deaths.
6. Do not "double dose" – use of the same drug in the feed and by injection can cause illegal residues.
7. Select needle size and injection sites carefully, if injections are necessary – misuse can lead to tissue damage, reduced effectiveness, and/or illegal residues.
8. Allow proper withdrawal times for feed containing drugs – during the withdrawal time ensure that storage bins and feed are completely free of medicated feed and feed only drug-free feed or illegal residues may result.
9. Keep accurate records of drugs used and animals dosed – poor records can be costly if drug residue violations occur.
10. Seek the advice of your veterinarian – your records will allow him/her to provide safer and more effective treatment and save you money by preventing illegal residues.

For a complete explanation of all the precautions you need to take in using any particular drug or feed medication, first consult the drug label or feed tag. If you have any questions about the proper use of any drugs, see your veterinarian.

Medications Commonly Used in Goats and Approximate Withdrawal Times

The following tables list medications commonly used in goats with their dosages and estimated withdrawal times (WDT). These tables are adapted with permission from the author Dr. Seyedmehdi Mobini of Fort Valley State University, Fort Valley, GA, from a paper that appeared in the proceedings of the Georgia Veterinary Medical Association Food Animal Conference in 2003. These recommendations were formulated by Dr. Mobini through a review of the literature in the United States and foreign countries, recommendations of the Food Animal Residue Avoidance Databank (FARAD), and personal experience. For many of the drugs mentioned, FARAD has calculated a Withdrawal Interval (WDI) to distinguish from the regulatory and approved WDT. The WDI is based on foreign drug approvals or extrapolations based on available tissue residue and/or related pharmacokinetic data on these drugs. In some cases, there is insufficient or no pharmacokinetic data from which FARAD can derive a WDI for goats. In those instances, FARAD has relied on sheep or cattle data and then added a scientifically-based time period to extend beyond the approved WDT to ensure safety as well as compliance with the Animal Medicinal Drug Use and Clarification Act of 1994 (AMDUCA).

Finally, the reader should be aware that there are several drugs which may be approved for specific species at a specific dose and route of administration, but are PROHIBITED FROM EXTRA-LABEL USE in any major or minor food animal species. These include Fluoroquinolones/Enrofloxacin (Baytril) and Phenylbutazone (Dairy). Other drugs are PROHIBITED FOR USE UNDER ANY CONDITION IN ANY ANIMAL THAT WILL BE USED FOR HUMAN FOOD. These drugs are: Dipyrone, Clenbuterol, Nitrofurazones, Nitrofurans (Furacin), Nitroimidazole (Metronidazole, Dimetridazole, Ipronidazole), Diethylstilbesterol, Glycopeptides (Vancomycin) and Chloramphenicol.

Herd Health at Different Production Stages

Goats have different health needs according to their stage of production. Providing for these health needs will increase your chances of having a healthy, productive herd.

Pre-breeding

Breeding does

Thirty to sixty days before the breeding season does should be examined for their udder and teat conformation, dentition (teeth), musculo-skeletal problems, and feet and body condition. Culling decisions should be made. Some common conditions seen in does include lameness, chronic mastitis, bad teats, and poor body condition due to a chronic disease, parasitism, old age, or other cause. Doelings should be at least 65 to 70% of their mature weight before their first breeding.

Prebreeding vaccination for *Chlamydia* should always be given. *Leptospirosis* and *Campylobacter* are less common causes of reproductive failure and abortion and vaccinations may be done, if the disease is present. Monitor fecal egg counts and deworm if needed. Does can be supplemented (flushed) with grain 2 to 4 weeks before breeding this will improve their fecundity (number of kids born per doe). Abrupt fence line exposure to bucks in the late transition period in the fall when does can begin to come into heat can help bring about cycling.

Breeding bucks

Bucks are too often neglected and omitted from herd health management practices. Some of the common conditions seen in bucks are urinary calculi (stones), lameness, urine scalding around the prepuce, and front leg injury due to a dominant buck in the pen. In the case of urinary scald, wash the affected area. Application of petroleum jelly can help protect the affected areas. Maintain a 2:1 ratio of dietary calcium to phosphorous and provide a high level of salt (up to 4%) and 1 to 2% ammonium chloride in the diet to prevent urinary calculi. Bucks should be vaccinated at the same time as the does and for the same diseases. Body condition and breeding soundness should be evaluated at least 4 weeks before the breeding season and adjustments made to prevent bucks from becoming overly thin or obese. As breeding season approaches, extremely aggressive and dominant bucks may need to be penned separated to prevent injury. Monitor fecal egg counts in bucks or FAMACHA score and deworm as needed.

Breeding Season

Watch does and bucks carefully during the breeding season. This is a particularly strenuous time for bucks. Lame or sick bucks will not be able to breed adequate numbers of does. Fertility is drastically decreased by hot weather. Do everything you can to cool the buck off. This may include shade and fans during the day in very hot climates.

Gestation

Pre-parturition

A kid health and management program should actually begin prior to parturition with attention to the nutritional needs of the gestating doe in late lactation and during the dry period. An adequate diet for dry does is essential to produce healthy kids. Pregnant does should be fed to have a good body condition (score of 3.0 to 3.5 just prior to kidding). Does should be scored in early pregnancy and again six weeks prior to kidding. Remember that most fetal growth occurs in the last one-third of gestation and feed quantity and quality may need to be increased during this time. Clean, cool water and free choice trace-mineralized salt should be available.

Booster vaccinations for Clostridium perfringens C and D and tetanus toxoid should be given not less than 3 weeks prior to kidding. Vitamin E/selenium injections may be given during the dry period to prevent white muscle disease in kids, especially in areas where soils are selenium deficient and supplementation is inadequate. However, a nutrition program designed to provide adequate dietary selenium is preferable to providing injections. Provide other vaccinations or boosters for diseases causing abortion. Monitor fecal egg counts or FAMACHA score and deworm as needed.

Parturition (kidding)

While most meat goat does kid on pasture, there may be times when animals are brought indoors for kidding. The doe should kid in a clean environment; either a well-drained clean pasture or a stall bedded with straw or other absorbent material. The kid prior to birth has been existing in a germ-free environment and parturition represents exposure to common disease organisms to which the mature animal has developed resistance. The kidding stall or pasture should be located near a well-traveled area so that the doe can be frequently observed for kidding difficulties. Few adult does require assistance at the time of kidding though problems are always a possibility. First-freshening does should be closely watched, especially if bred to bucks known to sire large kids.

Signs of impending kidding include udder engorgement, swelling of the vulva, restlessness, and mucous discharge. The ligaments in the pelvic area will relax and the udder secretion's will change from clear honey-like to thick white milk (colostrum). The doe may also lose appetite. There are three stages of parturition. Stage 1 consists of uterine contraction and cervical dilation. This stage may last from three to six hours or more. The water bag ruptures at the end of this stage. Abdominal contractions will occur in Stage 2 and the fetus should be born within one hour. If the doe is having to provide undue straining or birth is delayed then examination and assistance may be needed; particularly if the doe is straining hard for 15 minutes or more. A veterinarian may need to be called. Stage 3 consists of expulsion of the placenta and usually occurs within a few hours after the last fetus is born.

Problems in parturition

Most does will kid with little to no assistance required; however, problems can occur. Many of these problems revolve around either incorrect presentation of the fetus or a kid that is to large for the mother's pelvis. In a normal birth presentation the forefeet will enter the birth canal first, the hooves will be pointed downwards, and the head will be between the legs. Another presentation that is sometimes seen that usually causes little problem is when the rear legs enter the birth canal first. In this case, the kid's hooves will be pointed upwards. Abnormal presentations include the rump first (breech) or any of the legs or the head bent backwards. In these cases, assistance is required.

When assisting birth, it is important to clean the area around the vulva with disinfectant soap and warm water and to have clean hands. Wear gloves. There are certain diseases that can be transmitted to humans during this time period. Pregnant women should not assist with the kidding process. Lubricate the hand prior

to entering the vagina. Feel and identify the parts of the kid. Try to ensure that all body parts felt belong to the same kid and not to two separate bodies. If you feel only one leg or no legs at all, reach further and try to determine the exact position of the fetus. Arrange the legs and/or head gently in a proper position for birth. The fetus may have to be pushed forward towards the doe's head until a leg can be grasped and repositioned. Once the limbs are in a proper position, the kid should be gently pulled out and downwards using only your hands. Clear the mouth and nasal passages of the kid with straw or a towel and ensure it is breathing. Rubbing the body with a piece of cloth can sometimes stimulate breathing. Never pull on any presentation other than a normal presentation of two front legs and a head or a presentation of two hind legs and a tail. Pulling on any other arrangement of limbs and body parts will only make the problem worse.

If the anticipated kidding problems appear severe, call for a veterinarian immediately.

Kid management at birth

At birth two management practices are critical to the future health and survival of the newborn kid. The navel cord should be dipped in a solution of tincture of iodine (7% iodine solution) to prevent entry of disease-causing organisms through the navel cord and directly into the body of the kid. Make sure the entire cord is immersed in the iodine solution. If necessary, a long navel cord can be cut to 3 or 4 inches in length. Dipping the cord in iodine not only prevents entry of organisms but promotes rapid drying and the eventual breaking away of the cord from the navel.

Another critical practice is the feeding of colostrum as soon after birth as possible. The colostrum, or first milk, contains antibodies, which the doe does not pass to the fetal kid in the womb. Consumption of colostrum must occur as early as possible, ideally within 2-4 hours of birth. At 24 hours after birth there is a rapid reduction in the permeability of the intestinal wall to colostral antibodies. If a newborn kid does not or cannot nurse, the colostrum should be bottle-fed or the kid should be tube fed to insure adequate consumption. Excess colostrum can be frozen for use in orphan or bonus kids. Recent research indicates that disease organisms, especially caprine arthritis encephalitis (CAE), may pass from doe to kid through milk and transmission might be avoided through the use of extra colostrum frozen from does tested and shown to be CAE-free or by feeding pasteurized colostrum. CAE is not considered to be a problem on most meat goat farms.

Kids should receive colostrum equal to 10% of their body weight during the first 24 hours of life. For example a six pound kid (96 ounces) should receive 10 ounces (roughly 300 ml) of colostrum within 24 hours of birth. This should be divided into at least 3 feedings. If fresh or frozen goat colostrum is not available, a commercial goat, sheep or cow colostrum replacement could be used. Fresh cow colostrum may also be used if necessary.

Under certain conditions newborn kids may benefit from injections of vitamins A and D approximately four days after birth. An iron dextran injection can be given but care is needed as iron is potentially toxic. A vitamin E/selenium injection may be beneficial in areas of selenium-deficient soils. These injections should be planned with your veterinarian as part of your herd health calendar. In general injection of vitamins and minerals is not necessary. If supplementation is necessary it is done more safely by dietary supplements. Realize that the fat soluble vitamins and minerals are toxic if given in excess.

Kids should be checked carefully at birth for any physical deformities or abnormalities. Pneumonia is a major killer of young kids. A clean, dry, draft-free environment is an excellent preventative measure.

Artificial raising of kids

Milk is the principal component of the diet of the pre-weaning kid. Most meat goat kids will nurse their dam until weaning. However, for orphaned kids or for kids of does that have lactation problems it may be necessary to use a milk replacer. Goat milk replacers are commercially available. If necessary, a lamb milk

replacer may be used as a substitute for goat milk. Typical lamb milk replacers contain 22 to 24 % protein and 28 to 30% fat (on a dry matter basis). If no other milk replacer is available whole cows milk or calf milk replacers can be used. Maintaining milk replacer quality after mixing is particularly important when kids are fed ad libitum (all they can consume).

Milk can be fed by using bottles, pails, or self-feeder units. The method chosen will depend upon such factors as the size of the herd and available labor, as well as personnel preference. With any system, the health of the kid, sanitation, and available labor are the major factors to consider.

Under natural suckling, kids consume small amounts of milk at very frequent intervals. Ideally, artificial rearing should mimic natural suckling but the constraint of available labor precludes frequent feeding. Nevertheless, kids should be fed 4 to 5 times daily for the first and second week and 2 to 3 times daily thereafter. Bottle feeding is more labor intensive but kids receive more individual attention and are easier to handle post-weaning than kids that are allowed to suckle does. Pail or pan feeding may reduce labor somewhat but bodyweight loss and need for extra "training sessions" at the beginning must be expected.

For larger herds, self-feeder units such as a "lamb bar" may successfully reduce labor. The key to use of the system is the maintenance of a low temperature of the milk (40°F) that will limit intake by the kid at any one time. Small, frequent feedings increase digestibility and decrease digestive disturbances. Rapid consumption of large quantities of milk may lead to fatal bloat due to entry of milk into the reticulo-rumen. Rapid passage of milk through the abomasum and small intestines can result in diarrhea or nutritional scours.

The biggest problem with kids bottle fed lamb milk replacer occurs with the feeding schedule. Frequently kids become "pets" and there is a tendency to feed them as much milk as they will consume each feeding. Unfortunately, this may result in bloat and sudden death due to enterotoxemia or diarrhea. A restricted feeding schedule and amount is necessary.

Feeding schedule and amount for bottle fed kids.

Age	Amount of Fluid/Feeding	Feeding Schedule
1 to 3 days	4 ounces	5 times a day
3 days to 2 weeks	8 to 12 ounces	4 times a day
2 weeks to 3 months	16 ounces	3 times a day
3 months to 4 months	16 ounces	2 times a day

Dam raised kids

Most meat goat kids will be raised with their dams on pasture. While this removes the need for feeding milk replacer, these kids should not be forgotten in terms of nutritional and health needs. Producers must remember that since these kids are raised in the same environment as their dams, they are also exposed to the same health, disease, management, and grazing conditions. If internal parasites are a problem in the dams, expect the same in the kids and take management steps to reduce exposure to internal parasites through pasture rotation or other means. Crowding should be avoided and, if housed at any time, clean bedding and adequate ventilation are a must. Kids are naturally curious and will begin nibbling on items in their surroundings early in life. If there are toxic substances or plants, plastic, or other harmful materials lying about chances are some kids will eat them. If pasture is of very poor quality, kids beginning to nibble on grass or hay will not receive much nutritional benefit. This can slow down early growth.

Medications Commonly Used in Goats and Approximate Withdrawal Times

Dr. Seyedmehdi Mobini, Georgia Small Ruminant Research & Extension Center, Fort Valley State University, Fort Valley, GA

The drugs listed in this table are commonly used in goats. There are only a few drugs approved by the FDA to be used in goats. ***Use of drugs listed as "extra-label" is legal only if prescribed by your veterinarian in the context of a valid client-patient relationship.*** The withdrawal times for various drugs were compiled from different sources. The listed dosages and withdrawal times, as well as drug status and legality of use, is subject to change. Your veterinarian will prescribe the latest, most up-to-date drugs, dosages, and provide the correct withdrawal period. ***Consult your veterinarian before beginning any treatment!***

I. Antibiotics:	**Brand Name**	**Approval**	**Dosage**	**Route**	**Frequency**	**Withdrawal Time**	
						Meat	Milk
Ceftiofur	Naxcel®	APPROVED	0.5-1 mg/lb	IM	Once a day	0 days	0 days
Neomycin	Biosol® and other products	APPROVED	5 mg/lb	PO	Twice a day	3 days	NA
Amoxicillin	Amoxi-inject®	extra-label	5 mg/lb	SQ	Once a day	26 days	120 hours
Ampicillin	Polyflex®	extra-label	5 mg/lb	SQ	Once a day	10 days	72 hours
Benzathine Pen G	Pen BP-48®	extra-label	20,000 IU/lb	SQ	Every 48 hours	30 days	NA
Erythromycin	Erythro-200®	extra-label	1 mg/lb	SQ	Once a day	5 days	96 hours
Florfenicol	Nuflor®	extra-label	9 mg/lb	IM	Every 48 hours	28 days	120 hours
Oxytetracycline	LA-200®	extra-label	9 mg/lb	SQ	Every 48 hours	29 days	144 hours
Procaine Pen. G	Crysticillin®	extra-label	10,000-20,000 IU/lb	SQ	Once a day	16-21 days	120 hours
Sulfadimethoxine	Albon®	extra-label	25 mg/lb Day 1, 12.5 mg/lb Days 2 - 5	PO	Once a day	12 days	5 days
		EXTRA-LABEL USE IS PROHIBITED IN LACTATING DAIRY COWS. DO NOT USE IN LACTATING DAIRY DOES.					
Tylosin	Tylan®-200	extra-label	10 mg/lb	IM	Once a day	30 days	96 hours
Chloramphenicol	Chloramphenicol	EXTRA-LABEL USE IS PROHIBITED					
Enrofloxacin	Baytril® 100	EXTRA-LABEL USE IS PROHIBITED					
Furacin, nitrofurantoin	Furox®	EXTRA-LABEL USE IS PROHIBITED					
Gentamicin	Gentocin®	DO NOT USE					
Tilmicosin	Micotil®	DO NOT USE – TOXIC TO GOATS					

II. Anti-inflammatory Drugs:	Brand Name	Approval	Dosage	Route	Frequency	Withdrawal Time	
						Meat	Milk
Aspirin	Aspirin	extra-label	100 mg/kg	PO	Once a day	1 day	24 hours
Flunixin meglumine	Banamine®	extra-label	1.1-2.2mg/kg	IV or IM	Once a day	10 days	72 hours
Phenylbutazone	Bute	extra-label	10-20 mg/kg	PO	Once a day	60 days	DNU
		DO NOT USE IN LACTATING ANIMALS					
Dipyrone	Dipyrone	EXTRA-LABEL USE IS PROHIBITED					

III. Prevention of Coccidiosis:	Brand Name	Approval	Dosage	Withdrawal Time	
				Meat	Milk
Decoquinate	Deccox®	APPROVED	13-91 gm/ton of feed	0 days	24 hours suggested minimum, DNU
Monensin	Rumensin®	APPROVED	15-20 gms/ton of feed	0 days	96 hours suggested minimum, DNU
Amprolium	Corid®	extra-label	25-50 mg/kg BW in feed or water	2 days	48 hours
Lasalocid	Bovatec®	extra-label	20-30 gms/ton of feed	0 days	24 hours

IV. Anthelmintics:	Brand Name	Approval	Dosage	Route	Withdrawal Time	
					Meat	Milk
1. Avermectins:						
Doramectin	Dectomax®	extra-label	0.3 mg/kg	SQ	56 days	40 days
Eprinomectin	Eprinex®	extra-label	0.5 mg/kg	PO	NA	NA
Ivermectin	Ivomec® Drench	extra-label	0.3 mg/kg	PO	14 days	9 days
Ivermectin	Ivomec® 1%	extra-label	0.3 mg/kg	SQ	56 days	50 days
Moxidectin	Quest®, Cydectin®	extra-label	0.5 mg/kg	PO	23 days	56 days
	Cydectin® drench	extra-label	0.3 mg/kg	PO	14 days	NA
	Cydectin® Injectable	extra-label	0.2 mg/kg	SQ	30 days	DNU

2. Benzimidazoles:						
Albendazole	Valbazen®	extra-label	10 mg/kg	PO	7 days	120 hours
Fenbendazole	Panacur®/ Safeguard®	APPROVED at 5 mg/ Kg, extra-label as recommended	10 mg/kg	PO	14 days	120 hours
Oxfendazole	Synanthic®	extra-label	10 mg/kg	PO	14 days	120 hours
3. Cholinergic Agonists:						
Morantel Tartrate	Rumatel®	APPROVED	10 mg/kg	PO	30 days	0 days
Levamisole	Levasole®	extra-label	8 mg/kg	PO	10 days	4 days

V. Anesthetics and Tranquilizers	**Brand Name**	**Approval**	**Dosage**	**Route**	**Withdrawal Time**	
					Meat	Milk
Ketamine	Ketaset®	extra-label	5-10 mg/kg	IV or IM	3 days	48 hours
Lidocaine	Lidocaine	extra-label	Variable for local anesthesia use, 1% in goats			
Thiamylal Na	Biotal	extra-label	10-20 mg/kg	IV	1 day	24 hours
Xylazine	Rompun®	extra-label	0.05-0.1 mg/kg	IV or IM	5 days	72 hours
Yohimbine	Yobin	extra-label	0.25 mg/kg	IV	7 days	72 hours

VI. Hormones:	**Brand Name**	**Approval**	**Dosage**	**Route**	**Withdrawal Time**	
					Meat	Milk
Cloprostenol	Estrumate®	extra-label	125 microgram	IM	0 days	0 days
Dexamethasone	Azium®	extra-label	20-25 mg	IM	14 days	4 days
Dinoprost	Lutalyse®	extra-label	5-10 mg	IM	1 day	24 hours
Oxytocin	Oxytocin	extra-label	10-20 IU	IM	0 days	0 days

VII. Electrolytes	**Brand Name**	**Approval**	**Dosage**	**Route**	**Withdrawal Time**	
					Meat	Milk
Calcium	Calcium borogluconate	extra-label	60 to 100 ml of 20 to 25% Solution	IV	0 days	0 days
Calcium	Calcuim gluconate	extra-label	50 to 100 ml 10 to 23% calcium ion solution	IV	0 days	0 days

NOTE: In the table above PO = oral administration; SQ = subcutaneous injection; IM = intramuscular injection; IV = intravenous injection. DNU = insufficient data available to make WDI estimation, this drug is not approved for lactating goats.

Early access to a creep feed or creep pasture containing lush, nutritious forage will benefit kids becoming accustomed to solid feed, the development of their gastrointestinal tract, and in their early growth. Entry into the area containing creep feed or pasture should be restricted to kids by fencing or gates that prevent the entry of adult animals.

Weaning

In raising goat kids, increases in size and weight are not the only measure of success. A well-formed skeleton and proper development of internal organs are often neglected when the emphasis is on rapid gains. Dry feed consumption is important in developing body capacity. By increasing body capacity, feed intake and digestion increase.

In bottle fed kids over two weeks of age, limiting daily milk consumption to about 48 ounces will encourage daily consumption of dry feed. No later than three to four weeks of age a goat/lamb creep feed, other suitable creep feed, or even a calf starter should be offered. As the hay and grain consumption increases, gradually reduce the milk being fed. When the kid is eating ¼ pound of grain per day plus some hay and is drinking water from a bucket, it is time for weaning. Research has shown that at two months of age a weaned kid has a reticulo-ruminal capacity 5 times as large as suckling kids of the same age.

Kids on pasture should be consuming forages such as pasture grass or hay by two weeks of age and grain within four. Careful attention needs be given to formulation of a concentrate supplement for the pre-weaning kid. Palatability is of primary concern. Molasses at the rate of 10% of the total dry matter, corn (preferably chopped or rolled) and whole or rolled oats make up the energy "core" of a good pre-weaning diet. Balance the crude protein needs by adding cottonseed or soybean meal or another high protein source. Though few studies with kids have been done, crude protein contents of the pre-weaning ration should be within the range of 14-18%. Ground alfalfa may be added at 5% or less to provide additional stimulation for reticulo-ruminal development.

Several factors need to be considered when making the decision as to weaning. The most important consideration is whether or not the average daily consumption of concentrate and forage is adequate for growth and development to continue in the absence of milk. Fixed weaning ages are less desirable than weight goals such as 2.0 to 2.5 times birth weight.

Vaccination Schedule for Meat Goats

Other disease preventive measures

Dam – 1 month prior to kidding

- CDT vaccine to help increase antibodies against enterotoxemia and tetanus in the colostrum. In areas deficient in Se and where supplementation is inadequate, BoSe® to raise selenium levels and prevent white muscle disease in kids and retained afterbirth in dam. Providing a proper mineral nutrition program to ensure adequate consumption of all minerals is preferable. Get local veterinary advice on selenium injections as the need and dosage level depend upon how much selenium is in the soil in the region, as well as on the dietary supplementation.

Kid – birth to first week

- BoSe® + vitamins A&D – use depends on soil in the region and the diet of the dam.

Kid – 3 weeks – begin coccidiosis prevention

- 4 and 8 weeks – CDT series.
- 4 to 8 weeks - BoSe® - repeat if in selenium deficient area.
- 6 to 8 weeks – begin monitoring for parasites and deworm as needed, especially if kid has access to outdoors.

Period	Time to Vaccinate	Disease	Booster
Kids	4 and 8 weeks of age.	C. perfringens C&D*. C. tetanus – toxoid.	Prebreeding.
	Between 8 and 12 weeks of age (single vaccination).	Contagious ecythma.	If a problem in herd.
	8 and 12 weeks of age.	Caseous lymphadenitis.	If a problem in herd.
	16 weeks of age.	Rabies.	Given if there is a rabies concern. Yearly booster.
Prebreeding			
Doelings and bucklings	60 and 30 days prior to breeding.	Chlamydia. Campylobacter. Leptospirosis.	If a problem in herd.
Does and bucks	30 days prior to breeding.	Chlamydia. Campylobacter. Leptospirosis. C. perfringens C&D*. C. tetanus - toxoid.	If a problem in herd.
Gestation			
Does	30 days prior to kidding.	C. perfringens C&D*. C. tetanus - toxoid.	

-8-way clostridials like Covexin 8 could be used instead of C. perfringens C, D &T.

Herd Health Calendar

A custom designed calendar is an excellent way to ensure the health of the herd is maintained. A calendar can be designed based upon your specific herd's production cycle. Consult with a veterinarian on the timing and need for vaccinations and other management procedures related to the health and well-being of your herd.

Planning Calendar for Meat Goat Herd Health

Stage	Suggested Health Practices	Additional Practices
Pre-breeding (30-60 days)	*Bucks* • Be aware of heat stress. • Breeding Soundness Evaluation done. • Vaccinate for Clostridium perfringens type C&D, plus Tetanus Toxoid. • Vaccinate for Chlamydia, Campylobacter and Leptospirosis, if necessary. • Trim feet. • Body Condition Score and adjust management accordingly. • Deworm based upon fecal egg counts or FAMACHA score. *Does* • Vaccinate for Chlamydia, Campylobacter, and Leptospira if necessary. • Vaccinate for Clostridium perfringens type C&D, plus Tetanus Toxoid. • Trim feet. • Body Condition Score and adjust management accordingly. • Deworm based upon fecal egg count or FAMACHA score at least two weeks before breeding. • Final cull of does based on production records, udders, feet, and type.	• Vitamin E and selenium given to does 30-45 days before breeding in selenium-deficient areas. • See Vaccination Schedule for Meat Goats • Put bucks next to doe pens. The "buck effect" will bring transitional does into heat.

Breeding	*Bucks* • Provide additional feed. • Be aware of heat stress, provide shade. *Does* • Observe for heat or use marking harness on bucks • If desired, check for pregnancy at 45-60 days with ultrasound.	• Make sure cats are not defecating in feed to prevent Toxoplasmosis. • Perform fecal egg count or check FAMACHA score and deworm if necessary. • Treat for flukes if a problem in the herd.
Pre-kidding (15-30 days)	*Does* • Booster Clostridium perfringens type C&D, plus Tetanus Toxoid. • Deworm based upon fecal egg counts or FAMACHA score. • Body Condition Score, adjust management accordingly • Watch for pregnancy toxemia.	• Perform fecal egg count or check FAMACHA score and deworm if necessary. • Begin to collect supplies for kidding.
Kidding	*Does* • Observe 3-5 times per day. • Assist if needed. *Kids* • Clip, dip, and strip: • Clip navel cord to 2-4”, • Dip navel in 7% iodine, • Strip small amount of milk to make sure teat ends are open.	

Nursing/Lactation	*Does* • Feed extra feed to does with multiple kids. *Kids* • Observe daily for signs of diarrhea or respiratory disease. • Vaccinate – Clostridium perfringens type C&D and Tetanus, revaccinate at four weeks after first injection. • Castrate males before three months of age. • Start creep feeding by two weeks of age.	• See Vaccination Schedule for Meat Goats
Weaning	• Weaning at three to five months or when marketed as young kids. • Check for internal parasites and deworm if needed.	• May want to use coccidiostat in creep feed and post-weaning feed.
Post-weaning/Drying	• About every four weeks, check for internal parasites and deworm as needed. • Reduce feed to does just before weaning. • May want to reduce water availability for a day or two after weaning.	

Goat Guideline for Anthelmintic Dosages (internal parasite dewormers) July 2006

Important --- Please read notes on the following page before using this chart

		Oral dosing. Note: 1 ml = 1 cc						Subcutaneous injection
		Valbazen Albendazole[1]	SafeGuard Fenbendazole[2]	Ivomec Ivermectin[3]	Levasole Levamisole[4]	Cydectin Pour-on Moxidectin[5]	Cydectin Drench Moxidectin[6]	Cydectin *Injectable* Moxidectin[7]
Animal Weight		20 mg/kg	10 mg/kg	0.4 mg/kg	12 mg/kg	0.5 mg/kg	0.3 mg/kg	0.2 mg/kg
lbs	kg	2 ml/ 25 lb	1.1 ml/ 25 lb	6 ml/ 25 lb	3 ml/ 25 lb	1.1 ml/25 lb	3.4 ml/25 lb	1 ml/ 110 lb
20	9.1	1.6	0.9	4.8	2.4	0.9	2.7	0.2
25	11.4	2.0	1.1	6.0	3.0	1.1	3.4	0.2
30	13.6	2.4	1.4	7.2	3.6	1.4	4.1	0.3
35	15.9	2.8	1.6	8.4	4.2	1.6	4.8	0.3
40	18.2	3.2	1.8	9.6	4.8	1.8	5.4	0.4
45	20.5	3.6	2.1	10.8	5.4	2.1	6.1	0.4
50	22.7	4.0	2.3	12.0	6.0	2.3	6.8	0.5
55	25.0	4.4	2.5	13.2	6.6	2.5	7.5	0.5
60	27.3	4.8	2.7	14.4	7.2	2.7	8.2	0.5
65	29.5	5.2	3.0	15.6	7.8	3.0	8.8	0.6
70	31.8	5.6	3.2	16.8	8.4	3.2	9.5	0.6
75	34.1	6.0	3.4	18.0	9.0	3.4	10.2	0.7
80	36.4	6.4	3.6	19.2	9.6	3.6	10.9	0.7
85	38.6	6.8	3.9	20.4	10.2	3.9	11.6	0.8
90	40.9	7.2	4.1	21.6	10.8	4.1	12.2	0.8
95	43.2	7.6	4.3	22.8	11.4	4.3	12.9	0.9
100	45.5	8.0	4.6	24.0	12.0	4.6	13.6	0.9
105	47.7	8.4	4.8	25.2	12.6	4.8	14.3	1.0
110	50.0	8.8	5.0	26.4	13.2	5.0	15.0	1.0
115	52.3	9.2	5.2	27.6	13.8	5.2	15.6	1.0
120	54.5	9.6	5.5	28.8	14.4	5.5	16.3	1.1
125	56.8	10.0	5.7	30.0	15.0	5.7	17.0	1.1
130	59.1	10.4	5.9	31.2	15.6	5.9	17.7	1.2
140	63.6	11.2	6.4	33.6	16.8	6.4	19.0	1.3
150	68.2	12.0	6.8	36.0	18.0	6.8	20.4	1.4

Footnotes:

1. **Valbazen** Suspension (11.36 % or 113.6 mg/ml): ***Do NOT use in pregnant does in the first trimester of pregnancy.*** Meat withdrawal time is 9 days and 7 days for milk (FARAD).
2. **Safe-Guard/ Panacur** Suspension (10% or 100 mg/ml): Approved in goats at 5 mg/kg with meat withdrawal time of 6 days and no withdrawal period for milk. Although the label dose in goats is 5 mg/kg, it is generally recognized that 10 mg/kg dosage is required for good efficacy. At 10 mg/kg dosage, meat withdrawal is 16 days and 4 days for milk (FARAD).
3. **Ivomec Sheep Drench** (0.08% or 0.8 mg/ml): Protect from light. Coughing may occur during and following drenching. Meat withdrawal time is 14 days (FARAD).
4. **Levasole Soluble Drench Powder (Sheep)**: Oral solution ONLY. To prepare use 1 packet (13 gm/11.7 gm active ingredient) dissolved in 262 ml [8.9 oz.] water (44.7 mg/ml) {or 52 gram packet dissolved in 1048 ml water [35.4 oz.].} NOTE: This is different dilution from the label directions for administration. Meat withdrawal time is 4 days (FARAD).
5. **Cydectin Pour-on for cattle** (0.5% or 5 mg/ml): Meat withdrawal time is 23 days. ***Not for use in lactating dairy goats.***
6. **Cydectin Drench for sheep** (.1% or 1 mg/ml): Meat withdrawal time is 14 days. ***Not for use in lactating dairy goats***.
7. **Cydectin Injectable for cattle** (1% or 10 mg/ml): GIVE SQ. Meat withdrawal time is 30 days. ***Not for use in lactating dairy goats.***

NOTE for Guideline for Anthelmintic Dosages in Goats

The attached chart was developed by Ray M. Kaplan, D.V.M., Ph.D. (University of Georgia) and modified by Patty Scharko D.V.M., M.P.H. (University of Kentucky) and Lionel Dawson D.V.M., M.S. (Oklahoma State University). It is provided as a possible guideline for anthelmintic (deworming) dosages for goats. Producers should consult their veterinarian for advice on their specific management situation for determining dosages for their herd. ***With the exception of fenbendazole administered at the 5 mg/kg dose, these drugs are not approved by the Food and Drug Administration (FDA) for use in goats, and when used in goats are considered extra-label use (fenbendazole at the recommended dose rate of 10 mg/kg is considered extra-label usage). The FDA regards extra-label use of drugs as an exclusive privilege of the veterinary profession and is only permitted when a bona fide veterinarian-client-patient relationship exists and an appropriate medical diagnosis has been made. The chart is intended to serve as guideline for improving accuracy when dosing goats with an anthelmintic, but these drugs should be used in goats only when appropriate veterinary advice has been received.***

Drug resistance in parasites of goats is extremely common. The effectiveness of an anthelmintic should always be tested before being used by performing a FECRT (Fecal Egg Count Reduction test) or larval development (DrenchRite) assay if available.

*** The current recommendation is to use the Cydectin cattle **injectable** formulation and **NOT** the **pour-on** formulation (orally) or the sheep oral drench. When administered by subcutaneous injection, moxidectin provides improved drug levels as compared to oral administration.*

Basic Goat Husbandry

Mr. Jerry Hayes
Langston University

Introduction

Every goat producer is confronted with simple management tasks such as:

- telling the age of a goat.
- animal identification.
- hoof trimming.
- castration.
- body condition score.

Ageing Goats

Number and arrangement of teeth

Estimating the age of goats is done by looking at the teeth. The arrangement of teeth on the jaw, from front to back, is incisors, canines, premolars, and molars. Ruminants only have incisors on the bottom jaw. The top jaw has a thick layer of tissue called the "dental pad." Ruminants do not have canine teeth and this open space along the jaw is useful when needing to insert one's fingers to pry open a goat's mouth for drenching, tubing, or other purposes.

Mature goats will have a total of 8 incisors (4 pair), 6 premolars (3 pair), and 6 molars (3 pair). It is customary when ageing goats by looking at their teeth to discuss teeth in terms of "pairs" rather than in total.

Telling the age of goats

Young goats have deciduous or "baby" teeth that are replaced by permanent teeth at a later age. Kids are generally born with the central pair of deciduous incisors (incisors erupt from the center outward) with the second pair erupting at 1 to 2 weeks, third pair at 2 to 3 weeks and the fourth pair erupting at 3 to 4 weeks of age. Kids also will develop 3 pairs of deciduous premolars but no molars.

As kids age, the deciduous incisors are replaced by permanent incisors, again from the center pair outward. The middle pair of deciduous incisors will be replaced sometime around 12 months. The second, third, and fourth pairs are replaced at roughly yearly intervals at 1.5 to 2 years, 2.5 to 3 years, and 3.5 to 4 years of age. Thus, a goat with 1 pair of permanent incisors is roughly 1 year of age, 2 pair of permanent incisors is 2 years of age, and so on. At four years of age when all permanent teeth are in place, the animal may be referred to as having a "full mouth."

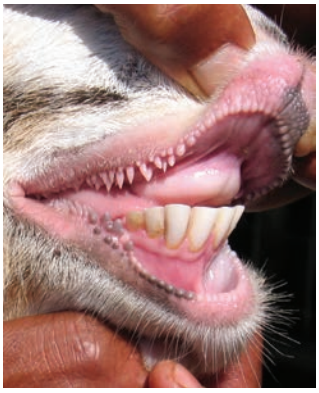
Ageing goats over 4 years of age is more difficult. Over time, the gums recede and teeth appear elongated. Teeth may also become broken or worn down from grazing and foraging. Animals that have broken or lost teeth are often referred to as "broken mouthed." "Undershot" is a condition in which the lower jaw is longer than the upper jaw whereas "overshot" is the opposite. Malformed teeth can affect the ability to graze and consume nutrients.

Animal Identification

The proper identification of animals is essential. Proper identification enables the producer to keep comprehensive records for milk production, reproduction, health problems, and management practices. The efficient maintenance of this information requires a permanent identification system. Several systems of identification may be used. The system selected will depend upon the size of the herd, the environmental conditions, the

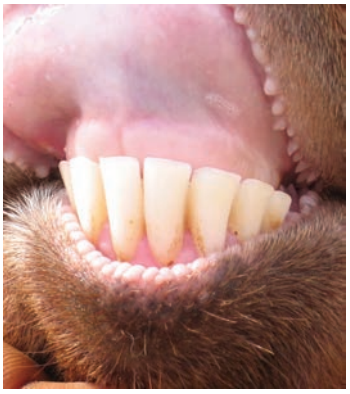
Kid (< 1 year old).

1 year old.

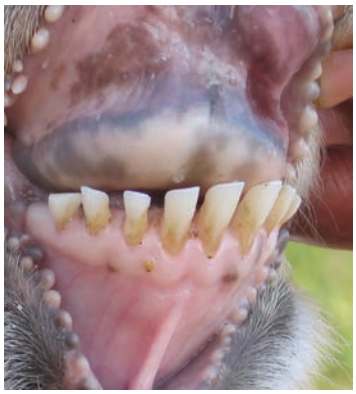


2 year old.

3 year old.



4 year old.



8½ year old.

Broken mouth.

primary purpose for identifying individual animals, and regulations of federal government and breed-governing bodies. There are two basic types of identification: permanent and non-permanent. Permanent identification includes tattooing, ear notches or microchips. Non-permanent identification includes paint, chalk and tags.

Tattooing is permanent identification.

Tattooing

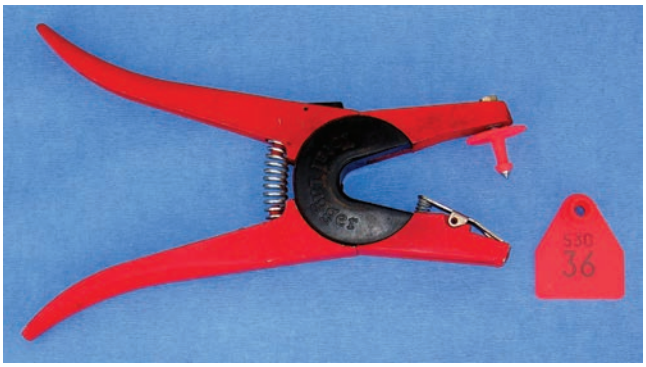
Tattooing is one method of identification that is permanent if properly done. However, it is not easily viewed and may require another complementary method of identification, such as an ear tag, that is visible from short distances. Tattooing involves making needlelike projections in the goat's skin. The tattoo ink is forced into the punctures and remains visible after the puncture wounds heal. It is a good idea to sterilize the equipment and clean the goat's ears to help prevent the spread of some blood-borne diseases. On older animals some tattoos may be difficult to read; holding a bright light source such as a flashlight behind the ear when reading may make the tattoo more legible.

To tattoo an animal, begin by inserting the proper digits into the tattoo pliers. Check for correctness by pressing the pliers onto a piece of paper or cardboard. Secure the goat with a halter or head gate and clean the ear to be tattooed with alcohol. Don't use water for cleaning as it could enter the ear canal and result in infection. Clip or trim any excessive hair present. A generous amount of ink should be applied to the center of the ear between the ribs of cartilage (green ink should be used for dark ears). Position the tattooing pliers between the ribs of cartilage and squeeze firmly forcing the needle-like numbers into the ear tissue. Care should be taken in removing the tattoo pliers from the ear to not scratch the tattooed area. Ink should be reapplied and rubbed into the tattoo. Using an old toothbrush will assist in pushing the ink into the punctures. Afterwards, the equipment and individual tattoo pieces should be cleaned and sprayed with alcohol.

Tattoo pliers and ink.

Ear tags

Ear tags are an easy way to identify each goat in the herd. Unlike tattoos, they can be read without actually having to catch the goat. Unfortunately, unlike tattoos, they can break or be ripped out of the goat's ear. Some producers use two ear tags because of this problem. Goats that are shipped are required to have a scrapie ear tag and these can be used for animal identification. Before putting in the ear tag, it is important to record what ear tag number is assigned to the goat. Ensure the ear tags are inserted between the cartilage ribs on the ears. The producer whose goats have been ear tagged will have an easy-to-read identification number which can be used for herd records.



Ear tag pliers and plastic ear tag.

Microchip

The insertion of a microchip in the base of the ear or tail web of the animal is another form of permanent identification. After insertion, the microchip should be scanned to ensure that it is reading correctly. Care should be taken in recording the microchip number against the tag number of the animal to ensure the integrity of the microchip identification. Exhibitors are required to provide their own reader at many livestock shows.

Ear notching

Ear notching is commonly practiced in identifying goats. It has the advantage of being visible from a distance allowing identification without the necessity of catching the animal and can accommodate numbers up to 9999. Ear notching pliers are used to put "V"-shaped notches in the edges of the ear and a hole punch is used to punch holes in the middle of the ear, if necessary. The animal is restrained and notches and holes may be treated with iodine. As this process results in bleeding, the notching pliers should be disinfected between animals to prevent transmission of any blood-borne diseases. The notching system used is that begun in the Angora industry and adapted for meat goats. However, some producers may use alternate numbering system.

Ear notching pliers.

Example of ear notching.

Generally, notches on the goat's left ear mean: 10 (top), 1 (bottom), 100 (end); and 1,000 (center hole). On the goat's right ear, notch values are: 30 (top), 3 (bottom), 300 (end); and 3,000 (center hole). Thus, a goat with the number 135 would look as follows: 1 notch on end of left ear (100); 1 notch on top of right ear (30), 2 notches on bottom of left ear (2); 1 notch on bottom of right ear (3) with a total value equaling 135.

Hoof Trimming

Hoof trimming goats is a simple task that can be easily learned. The goal of hoof trimming is to allow your goat to walk normally. The lack of trimming, or improper trimming, can lead to foot and leg problems. The amount of time between trimmings depends on many factors, such as type of terrain, the goat's age, level of activity, nutritional level, and genetics. In environmental areas where natural wearing does not occur, producers need to trim hooves on a regular basis. Goats raised in relative confinement and on small acreages may require more frequent trimmings than goats raised in vast pastures. Generally, foot trimming should be done as needed.

Overgrown hoof.

Proper hoof trimming technique.

Each hoof of the goat has two toes. The wall of each toe tends to overgrow and must be trimmed. The heels of the hoof and the dewclaws (especially on an older goat) may also develop extra tissue that needs to be trimmed. Most producers use foot shears or hoof trimmers. Other tools used may include a hoof knife with sharp edges, a pocketknife or a rasp. Pocketknives or a hoof knife can be dangerous to use for both operator and animal as goats may jump. Some people like to use hoof nippers to cut off the tip of the hoof or file it down with rasps.

Initially, use the point of the hoof trimmers to remove any dirt from the outside and the bottom of the hoof. The front of badly overgrown hooves can then be removed. The sides of the hoof should be cut back even with the sole of the foot. Continue to trim the sides around one toe and repeat the process on the other toe. Trim the frog and heel flat until the sole is parallel to the hairline of the pastern. Trim off thin slices. A good rule to follow is to stop when you see pink. If blood appears stop trimming and apply blood stop powder and finish the trimming at a later time.

Castration

All young bucklings that are not to be evaluated as replacement bucks should be castrated. For some producers, this means castrating between the ages of 2 and 4 weeks. Castration of young animals produces less stress in the animals and there is less chance of complications occurring due to the procedure. Young bucks are capable of breeding females as early as 4 to 5 months of age. If a decision is made to not castrate young males, management practices should be in place to prevent unwanted matings.

Three common ways to castrate bucks is through the use of an elastrator that places a rubber ring around the scrotum, a Burdizzo® clamp that crushes the spermatic cord, and the use of a knife to cut the scrotum and remove the testicles.

Elastrator with rubber bands.

Elastrator

Using an elastrator is an inexpensive, quick, and bloodless method of castration. It involves putting a heavy rubber ring around the scrotum near the body. The ring stops blood circulation to the scrotum and testicles and these will dry, shrivel, and slough off in 10 to 14 days. It must be done while the scrotum is still very small, i.e., from three days to three weeks of age depending on breed size, before the scrotal muscles and associated tissues develop.

The rubber ring is first put on the prongs of the elastrator (a pliers-like device that when squeezed will open the ring allowing the scrotum and testes to pass through). The male

kid is restrained and the scrotum is passed through the open ring with the prongs of the elastrator facing the kid's body. The producer must feel the scrotum to ensure that both testicles are in the scrotum below the ring. The rubber ring is positioned close to the body and then slipped off the elastrator prongs. Care must be taken to not apply too close to the body where one runs the risk of trapping the urethra

Body Condition Score

Every goat producer has animals that are either too thin (under-conditioned) or too fat (over-conditioned). Failure to recognize these animals and take corrective actions will cost dearly in terms of decreased fertility, increased disease or internal parasite incidence, decreased milk production, and increased operating costs. Thus, goats need to be maintained with a moderate amount of body condition. When overall body condition starts to decrease in the herd, it is a sign that managerial intervention is needed such as supplemental feeding, deworming, pasture rotation, etc. Conversely, when overall body condition starts to increase in the herd, it is a sign that the producer should reduce supplemental feeding. Ignoring an animal's body condition and waiting to intervene until goats become either too thin or too fat may result in production and(or) animal losses or decreased profits from overfeeding. Therefore, producers need to develop skills in assessing body condition of their goats so that a desired moderate body condition can be maintained.

Body condition score (BCS) has been shown to be an important practical tool in assessing the body condition of cattle, sheep, and goats because BCS is the best simple indicator of available fat reserves which can be used by the animal in periods of high energy demand, stress, or suboptimal nutrition.

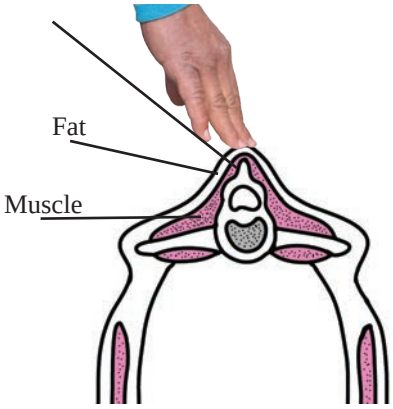
Scoring is performed in goats using a BCS ranging from 1.0 to 5.0, with 0.5 increments. Examples of BCS of 1.0, 2.0, 3.0, 4.0, and 5.0 are given using photographs and written descriptions. Assigning the 0.5 score increment is done when the animal being evaluated is intermediate to the BCS described. A BCS of 1.0 is an extremely thin goat with no fat reserves and a BCS of 5.0 is a very over-conditioned (obese) goat. In most cases, healthy goats should have a BCS of 2.5 to 4.0. BCS of 1.0 , 1.5, or 2.0 indicate a management or health problem. A BCS of 4.5 or 5 is almost never observed in goats under normal management conditions; however, these BCS can sometimes be observed in show goats.

It is important to note that BCS cannot be assigned by simply looking at an animal. Instead, the animal must be touched and felt. The first body area to feel in determining BCS is the lumbar area, which is the area of the back behind the ribs containing the loin. Scoring in this area is based on determining the amount of muscle and fat over and around the vertebrae. Lumbar vertebrae have a vertical protrusion (spinous process) and two horizontal protrusions (transverse process). Both processes are used in determining BCS. You should run your hand over this area and try to grasp these processes with your fingertips and hand. The second body area to feel is the fat covering on the sternum (breastbone). Scoring in this area is based upon the amount of fat that can be pinched. A third area is the rib cage and fat cover on the ribs and intercostal (between ribs) spaces.

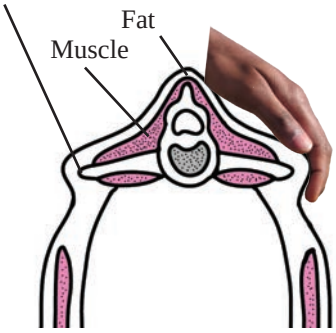
With practice, evaluating the BCS of an animal will only take about 10-15 seconds. By adding BCS as a regular part of your management program, you can more effectively monitor your feeding and herd health program for a healthy and productive herd.

Lumbar Region

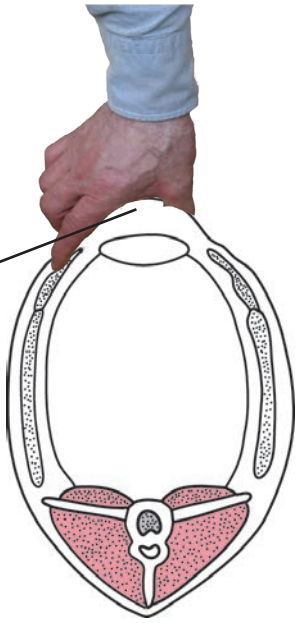
Spinous process



Transverse process



Sternum



Fat

BCS 1.0

Visual aspect of the goat: Emaciated and weak animal, the backbone is highly visible and forms a continuous ridge. The flank is hollow. Ribs are clearly visible. There is no fat cover and fingers easily penetrate into intercostal spaces (between ribs).

The spinous process of the lumbar vertebrae can be grasped easily between the thumb and forefinger; the spinous process is rough, prominent, and distinct giving a saw-tooth appearance. Very little muscle and no fat can be felt between the skin and bone. There is a deep depression in the transition from the spinous to transverse process.

The hand can easily grasp the transverse processes of the lumbar vertebrae which are very prominent. Clearly half of the length of the transverse process is discernible.

Diagrams adapted from Edmonson, et. al, 1989. J. Dairy Science, 72:68-78. Used with permission from the American Dairy Science Association.

Sternal fat can be easily grasped between thumb and fingers and moved from side to side. The cartilage and joints joining ribs and sternum are easily felt.

BCS 2.0

Visual aspect of the goat: Slightly raw-boned, the backbone is still visible with a continuous ridge. Some ribs can be seen and there is a small amount of fat cover. Ribs are still felt. Intercostal spaces are smooth but can still be penetrated.

The spinous process of the lumbar vertebrae is evident and can still be grasped between the thumb and forefinger; however, a muscle mass can be felt between the skin and bone. There is an obvious depression in the transition from the spinous to transverse process.

The hand can grasp the transverse process but the outline of the transverse process is difficult to see. About one-third to one-half of the length of the transverse process is discernible.

Sternal fat is wider and thicker but can still be grasped and lifted by the thumb and forefinger. The fat layer can still be moved slightly from side to side. Joints are less evident.

BCS 3.0

Visual aspect of the goat: The backbone is not prominent. Ribs are barely discernible; an even layer of fat covers them. Intercostal spaces are felt using pressure.

The spinous process of the lumbar vertebrae cannot be easily grasped because the tissue layer covering the vertebrae is thick. When running a finger over the spinous process, a slight hollow is felt. There is a smooth slope in the transition from the spinous to transverse process.

The outline of the transverse process of the lumbar vertebrae is slightly discernible. Less than one-quarter of the length of the transverse process is discernible.

Sternal fat is wide and thick. It can still be grasped but has very little movement. Joints joining cartilage and ribs are barely felt.

BCS 4.0

Visual aspect of the goat: The backbone cannot be seen. Ribs are not seen. The side of the animal is sleek in appearance.

It is impossible to grasp the spinous process of the lumbar vertebrae, which is wrapped in a thick layer of muscle and fat. The spinous process forms a continuous line. There is a rounded transition from the spinous to transverse process.

The outline of the transverse process of the lumbar vertebrae is no longer discernible. The transverse process forms a smooth, rounded edge, with no individual vertebrae discernible.

Sternal fat is difficult to grasp because of its width and depth. It cannot be moved from side to side.

BCS 5.0

Visual aspect of the goat: The backbone is buried in fat. Ribs are not visible. The rib cage is covered with excessive fat.

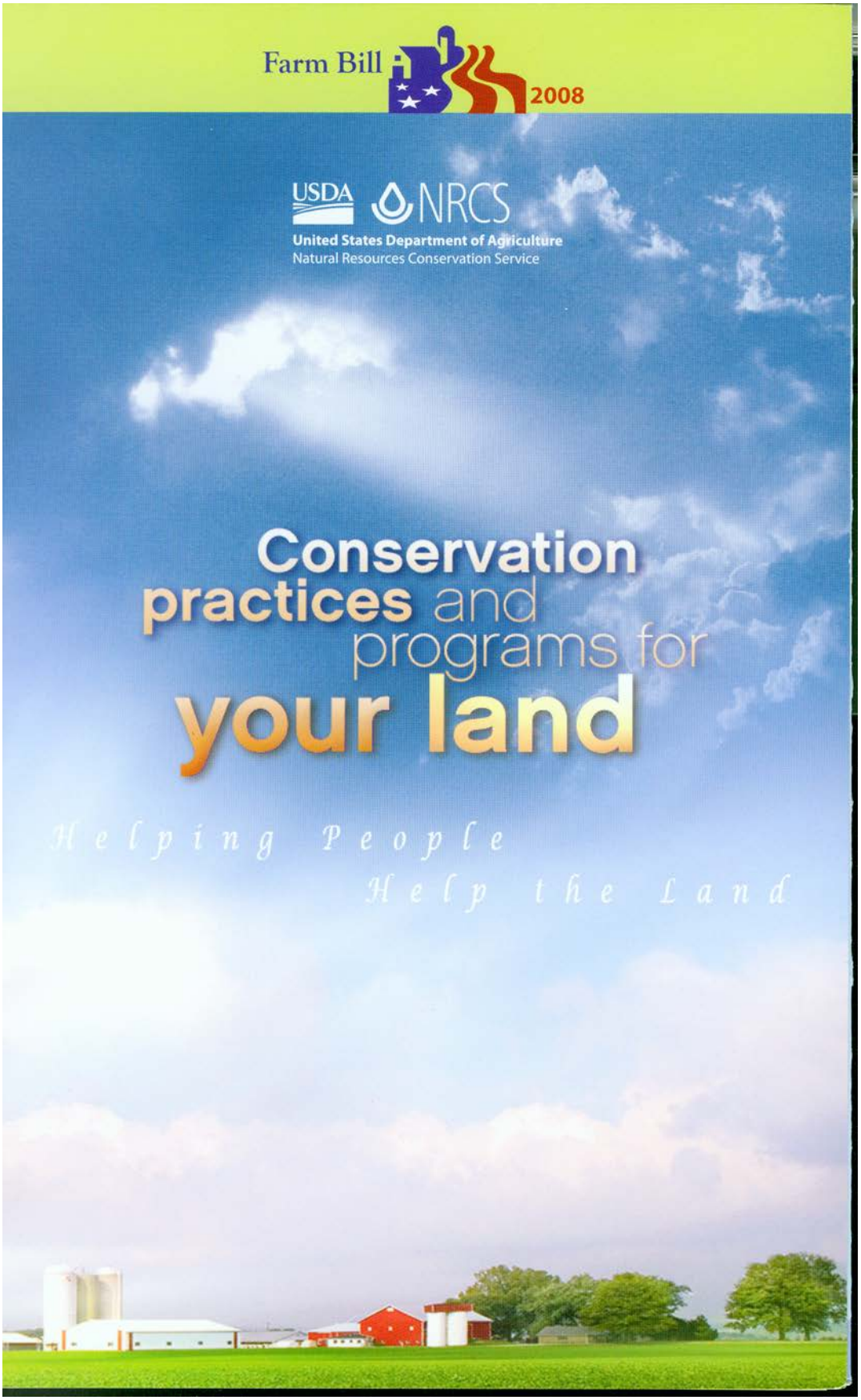
The thickness of the muscle and fat is so great that reference marks on the spinous process are lost. The spinous process forms a depression along the backbone and there is a bulging transition from the spinous to transverse process.

The thickness of the muscle and fat is so great that reference marks on the transverse process are also lost. It is impossible to grasp the transverse process.

The sternal fat now extends and covers the sternum, joining fat covering cartilage and ribs. It cannot be grasped.

Benefits of USDA Programs

Mr. Dwight Guy, Mr. Phil Estes, Mr. Kenneth Hitch, and Mr. Wil Hundl
USDA


Farm Bill 2008
USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service
Conservation practices and programs for your land
Helping People Help the Land

FAQ

frequentlyasked**questions**

How do I improve the chances of my conservation program application being accepted?

Most program applications are selected according to ranking processes specific to your area. Working with your local NRCS representative, you can develop a conservation plan for your land that provides alternatives for various levels of resource treatment relevant to application ranking considerations in your area. You can select the level of treatment that best meets your individual needs while improving your chances of being accepted for funding.

If I enroll my land in a conservation program, do I maintain ownership? Am I required to allow public access to my land?

If you enroll land in any of our conservation programs, you retain ownership of the land. Although participation in conservation easement programs limits certain uses of the land during the term of the agreement or easement, you still maintain control of public access.

Will I be responsible for maintaining practices that I install under a conservation program?

All programs require practice operation and maintenance as stated in the agreement.

What types of wildlife will I attract if I enroll in conservation programs?

The practices you implement and the plants you establish will affect the types of wildlife you attract to your land. Practices can be designed and managed to attract particular species, such as turkey, quail, deer, songbirds, and other wildlife species.

PA - 2037 November 2009

What USDA Offers

	Program	What Land is Eligible?	Length of Agreement	Contract Payments	Easements	Program Payments	Producer Responsibilities
Financial Assistance Programs	Agricultural Management Assistance (AMA) Program	Private or Tribal land in agricultural production including cropland, hayland, pastureland, rangeland, grassland, and non-industrial private forest land.	1-10 years			Payments support practice implementation based on incurred cost and income foregone*	Develop and follow an AMA plan that describes the conservation and environmental objectives. Contribute to installation costs.
	Agricultural Water Enhancement Program (AWEP)	Private, public, and Tribal land in agricultural production including cropland, grassland, and non-industrial private forest land. Does not include land enrolled in CRP, WRP, or GRP.	Up to 5 years for AWEP partnership agreements; 1-10 years for producer EQIP contracts			Payments support practice implementation based on incurred cost and income foregone*	Develop and follow an AWEP EQIP plan that addresses water conservation and water quality and describes the environmental objectives. Incur installation costs.
	Conservation Stewardship Program (CSP)	Private or Tribal agricultural land and non-industrial private forest land. Does not include land enrolled in CRP, WRP, GRP, or Conservation Security Program.	5 years; 5-year renewal option, subject to funding availability	Annual payment based on level of conservation stewardship; supplemental payment available for participants who adopt a resource-conserving crop rotation			Implement a conservation stewardship plan that addresses resource concerns in a comprehensive manner by installing and adopting additional conservation activities and improving, maintaining, and managing existing activities.
	Environmental Quality Incentives Program (EQIP)	Private, public, and Tribal land in agricultural production including cropland, grassland, and non-industrial private forest land. Does not include land enrolled in CRP, WRP, or GRP.	1-10 years			Payments support practice implementation based on incurred cost and income foregone*	Develop and follow EQIP plan of operations that describes the conservation and environmental objectives. Incur installation costs.
	Wildlife Habitat Incentive Program (WHIP)	Private or Tribal agricultural land. Does not include land enrolled in CRP, WRP, HFRP, or a similar program.	1-10 years, or minimum of 15 years for long-term agreements for critical habitat			Payments support practice implementation based on incurred cost*	Prepare and follow WHIP plan of operations that describes the wildlife habitat objectives to be achieved. Contribute to installation costs.
Easement Programs	Farm and Ranch Lands Protection Program (FRPP)	Private land that contains at least 50% prime, State, or locally important farmland; contains historic or archeological resources; or supports the policies of a State, local farm, or ranch protection program. Includes cropland, rangeland, grassland, pastureland, and forest land.	Cooperative agreements obligate funds annually to entities that acquire permanent easements		One-time, up-front payment or up to five annual payments		Continue to use the land for agricultural purposes. Comply with conservation plan for highly erodible land and terms of conservation easement deed.
	Grassland Reserve Program (GRP)	Private or Tribal grassland, shrubland, land containing forbs (including improved rangeland and pastureland) for which grazing is the predominant use, and land in an area that historically contained those features.	10-, 15-, and 20-year rental contracts or permanent easements	Annual rental payment based on county rate determined by FSA	One-time, up-front payment or up to 10 annual payments	50% of actual cost	Develop and comply with a grazing management plan for the easement, rental contract, or restoration agreement. Contribute to installation costs and maintain practices.
	Healthy Forests Reserve Program (HFRP)	Non-industrial private or Tribal forest land capable of supporting habitat for a selected wildlife species.	10-year cost-share agreements, 30-year contracts, and 30-year or permanent easements		One-time, up-front payment or up to 10 annual payments	Up to 75% for cost-share agreements, 30-year contracts, and 30-year easements; up to 100% for permanent easements	Develop and implement HFRP restoration plan that promotes restoration, protection, enhancement and maintenance of forest land functions and values. Contribute to installation costs.
	Wetlands Reserve Program (WRP)	Private or Tribal farmed wetlands or wetlands converted prior to December 23, 1985, and adjacent lands that maximize wildlife benefits.	30-year or permanent easements, 30-year contracts, or cost-share restoration agreements		One-time, up-front payment or up to 30 annual payments for either easement option or 30-year contract	Up to 75% for restoration cost-share agreements, 30-year contracts, and 30-year easements; 100% for permanent easements	Develop and implement WRP plan of operations for the restoration and maintenance of the wetland. Contribute to restoration costs.

All programs are subject to final USDA regulations. *Historically underserved participants may be eligible for increased payment rates up to 90%; EQIP offers up to 30%.

2008 FARM BILL: WHAT'S IN IT FOR YOU?

Conservation practices & programs for your land

What's in it for you?

The 2008 Farm Bill offers America's agricultural producers and non-industrial private forest landowners more assistance than ever before to voluntarily conserve natural resources on our Nation's privately owned farm and ranch lands. Its provisions provide technical and financial assistance to help producers implement conservation practices that reduce erosion, protect our waters, improve fish and wildlife habitat, improve air quality, and conserve energy. This guide introduces the assistance available.

What's New?

- Increased focus on energy conservation, organic and specialty crop production, forestry, air quality, and climate change.
- New programs and initiatives that include the Agricultural Water Enhancement Program (AWEP), Cooperative Conservation Partnership Initiative (CCPI), Chesapeake Bay Watershed Initiative (CBWI), the Environmental Quality Incentives Program (EQIP) Air Quality Initiative, and the Conservation Stewardship Program (CSP).
- Set-aside funding for beginning and socially disadvantaged farmers and ranchers.

Financial & Economic Incentives

The Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA) offers a variety of programs to producers and landowners interested in conservation. Some programs offer annual conservation for long-term contracts and conservation easements. Whether through an agreement or easement purchase, all programs include Federal funds to assist with or offset costs of conservation practices and activities.

Technical Assistance

NRCS helps customers plan and implement conservation practices on private lands through technical assistance of the highest quality and standards. Technical assistance is also available through certified Technical Service Providers (TSPs).

Partnerships Enhance Assistance to NRCS Private Land Programs

NRCS works with many partners to deliver conservation services and programs. Partners such as local conservation districts, Resource Conservation and Development (RC&D) Councils, Cooperative Extension, State natural resource agencies, and nongovernmental conservation organizations all play important roles. Professionals in each organization provide technical help. Additional educational and financial assistance for establishing conservation practices on farms and ranches may be available.

For More Information

Contact your local NRCS Office, USDA Service Center, or local conservation district,

Water Erosion

Curbing water erosion

To reduce soil movement and nutrient runoff consider these or similar practices:

- Grassed waterways
- Residue management
- Grassed riparian buffers
- Grade stabilization structures
- Contour buffer strips

Begin with a look at these programs:
EQIP, AMA, WHIP, CSP

Wind Erosion

Curbing wind damage

To mitigate the effects of wind on farm and ranch lands, consider these or similar practices:

- Residue management
- Shelterbelts
- Windbreaks
- Field stripcropping

Begin with a look at these programs:
EQIP, WHIP, CSP

Soil

Conserving soil and water resources

To improve soil and water quality, consider these or similar practices:

- Nutrient management
- Pest management
- Crop rotation
- Filter strips
- Riparian buffers
- Surface water management

Begin with a look at these programs:
EQIP, AWEP, AMA, WHIP, CSP

Waterways

Protecting waterways from erosion and degradation

Consider these or similar practices:
- Riparian buffers
- Filter strips
- Stream crossings
- Stream bank stabilization/Shoreline protection

Begin with a look at these programs:
EQIP, WHIP, AMA, CSP, CRP

Manure

Managing manure

To prevent nutrient loss and protect air, soil, water, fish, and wildlife resources, consider these or similar practices:
- Waste storage structures and lagoons
- Nutrient management
- Compost facilities
- Waste utilization

Begin with a look at these programs:
EQIP, CBWI

Grasslands

Managing grasslands

To improve forage quality, control invasive species, and conserve fish and wildlife habitat, consider these or similar practices:
- Prescribed grazing
- Pest management
- Prescribed burning
- Watering facilities
- Brush management

Begin with a look at these programs:
EQIP, GRP, WHIP, WRP, CSP, CRP

Wildlife

Establishing wildlife habitat

To enhance, restore, manage and protect fish and wildlife habitat, consider these or similar practices:
- Upland/Wetland habitat management
- Wetland restoration
- Forest stand improvement
- Stream habitat improvement
- Prescribed burning
- Tree/Shrub establishment

Begin with a look at these programs:
WHIP, WRP, GRP, EQIP, HFRP, CSP

Forest Lands

Managing forest lands

To restore and protect forest resources and improve fish and wildlife habitat, consider these or similar practices:
- Tree planting
- Forest stand improvement, thinning
- Prescribed burning
- Controlling invasive plants

Begin with a look at these programs:
HFRP, WHIP, EQIP, CSP

Air, Energy & Climate Change

Improving air quality, conserving energy, and mitigating climate change

Consider these or similar practices:
- Residue management
- Dust abatement
- Cover crops
- Conservation buffers
- Windbreak/ Shelterbelt plantings
- Tree planting
- Conversion of cropland to grassland

Begin with a look at these programs:
EQIP, AMA, HFRP, GRP, CSP

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Farm Bill 2008

Fact Sheet: Environmental Quality Incentives Program On-Farm Energy Initiative

January 2012

Overview
The Environmental Quality Incentives Program (EQIP) is a voluntary program that offers financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length. These contracts provide assistance to plan and implement conservation practices that improve soil, water, plant, animal, air, energy conservation, and related resources on agricultural land and non-industrial private forestland. In addition, EQIP can help producers meet federal, state, Tribal and local environmental regulations.

On-Farm Energy Initiative
The 2008 Farm Bill includes provisions for the use of EQIP to assist producers with addressing energy conservation. The NRCS EQIP On-Farm Energy Initiative offers assistance to producers in two ways: 1) it enables the producer to identify ways to conserve energy on the farm through an Agricultural Energy Management Plan (AgEMP) conservation activity plan (CAP), also known as an on-farm energy audit, and 2) provides financial and technical assistance to implement conservation practices recommended in the energy audit, such as residue and tillage management, and Farmstead Energy Improvement (Conservation Practice Standard 374).

Eligibility
Eligible applicants include individuals, legal entities, Indian Tribes or joint operations engaged in agricultural production. Producers who grow agricultural commodities on eligible land and have resource concerns which may be addressed by energy conservation practices may participate in the On-Farm Energy Initiative.

Eligible producers interested in entering into a financial assistance agreement with NRCS for EQIP assistance may file an application at their local USDA Service Center at any time. Your local office can be found at http://offices.sc.egov.usda.gov/locator/app.

Applicants must:

- Be an agricultural producer and have control of eligible land for the term of the proposed contract period.
- Be in control of eligible land such as cropland, pasture, rangeland and headquarters.
- Be in compliance with the provisions for protecting the interests of tenants and sharecroppers, including the provisions for sharing EQIP payments on a fair and equitable basis.
- Be in compliance with the highly erodible land and wetland conservation compliance provisions of the 2008 Farm Bill.
- Be within appropriate payment limitation requirements, as specified in the 2008 Farm Bill.
- Be in compliance with adjusted gross income requirements of the 2008 Farm Bill.

How EQIP Works
NRCS staff will work with the applicant to develop a conservation plan and an EQIP plan

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of operations. This plan becomes the basis of the EQIP contract between NRCS and the participant.

NRCS may also provide financial assistance to participants for conservation planning services through a Technical Service Provider (TSP). These services are utilized to develop Conservation Activity Plans (CAP) which will be included in the plan of operations as they provide in depth analysis of specific resource concerns.

Applications submitted for the EQIP On-Farm Energy Initiative are accepted on a continuous basis throughout the year. Applications are evaluated and ranked according to environmental benefits expected through implementation of approved conservation practices.

For fiscal year 2012, NRCS has established application deadlines where eligible applications will be ranked and considered for funding as follows:

- Application Period 1
  Submission Deadline: Friday, February 3, 2012
- Application Period 2
  Submission Deadline: Friday, March 30, 2012
- Application Period 3
  Submission Deadline: Friday, June 1, 2012

Applications submitted after the deadlines will be evaluated and considered for later funding opportunities.

Payment Limitations

Program payments are limited to $300,000 a person or entity for all contracts entered into during any six-year period. This limitation includes unpaid prior year contract obligations as of October 1, 2008, as well as new contract obligations. For the purpose of applying this requirement, the six-year period will include those payments made in fiscal years 2009-2014. Payments received for technical assistance are excluded from this limitation.

More Information

For more information and updates about the EQIP Initiatives and other 2008 Farm Bill topics, please visit the NRCS website at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip.

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Farm Bill 2008

Fact Sheet: Environmental Quality Incentives Program Seasonal High Tunnel Initiative

January 2012

Overview

The Environmental Quality Incentives Program (EQIP) is a voluntary program that offers financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length. These contracts provide assistance to plan and implement conservation practices that improve soil, water, plant, animal, air, energy conservation, and related resources on agricultural land and non-industrial private forestland. In addition, EQIP can help producers meet federal, state, Tribal and local environmental regulations.

Seasonal High Tunnel Initiative

The Seasonal High Tunnel Initiative is a voluntary program that provides financial and technical assistance to agricultural producers. The goal of the initiative is to assist producers with extending the growing season for high value crops in an environmentally safe manner. The initiative can assist producers with improving plant and soil quality, reducing nutrient and pesticide transportation, improving air quality through reduced transportation inputs, and reducing energy use by providing consumers with a local source of fresh produce.

Eligibility

Eligible applicants include individuals, legal entities, Indian Tribes or joint operations engaged in agricultural production. Producers who grow agricultural commodities on eligible land and have resource concerns which may be addressed by a seasonal high tunnel may participate in the new Seasonal High Tunnel Initiative.

Eligible producers interested in entering into a financial assistance agreement with NRCS for EQIP assistance may file an application at their local USDA Service Center at any time. Applicants must:

- Be an agricultural producer and have control of eligible land for the term of the proposed contract period.
- Be in control of eligible land such as cropland.
- Be in compliance with the provisions for protecting the interests of tenants and sharecroppers, including the provisions for sharing EQIP payments on a fair and equitable basis.
- Be in compliance with the highly erodible land and wetland conservation compliance provisions of the 2008 Farm Bill.
- Be within appropriate payment limitation requirements, as specified in the 2008 Farm Bill.
- Be in compliance with adjusted gross income requirements of the 2008 Farm Bill.

How EQIP Works

NRCS staff will work with the applicant to develop a conservation plan and an EQIP plan of operations. This plan becomes the basis of the EQIP contract between NRCS and the participant.

NRCS may also provide financial assistance to participants for conservation planning services through a Technical Service Provider (TSP).

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These services are utilized to develop Conservation Activity Plans (CAP) which will be included in the plan of operations as they provide in depth analysis of specific resource concerns.

Applications submitted for the Seasonal High Tunnel Initiative are accepted on a continuous basis throughout the year. Applications are evaluated and ranked according to environmental benefits expected through implementation of approved conservation practices.

For fiscal year 2012, NRCS has established application deadlines where eligible applications will be ranked and considered for funding as follows:

- Application Period 1
  Submission Deadline: Friday, February 3, 2012
- Application Period 2
  Submission Deadline: Friday, March 30, 2012
- Application Period 3
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Payment Limitations

Program payments are limited to $300,000 a person or entity for all contracts entered into during any six-year period. This limitation includes unpaid prior year contract obligations as of October 1, 2008, as well as new contract obligations. For the purpose of applying this requirement, the six-year period will include those payments made in fiscal years 2009-2014. Payments received for technical assistance are excluded from this limitation.

More Information

For more information and updates about the EQIP Initiatives and other 2008 Farm Bill topics, please visit the NRCS website at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip.

Meat Goat Nutrition

Dr. Steve Hart
Langston University

Introduction

Proper nutrition is essential for the health and productivity of all animals and is the basis of successful production systems. A well planned and executed preventive health program cannot overcome problems that are created by poor nutrition. Nor can advanced reproductive technologies overcome nutritional limitations of reproduction. Therefore, nutrition of the goat is of paramount importance for successful goat production. Nutrition is the science of providing nutrients to animals in adequate amounts and in forms that the animals will consume. For sustainable and profitable production, these nutrients must also be provided in a cost-effective manner.

The ruminant stomach

Goats are ruminants, animals with a four-compartment stomach, as are cattle, sheep, and deer. The compartments are the reticulum, rumen, omasum, and abomasum (true stomach). Monogastric or simple-stomached animals such as humans, dogs, and cats consume food that undergoes acidic breakdown in the stomach and enzymatic digestion in the small intestine where most nutrients are absorbed. In ruminants, feed first undergoes microbial digestion in the reticulum and rumen (together often called the reticulo-rumen) prior to acidic digestion in the abomasum and enzymatic digestion and nutrient absorption in the small intestine. It is the microbial digestion in the reticulo-rumen that enables ruminants to consume and utilize grass, hay, leaves, browse, etc.

The reticulum and rumen form a large fermentation vat that contains microorganisms, mainly bacteria, that breakdown and digest feedstuffs, including the fibrous component of grass, forbs, and browse that cannot be digested by monogastric animals. Some of the breakdown products produced through digestion of feed by bacteria are absorbed by the animal through the rumen wall and can supply a large part of the energy needs. The rest of the byproducts of digestion, undigested feed, and ruminal microorganisms flow out of the reticulo-rumen into the omasum where large feed particles are trapped for further digestion and water is reabsorbed. Material then flows into the abomasum where acidic digestion takes place and then to the small intestine for further enzymatic digestion and nutrient absorption.

The rumen provides several advantages to the goat in addition to digestion of dietary fiber. The bacteria in the rumen are capable of synthesizing all B vitamins needed. Bacteria can also synthesize protein from nitrogen recycled in the body, which may be advantageous on low protein diets. For proper ruminal function, goats require a certain level of fiber (measured as crude fiber, acid detergent fiber, or neutral detergent fiber) in the diet. Goats have bacteria in the rumen that can detoxify antinutritional factors, such as tannins. This enables goats to better utilize feedstuffs containing high tannin levels such as those found in browse. There are very few situations in which a goat will not consume adequate fiber, but one is when a very high grain diet is being fed. Inadequate fiber consumption can then lead to several disease conditions. The most important disease condition is acidosis or an extremely low pH in the rumen, causing decreased feed consumption.

When ruminants are born, the first three compartments of the stomach are underdeveloped and the stomach functions similar to that of a monogastric animal. This enables absorption of antibodies in colostrum and efficient utilization of nutrients in milk. As the young ruminant consumes solid feed, especially high in fiber, and the microbial population is established, the rumen is stimulated to develop. The rumen must have an acceptable degree of development for successful weaning.

The greatest asset of goats is the ability and tendency to utilize woody plants and weeds, not typically consumed by other species of animals (e.g., cattle and sheep), converting them into a saleable product. Therefore, these plant species can be inexpensive sources of nutrients and make for a very profitable goat enterprise. Goats typically consume a number of different plant species in any one day and can utilize some poisonous plants because they do not consume enough to be toxic. Similarly, goats are believed to have a relatively high ability to detoxify absorbed anti-nutritional factors. Goats are more resistant to bloating than other ruminants, and after a brief adaptation may graze alfalfa without bloating.

Nutrients

Nutrients are defined as substances that aid in the support of life. The six classes of nutrients include protein, carbohydrate, fat, vitamins, minerals, and water. Nutrients are often classified as organic (carbon-containing) or inorganic (minerals).

Energy is not considered a nutrient, but can be derived from the breakdown of several nutrients including fat, protein, and both simple and complex carbohydrates. Energy is required to propel the biochemical processes that are necessary to sustain life. A deficiency of energy will cause weight loss, low productivity, and ultimate death of an animal. An oversupply of energy will usually result in excessive fatness, which is also unhealthy. A simple unit of measurement of energy is pounds of total digestible nutrients (TDN). A lb of TDN, equivalent to a pound of digested carbohydrate, equals 2,000 Kilocalories (or Calories as used in human nutrition) of digestible energy. There are a number of other measures of energy used, but they are less easily understood.

Water

Water is an essential nutrient for all animals and is sometimes overlooked. While goats require less water than cattle, they do need water and require additional quantities when lactating or coping with hot weather. A 110 lb goat will require 1 to 3 gallons of water per day depending upon diet, intake, and weather, toward the lower range in winter and toward the upper range in the hottest days of summer. A lactating goat will require an additional 1 quart of water for every 1 pint of milk produced. If a goat is producing 5 pints of milk at peak lactation while raising twins, 2.5 gallons of water are required each day. If goats are eating green material, a substantial part of their water requirement can be met by water contained in the plant material. However, if dry feed such as hay is consumed, water must be supplied to meet the requirement.

Water should be kept clean to encourage intake. This usually involves regular cleaning of the waterer. It is important that the area around the waterer not be muddy, as this is a good environment to spread foot rot and internal parasites. Placing some rock or gravel around the waterer can help keep feet dry and reduce disease problems. Water cleanliness is especially important for bucks on high grain diets. Their water needs to be shaded in summer and warm in the winter to encourage intake and reduce the risk of urinary calculi.

Carbohydrates

Carbohydrates usually provide the majority of energy to goats. Carbohydrates can be classified as simple, such as sugars (easily identified by their sweet taste; maybe 1, 2, or 3 sugar molecules linked together), or complex, such as starch (found in grains) or cellulose (i.e., fiber). Grass, forb, and browse plant species generally contain high levels of cellulose, which must be digested by rumen bacteria to provide energy.

Cellulose is often referred to as fiber, although the term fiber also pertains to other substances such as hemicellulose and lignin. Fiber in young plants may be highly digestible and provide a high level of energy, but fiber in older, mature plants is often poorly digested and may only provide half the energy of other carbohydrates. Fiber in the diet may be characterized chemically in several ways, such as crude fiber (CF), acid detergent fiber (ADF), and neutral detergent fiber (NDF). These abbreviations are used in hay analysis

and may appear on feed tags. In general, the lower the fiber level, the higher the level of digestible energy. However, a certain minimum fiber level is required for healthy rumen function.

Goats do not adapt as easily to high concentrate diets as cattle and sheep and are more likely to get acidosis, founder, urinary calculi, and enterotoxemia. To avoid these problems, very gradually increase the concentrate level in the diet when placing goats on high concentrate diets and maintain a minimum of 12% crude fiber in the diet or about half of the diet as grass, browse, or hay. Goats are typically not feed efficient, except for some rapidly growing Boer goats, and may require 7 lbs or more of feed per pound of gain. Also, one must be very alert for health problems with goats on high grain diets.

Fats

Fats, also called lipids, are very high in energy, providing more than twice the energy of carbohydrate on a weight basis. The fat content of ruminant diets is generally low, as plants have a low fat content. Plant waxes are fats that goats consume as they graze and browse, but they are not digested. Fat may be added to diets to increase the energy content. However, high levels of added fat depress fiber digestion unless treated to be inactive in the rumen. These fat sources are termed "bypass" and may be used in dairy goat diets but are generally not used in meat goat diets.

Protein

Protein is composed of building blocks called amino acids that the body uses to produce all of the different proteins required for growth, production, and maintenance. Protein is required in the diet for accumulation of new body mass (growth) and for replacing protein lost by normal wear and tear.

Ruminant animals are usually fed supplemental protein to make up for dietary shortfalls. In the rumen, bacteria degrade much of the consumed protein and use the amino acids to form bacterial protein. Bacteria can also form protein from nonprotein sources such as urea and, if provided with sufficient energy, can form significant quantities of protein. To prevent breakdown and digestion by ruminal bacteria, some protein sources are protected from degradation by coating or other means. Some natural proteins are also resistant to ruminal degradation by bacteria. These types of proteins are referred to as "bypass protein" as they bypass digestion in the rumen. Other common terms for bypass protein are "ruminal escape" and "rumen undegraded." Bypass protein sources are very important in dairy cow nutrition, but have lesser significance in most meat goat production systems.

Urea is the main nonprotein nitrogen source fed to ruminants. However, goats are not commonly fed urea as frequently as cattle. This may be because goats are more subject to urea toxicity than cattle. Goats appear more efficient than other species at recycling nitrogen in the body to the rumen where it can be used to form microbial protein, given that sufficient energy is available. This recycling of urea to the rumen helps to reduce the amount of protein required in the diet. When animals are consuming a low quality forage, a grain supplement may also improve protein status by providing additional energy for protein synthesis by ruminal microbes.

Vitamins

Vitamins function as critical chemicals in the body's metabolic machinery and function as co-factors in many metabolic processes. A deficiency of a vitamin will slow or block the metabolic process in which that vitamin is involved, resulting in deficiency symptoms. Vitamins are divided into those that are fat soluble (i.e., A, D, E, and K) and those that are water soluble (i.e., B vitamins and C).

The bacteria in the rumen of the goat can synthesize adequate amounts of the water soluble vitamins. Thiamine, or vitamin B1, may become deficient under some conditions (e.g., feeding a high concentrate diet, especially those with high sulfur which may come from a high level of molasses) and cause the disease polioencephalomalacia. Sometimes, however there are other unexplained causes of polioencephalomalacia.

Another situation that could lead to thiamine deficiency is improper feeding of the coccidiostat Corid®. The coccidiostat ties up thiamine, making the coccidia unable to reproduce. Feeding Corid® longer or at higher levels than recommended could lead to polioencephalomalacia. Polioencephalomalacia is a nervous disorder where the animal becomes blind, depressed, presses with his head, and the pupil slit in the eyes becomes up and down rather than the normal side to side profile. Treatment requires immediate injection of large quantities of thiamine.

Fat soluble vitamins must be supplied to the goat because the body cannot directly make them. The recommended levels of vitamins in formulated feed is 5,000 IU (international units, a measure of the potency of vitamins) of vitamin A per lb, 2,000 IU/lb of vitamin D, and 80 IU/lb of Vitamin E. The liver can store significant amounts of the fat soluble vitamins.

Vitamin A can be synthesized from carotene, the pigment that gives grass and hay their green color. As long as sufficient green feed is consumed, vitamin A intake will be adequate. Vitamin A is necessary for normal epithelium (skin) development and vision. A deficiency of vitamin A causes many symptoms, including tearing of the eyes, diarrhea, susceptibility to respiratory infection, and reproduction problems. Vitamin A is often supplied to animals not consuming green forage such as in winter months. Many mineral and vitamin supplements contain vitamin A.

Vitamin D is called the sunshine vitamin because animals can synthesize the vitamin with the help of the sun. Ultraviolet light in sunshine converts pre-vitamin D found in the skin to a pro-vitamin D form that is used by the animals. Usually, even limited sunlight exposure is adequate to provide a day's supply of vitamin D. Sun-cured hay contains Vitamin D. Vitamin D is necessary for calcium absorption and metabolism by the body. A deficiency of vitamin D, called rickets, results in lameness, weak bones, and bowed and crooked legs. The liver is the main Vitamin D storage site in the body. Vitamin D is normally present in mineral supplements and often added to complete feeds.

Vitamin E functions as an antioxidant in conjunction with the mineral selenium. The requirements for one can be partially met by the other. Thus, vitamin E is very important in areas with marginal or deficient levels of selenium. A common vitamin E deficiency disease, particularly in newborn or young animals, is white muscle disease, where white spots are seen in the heart and skeletal muscle due to oxidation damage. A marginal deficiency of vitamin E can depress the immune system and cause reproductive failure. Green grass and green sun-cured hay have high levels of vitamin E. Most mineral supplements and complete feeds contain vitamin E, especially in areas that are deficient in selenium. Vitamin E is expensive and minimal supplemental levels are used in contrast to vitamins A and D that are less expensive and often included at generous levels.

Vitamin K is technically required by animals and functions in the clotting of blood. Vitamin K is produced by bacteria in the lower digestive tract and absorbed. Generally, goats do not need to be supplemented with vitamin K.

Minerals

The inorganic nutrients are called minerals. Minerals are further subdivided into macrominerals, those required at 0.1% or more in the diet (macro means large), and microminerals, those required at the part per million (ppm) level (micro means small). A ppm is the weight of a paperclip in a thousand pounds of feed. A hundred ppm is equal to 1.6 ounces in a thousand pounds of feed. Macrominerals include calcium, phosphorus, sodium, potassium, chloride, sulfur, and magnesium. Microminerals include iron, copper, cobalt, manganese, zinc, iodine, selenium, molybdenum, and others. Minerals function in many ways in the body. Some such as calcium and phosphorus are major structural components of bones and teeth, as well as having other functions. Other minerals facilitate nerve functioning or fulfill a role as electrolytes. The mineral requirements

for goats are not as well known as they are for other livestock species and have often been extrapolated from sheep or cattle requirements due to a lack of studies in goats. As such, mineral recommendations for goats often have a wide range because of lack of accurate goat-specific information.

Macrominerals

The macrominerals are listed below, followed by the abbreviation, normal dietary range, function, deficiency symptoms, and major dietary sources.

Calcium (Ca) 0.3 - 0.8%

The major biological function of calcium is for bones. Bones contain 99% of the calcium in body. Calcium is also necessary for muscle contraction, nerve conduction, and blood clotting. The main deficiency symptoms are seen in the skeletal system. Bones can become soft and weak and may be deformed resulting in lameness. This condition is called rickets or osteomalacia. Vitamin D deficiency causes similar symptoms due to the role of vitamin D in the absorption and metabolism of calcium. Calcium is relatively high in milk and lactating goats need adequate levels of calcium for milk production. Does can get hypocalcemia (milk fever) while lactating due to a metabolic disorder which results in a shortage of calcium in the blood due to calcium being used for milk production. Urinary calculi is a condition brought about in part by an imbalance in the calcium to phosphorus ratio in the diet. Generally, about twice as much calcium as phosphorus should be in the diet of ruminant animals. An excess of calcium can cause abnormal bone growth. Major common dietary sources of calcium include forages, limestone and dicalcium phosphate.

Phosphorus (P) 0.25 - 0.4%

Approximately 80% of the body's phosphorus is found in bones, with the remainder in the blood and other tissues. In addition to skeletal structural functions, phosphorus is essential in energy metabolism, acid-base balance, and is a constituent of enzymes and genetic material. The major symptoms of phosphorus deficiency include reduced growth, listlessness, unkempt appearance, depressed fertility, pica (depraved appetite-eating wood, rocks and bones), and decreased serum phosphorus. Phosphorus is the most commonly encountered mineral deficiency and also the most expensive macromineral. Sources of phosphorus include protein supplements, cereal byproducts, mineral supplements, and dicalcium phosphate.

Sodium (Na) 0.2%

Potassium (K) 0.8 - 2.0%

Chloride (Cl) 0.2%

All three of these minerals function as electrolytes in the body. Electrolytes are mineral ions, carrying a positive or negative charge that the body uses for osmotic balance, pH balance, and water movement. They are also essential in transmission of nerve impulses. These minerals are highly water soluble and are easily lost with diarrhea. Electrolyte solutions used to treat animals with diarrhea contain all three of these minerals. A deficiency of potassium could occur on high concentrate diets, with symptoms including poor appetite, urinary calculi, body stiffness progressing from front to rear, and pica (depraved appetite as described above). A deficiency of chloride depresses growth. A deficiency of sodium causes reduced growth and feed efficiency. Salt provides both sodium and chloride. Most forages have adequate levels of potassium.

Sulfur (S) 0.2 - 0.32%

The major biological function of sulfur is as a component of sulfur-containing amino acids. Therefore, sulfur is important in protein synthesis, milk and hair production, enzymes, hormones, hemoglobin, and connective tissue, and is a component of the vitamins biotin and thiamine. The major deficiency symptoms include poor animal performance, hair loss, excessive salivation, tearing of eyes, and weakness. Major source of sulfur is protein which contains sulfur as a component of some of the amino acids. Therefore, sulfur is important in

diets where nonprotein nitrogen (e.g., urea) is used to substitute for some protein. Sulfur-containing mineral blocks are often used for control of external parasites in goats. Excessive sulfur in high concentrate diets can contribute to polioencephalomalacia as discussed for the water soluble vitamin thiamine.

Magnesium (Mg) 0.18 - 0.4%

Magnesium is found in bones (60 to 70% of that in the body), liver, muscle, and blood. It is required for normal skeletal development, and nervous and muscular system functions, as well as for enzyme systems. It is also closely associated with metabolism of calcium and phosphorus. In ruminants, a major magnesium deficiency disease is grass tetany, often seen in animals grazing fast-growing, lush, cool season pastures. Affected animals have low blood magnesium levels, exhibit a loss of appetite, are excitable, stagger, have convulsions, and may die. High fertilization rates, cool temperatures, and high levels of plant potassium and(or) rumen ammonia may contribute to the disease. A major supplemental source of magnesium is magnesium oxide, which is often supplemented on winter wheat pasture and mixed with a protein source to encourage consumption.

Micro or trace elements

The first level after the mineral name is what is thought to be the minimum requirement in the diet, while the second is the value above which the element can become toxic. Most supplemental trace minerals are provided by trace mineralized salt or mineral mixes that are designed to provide 25 to 50% of requirements. This is adequate if the animal's diet is marginal in a mineral but inadequate if that mineral is severely deficient. Unless a documented deficiency exists, it is best not to provide 100% of a trace mineral, because an excess of one mineral may depress the absorption of another creating a deficiency. Excess supplementation of some minerals can cause toxicity problems, especially with copper and selenium.

Iron (Fe) 35 - 500 ppm

The major function of iron is as a component of hemoglobin, required for oxygen transport. It is also a component of certain enzymes. The major iron deficiency symptom is anemia. Anemia can also be caused by blood loss due to several factors, including injury, internal parasites (barberpole worm or liver fluke), and a bad case of external parasites such as lice. Iron is stored in the liver, spleen, and bone marrow. Milk is very low in iron; therefore, kids raised for a long time on milk alone will develop anemia. Soil contamination on forages can provide significant levels of dietary iron. Iron sulfate is a common means of adding iron to the diet. Forages in some areas have excessively high levels of iron that suppress utilization of other trace minerals.

Copper (Cu) 10 - 50 ppm

Copper is essential in formation of red blood cells, hair pigmentation, connective tissue, and enzymes. It is also important in normal immune system function and nerve conduction. Deficiency symptoms include anemia, "bleached" looking (lighter color) and rough hair coat, diarrhea, and weight loss. Young goats may experience progressive incoordination and paralysis, especially in the rear legs. High dietary molybdenum can depress absorption of copper and cause a deficiency. There should be at least four times as much copper as molybdenum in the diet.

Sheep (both hair and wool types) are sensitive to copper toxicity, whereas goats require copper levels similar to beef cattle. Angora goats may be more sensitive to copper toxicity than meat and dairy goats. There are differences in copper requirements for several sheep breeds, and this could be true for meat goats, but no data are available. Although most of the United States has adequate copper levels (Figure 7), many areas have high levels of molybdenum (Figure 6) due to soil geology and, therefore, require copper supplementation. The liver stores copper, which can protect against toxicity in the short term. However, when liver capacity is exceeded, animals can die rapidly from a hemolytic crises caused by stress, such as being chased.

Cobalt (Co) 0.11 - 25 ppm

The only well accepted biological function of cobalt is as a component of vitamin B_{12}. Rumen microbes utilize cobalt for growth and produce vitamin B_{12}. Cobalt deficiency symptoms include loss of appetite, anemia, decreased production, and weakness. Most natural feedstuffs contain adequate levels of cobalt. There are cobalt-deficient areas in the United States (Figure 1).

Zinc (Zn) 40 - 500 ppm

Zinc is found in all animal tissue and is required by the immune system and for normal skin growth. Zinc is also essential for male reproduction. Deficiency symptoms include dermatitis (thick, dry patches of skin), hair loss, skin lesions, swollen feet, and poor hair growth. The bran and germ of cereals contain high levels of zinc.

Manganese (Mn) 40 - 1000 ppm

Manganese is important for bone formation, reproduction, and enzyme functioning. Deficiency symptoms include a reluctance to walk, deformity of forelegs, delayed onset of estrus, poor conception rate, and low birth weight. It is unusual to have a manganese deficiency.

Selenium (Se) 0.1 - 20 ppm

Selenium functions with vitamin E as an antioxidant, protecting cell membranes from oxidation. Selenium also affects reproduction, metabolism of copper, cadmium, mercury, sulfur, and vitamin E. Deficiency symptoms include poor growth rate, kids being unable to suckle, white muscle disease (cardiac and skeletal muscles have white spots), sudden death by heart attack, progressive paralysis, and retained afterbirth. Selenium is deficient in many areas because of low soil levels (geological factors; Figure 8); however, there are a few regions of high selenium soils leading to high to toxic levels in plants. Toxic levels of selenium cause shedding of hair, diarrhea, and lameness. Most plants that are not grown in selenium deficient soils will have adequate selenium levels. It is more effective to provide selenium supplementation through feed than by injection.

Molybdenum (Mo) 0.1 - 5 ppm

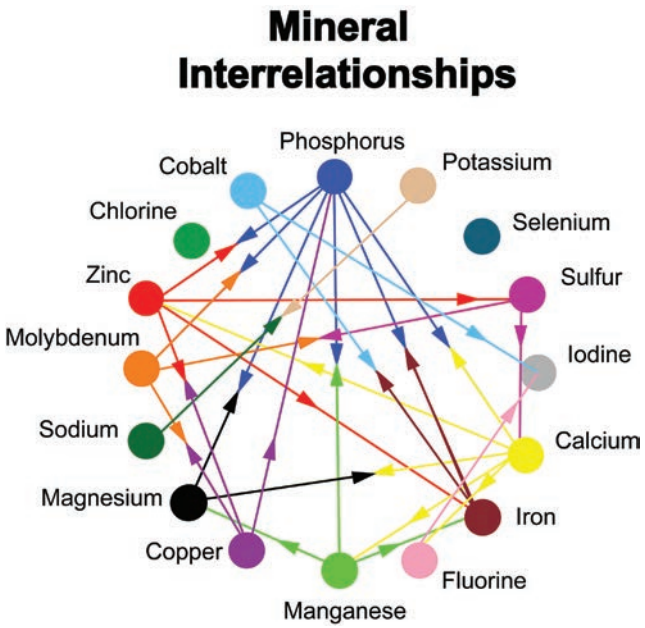
Molybdenum deficiencies are very rare. Toxicity occurs above 3 ppm due to reduced copper absorption, resulting in a copper deficiency. The copper level must be four times the molybdenum level to overcome this effect. High dietary levels of molybdenum are usually related to soil content. Molybdenum (as ammonium tetrathiomolybdate) is often used to treat copper toxicity in animals (Figure 6).

Iodine (I) 0.5 - 50 ppm

The only proven biological function of iodine is as a component of thyroid hormones that regulate energy metabolism and reproductive function. The major iodine deficiency symptom is goiter - a swelled or enlarged thyroid gland in the neck. This should not be confused with the thymus gland in the neck on young animals (the thymus gland is especially pronounced in Nubian kids, but shrinks after several months of age). Also, iodine deficiency causes reduced growth and milk yield, pregnancy toxemia, and reproductive problems such as late term abortion, hairless fetus, retained placenta, and weak kids. Most of the southern U.S. has adequate iodine in the soil and most minerals and trace mineralized salts contain iodine. A number of areas in the northern U.S. are deficient in iodine due to soil geology.

Mineral nutrition considerations

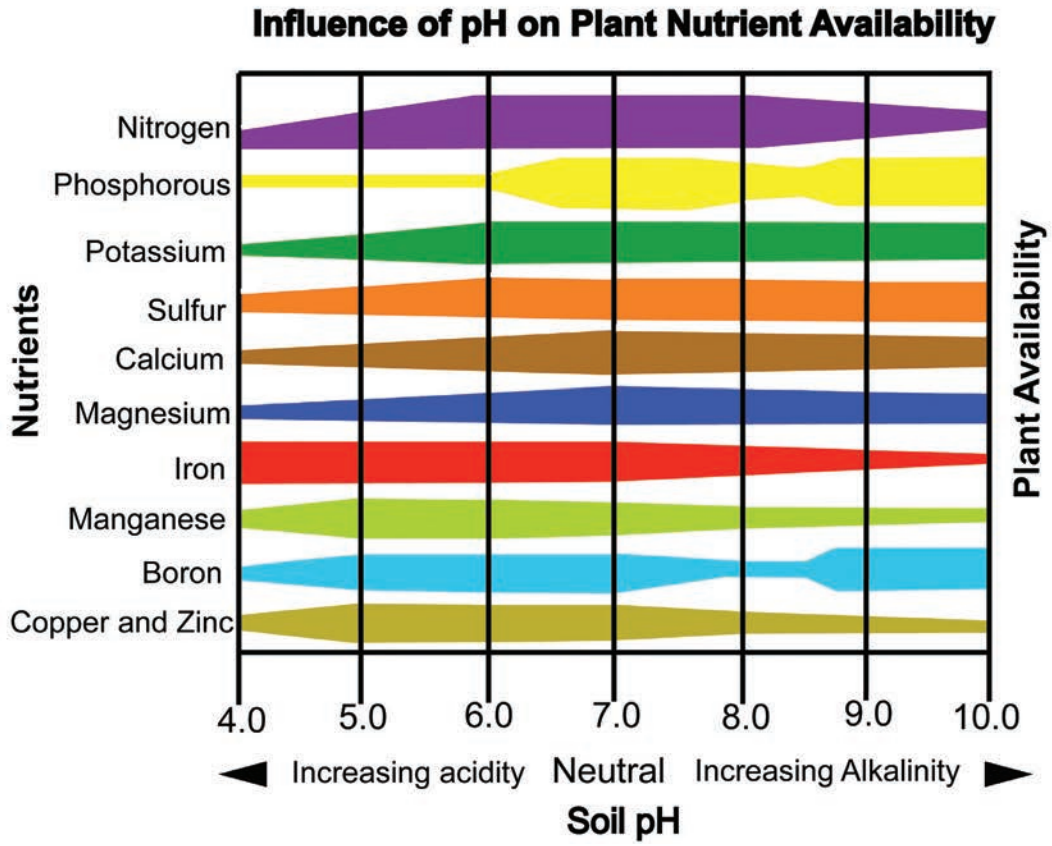
Plants are a major source of minerals for the goat, requiring all minerals that goats require except iodine. However, plant requirements for minerals, such as cobalt and selenium, may be much lower than the level required for animals. Some soils are inherently deficient in some minerals such as iodine and selenium due to soil geology. Plants grown on soils deficient in a mineral are likely to be deficient in that mineral. However,



Drawing by K. Williams.

some plants have an ability to concentrate the minerals available in the soil. Maps of mineral deficient areas of the U.S. are available. However, consulting local extension agents is a better method of determining soil mineral deficiencies or toxicities that could affect mineral levels in local forages. Soil maps showing deficient areas of selenium, copper, molybdenum, and cobalt are located at the end of this article.

Various factors other than soil mineral level can interact to influence the mineral content of forages. Soil pH is one factor that affects mineral uptake by plants. Under acidic soil conditions, many trace minerals are less available for plant uptake. Environmental temperature at certain times of the year may also affect mineral uptake. Interactions among minerals after soil fertilization can also affect their availability for incorporation into plant material. Season of the year affects plant mineral concentrations, mainly due to a



Influence of pH on availability of plant nutrients.
Redrawn from S.S.S.A.P., 1946. 11:305 by K. Williams.

dilution effect, with decreasing mineral levels as plants mature. Different plant species will also have varying contents. Browse and forb plant species may have higher mineral concentrations than do some grasses. As goats eat a variety of plants, they are less likely to have mineral deficiencies than other species of animals that eat predominantly one plant species.

To determine plant mineral content a producer can collect and send samples for analysis. Parts of plants that are being consumed throughout the day and growing season should be sampled. Analysis of a sample will cost a minimum of $25.00. To obtain enough data to formulate a custom mineral supplement would require sampling several times over a growing season and over more than 1 year if possible. This could be worthwhile for a large goat herd but too expensive for most producers. The alternative is to use a commercially prepared mineral block or loose supplement. Some mineral mixes are formulated for regions and are more appropriate to use than a mineral formulated for the whole United States. Many state extension specialists know what minerals are likely to be deficient in given areas of a state and know what levels of calcium and phosphorus are appropriate for beef cattle production. Those recommendations are a good place to start for goat mineral nutrition.

Mineral supplements should not be overfed. Mineral supplements are formulated for goats to consume a sufficient quantity. Many minerals interact with one another (interactions shown on opposite page) and excess consumption of one mineral may decrease absorption and(or) utilization of another. For example, it is well known that excess iron depresses absorption of zinc, copper, manganese, and selenium. There are several regions of the United States that have high enough levels of iron to depress absorption of these other minerals, requiring them to be supplemented. Feeding a regional mineral with no supplemental iron would be preferable to feeding an all-purpose mineral containing high levels of iron that would further depress absorption of these minerals.

The range between safe supplementation and toxic levels is narrow for many of the trace minerals. Do not overfeed trace minerals or mix additional minerals in a diet if another source of trace minerals, such as a trace mineral block, is present. Formulation of mineral supplements requires considerable expertise since the addition of high levels of one mineral may depress the utilization of another, causing a deficiency. Also, some trace minerals can be toxic in excess.

Calculation of supplemental levels for feed formulas requires a certain amount of technical expertise and specialized scales for weighing, along with sophisticated mixing equipment. Most common farm mixing methods are inadequate, resulting in “pockets” of dangerously high mineral levels in a batch of feed.

Choosing a mineral supplement

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

The mineral supplement should also contain trace minerals that are deficient in the area. Levels of trace minerals used in local cattle supplements can provide a guide for goats. Most mineral supplements are formulated to provide less than half the trace mineral requirements due to toxicity concerns. A mineral supplement should be provided in the loose form to maximize consumption. The salt level in the mineral drives intake; therefore, no other sources of salt should be available. A mineral feeder should be used to protect from rain and keep the supplement clean. Replenish minerals frequently to keep them fresh.

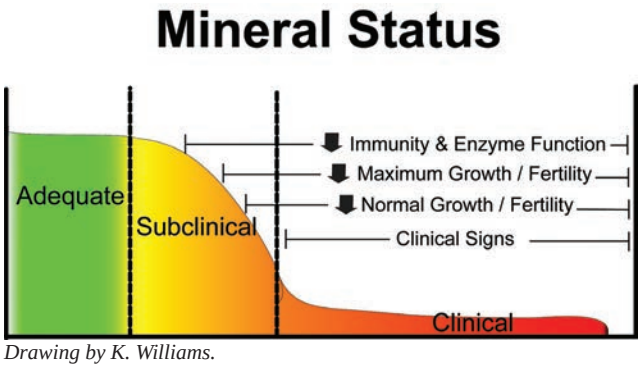
Current approximate wholesale costs for supplying 100% of mineral needs of a 150 lb goat for various minerals in 1 year are as follows:

Calcium	$1.15
Phosphorus	$4.50
Salt	$0.40
Magnesium	$1.11
Potassium	$1.50
Trace minerals	$0.45
Other minerals	$0.65
Total	$9.70

Feedstuffs will normally provide at least half of all minerals and in some cases all required. It should be noted that phosphorus alone accounts for half the mineral cost.

Diagnosing mineral deficiencies or toxicities

The proper procedure for diagnosing a mineral deficiency or toxicity depends on which mineral is being considered. Secure the assistance of a local veterinarian and extension animal nutritionist in the state who are familiar with minerals in the region.



Drawing by K. Williams.

1. Deficiency or toxicity symptoms usually provide initial indications of mineral status (e.g., manganese and "knuckling over"). However, deficient animals do not always show classic symptoms and the major symptom may only be a 'poor doing' animal.
2. Blood tests are adequate for some minerals such as magnesium, calcium, and phosphorus, and for other blood factors that give an indication of mineral status. Examples of these factors include: glutathione peroxidase for selenium, hemoglobin for iron, zinc binding protein for zinc, and thyroid hormones for iodine.
3. Hair analysis has been used for zinc and selenium but in general is a poor diagnostic test.
4. The liver is a good tissue to test for iron and copper adequacy. Liver samples can be obtained via biopsy or from animals that are slaughtered or die.

Take home lessons on mineral nutrition

1. The diet should contain adequate levels of calcium and phosphorus and have close to a 2:1 calcium to phosphorus ratio.
2. Provide a free-choice loose mineral supplement with appropriate levels of calcium and phosphorus that contains trace minerals deficient in the region.
3. Monitor intake of the mineral to make sure the animals are eating an appropriate amount.
4. Avoid excessive feeding of any supplementation.

Body Condition Scoring

The adequacy of a nutritional program can be assessed by observing changes in body weight and condition of the animal. If animals lose weight, body condition will be reduced (animal is thinner), alerting an observant manager to a problem. Body condition is particularly responsive to energy and protein adequacy.

Body condition scoring is a system of assigning a numerical score based on physical characteristics indicative of fatness. These include the amount of muscle and fat covering the spine in the loin area and ribs and fat pad at the sternum. Body condition scores range from 1 (very thin) to 5 (obese) in one-half score increments. Langston University has information on the American Institute for Goat Research website describing Body Condition Scoring of Goats (see following section on BCS or http://www2.luresext.edu/goats/research/bcshowto.html) and Examples of Body Condition Scores in Goats (see following section on BCS or http://www2.luresext.edu/goats/research/bcs.html).

Animals should achieve a certain body condition during specific periods of the production cycle. For example, animals should have a body condition of at least 2.5 but no more than 4.0 at the beginning of the breeding season. Prior to entering the winter a minimum score of 3.0 is desirable. Also, if body condition score is 4.5 or greater, pregnancy toxemia prior to kidding is likely, as also is the case with a score of less than 2.0.

Using the Langston Interactive Nutrient Calculator

Practical goat nutrition involves providing sufficient nutrients for a desired level of productivity (milk, meat, or kids) at a reasonable cost. Nutrients are supplied via a combination of pastures, hay, supplements, and other feedstuffs; adequate amounts are required for animals to produce at an economically viable level. For commercial meat goat production, the economics of nutrition are of paramount importance due to their great impact on cost of production and subsequent profit. For show, purebred, and companion goats, the economics of nutrition may be of lesser importance.

Applied nutrition involves determining nutrient requirements and then working with available feedstuffs, including pasture, hay, or supplemental feeds, to provide the required nutrients in proper amounts. Nutrient requirements are affected by an animal age, weight, and production type and stage. For example, pregnancy, number of fetuses, etc. will affect the amount of nutrients needed by a doe.

Calculating nutrient requirements by hand can be difficult, but the Langston Interactive Nutrient Calculator (LINC) makes the task easy, only requiring answering several questions. In addition, it is linked to a nutrient balancer program that allows selection and use of pastures and feeds to meet the requirements. The calculator will determine not only protein and energy requirements, but also calcium and phosphorus needs.

Getting started

To teach you to use LINC, we will go through an example. Here is the assignment, calculate the nutrient requirements for a nonpregnant 3 year old mature ½ Boer cross doe that had twins 6 weeks ago. The doe has a 32 inch heartgirth and is under intensive grazing management. Her body condition score is 2.5.

First, go to the Langston web site http://www2.luresext.edu/goats/research/nutritionmodule1.htm.

Question 1 asks the biotype of goat. A drop down menu will give the choices of Boer, Boer cross, Spanish or indigenous (native) goat, dairy goat, or Angora goat. For Kiko goats, use the selection for Spanish and indigenous. Select “Boer cross.”

Question 2 asks the class of goat, and selections include suckling, growing goat less than a year and a half of age, mature goat including late gestation, and lactating goat including meat and dairy goats. If a lactating goat is selected, another drop down menu asks information needed to predict milk production. This information includes litter size (number of kids), week of lactation (weeks since she kidded), and age of doe at kidding in years. Milk production, along with fat and protein percentages, are then predicted. These figures can be edited, which is useful for dairy goat producers who are more likely to know the amount of milk produced and its fat and protein contents.

For the example, select "lactating goat". Then in the subsequent menu, select the number of kids (twins) and input week of lactation (6) and age at kidding (2 - 3 years). The program predicts that the doe will produce 3.6 lbs of milk containing 3.6% fat and 3.3% protein.

Question 3 asks the gender of the goat, and the drop down menu has choices of doe, buck, and wether. Select "doe."

Question 4 asks the body weight of the goat. If the weight is known or a good estimate is available, it should be entered in the box. If the weight is unknown, the heartgirth (chest circumference) can be measured to predict body weight. Check the box to estimate weight via heartgirth and enter heartgirth in inches. A menu will appear with choices of genotype (breed) of goat (Alpine, Angora, Boer, ½ or less Boer, ¾ or ⅞ Boer, LaMancha, Nubian, Oberhasli, Saanen, Toggenberg, and Spanish). Some breeds require input of body condition score. Body weight is then estimated. Input "32" inches for a "½ or less Boer" and the estimated weight of the doe is 105 lbs. This can be used for estimating bodyweight for medicine dosage or weights for management purposes.

Question 5 asks the desired amount of weight gain or loss expected in a 1 month period, with selections ranging from losing 5 pounds (-5) to gain of 30 pounds. This gain is in addition to any pregnancy weight gain. Select 0 lbs per month.

Question 6 adjusts nutrient requirements for the energy expended during grazing if goats have access to pasture. The drop down menu includes choices of stable feeding, intensive management, semi-arid grazing (goats on extensive ranges), and arid (desert) grazing. For the sample calculation select "intensive management, temperate or tropical range." This selection will be used in all the examples that follow.

Question 7 asks the percentage TDN of the diet being fed and uses a default value of 60. If the TDN level in the feed is known, this value can be adjusted. For dairy goats, the default value is 65%. Use the default of 60%. If you know the value of the feed you plan to use put it in here. This value is important in prediction of intake.

Question 8 asks the percent protein in the diet and the default is 10%. For dairy goats, the default is 14%. Use the default of 10%. If you know the value of the feed you plan to use, put it in here. This value is used to help predict intake.

Click on the "Calculate Requirements" button to calculate the energy and protein requirements, estimated dry matter intake, and calcium and phosphorus requirements. In this example, the requirements should be 2.5 lbs of TDN for energy, 0.34 lbs of crude protein, 6.65 grams of calcium, and 4.65 grams of phosphorus, with a predicted intake of 3.65 lbs of dry matter.

Providing needed nutrients

After calculating the nutrient requirements for goats, those nutrients must be provided using feedstuffs such as pasture, hay, concentrate, and minerals. For most goats throughout much of the year, nutrient requirements can be met by available pasture, a mineral supplement, and water. During times of limited forage availability or quality such as winter, or feeding poor quality hay or stockpiled forage, a supplement will be needed to supply deficient nutrients. The level of supplemental feeding should be adjusted with changes in animal requirements, such as increased needs of late pregnancy. Sometimes it may be preferable to put an animal in a lot and feed a complete diet or one high in concentrate such as with dairy goats.

There may be periods when nutrient requirements cannot be met, resulting in loss of body weight. This is acceptable at certain times in the production cycle if body condition is sufficient for the animal to draw upon body reserves and maintain the desired production level. An example would be weight loss during early lactation because sufficient nutrients cannot be consumed. However if the doe is in poor body condition, is a growing yearling, or has severe weight loss during this time, milk production will be depressed. During a

drought, it may be acceptable for open or early pregnant animals that are not lactating to lose weight. During late pregnancy, inadequate nutrition can have adverse effects on pregnancy outcome and subsequent lactation. We can estimate what the projected bodyweight losses would be by reducing the bodyweight gains in question five and then calculating nutrient requirements until the energy and protein requirements match intake of those nutrients. Severe undernutrition can cause abortion, reduced livability of the kid(s), reduced milk production and adversely affect maternal behavior.

Feeding Different Classes of Goats

The feeding suggestions that follow are oriented to commercial goat producers. Purebred, show, and companion animals are often fed more for larger frames and better body condition, but excessive body condition can be deleterious to the animal health.

Feeding bucks

Mature bucks can obtain most of their nutrients from pasture. However, yearling and 2 year old bucks have greater nutrient requirements since they are still growing. Bucks need to be in good body condition (BCS greater than 3) before the breeding season because feed intake may be relatively low during that time, with loss of body weight. Thus, body condition should be evaluated 3 months before the breeding season. Decisions can then be made on the supplemental nutrition needed for the buck to achieve the desired BCS.

Whenever bucks cannot meet nutritional needs from pasture, supplementation is necessary. Under most conditions, whole shelled corn or sweet feed at 0.25 to 0.5% of body weight will be adequate (0.5 to 1 lb of feed for a 200 lb buck). Feeding bucks high levels of grain (greater than 1.5% of body weight) for a long period of time makes them prone to urinary calculi. The levels of grain recommended above are safe for bucks. When pasture is scarce, bucks can be fed medium quality hay free-choice (all they can eat).

Using LINC, calculate the nutrient requirements for a 3 year old, 200 lb Boer cross buck, gaining no weight, and on pasture (intensive management). The calculated requirements are 2.39 lbs of TDN, 0.26 lbs of crude protein, 5.05 grams calcium, and 4.09 grams phosphorus, with predicted dry matter intake of 3.55 lbs. However, it is important to note that the estimated dry matter intake is influenced by the dietary TDN and CP concentration inputs. Therefore, if the default values are used and a forage, which makes up all or most of the total diet other than a mineral supplement, has different levels, then the predicted dry matter intake may not be close to the actual amount. In the example above, default values were assumed. To determine if these nutrient requirements can be met by native range with a mineral supplement, click on "Select Feed Ingredients" at the bottom of the page. A page listing different feeds will appear. In the "Forages" section below "Concentrates," click on "range, early summer," and under "Minerals" choose a 12-12 mineral supplement. Go to the bottom and click on "Input These Feed Ingredients into the Ration."

The ration window will appear that lists each ingredient chosen. Intake figures should be entered in the column labeled "Amount, lbs as fed." The estimated intake for this buck is 3.55 lbs dry matter (lbs of diet not including the water content of the feedstuffs), whereas in this window the consumption amount is entered as the "as fed" form. Because feedstuffs vary in water content (compare the water content of fresh, green pasture to the same forage dried and harvested as hay), nutrient requirements and intake estimations are calculated on a "dry matter basis." Dry matter basis means that all water has been removed. However, animals eat feed in an "as-fed" form. This calculator will determine the amount of dry matter intake for each ingredient from the as-fed figures entered. This relieves the producer from having to estimate dry matter, allowing the amount fed to the animal to be entered, with the program performing the needed dry matter calculations.

The mineral supplement bag label predicts intake of 0.5 to 1 lb/month/hundred lbs of body weight. At that rate, the 200 lb buck will consume 2 lbs/month or 0.067 lbs/day (2 lbs ÷ 30 days), roughly 1 ounce. Some supplements estimate an intake such as 1 to 1.5 oz/day, but this can vary with the size of the goat. Enter 0.07

lbs for the mineral. Therefore, in this example it can be assumed that forage dry matter intake is 3.55 lbs. The value of 3.55 is entered into the "Amount, as-fed" column for range forage. Clicking in the "Amount, lbs DM" column will calculate the amount of DM and nutrients provided (Running total) compared with the Requirements. The amount of as-fed native range grass provided should be increased until the forage dry matter provided equals the 3.55 lbs previously calculated. This is done by trial and error method until a correct answer is found. In this case, the correct amount is 3.95 lbs of as-fed native range, which will provide 3.55 lbs of dry matter. Therefore, the estimated daily ration for this buck is 3.95 lbs of native range grass hay, or an equivalent amount of pasture, on a dry matter basis plus 0.07 lbs of mineral per day.

Comparing the Running total with the Requirements shows that this diet did not meet the requirement for TDN (2.12 lbs provided vs a requirement of 2.39; 89%). Crude protein, calcium, and phosphorus are supplied in excess of requirements. Because the equations used in these predictions include a small safety margin (i.e., requirements are most likely slightly greater than actual), if the deficiency is not marked the diet could be used as is with careful monitoring of performance measures, most notably BCS. In addition, one should consider that the diet actually consumed could be higher in quality than the 'book' composition values used. In this regard, when taking plant samples, plants are often cut at the ground level, such as for hay. Conversely, goats select certain plant parts (especially leaves) that have higher nutrient contents. Therefore, the composition analysis used in the calculations might not have matched what was actually eaten. For example, if a TDN concentration in consumed forage of 65% and a crude protein level of 12% are assumed, the predicted TDN intake is 95% of that necessary to satisfy the TDN requirement.

Accurate and abundant data on the nutrient content of plant parts consumed by goats are lacking. When hay is fed and animals are 'forced' to consume most of it, the hay analysis will closely match what is consumed. The same applies to supplemental feeds that are totally consumed. One way to more accurately determine the true composition of diets of grazing goats is to follow the animals for a couple of hours and hand pluck the portions of plants consumed and send the sample in for analysis. However, plant composition and plant parts selected vary over time, making it desirable to sample plants monthly or more frequently.

In the absence of feed nutrient analysis, it is important to try to match the description of feeds or pasture as closely as possible to that in the LINC feed tables. If actual analysis has been determined, it can be entered into LINC at the bottom of the feed library. Information required includes concentrations of TDN, crude protein, calcium, and phosphorus. Hopefully in the future, more applicable data will be available for herbage grazed by goats.

Feeding replacement bucks and does

Replacement bucks and does must gain sufficient weight from weaning to breeding to be of adequate size and sexually mature. A Spanish doe weaned at 12 weeks of age would be expected to weigh 40 lbs and gain 5 lbs per month to achieve a minimum breeding size of 60 lbs at 7 months of age. A Boer doe weaned at 12 weeks of age would be expected to weigh 50 lbs and would need to gain 7.5 lbs per month to be 80 lbs at breeding. These are minimum weights, and it is advantageous for animals to be slightly heavier. Some purebred breeders wait to breed their doelings at 19 months of age because a doe with a bigger frame size is desired. Most commercial goat producers cannot afford the cost of an extra year of maintaining an animal with no production.

Does will generally gain sufficient weight if an adequate amount of a moderate quality forage is available. If doelings are not gaining adequate weight (as measured by a scale or through the heartgirth conversion program), they could be supplemented with whole shelled corn at 0.5 to 1% of body weight per day (¼ to ½ lb of corn per head per day for 50 lb doeling). Feeding excessive grain to does causes an overly fat condition. Fat may be deposited in the udder, leading to reduced formation of milk secretory tissue. The doe is also more likely to have pregnancy toxemia and birthing problems. If sufficient good quality pasture is not

available, growing doelings will need good quality hay and a supplement such as whole shelled corn, sweet feed, or range cubes or pellets at 0.5 to 1.0% of body weight.

Bucklings must gain more weight than doelings to reach puberty. While there are no available recommendations for weight of meat goat bucklings at first breeding, these animals need to reach an adequate size to achieve puberty. Like doelings, body condition should be monitored and supplemented at 0.5 to 1% of body weight per day (¼ to ½ lb of corn per head per day for 50 lb buckling). Most bucks do not let a lack of body weight interfere with breeding, but some body reserves are necessary to maintain fertility and mating activity throughout the breeding season.

Feeding does throughout their life cycle

The four production periods of does are dry nonpregnant, pregnant, late gestation, and lactating. Does that are open (nonpregnant) or in the early stage of pregnancy (< 95 days) have fairly low nutrient requirements. For open does, the goal is to gain a little weight to be in good condition for breeding. A medium quality pasture, such as in late summer, or a medium quality hay is sufficient to prepare for breeding and the early stage of pregnancy. However, adequate quantities of feed are necessary.

Use the LINC to calculate the nutrient requirements for a 130 lb nonpregnant, mature Boer doe without change in body weight and with intensive pasture grazing. The requirements are 1.50 lbs of TDN, 0.18 lbs of crude protein, 4.03 grams of calcium, and 2.82 grams of phosphorus, with an estimated dry matter intake of 2.31 lbs (based on the composition of fall bermudagrass; 50% TDN and 9% CP). Feeds used are fall bermudagrass and a mineral supplement. A 130 lb doe is expected to consume the mineral at 0.1% of body weight per month = 1.3 lbs/30 days = 0.04 lbs of mineral per day. The estimated 2.27 (2.31-0.04 = 2.27) lbs dry matter intake of fall bermudagrass (3.25 lbs as-fed) provides 1.14 lbs of TDN (76% of requirement) and 0.20 lbs of crude protein (111% of requirement). In this example, it appears questionable as to whether or not body weight of the doe could be maintained with this forage (i.e., 50% TDN). The goat's ability to select higher quality plant parts, as noted above, might enable them to maintain their body weight. In this regard, if they are able to select a diet with a TDN concentration of 60% rather than 50% then the amount of TDN supplied is (2.27 × 0.60 = 1.36 lbs) which is 91% of the required amount, somewhat close to her requirements. Again, it is important to monitor body condition.

Calculate the nutrient requirements for a Boer doeling weighing 70 lbs, gaining 5 lbs per month, and with intensive pasture grazing, using LINC. The requirements are: 1.3 lbs TDN, 0.25 lbs crude protein, 2.98 grams of calcium, and 2.08 grams of phosphorus with a dry matter intake estimate of 2.06 lbs. If we adjust estimated TDN and estimated protein for the forage (questions 7 and 8 in LINC) since the 50% TDN of fall Bermudagrass is different than the 60% assumed, and use 9% CP instead of the 12% assumed, predicted dry matter intake is 2.32 lbs. Using the same feeds, fall bermudagrass and mineral, with a mineral consumption of 0.02 lbs (1% of body weight /month, divided by 30) and using fall bermudagrass for the remainder of her intake (3.3 lbs as fed), both TDN (1.16 lbs intake, 89% of requirement) and crude protein (0.21 lbs intake, 84% of requirement) are inadequate. To achieve the desired growth rate, supplementation may be necessary. By trying sweet feed as a third feedstuff it is determined, through trial and error, that 0.75 lbs of sweet feed along with 2.0 lbs of fall pasture will provide most of the energy requirement but only 0.19 lbs of crude protein (76% of requirement), which is inadequate. By deleting the sweet feed and changing to a 16% dairy ration to supply the needed crude protein, it is finally determined that 0.75 lbs of a 16% crude protein dairy ration, 2.0 lbs pasture, and 0.02 lbs of mineral will provide 1.3 lbs of TDN (100% of requirement) and 0.25 lbs of protein (100% of requirement). The weight gain to achieve adequate breeding size should continue to be monitored with possible feeding adjustments made. The lesson here is that this doeling, because of the need for growth, has higher requirements than a mature doe and needs extra nutrition.

Flushing meat goats

Some people advocate "flushing" of meat goats prior to breeding. Flushing refers to the practice of providing extra nutrition to does approximately 2 weeks prior to breeding and for a variable portion of the breeding period (e.g., 1-2 weeks) to increase the number of ovulations and have a greater proportion of twins and triplets. This is widely advocated with sheep producers and Angora goat producers. Producers have extrapolated the practice to meat goats. However, several controlled studies with Spanish goats in reasonable body condition (BCS 2.5 – 3.5) have shown no response in kidding or conception rate of meat goats to flushing with extra protein, energy, or both. The practice may have utility for meat goats in poor body condition, but there does not appear to be justification for flushing does in acceptable body condition.

Winter feeding of does

Early to mid-winter is a time when does should be in early pregnancy. The goal of a wintering program is to economically provide the necessary nutrients to maintain a reasonable body condition, lose no weight, and keep them warm. In general, most wintering programs consist of both forage and supplement components. The forage component can consist of hay, stockpiled forage, or a cheap byproduct roughage feed. The supplement usually contains energy, protein, and often vitamins and minerals, although these may be provided separately as a mineral mix. Commonly utilized supplements include whole shelled corn (inexpensive source of energy), range cubes (inexpensive source of energy and protein), sweet feed, protein blocks, molasses blocks or tubs, and liquid feed.

Stockpiled forage is forage that is grown during the summer or fall upon which animals are not allowed to graze, reserving it for the winter months. In drier areas, the forage is well preserved, but in a more humid climate quality declines rapidly, making the practice less satisfactory. Stockpiled forage is a very inexpensive forage source since it does not have to be mechanically harvested (baling forage doubles the cost of forage); animals harvest stockpiled forage by grazing. Animals make much more efficient use of stockpiled forage when strip grazed (using temporary electric fence to limit animal access to an area containing a 1 to 3 day supply of forage) to minimize trampling. Fescue is used in many temperate regions for stockpiling and retains its quality well into late winter even in humid areas. Most recommendations for stockpiling fescue include late summer fertilization, clipping, and deferred grazing. Warm season grasses such as native range and bermudagrass can be stockpiled. The amount of deterioration is dependent on grass species and rain. If local cattlemen are using stockpiled forage it will probably work for certain classes of meat goats. Consult your state forage extension specialist for further information.

Calculate the requirements for wintering a 95 lb mature Kiko doe (use Spanish biotype) in early pregnancy gaining no weight and with intensive pasture grazing, using LINC. The requirements are 1.19 lbs TDN, 0.14 lbs protein, 3.13 grams of calcium, and 2.19 grams of phosphorus, with 1.86 lbs of dry matter intake estimated (based on default dietary TDN and CP levels). Feedstuffs that can be used include stockpiled (winter) bermudagrass and a 16% molasses lick. The estimated intake from the molasses lick label is 4 ounces or 0.25 lbs. Assume the remainder of dry matter intake is from the stockpiled bermuda pasture.

The molasses lick is not in the feed library so must be entered manually as a new feedstuff. Click on "Add/ Delete Ingredient to Feed Library," to bring up a table to be filled out. First, the feedstuff class is selected. This molasses lick is in the "concentrate" class. Then the name "16% molasses lick" is entered, and remaining values are entered. These values can be obtained from the feedstuff tag or label or by calling the manufacturer. If a value is unknown, leave it blank. For this example, enter dry matter of 85%, 16% crude protein, 75% TDN, 2.8% calcium, and 0.45 % phosphorus. Click on "Add Feed Ingredient to Library" and the Select Feed Ingredient page appears. If needed, click on refresh feed library and 16% molasses lick appears under "Your Feed Ingredient Library." If you have a dry hay or feed, 85% dry matter is a good assumption.

To continue formulating the ration, select the 16% molasses lick and winter bermudagrass, then click on "Input these Feed Ingredients to the Ration." Enter 0.25 lbs for the 16% molasses lick under the "Amount, as-fed" column and guess at 1.5 lbs of winter bermudagrass. Through trial and error a total of 2.0 lbs bermudagrass is selected to fulfill intake requirement. The table shows that this diet provides 0.91 lbs of TDN (76% of requirement), 0.12 lbs CP (86% of requirement), 4.74 grams of calcium, and 1.52 grams of phosphorus (deficient). The diet is quite deficient in energy. To provide additional energy, add whole shelled corn. The diet is then reformulated to contain 0.6 lbs whole shelled corn, 1.4 lbs winter bermudagrass, and 0.25 lbs of lick molasses. This provides 1.15 lbs TDN (97% of the energy requirement) and meets the CP needs. Phosphorus is slightly deficient (13%), but if the bermudagrass is better than average the requirement can be satisfied. Mineral supplements vary in their phosphorus levels as phosphorus is an expensive ingredient. If a mineral supplement with a high phosphorus level is selected for feeding, the requirement would be met but likely at a high monetary cost.

Feeding does in late gestation

Energy requirements increase dramatically in late pregnancy (Figure 4). Using LINC, calculate the nutrient requirements for a 130 lb mature Boer doe, 140 days pregnant (10 days from kidding), gaining no weight, other than that due to pregnancy, and carrying twins. Under question 3, after clicking on the box for greater than 95 days pregnant, a form drops down for pregnancy number (twins), breed (predicts birth weight, can enter yours if known), and days of pregnancy (140). The requirements are 2.45 lbs TDN, 0.45 lbs crude protein, 3.97 lbs intake, 6.03 grams calcium, and 4.22 grams phosphorus.

A ration can be balanced using bermudagrass hay and 20% range cubes to meet the requirements by feeding 1.5 lbs of range cubes and 3.0 lbs of bermudagrass hay. This illustrates the high level of nutrition that is needed, especially in the last 3 weeks of pregnancy. High quality hay as well as supplementation is usually required. The range cubes contain a mineral supplement so no additional mineral mixture is needed.

Doelings require more supplementation than mature does, as the doelings are still growing. The nutrient requirements for a 95 lb growing Boer doeling with a predicted intake of 3.37 lbs, gaining 1 lb per month in addition to pregnancy weight gain and 140 days pregnant with a single kid are 1.77 lbs TDN, 0.36 lbs CP, 5.23 grams calcium, and 3.66 grams of phosphorus. If the same ingredients are used as those for the mature doe, how much of each will be required? The doeling could be fed 3.8 lbs of bermudagrass hay alone to meet the nutrient requirements for pregnancy with a single kid. However, if the doeling is carrying twins and is 140 days pregnant, her requirements are 2.27 lbs TDN and 0.47 lbs CP. This doeling will require 1.0 lbs of range cubes and consume 3.3 lbs of hay. If an abundance of high quality pasture is not available, the doeling will need some type of supplementation. If the forage (or hay) of adequate quality is available, only 1 to 1.5% of body weight of whole shelled corn may be needed as an energy supplement. This is important in that feed intake may be reduced in the last 4 to 6 weeks of gestation by the growing kids that reduce available abdominal space.

Feeding the lactating doe

The lactating doe has very high nutrient requirements. Calculate the requirements for a 4 year old 110 lb Boer cross doe nursing twins in week 4 of lactation. When lactating is selected under question #2 on LINC, a form drops down. Select litter size (twins), week of lactation (4), and age at kidding (4). The program then predicts production of 4.5 lbs of milk per day with 3.6% fat and 3.3% crude protein. Nutrient requirements are 2.65 lbs of TDN, 0.41 lbs of protein, 7.61 g of calcium, and 5.33 grams of phosphorus, with 4.14 lbs of dry matter intake predicted (based on default dietary TDN and CP concentrations). During lactation, the doe can consume nearly enough nutrients if an abundant supply of high quality pasture is available, such as in spring or early summer. If "Range, early summer" is selected and fed at 4.7 lbs, the diet meets protein and calcium requirements, and 90% of energy requirement. However, phosphorus is deficient (3.76 vs. 5.33)

and needs to be supplemented. However, does will likely lose some bodyweight due to the high demands of peak lactation (weeks 3 to 8 of lactation) and an inability to consume an adequate quantity of feed. Kidding should take place when there is an adequate supply of high quality pasture. If there is not adequate pasture, supplemental feed will be required. Inadequate nutrition will decrease body condition, reduce milk production, reduce kid weaning weight, and increase kid mortality.

If feeding bermudagrass hay and a 16% dairy ration, 2.6 lbs of hay and 2.0 lbs of the ration are required to fulfill requirements. However, the doe will still lose 2.0 lbs of bodyweight per month. When feeding high levels of grain such as the amount in this example, the animal should go through an adjustment period of two to three weeks during which time the grain portion of the diet is gradually increased to prevent digestion and other problems from occurring. Feeding a dairy ration and hay to a doe during late gestation and the lactating period will cost approximately $30 per animal. Utilizing available pasture as a feed source is a much cheaper alternative.

Kids are usually weaned at about 12 weeks of age. Milk production of the doe begins to decrease after the 6th week of lactation and is quite low by the 12th week. Nutrient requirements decline as stage of lactation advances, enabling the doe to maintain or even increase body condition on pasture alone. Kids may be creep fed while nursing to increase growth rate of the kids and reduce nutrient demands on the doe for milk production.

Creep feeding

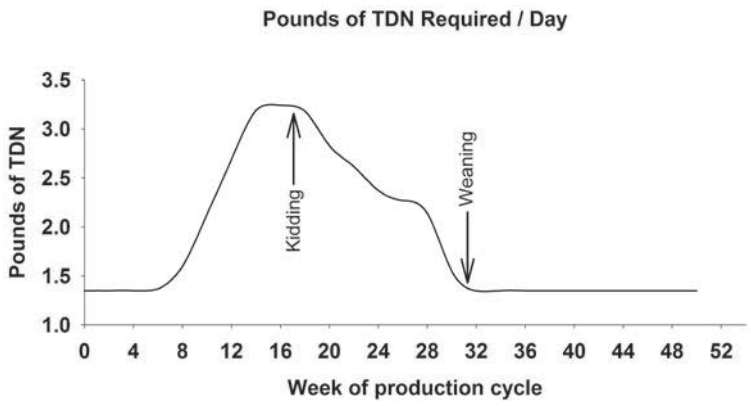
Creep feeding is a method of providing feed for the kids only. This is accomplished by fencing around a feeder and using a creep gate that has holes about 5 inch wide by 1 ft high. These holes are small enough so that kids can enter the feeder, but adults are excluded because they are too big to go through the hole. Creep feeding will provide extra growth for the kids and train them to eat feed, facilitating weaning. A commercial creep feed with at least 16% crude protein that is medicated with a coccidiostat should be used. It requires about 6 lbs of feed to produce 1 lb of animal gain. The more rapid growth from creep feeding may be beneficial for producing show prospects.

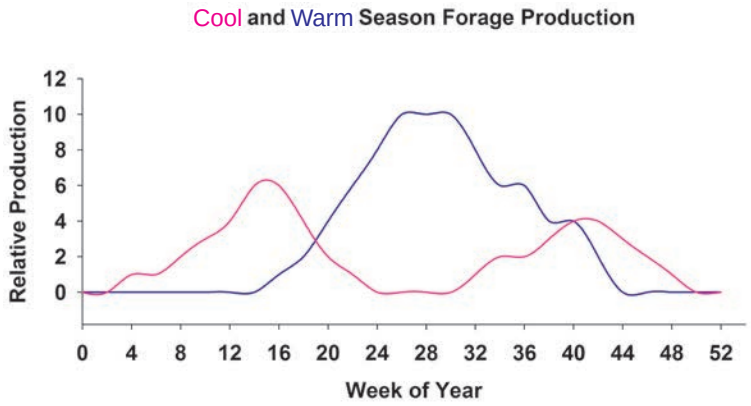
An alternative to grain-based creep feeds that is used in the beef cattle industry is to creep graze calves, using a creep gate that allows calves access to ungrazed high quality pasture. This may have application for goats using high quality pastures (crabgrass or sudangrass that is planted for the kids). In rotational grazing of cattle, the calves are often allowed to creep graze the next pasture before cows so that they have relatively high nutrient intake. Those pastures often have less parasites and disease organisms because of the time since last grazing.

Effect of Kidding Season on Nutrient Requirements

Nutrient requirements of does change dramatically with stage of production. Requirements increase dramatically the last 6 weeks of gestation due to increasing fetal growth and remain high in early lactation (kidding occurred on week 18 in chart). During the month prior to kidding and for the following 3 months (assuming weaning at 12 weeks of age), the doe will consume nearly as much nutrients as in the remaining 8 months of the production cycle. Thus, during that time it makes sense to supply nutrients from an inexpensive source, typically pasture. The cost of providing the same nutrients as hay is more than twice that of pasture, and supplying through purchased feeds may be four to five times greater than for pasture.

Kidding should be planned for a time when pasture is rapidly growing. This period corresponds to late spring for pastures comprised of warm season forages such as bermudagrass or native range, browse, and forbs, but could be either fall or early spring for cool season grasses such as ryegrass, wheat, orchardgrass, and fescue. Cool season grasses usually produce less forage per acre than warm season forages, but generally are higher in energy and protein. The accompanying figure shows the relative production of cool and warm





season forages for central Oklahoma. Consult a local pasture extension specialist or livestock extension specialist for local forage growth patterns. Rapidly growing pasture is high in protein and energy. A major consideration in determining the date to kid is level of forage production at that time. However, there are other considerations in selecting kidding date, such as parasites and market opportunities. Some markets provide a substantial price premium from kidding at a specific time of the year, such as producing prospect show wethers or registered animals. However, it may take a considerable market premium to cover the cost of purchased feed, so general reliance on pastures and forages is best.

Artificial Raising of Kids

Sometimes it is necessary to bottle feed young kids due to death of the mother or the mother refusing to take them. Milk feeding of commercial meat goats is usually not economical. It may be avoided by cross-fostering kids onto another doe as described under the goat management section. If a bottle raised kid is with other kids and does, they may learn to 'steal' sufficient milk to raise themselves. Kids can be raised on cow milk replacer, goat milk replacer (expensive) or, if none is available, cow milk from the store may be used.

It is very important that kids receive colostrum within 12 hours of birth. After 12 hours, antibodies absorption decreases. Colostrum may be milked from another doe that recently kidded. Colostrum contains antibodies that strengthen the immune system for the first months of life. A kid should be fed one ounce of colostrum per lb of weight (average birthweight 7 lbs, therefore, 7 ounces of colostrum) at each of three feedings in the first 24 hours. If the kid is too weak to nurse, it is appropriate to provide the colostrum via stomach tube. This does take some practice, but obtaining colostrum is critically important to kid survival.

Initially kids can be fed using a baby bottle or a nipple such as the Pritchard teat which fits on a plastic soda bottle. Kids can be bottle fed twice a day, although three times a day the first 4 to 6 weeks of life may increase growth rate. Kids are very susceptible to bloating and other gastrointestinal problems from milk replacers that contain a high level of lactose due to use of dried whey in their formulation. Reduced lactose milk replacers will reduce bloating problems.

A calf starter feed (with a coccidiostat such as Rumensin or Deccox, sometimes called medicated) and high quality hay should be made available the second week of life. Deccox can be used in the milk from week 2-6 to prevent coccidiosis. After 4 weeks of life, kids can be limit fed milk at one pint in the morning and also in the afternoon. This will stimulate consumption of starter feed and facilitate weaning.

Kids can be weaned after 8 weeks of age if they are consuming 2 ounces of starter per day and weigh two and a half times their birth weight (about 18 lbs). Weaning shock can be reduced by going to once a day milk feeding for several days to encourage consumption of the starter.

Considerations in Ration Formulation

Rations should be balanced not only for protein and energy, but calcium and phosphorus contents should be calculated, macrominerals supplemented, and a trace mineralized salt used to provide microminerals. A vitamin premix should be used to provide at least vitamin A and E.

If the diet is being fed at high levels to bucks or wethers, there is risk of urinary calculi. To prevent urinary calculi, the ration should be formulated with a minimum of phosphorus, over twice as much calcium as phosphorus, and a urine acidifier such as ammonium chloride at 0.5-1.0 % of the diet. Salt can also be included in the diet, such as at 1%, to reduce incidence of urinary calculi.

If the ration is being fed at high levels, sufficient fiber should be included in the diet to prevent acidosis. Dried brewers yeast and probiotics are often used in rations fed to animals at high levels to help prevent them from going off feed.

Feeds may have a coccidiostat included in the formulation to prevent coccidiosis. There are a number of coccidiostats, but Food and Drug Administration approved drugs commonly used include Deccox and Rumensin. Since goats are very susceptible to coccidiosis when stressed, such as at weaning or shipping, many starters and show feeds contain coccidiostats and have the term 'medicated' on the feed tag. Management considerations to reduce coccidiosis incidence include sanitation, cleanliness, and dry housing.

Feeding Systems

There are many methods of feeding goats. Feeds should be offered in such a way to minimize mold growth or fecal contamination that reduces intake. Mineral mixes must remain dry and should be replenished at 2 week intervals to avoid caking. Feed troughs should be designed to facilitate removal of feces and leftover feed. Troughs generally require a bar running above the length of the trough to keep goats from defecating in them.

Self feeders can be used for feeds containing sufficient roughage for use as a complete feed or for feed that has a built-in intake limiter. For large range operations, feeds such as whole shelled corn or range pellets or cubes are often fed on the ground. The feeding area is moved each day to have clean ground upon which to feed.

Round hay bales should be fed in a rack off the ground. Feeding round hay bales on the ground results in hay wastage and leaves a mess that is difficult to clean. Hay can be fed in a manger or hay feeder with keyhole slots, but horns may cause problems preventing access to feed. For large operations, unrolling round bales on the ground works well.

Nutritional Disorders

There are several diseases associated with nutritional management. These include acidosis, founder, enterotoxemia, pregnancy toxemia/ketosis, polioencephalomalacia, and urinary calculi.

Acidosis, founder, and enterotoxemia are all related to either feeding high levels of grain or a rapid increase in the level of grain in the diet. Acidosis is associated with the production of high levels of lactic acid in the rumen from a large supply of starch that the animal consumed. Endotoxins may also be produced by ruminal bacteria that exacerbate the problem.

Founder refers to problems that occur with the feet of the animal as a consequence of acidosis. The blood vessels in the hoof constrict and in the long-term cause the hoof to grow rapidly, necessitating weekly hoof trimming.

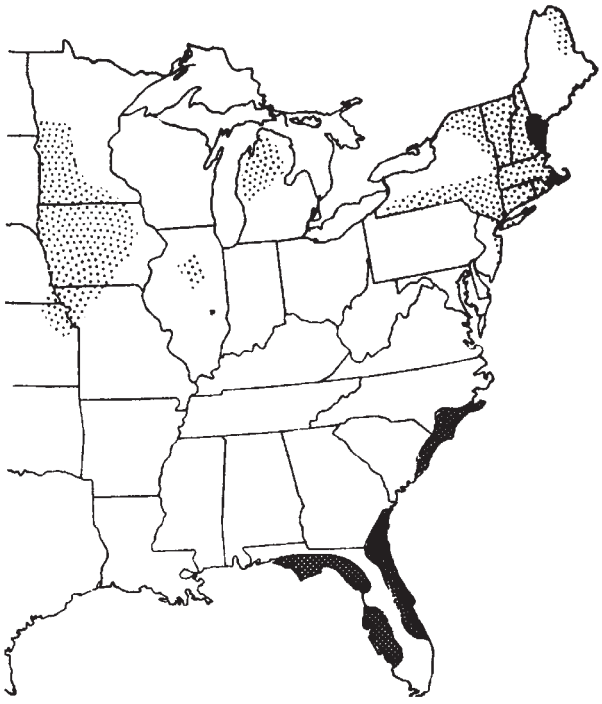
Enterotoxemia is caused by bacteria in the intestine that grow rapidly and produce an endotoxin in response to high levels of starch (grain) in the diet. Animals are in extreme pain from the effect of the endotoxin and often die quickly. Vaccination will help prevent this disease.

High levels of grain in the diet and stress are associated with polioencephalomalacia, which is a thiamine deficiency. High dietary levels of sulfur (such as from molasses in the diet) can increase incidence of the condition. The animals appear drunk, may not be able to stand, become blind, and slowly die. There is often a dramatic response to a large dose of thiamine (5 mg/lb), which may need to be repeated. These diseases can be best prevented by increasing the grain level in the diet slowly and maintaining 50% forage in the diet. Thiamine can be added to high concentrate diets at 0.25 lb/ton to aid in the prevention of polioencephalomalacia.

Pregnancy toxemia is a metabolic disease usually caused by animals being too fat (body condition score greater than 4) prior to kidding; although very thin animals (body condition score less than 2) are subject to the disease also. It is caused by a high demand for nutrients by the growing fetus in late pregnancy that is not being met (excess fat in the body and the growing fetus limit room in the stomach for food, reducing intake of the diet). This unmet nutrient demand causes a rapid breakdown of fat reserves, forming ketone bodies at high levels which are toxic. Treatments include administration of propylene glycol, large doses of B vitamins, glucose given intravenously and possibly Caesarian-section (to remove the fetuses and immediately reduce energy demand; see the Goat Health section). Prevention of the disease is far easier and more effective than treatment. Simply monitor animal body condition and adjust nutrition, especially energy, to manipulate body condition. Do NOT sharply reduce feed in late gestation as this may cause pregnancy toxemia. Also, pregnant goats in the last third of pregnancy will need a more nutrient dense diet (higher quality) due to fetal growth and reduced intake because of reduced stomach capacity. Exercise will help. Does can be encouraged to exercise by separating hay, feed and water at a substantial distance, forcing them to walk more.

Soil-Related Nutritional Problem Areas for Grazing Animals

Figure 1. Geographical distribution of Co-deficient areas in the eastern United States (ppm = 1 $\mu g/ g^{-1}$). From Kubota and Allaway, 1972, by permission Soil Science Society of America.



All soil maps were taken from Kubota, Welch, and Van Campen. 1987. Adv. Soil Sci. 6:189-215.

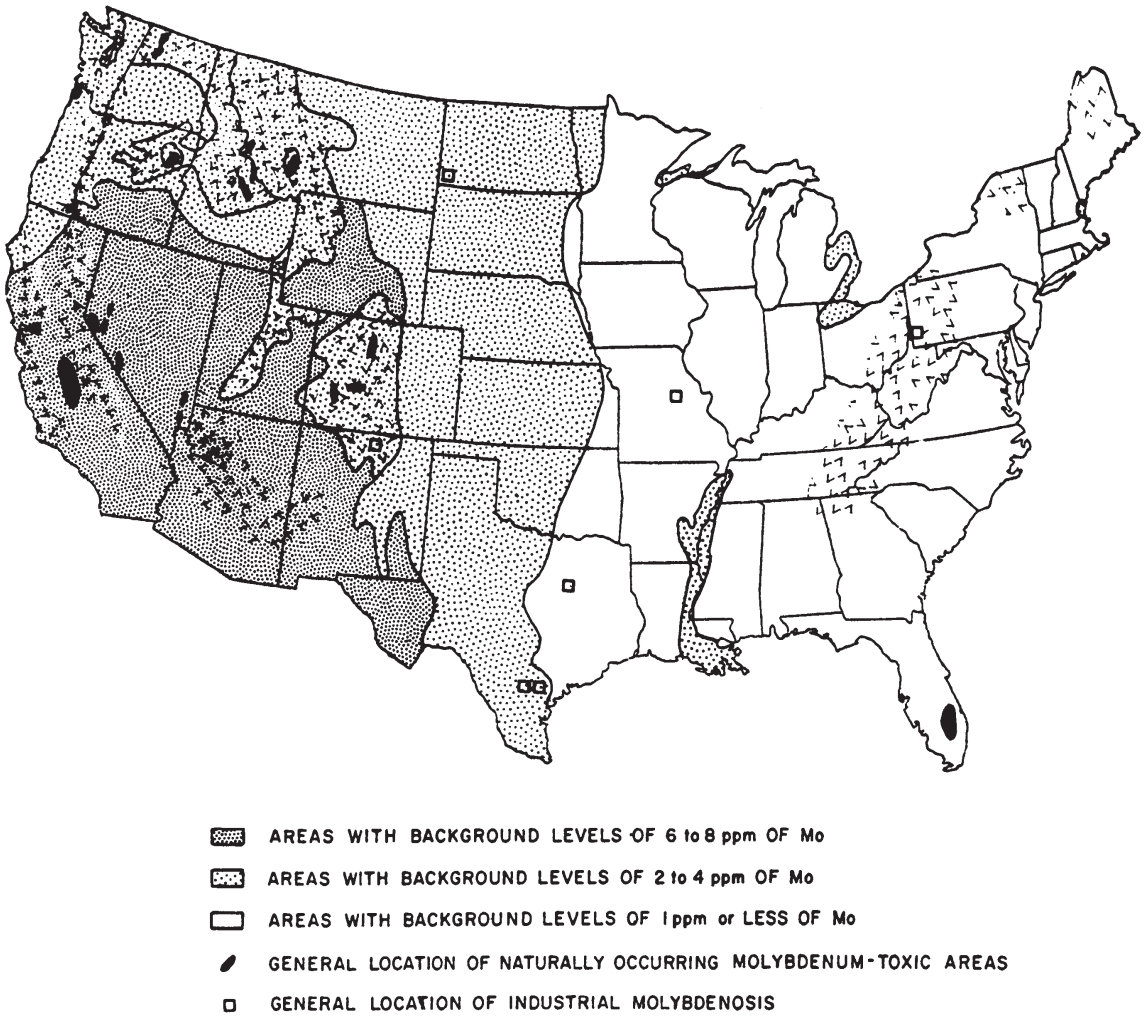


Figure 6. Generalized regional pattern of molybdenum concentration in legumes of the United States (ppm = 1 μg/ g^{-1}). From Kubota, 1977, by courtesy Marcel Dekker, Inc.

All soil maps were taken from Kubota, Welch, and Van Campen. 1987. Adv. Soil Sci. 6:189-215.

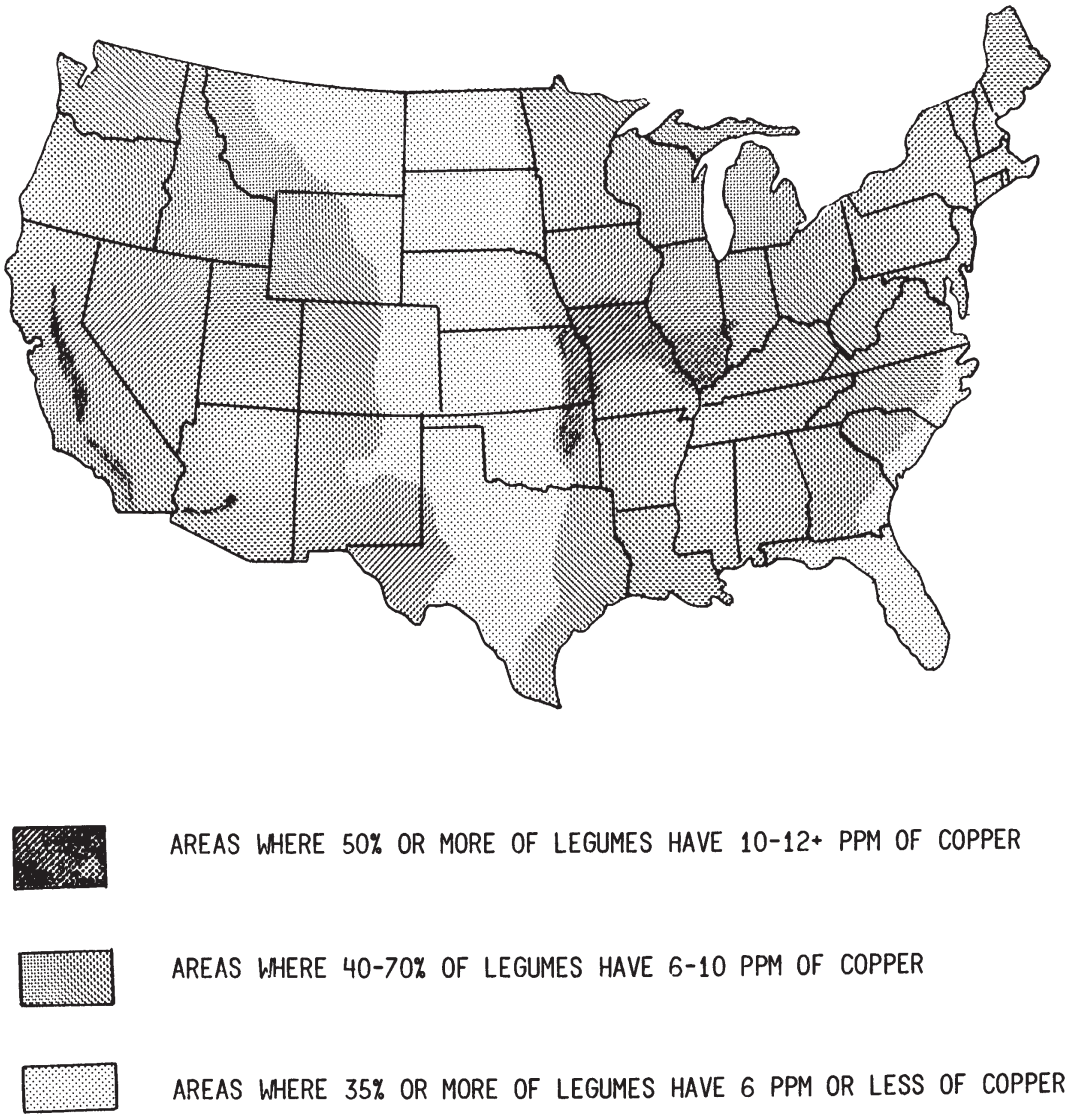


Figure 7. Generalized distribution of copper concentration in legumes of the United States (ppm = 1 μg/ g^{-1}). From Kubota, 1983a, by permission Amer. Society of Agronomy.

All soil maps were taken from Kubota, Welch, and Van Campen. 1987. Adv. Soil Sci. 6:189-215.

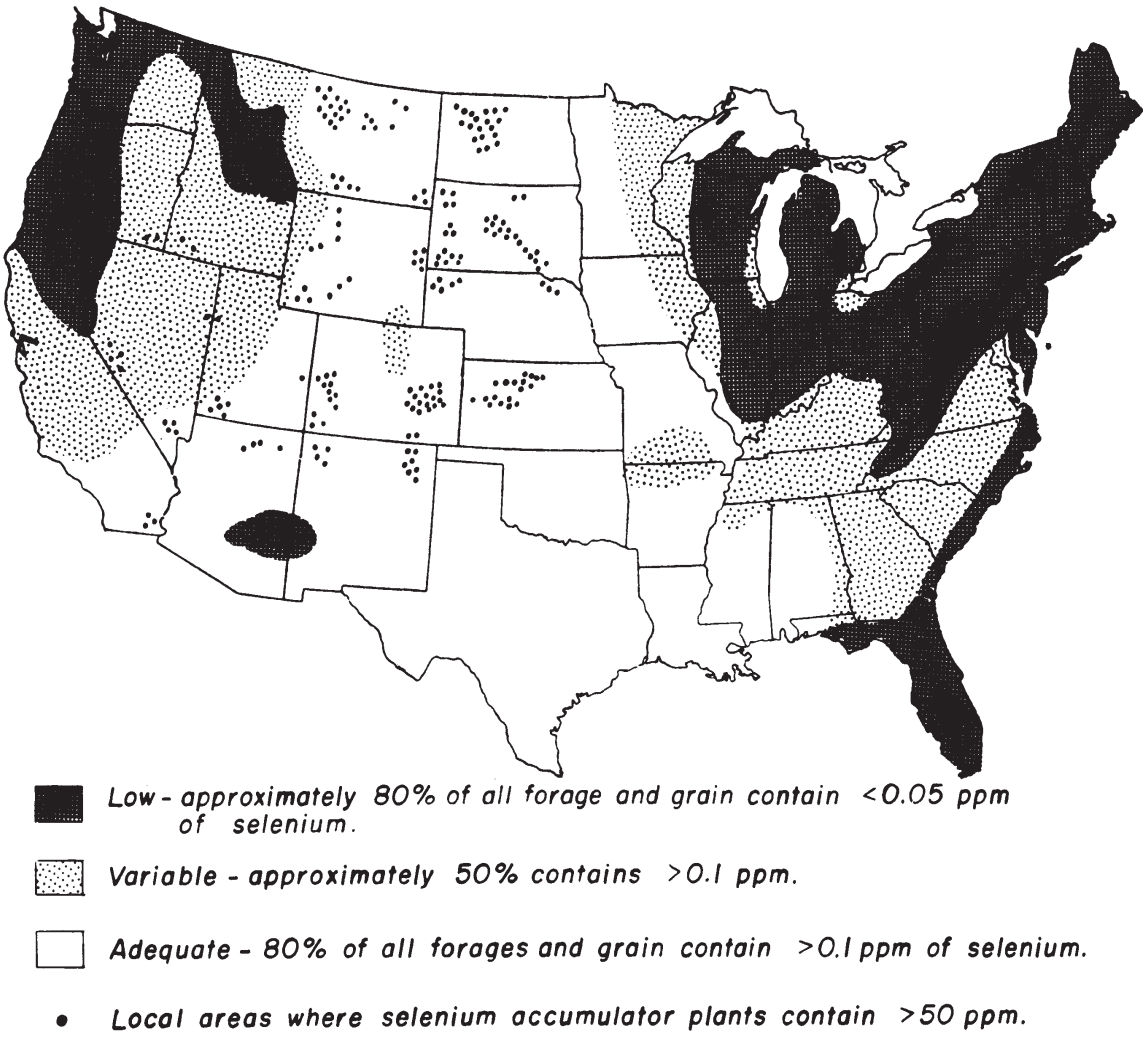


Figure 8. Geographical distribution of low-, variable-, and adequate-Se areas in the United States (ppm = 1 μg/g). From Kubota and Allaway, 1972, by permission Soil Science Society of America.

All soil maps were taken from Kubota, Welch, and Van Campen. 1987. Adv. Soil Sci. 6:189-215.

Definitions useful for this section

Acidosis - A disease usually caused by feeding too much grain or increasing the level of grain in the diet too rapidly. It results in the rumen having very acid conditions, and endotoxins may be produced that adversely affect various parts of the body.

Body condition score - Abbreviated BCS. Applying a numerical score to describe the amount of muscle and fat cover on an animal. Usually performed by feeling along the backbone in the loin area, over the ribs, and at the breastbone (sternum). Scores range from 1 (extremely thin) to 5 (extremely obese).

Browse - Vegetative parts of woody plants, primarily leaves and twigs, that typically contain high levels of tannins.

Carbohydrates - The major energy source found in most feedstuffs. Carbohydrates contain twice as many hydrogen atoms as carbon and as many oxygen atoms as carbon, commonly designated as CH_2O. They include substances such as sugar, starch, fiber, cellulose, and hemicellulose.

Cellulose - A major structural carbohydrate in plants. A component of fiber that is poorly digested by nonruminant animals. Cellulose is composed of glucose molecules chemically linked by a "beta" linkage that is only digested by bacteria such as those in the rumen and(or) cecum.

Coccidiosis - An infectious intestinal disease caused by protozoan organisms (coccidia). The disease causes diarrhea and damages the lining of the intestine. Moisture, stress, and unsanitary conditions are conducive to coccidiosis.

Concentrates - A feed with less than 20% crude fiber and usually more than 60% TDN on an as fed basis. Often a mixture of feedstuffs with added minerals and vitamins.

Crude fiber - The more fibrous, less digestible portion of a plant primarily consisting of cellulose, hemicellulose, and lignin. A method of estimating the fiber content of a feedstuff through sequential extraction with acid and alkaline solutions.

Enterotoxemia - A disease caused by an overgrowth of bacteria (*Clostridia perfringens*) in the intestine usually due to fermentation of a large quantity of starch, with production of endotoxin. Usually causes rapid death of animals.

Fiber - A component of the feed that consists of cellulose, hemicellulose, and lignin. It is necessary for normal rumen health.

Forage - The edible part of the plant, other than separated grain, that can provide feed for grazing animals.

Founder - Refers to a consequence of acidosis, resulting in rapid growth of the hoof.

Mineral - The inorganic group of nutrients including elements such as calcium, phosphorus, copper, etc.

Nutrient - One of six classes of chemical compounds having specific functions in the nutritive support of animal life.

Nutrient requirements - The level of specific nutrients required to keep an animal healthy and productive.

Nutrition - The study of nutrients, determining what nutrients are required, what levels of nutrients are necessary for various levels of productivity, and how to provide those nutrients.

Polioencephalomalacia, PEM, or 'polio' - A neurological disease of goats caused by thiamine deficiency. The rumen normally produces adequate levels of thiamine, but under some conditions such as a high grain diet, high sulfur in the diet, stress, or being 'off feed,' the thiamine is degraded, thus causing the disease.

Stockpiled forage - Forage that is allowed to accumulate for grazing at a later time.

Supplement - A feed designed to provide nutrients deficient in the animal's main diet.

TDN - Total Digestible Nutrients, a measure of digested energy. A lb of TDN equals 2,000 Calories (kilocalories).

Vitamins - Specific organic substances required for various metabolic functions.

Increase your goat conception rate by improving your AI technique

Dr. Erick Loetz
Langston University

Introduction

Artificial insemination (AI) represents the first widespread use of assisted reproductive technologies adopted in goat production; now approximately a 3 decade old technique.[1, 2] Among many benefits, when you can use thawed-frozen semen from bucks determined to be superior for specific economically important traits, AI has been proven to be invaluable for spreading and incorporating that specific selected genetic potential into goat herds.

AI can be performed in two basic ways that aim to place the male gametes (sperm) inside the uterus. Transcervical insemination (TrAI) and laparoscopically-aided insemination intra uterine (LAI) techniques have been used in combination with hormonal estrus/ovulation synchronization and more recently with fixed-time AI. This document focuses on transcervical AI since it is the technique used more frequently by goat producers.

Cost/benefit analysis

In most cases whether or not artificial insemination (AI) will be used depends on an economic issue (which should include time investment). The basic question has been and remains, under the existing conditions in our specific farm, does it pay to use AI? How much does the use of AI impact net return? Representative commercial goat data is very scarce to answer this question unequivocally.

For reasons of time efficiency, AI is usually combined with a program of estrus/ovulation synchronization. When this approach is used our ability to predict AI costs becomes even more difficult because the animal response to breeding becomes more variable and now, return on investment, also has to consider the cost of hormonal estrus synchronization which may be one of a long list of costs associated with protocols that are presently being used.

Even though the similarities between meat or dairy goat operations with that of cattle production are very few, we know that AI has been proven to increase net returns to beef cattle and dairy producers.[3] Cost-benefit evaluation of artificial insemination for genetic improvement of wool-producing sheep has also shown to yield a net economic gain.[4]

Although overall breeding costs (natural service or AI) is the easiest part of calculating the cost/benefit analysis (see Loetz, 2006[5] or Hutchens[6]) which allows comparison between these two systems of breeding, the potential benefits associated with each are not easy to determine because they depend on specific scenarios of production.

Efforts to characterize a cost/benefit analysis for artificially inseminating meat or dairy goats in Kentucky[6] have shown that AI is not a viable alternative for all farms in terms of only costs associated with each system.

There is need to include in the math formula the benefits obtained such as has been done for cattle,[3] for example for a goat meat operation: Kidding rate, percent kid cropped weaned, weaning age, weaning weight, weaned litter weight per female exposed. And, similar variables for a dairy operation, but also those associated with milk production: such as: age at first kidding, average daily milk production, total seasonal milk production, days in milk, butterfat and protein content of milk and traits associated with reproduction such as: age at first breeding, fertility, fecundity, prolificacy, and kidding rate.

Breeding program evaluation

There are several traits that can be taken into consideration when evaluating reproductive performance[7]. Nevertheless, inseminating technique is best evaluated as early as possible in connection to an event which can be monitored to evaluate our success or failure. The first two landmark reproductive events that are a consequence of insemination are fertilization and conception. Both traits are, in practical terms, and with the technology available, undetectable.

Fertilization. The union of sperm and oocyte in the female's reproductive tract lead eventually to the event we call "fertilization"; the creation of a one cell organism (i.e., the product of fertilization, the zygote) that has now two complete sets of genetic material coming in equal amount from the dam and sire. As the zygote divides it becomes and embryo which approximately by day 40 of pregnancy we will start calling a fetus until birth.

Conception. Unfortunately conception is one of the most difficult events to determine because it occurs during a time when the embryo and developing placental membranes (i.e., the conceptus) does not cause detectable changes in the mother's hormonal chemistry until there is the so called "maternal recognition of pregnancy". That is when the, until now "free-roaming", embryo attaches to the mother's uterus and causes the female to start important physiological changes in preparation for the approximately 5 months of gestation.

After maternal recognition of pregnancy it is possible to detect a chemical pregnancy or to evidence other physiological changes in the mother which are first observed when the female does not return to her next scheduled estrus or by actually seeing the embryo (30 to 45 d after conception) by means ultrasound imaging technology.

The important message is that a pregnancy is considered to be established only after implantation is complete. This implies that our effort to evaluate "AI technical ability" at a later time, by using for example pregnancy rate, means that we are in fact measuring the effect of many more influential factors than those

directly responsible of our good or bad AI technique. Therefore, the rule of thumb is that, the later we diagnose that a goat is "not pregnant" (open), the greater that the reproductive status result reflects, not only the AI technique used, but many more influential factors.

Biological traits behave in a curious way

Biological quantitative traits do not have a fixed value. Hence, reproductive characteristics vary when measured among different individuals. The variation in expression can be due to combinations of genetic and environmental factors, as well as chance. This is why when we measure and re-measure, even when using the same system, tools, etc. and even using the same animal and protocol of measurement, they never (rarely) produce the same result. Therefore, when evaluating a trait we must consider this innate variability before we conclude that two (or more) results are different.

Biologic traits, such as reproductive characteristics, express their values in a continuum. When all possible values are gathered and organized from numerically low to high, they commonly are bunched up (distributed) in such a way that when a graph is made using all these values, it forms a shape that reminds us of the shape of a bell. Hence the name of a "bell distribution" or "bell curve" has been coined.

In practical terms a bell distributed group of data means that we have few low and high values at the extremes of the bell curve and most (the average) at the center of the bell distribution. This means that when we make only one or few observations we do not know where in the graph our observation is located. Is it a reflection of a low, high value or is it a typical (average) value?

The reason why biologic variables behave the way they behave is because they respond to all kinds of influential factors. In general influential factors are grouped into two large categories: Genetic and environmental. All the influences that are not heritable, that is, passed from generation to generation are said to be environmental. Productive traits are highly influenced by many activities and procedures we perform while raising animals in a farm.

What influences the conception rate attained?

The list of influential factors which determine whether or not a female will become pregnant, as a result of AI, is long and wide. Although in this workshop we are placing all our attention only on AI technique, there is need to recognize two important concepts:

1. No matter how good our AI technique is, if the other influential factors are poorly managed the breeding program will be a reflection of all of them together. AI technique alone cannot make a positive difference.
2. If your AI technique is poor that is enough of an influence to bring down your breeding program regardless of all the efforts you may have placed to manage well all other influential factors. AI technique alone can make a negative difference.

What influences AI technique results?

When inseminating a goat five factors have major individual effects on the implementation of AI technique. The interaction between these factors can also be considered a separate influence:

1. The animal to be inseminated.
2. The AI technique used to breed the goat.
3. The proficiency of the person helping to restrain the goat (usually a necessity).
4. The AI equipment chosen.
5. The facilities used when AI'ing.
6. The interaction among all five single factors above.

Each of the above influential factors have themselves several components and they depend on individual choices and others are set by the type of goat operation a producer runs.

1. Not all females are good AI candidates.
   a. BCS
   b. Age
   c. Health
   d. Anatomy
   e. Personality
   f. Use past history:
      - On multiparous does use breeding records which show which mothers became pregnant to AI.
      - Select nuliparous doelings from easy breeding mothers.
2. Artificial insemination technique

   Knowledge.

   Experience.

   a. Make use of AI training programs. These programs can be as short as a 1-day course to a full college semester.
   b. Need to develop manual skills either by training with excised reproductive tracts and with live females.
   c. Organized area of work.
   d. Inseminating supplies should be kept dry and clean at all times. Leave breeding sheaths in the original package until used.
   e. Good sanitary practices.
   f. Learn how to create a low stress environment.
   g. Getting the animal
   h. Bringing the animal.
   i. Familiarity with facilities, people and equipment.
   j. Securing the goat.
   k. Lifting.
   l. So that your hands "see" where they are going you must get a good knowledge of goat reproductive anatomy.
   m. Avoid cold shock temperatures.
   n. Use non-spermicidal lubricants.
   o. Wipe the vulva region clean with a dry paper towel from top to bottom. Do not go over the same place with the same paper towel.
   p. Inserting speculum at the appropriate angle.
   q. Inserting the lighting device and appropriate manipulation.
   r. Finding the os cervix.

      Types of cervices.

   s. Appropriate semen handling, thawing and AI gun loading.
   t. The inseminating rod should be placed between the folds of the paper towel and inserted into the vaginal vestibule avoiding contact with the lips of the vulva.
   u. Speed.
   v. Getting through the cervix.

w. Goat categories (e.g., age, parity, breeds) as they all have peculiar challenging idiosyncrasies. Tractable and non-tractable goats.
x. Finding the target: body of uterus.
y. Relationship between sizes of different reproductive parts.
z. AI technique fine-tuning accomplished by improving on an already good technique… again and again.

3. Proficiency of helping hands.
   a. Should be familiar with the procedures used and be part of the necessary pre-established choreography not a hindrance to the flow of events.
   b. Bringing the selected goat at the appropriate time.
   c. Ensure goat is indeed in standing estrus.
   d. Check goat identification.
   e. Correct manner to have the animal climb on the milk stand.
   f. Correct head restraint.
   g. If using a milk stand with adjustable height makes sure the appropriate height is chosen.
   h. Usually chooses and prepares the speculum.
      i. Correct size.
      ii. Correct lubrication (amounts and placement).
   i. Restrain of the animal should be deliberate, gentle and accomplished in one smooth effort.
      i. Needs to know where to place his supporting leg.
      ii. Correct manual restraint to prevent injuries to the goat and to the AI technician.
      iii. Correct alignment of the animal.
      iv. Correct stretching of body.
      v. Attentive and responsive to verbal commands and/or other cues (body language) of the lead inseminator.
      vi. Correct way of bringing down the animal to full four legged stance.
      vii. Correct way to let the animal down from the stand.

4. AI equipment chosen.
   a. A complete AI kit is necessary. See (Loetz, 2006)[5].
      1. Organized.
      2. Clean
      3. Some items must be kept sterile.
   b. ii. Must be familiar with the use of each tool used.
   c. iii. Must have replacement parts. Murphy's law.
   d. iv. Lighting always an issue. Ensure extra batteries.

5. Facilities used when AI'ing.
   a. One that the goat is familiar with.
   b. Clean.
   c. Good lighting.
   d. Isolated and calm.
   e. Safe.
   f. No drafts.
   g. Cool temperature. Avoid extremes if possible.

6. Interaction among AI influential factors (1→5).

The interaction between all influential factors is difficult to predict beforehand. Experience helps but experience also shows that, if there is one thing you can count on, that is the unpredictability of events. Be ready to deal with various challenges. All your frustrations and behavior thereof, will affect your technique if you are unable to bring them under control. Animals will respond to your mood. When at all possible have a plan B.

AI Technique goals:

By accomplishing the following goals you will, not only become a successful AI technician able to generate high conception rates, but increase considerably the chances of having a positive cost/benefit ratio in your AI program as well as becoming a profitable goat producer.

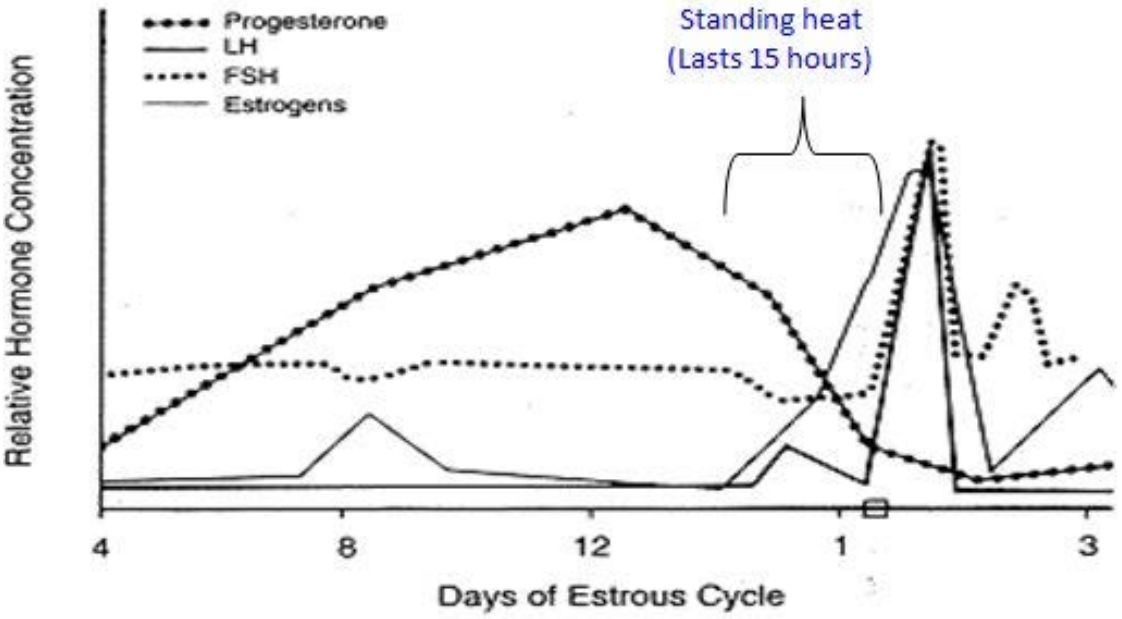
- ► Animal welfare
- ► Hone your AI technique by fine-tuning each pro-cedure.
- ► Consistency. Will allow you to troubleshoot prob-lems.
- ► Accuracy. Will allow you to be close to the target.
- ► Precision. Ensures consistency in your attempts.
- ► Speed. Short AI'ing time means less stress on the animal.
- ► Volume. Increase the number of goats you are able to AI.
- ► Generate honest, retrievable, and readable record keeping.

Summary

Whether or not artificial insemination (AI) is a procedure that will provide you with a positive return to your investment is directly related to the size and type of your goat operation. The cost/benefit analysis is highly influenced by the conception rate you can attain in your particular facilities. The number of goats that get fertilized, conceived and go on to become pregnant per insemination is the outcome resulting from a multitude of factors that interact in an intricate fashion. The more relevant effects on reproductive performance are a result of: female and male fertility, reproductive health, changes in body condition (which are dependent on the appropriate nutrition) age, breed, parity, environmental factors, worm load, reproductive management, tech-niques used in AI, which include accuracy of heat detection, timing of insemination, semen han-dling and placement in the reproductive tract. This document focuses on only one factor (the transcervical technique used at time of insemination) and its effect on one reproductive trait (conception rate) as measured indirectly by pregnancy rate.

How to detect heat in goats

"Heat occurs during estrous. Estrous is defined as the period of time when the female is receptive to the male and will stand for mating. Accurate heat detection is the key to a successful artificial insemination program. If you can't catch the doe in heat, it doesn't matter how good the semen is, how careful your thawing procedure, or how skillful your insemination technique. In the figure below, heat occurs approxi-mately 17-21 days after estrous when there is a spike in FSH,LH and estrogens and a reduction in p4".



Source: http://www.infonet-biovision.org/default/ct/791/livestockspecies

Hormonal changes in the peripheral plasma during the goat estrous cycle.

Fertility process 6-28 hours after the onset of heat *

When to breed for best success? 6-28 hours after the onset of heat *												
Heat Period	Before heat	Standing heat **						After standing heat				After heat
Hours after onset of heat		0	3	6	9	12	15	18	21	24	27	
When to breed for best success	Too early to breed			Good time	Excellent Time To Breed					Good time		Too late to breed

* Heat: the female reproductive cycle

** standing heat: that point in a doe's heat cycle when she is receptive to the buck

Source: http://www.infonet-biovision.org/default/ct/791/livestockspecies

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Small Stock Mortality Composting

Dr. Roger Merkel[1], Dr. Terry Gipson[1], Ms. Janelle Malone[2] and Dr. Kefyalew Girma Desta[2]
[1]Langston University
[2]Oklahoma State University

Why Compost Sheep and Goat Mortality?

All livestock producers encounter mortality. Goat and sheep operations may experience annual mortality losses of up to 10% of young before weaning and 5% of adult breeding animals. For a producer with 30 breeding females, two-thirds of whom have twins, this would mean a loss of about 5 young and 2 adults. Severe disease or internal parasite outbreaks may add to this loss. Finding appropriate carcass disposal methods can be challenging.

The State of Oklahoma Department of Agriculture, Food and Forestry lists five acceptable options for animal carcass disposal: 1) rendering, 2) burial, 3) incineration, 4) landfills, and 5) composting. Finding a rendering service for sheep and goats is difficult. Since July 1, 2006 there has been no rendering facility in Oklahoma that accepts goat carcasses or offal (Dan Parrish, Director, Agric. Env. Mgt. Serv. Div., Oklahoma Dept. of Agric., personal communication). Burial may be expensive if proper equipment must be rented. Further, there are rules on burial that must be followed. Carcasses may not be buried less than 1 foot above flood plains or within 2 feet of the water table or bedrock. Burial cannot take place within 300 feet of water sources, houses, public areas or property lines and carcasses must be covered with a minimum of 2.5 feet of soil. The cost to purchase and operate an incinerator is not economical for most producers. Not all landfills accept carcasses, and those that do charge disposal fees.

Composting is an inexpensive, environmentally friendly method of disposing of animal mortality that is commonly used in the poultry and swine industries. In the same way that microorganisms degrade vegetative waste and turn it into a rich soil amendment, animal carcasses can be turned into an organic matter-rich material that can be spread on pastures and other agricultural land. When properly done, animal composting generates no odor and temperatures generated during composting are high enough to kill most pathogens. However, animals suspected to have died from severe zoonotic diseases, i.e., diseases that can be passed to humans, such as anthrax, should not be composted. Sheep and goats that die from scrapie should never be composted as the agent responsible for this neurological disease is not killed at common compost pile temperatures. However, for most cases of mortality, composting is a safe, low-cost alternative to other carcass disposal options.

Mortality Composting Basics

To successfully compost animal mortality requires attention to the basics of a good compost pile: proper carbon to nitrogen ratio (C:N), moisture content, available oxygen, and pore size of material. Proper composting is done by aerobic microorganisms, meaning that they need oxygen to survive, in a temperature range of 130 – 150°F. These microorganisms require nutrients in the form of carbon and nitrogen in a C:N ratio of roughly 30:1 or 30 parts carbon for each part nitrogen. Animal carcasses are high in nitrogen and the surrounding compost material should be high in carbon to create the proper C:N ratio. There are many suitable carbon sources for mortality composting. One commonly used material is sawdust. Wood shavings and old hay or straw can be used when mixed with other material, such as manure or finished compost, in a 50:50 mixture. Mixtures of animal bedding and manure, such as that from horse stalls, are an acceptable carbon source. Used bedding after a livestock show at a local fairgrounds or horse arena can be a source of carbon material. Poultry litter has been used in mortality composting as a source of nutrients and microor-

ganisms but it is very high in phosphorus. Because of environmental concerns, the Oklahoma Department of Agriculture, Food and Forestry (ODA) requires mortality composting piles using poultry litter to be covered and runoff prevented.

Optimum moisture content for a compost pile is around 50%. If the material is too dry, the bacteria have insufficient moisture and composting will be very slow. If the material is too wet, water fills the pore spaces in the compost pile resulting in aerobic bacteria being replaced by anaerobic bacteria that do not require oxygen. Decomposition by anaerobic bacteria is very slow, generates odors, and does not produce sufficient heat. Squeeze a handful of the compost material. If water drips out, it is too wet. If none sticks to your hand, it is too dry. For a more accurate moisture level reading, use a portable moisture probe.

If the particle size of material making up the carbon source is too small, there is inadequate pore space to trap oxygen. If the material is too large, such as chopped hay or straw, there can be too much air transfer and heat, odors and moisture can escape the pile. Sawdust, mixtures of shavings and manure, or bedding and manure all have good sized particles providing adequate pore space.

Site Selection

After deciding to compost mortality, the next decision is where to construct the compost pile. Use ODA guidelines for animal burial to properly situate your mortality compost piles away from streams, wells, roads and property lines. Do not compost in areas with poor drainage or excessively sandy soil. A firm surface near the pile is needed for equipment and vehicle access and for storage of the carbon source. It is best to place compost piles away from public view. Mortality compost piles can be made with no surrounding structure; however, curious animals may dig into the pile so some type of surrounding wall or fence is beneficial.

Mortality Composting Bins

Depending upon the level of mortality expected, the amount of funds available and the permanence desired, different types of bins can be constructed.

Permanent bins

Permanent bins are constructed on a concrete pad of sufficient strength for the equipment to be used in building and turning compost piles, usually a tractor or skid steer with a bucket. The concrete pad helps prevent runoff and liquid seepage into the ground and provides a good working surface. A graveled area surrounding the pad helps when working in wet weather. The structure should be large enough to accommodate expected annual mortality and house a minimum of three bins, two working bins plus a third that can be used to store additional carbon source or where material is transferred as piles are turned. Permanent bins usually have a roof sheltering the pile from the weather allowing for better control of composting conditions.

Bins should be constructed from pressure treated wood with a minimum depth and height of five feet. Bin width should be a minimum of six feet wide or 1.5 times the width of tractor or skid steer buckets used in constructing and turning compost piles. When constructing the walls of the bins, spaces should be left between boards to allow for air exchange. The front of the bin should be removable or hinged and could be wooden or a type of gate made with mesh wire to enhance air exchange. Should a roof not be constructed, covering bins with a tarp helps protect the pile from rainfall that could make the compost too wet resulting in poor decomposition and odor generation.

Permanent bins are the most expensive to construct but provide the most control over the composting process and, once built, can be used for many years. An alternative to building a structure for permanent bins would be to utilize an unused storage or equipment shed.

Figure 1. A set of two wooden bins, with a third bin separately built to the side (not shown).

Low-cost alternatives

There are many low-cost alternatives to wooden bins. Two wire stock panels can serve as a bin by shaping them in a circle to enclose a mortality compost pile. Eight wooden pallets on edge can be held in place by t-posts or wired together to make an easy, low cost bin. Wire with small openings or unused chain link fence held in place by t-posts or wired to stock panels will help hold compost material in piles and prevent disturbance from wildlife and dogs. Bins should be made so they can be easily opened to build and turn compost piles, as well as for removing completed compost.

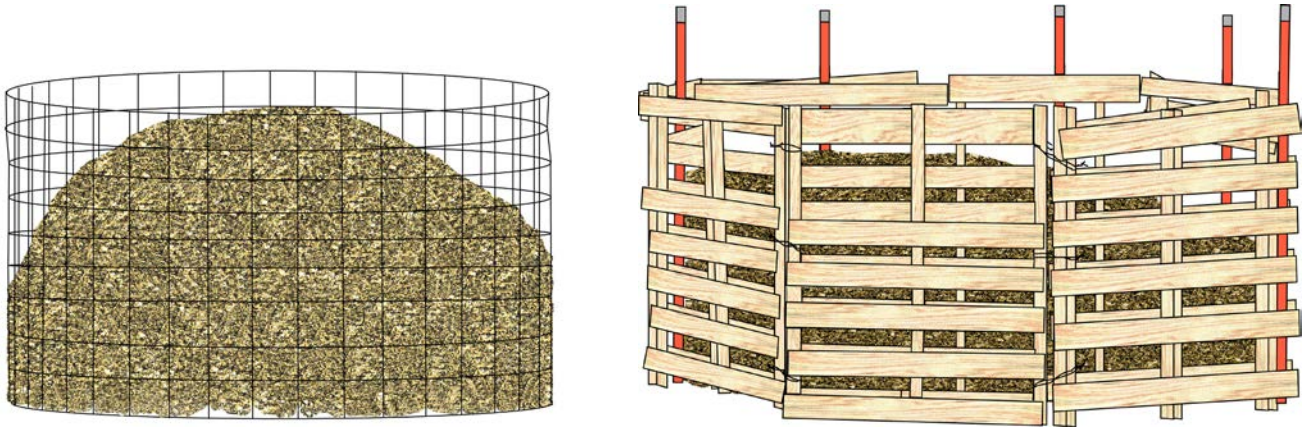

Figure 2. Bins can be made from wire panels or wooden pallets at minimal cost (All illustrations by K. Williams, Langston University).

Table 1. Estimated construction cost of different types of composting bins.

Bin type	Estimated cost[a], $
Permanent composting structure with 5" thick concrete pad, gravel work area, 3 – 6' x 6' bins with 5' side walls, pressure treated lumber, metal roofing	>5,000
Permanent simple structure with 3" thick concrete pad, 2 – 5' x 6' bins with 5' walls, pressure treated lumber, tarp covering	500 - 700
Non-permanent stock panel and wire	25 – 30
Non-permanent pallets and 8 t-posts (pallets assumed free)	25 – 30
Non-permanent woven wire and t-posts	25 – 30

[a]*All costs are estimates and can vary depending on several factors such as materials used, labor, etc.*

Windrow systems

Farms with large numbers of animals may wish to consider a windrow system for mortality composting. In this system, successive mortalities are added to the end of the pile made for the previous mortality. Usually, a portion of the covering carbon source material is removed and the carcass placed and covered. This continues until the row is considered complete.

Mortality Composting Process

Ensure you have plenty of carbon source material before beginning mortality composting. Approximately 100 ft^3 (3.5 yd^3) or 4 to 5 tractor buckets of the carbon source mixture are needed for each 100 lbs of mortality. If two or three carcasses are layered in a bin, the total will be somewhat less on a per animal basis as the base layer will be used for more than one carcass. However, too thin a base or covering layer of carbon source will lead to poor decomposition, excessive leachate or odors.

Building the pile:

1. Cover the base of the bin with 18 inches of carbon source material as an absorbent layer to trap liquid leached from the carcass during composting.
2. Place the carcass in the middle of the base a minimum of 12 inches from bin walls or sides.
3. Use a knife to lance the rumen and thorax. This provides access by microbes to the inside of the carcass and prevents the rumen from bursting due to gas build up from ruminal microbes.
4. If the bin is of sufficient size, add another carcass to the layer. Place adult carcasses back to back 8 to 10 inches apart and lamb or kid carcasses 6 inches apart with feet pointing to the pile's edge.
5. Cover the carcass layer with 6 to 12 inches of carbon source material.
6. Add enough water to create a suitable moisture content of roughly 50%. Two to three five-gallon buckets of water can be added per 100 lbs mortality. Adjust the amount depending on the dryness of the carbon source.
7. A second layer of carcasses can be added as described.
8. After all carcasses have been added, top off the pile with 18 inches of carbon source material creating a cone shape to shed rainwater if no roof or tarp covering will be used.

After a couple weeks, the pile will have shrunk and additional carbon source may be added to the covering layer. Check the pile occasionally to ensure animals have not disturbed it, that no portions of the carcass are visible, for noticeable odors, and pile temperature.

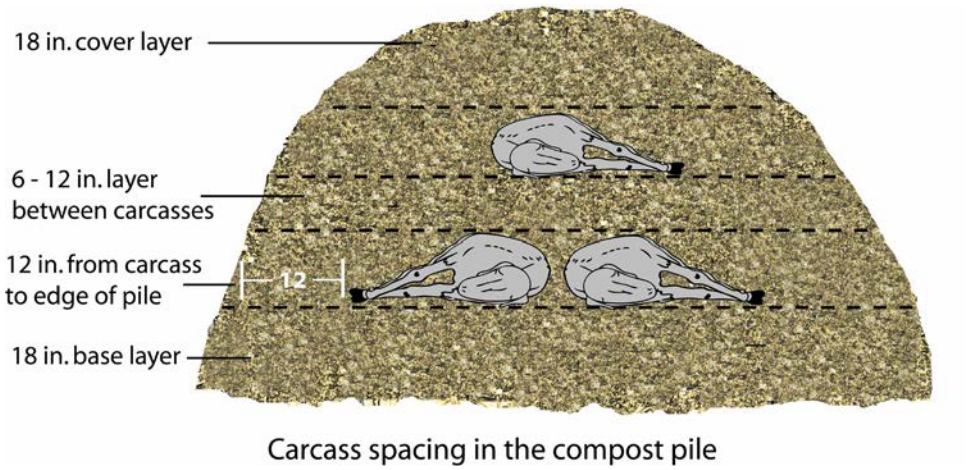

Figure 3. Use these minimum depth recommendations to ensure proper spacing and thickness of carbon source layers when layering carcasses.

Pile Temperature

After building the pile, bacteria will be working and generating heat. After three or four days, pile temperature should reach over 130°F and remain at that temperature for up to two weeks before beginning a gradual decline. A compost pile temperature above 131°F for a minimum of 3 days reduces pathogens below detectable levels and is needed to fulfill the requirements of a Class A biosolid allowing the completed compost to be used on public and private land. Requirements for Class B biosolids are less stringent and require a temperature in excess of 104°F for 5 consecutive days with a temperature of 131°F or greater for at least 4 hours during that period. Class B biosolids can be applied to agricultural land. For further information see http://www.epa.gov/owm/mtb/biosolids/503pe/index.htm. Temperature in excess of 145°F kills most weed seeds. A pile temperature that is too high, greater than 160°F, can affect bacterial survival. It is best to monitor temperature using a 36" or 48" compost thermometer thrust into the pile's core. Compost thermometers range in cost from $115 - $150. Two sources of long-stem compost thermometers are REOTEMP Instrument Corporation[1], Heavy Duty Windrow Thermometers, http://www.reotemp.com/ and Omega Engineering Corp., Compost Thermometers, http://omega.com/. If a thermometer won't be used, insert a long piece of metal rod, such as a piece of rebar, into the pile withdrawing it occasionally to feel if the pile is heating. At temperatures above 130°F, the tip of the rod can be held in one's hand for only one or two seconds.

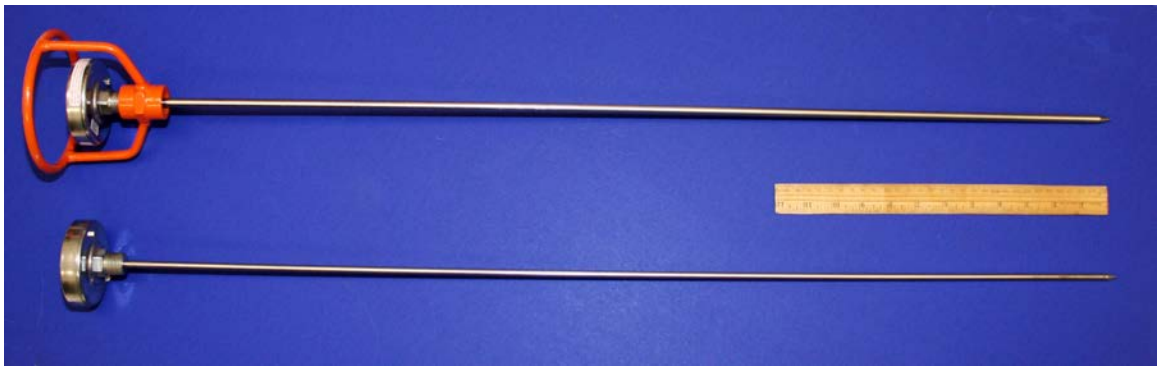

Figure 4. Compost thermometers are 3 to 4 feet long.

[1]Listing of trade names, proprietary products, or vendors does not imply endorsement by Langston University of the products or vendors named or criticism of similar products or vendors not mentioned.

Figure 5. Compost thermometers should measure core temperature. Temperatures over 131° F kill most pathogens.

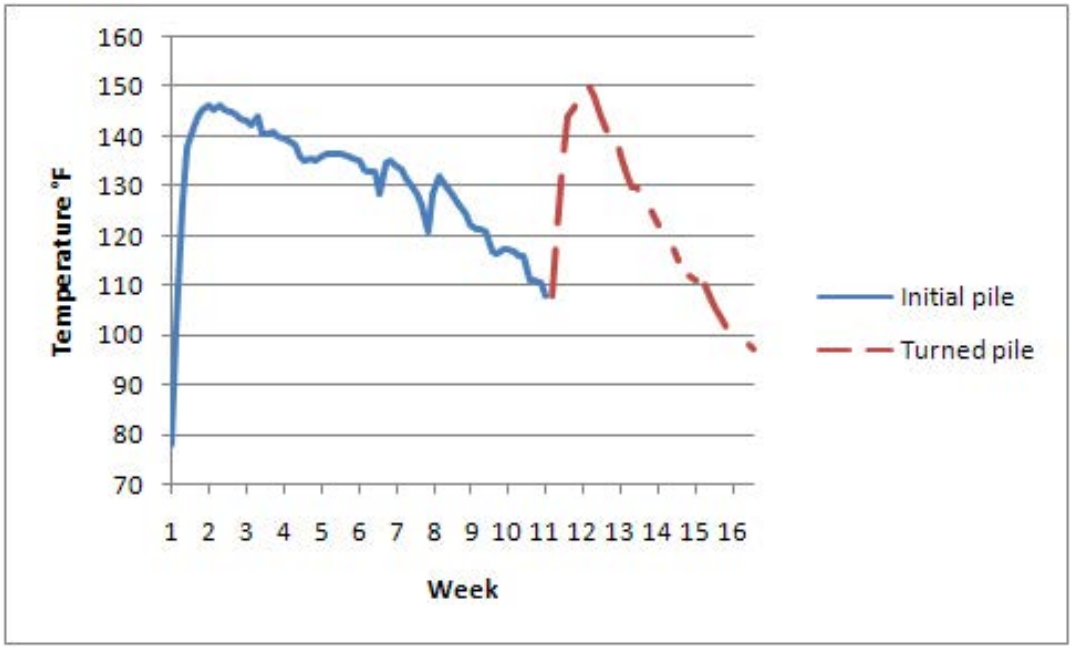

Figure 6. Temperature of a goat carcass compost pile made with a mixture of horse bedding and wood shavings.

Turning Compost Piles

When the temperature of the pile decreases to environmental temperature, or below 110°F, the pile should be turned to mix contents and aerate the pile. By this time, all flesh and soft tissues will have been decomposed and mainly bones are left. For carcasses of adult animals, this occurs two to three months after the pile is built. Lamb and kid carcasses may take only a few weeks. Use a tractor bucket to pick up material and either dump it back on the pile or move it to a new bin. Make sure enough covering layer is put on the turned pile. Moisture can be added if the pile is too dry or the pile can be allowed to dry if it is too wet, from trapped rainfall, for example. After turning, the pile should heat again and continue composting. After another two month period, the compost could be turned again and left to cure for several weeks before use.

Figure 7. Bones of goats after 10 weeks of composting.

Troubleshooting Mortality Compost

Low temperature

Low temperatures are usually the result of either too little or too much pile moisture or an improper C:N ratio. Remove some of the covering layer and check pile moisture using the handful squeeze method. If nothing sticks to your palm, add water. If water drips out, turn the pile and allow it to dry. Check the temperature a few days later to see if the pile has begun heating. A pile will also not heat sufficiently if the carbon source material does not pack tightly enough. For example, chopped cornstalks and long-stem hay or straw allows too much air movement to the extent that heat is lost and composting is poor. These materials should be mixed with manure or finished compost before using.

Pile odor

Odors can arise from compost that is too wet. Turn the compost and add additional carbon source. Wooden bins may trap rainwater if not covered and composting material on the sides and bottom can become too wet. Too low a C:N ratio and too thin a covering layer also contribute to odor. Make sure there is a good C:N ratio, the covering layer is at least 18 inches thick, and carcasses are a minimum of 12 inches from the pile's edge. The covering layer not only acts to shed rainwater, it also serves as a biofilter trapping gasses and odors generated by the composting process.

Failure to decompose

Failure to decompose is due to improper C:N ratio or carcasses that were laid too thickly or too close to the edge of the pile. Ensure that the pile is properly constructed and use fewer carcasses per layer.

Insect/fly larvae

Seeing insects or fly larvae is due to insufficient covering layer over carcass or liquids leaching from the pile creating odors. Build the pile with a thick absorbent base, ensure an adequate cover throughout the decomposition process and maintain a clean area surrounding the pile.

Compost Use

About one-half of the material from a mortality compost pile can be reused in a new pile and mixed with additional carbon source material. This reduces the amount of carbon source that needs to be on hand and also provides a source of bacteria for the new pile. The remaining composted material is a nutrient-rich medium that can be applied to pasture and other agricultural land. It is not recommended to use small stock compost on vegetables or areas where food is produced for direct human consumption.

Summary

Mortality composting is an easy, lawful, low-cost alternative for producers to dispose of livestock losses. Select sites away from water sources and the public. Producers may wish to construct permanent wooden bins on a concrete pad or use simple wire or pallet enclosures in which to compost. A carbon source such as sawdust, wood shavings mixed with manure, stable bedding or other carbon-rich material is needed to combine with the carcass to obtain a C:N ratio of 30:1. Temperatures in a properly made pile will be high enough to kill most pathogens. A portion of the resulting compost can be reused and the remainder spread on pasture land.

Acknowledgment

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Internal Parasite Control for Meat Goats

Dr. Dave Sparks
Oklahoma State University

Introduction

Two of the most common questions on the minds of many goat producers are; "when should I deworm my goats?", and "what should I use to do so?". Unfortunately, there are no simple answers to these questions because all production programs differ in many ways. Therefore, we will look at some of the factors that affect these answers so you can better make the decisions for your herd.

When it comes to internal parasites, goats have special problems. In cattle, roundworms are usually an economic problem in that they waste feed inputs and decrease growth and production. In goats, these same considerations are valid, but the very life and health of the animal may be threatened by *Haemonchus contortus*, or the "barber pole worm." It bleeds the goat and causes death by anemia. In addition there is a serious lack of parasiticide drugs that are labeled for legal use in goats. Only two such drugs exist at this time and research has shown that neither is very effective on Oklahoma goat farms. While there is a strong temptation to use drugs labeled for cattle or sheep according to the dose and route of administration for these species, goats are actually very different. Using cattle or sheep doses and routes will likely not be effective and can lead to resistance problems.

The reason for the lack of research and availability of legal drugs for use in goats is simple economics. A market of one million goats just can't support the research and development costs that a market of 100 million cattle can. For this reason, many of the drugs used today are used "off-label". This means that in order to be legal they must be prescribed by a licensed veterinarian who has first hand knowledge of the animals. Because all goat operations are different and any effective program will probably involve usage of off-label drugs, your local veterinarian is the best source for helping you set up a comprehensive treatment and management parasite control protocol for your farm.

Life Cycle of Roundworms

Although there are many different roundworms that live within livestock, they all have very similar life cycles. A common characteristic is that part of the life cycle takes place inside the host animal and part of it is lived in the environment. Although details will vary between parasites, the cycle can be broken down into three stages: a developmental period, a prepatent period, and a patent or adult period. Understanding what happens in each period will help to understand how management practices can reduce parasite burdens.

The developmental period is the time that the parasite lives in the environment. This period starts when the eggs passed in the host animal's manure hatch and the larvae crawl away into the grass. In the environment the larvae undergo several maturation changes, until the infective larvae (also called L3 or 3rd stage larvae) are able to climb up vegetation, on films of moisture, to await ingestion by a grazing animal. The rate at which this period progresses is determined by environmental conditions. Parasites prefer warm, wet conditions, so the cycle progresses faster and survivability is greatest in the early summer. This is the time of greatest pasture contamination. L3 can survive freezing conditions, but are very susceptible to drying. The eggs do not handle freezing well, but can survive drought conditions.

The prepatent period is extends from the time the L3 are ingested by a grazing animal until the mature worms start to lay eggs in the digestive tract. During this period the parasite develops through the L4 and L5 or young adult stages, and may migrate through various tissues of the body during these stages before taking up residence inside the digestive tract. The preferred area of residence in the gut will vary with the

species of worm. The prepatent period usually lasts from 2 to 3 weeks in young animals. Due to the higher level of immunity in adults, the prepatent period may last longer. This is important in timing parasite control program as this is how long it takes from ingestion until that animal starts contributing to pasture contamination. It is also possible for the L4 to enter an arrested development phase by burrowing into the wall of the gut if environmental conditions are not conducive to starting another generation. This allows the parasite to over-winter in the goat as well as in the environment.

The adult or patent period is the time when adult worms are present in the gut and shedding eggs into the environment via the stool. This is the time when the worms are most susceptible to control by parasiticide drugs. In the case of Haemonchus, this is also the time that the adult worm is attached to the gut wall and sucking blood from the host. Adult Haemonchus females can produce up to 5,000 eggs per female per day, and go through as many as 4 generations in one season. The adult barber pole worm population in the digestive tract of the goat can consume up to 1/10th of the goat's total blood per day.

Deworming Programs

Parasite control programs can be categorized as either therapeutic, tactical or strategic. Implementing the right program will have a tremendous impact on the level of rewards you reap from your goat operation.

Years ago all parasite programs were therapeutic programs. These involved treating the animals only when the condition progressed to the point where it caused clinical disease. At this point the program becomes an effort to salvage the affected animals. Therapeutic programs do nothing to address the subclinical losses such as decreased performance, nor do they address the problem of pasture contamination.

Tactical parasite control programs involve treating all animals in the population, often when it is convenient for the herdsman. Tactical programs help to minimize subclinical losses, but they probably do not minimize recontamination and may, in fact, contribute to parasite drug resistance problems.

Strategic parasite control programs involve a combination of management, responsible drug usage, and proper timing to ensure that animals are grazing "parasite safe" pastures for most or all of the year. Strategic programs usually take less drug inputs but require more in management, observation and herdsmanship. They address all the issues of clinical disease, subclinical losses, and contamination of the environment with subsequent reinfestation.

Parasite Control Drugs

Drugs available today for parasite control fall into four classes. It is important to know which active ingredients are in which classes because usually, when resistance occurs to one drug it confers to other drugs within that class. The main concern with parasite resistance to drugs that we have today is due to the fact that there are no new drugs on the horizon. It takes up to 10 years to get approval for a new drug and there are currently no parasite control drugs in development. Most of the drugs on the market today still work very well in cattle. Since this is the major market for food-animal drugs, there is no incentive for drug companies to undertake the massive cost of getting new drugs on the market at this time.

Only two of the drugs in the table above, albendazole and morantel, are labeled for legal use in goats. All other parasite control drugs, when used in goats, constitute "off label use" which is the domain of licensed veterinarians. As stated above, goat dosages are not the same as for sheep and cattle because their metabolism is not the same. Goats have larger livers as a percent of their body weight so they clear the drugs faster. The route of administration may also be different. Goats do not absorb drugs as easily through their skin as do other food animals. In addition to providing the correct dosage and route of administration instructions, the prescribing veterinarian must also address the correct withdrawal time requirements for goats. Goats, when slaughtered, are randomly sampled for drug residues, and any violations are attributed to the producer

who originally marketed the goat. Violations can lead to federal prosecution, stiff penalties, and for repeat offenders even incarceration.

Examples of active ingredients in the different classes of de-wormer medications.			
Benzimidazoles	*Imidazothiazoles*	*Macrocylic Lactones*	*Tetrahydropyrimidines*
Albendazole	Levamisole	Doramectin	Morantel
Fenbendazole		Eprinomectin	
Oxfendazole		Ivermectin	
		Moxidectin	

Drug Resistance

Not many years ago we began to hear of farms in Australia and New Zealand where they could no longer graze small ruminants because of the resistance of the parasites to parasite control drugs. Today we have farms in the Southeast United States that have the same problem. A recent study done by Langston University shows that serious resistance to parasiticides is developing on most goat farms in Oklahoma. Although there is nothing we can do to completely eliminate this resistance, today's parasite control programs must be designed to slow and delay it as much as possible. We can achieve this by proper use of the drugs we have, incorporating management practices into the plan, and selecting the right individuals to build our future herds on.

The following chart shows the degree of resistance found on several Oklahoma farms to Ivermec, Valbazin, Levisole, and in one case Cydectin. The numbers in the respective columns represents the percent kill the drugs achieved based on the results of fecal egg count reduction tests.

FARM	IVM	VAL	LEV	CYD
1	12	87	98	
2	37	88	99	
3	7	67	99	
4	63	85	92	
5		55	99	100
6	46	42	98	
7	41		91	
8		0	97	
9	69	74	94	

We get drug resistance because we select for it, or because we pay good money for it and bring it home in animals we purchase from other farms who have selected for it. When we deworm using drugs that are not completely effective, or when we use dosages that are too low, we kill the more susceptible worms and leave the more resistant worms. These resistant worms then become the parents of the next generation of worms. Over time as our program selects for more and more resistant worms, the drugs are less and less effective.

When deworming, it is important to leave some susceptible worms to provide competition for the resistant ones. It is also important to know what drugs are or are not effective on your farm. When half of the worms are killed you will see a good clinical response, but it will be short lived and deworming will get more and more frequent. If anything less than 95% of the worms are killed, resistance is developing. This means that by the time that you are aware clinically that the drug you are using is no longer effective, the kill rate has dropped to less than 50% and the use of this drug is lost to you. Once parasites are resistant to a drug, the resistance lasts for many years. A means to measure the effectiveness of parasiticide drugs is discussed later in this paper.

Newly purchased animals should be quarantined and aggressively dewormed in a dry lot until stool samples are shown to be clean. This prevents introducing someone else's resistance problems into your goats and across your pastures.

Management as a Parasite Control Tool

There are several ways that proper management and grazing techniques can help to control parasite problems on Oklahoma goat farms. When goats are allowed to browse as they do in nature they have few parasite problems. When we mold them to domestically managed situations we often cause these problems. Grazing and browsing systems that mimic nature as closely as possible will usually reduce the degree of parasite problems experienced.

One management technique that helps is to closely monitor the grazing height. This is not the same as the height of the vegetation. You need to actually watch and see at what level the goats are eating when they select their plants to consume. As previously stated, the L3 climb on a film of water up the vegetation so that they can be ingested. Their ability to climb, however, is not limitless. Eighty percent of the infective larvae are located in the lower 2 to 3 inches of vegetation. The goats will get almost no infective larvae if they are grazing at or above the 4 to 5 inch level. Time of grazing also is important. The film of water is vital for the larvae to climb. Producers with heavily contaminated pastures during warm and wet times of the year may consider confining the goats at night and turning them out to graze after the dew is off the plants. This greatly reduces the infestation rate.

Pasture rotation is beneficial to improve pastures and maximize utilization of the forage. It is commonly thought that this practice also reduces parasite problems, but this may or may not be true. In order to be effective as a parasite control technique, rotational grazing must be timed to break up the life cycle of the roundworms. If the animals stay in one paddock long enough for the eggs to hatch and mature to the L3 stage, or if they go around the system and return as the larvae mature to the L3 stage, the rotation doesn't help with control. Additionally the timing will change as the season, and thus the maturation process, changes.

Perhaps the most important management tool in controlling parasites is to treat only the individual goats that need help. This helps to maintain a base population of susceptible worms to compete with resistant worms. It is equally important to identify and cull those animals that repeatedly have problems. Eighty percent of the eggs that contaminate the pastures are passed by 20% of the goats. There is a good economic reason for culling these problem individuals as well. A culled goat is worth a lot more than a dead goat.

Larger commercial producers should consider a multiple species grazing program, usually involving goats with cattle or, less frequently, horses. Although all domestic animals have roundworms that are closely related, the actual species of worms are host specific. This means that cattle worms cannot develop in goats and goat parasites cannot develop in cattle. When one type of animal ingests the infective larvae of another type of animal, those larvae are essentially cleaned up or eliminated. There are economic benefits as well because cattle are grazers and prefer grass, while goats are browsers and prefer weeds, shrubs, and brush.

There is limited overlap of their preferred food supplies and it is possible to realize two income streams from one land resource, which is usually one of the highest input costs for the operation.

Parasite Resistance and Parasite Tolerance

Some goats have more problems with parasites than others, while some goats are relatively problem free under proper management. There are actually two phenomena at play here, parasite resistance and parasite tolerance. Parasite resistance is the goat's ability to suppress the population of worms that is trying to develop in the digestive tract. This is a function of the individual goat's immune system. Some individuals may have stronger specific immunity to the worms while others just have stronger ability to respond to any immunological challenge. Both genetics and nutrition play a roll here. Parasite tolerance is the individual goat's ability to carry a given parasite load with minimal impact on the goat's system. Again, both genetic and nutritional factors come into play.

These characteristics are very desirable in Midwestern goats. Researchers at Tennessee State University have shown that there are definite differences expressed between breeds. In general, breeds that were developed in wet, rainy climates have an advantage over breeds that were developed in hot, arid climates for production of goats in areas of significant rainfall. Differences between individuals within a given breed exist as well. Record keeping is important to eliminate genetics that are predisposed to parasite problems while propagating genetics associated with fewer problems.

Evaluating Parasite Problems

In order to tailor a parasite control program for your herd, it is necessary to be able to quantify what problems you are having, how serious they are, and which individuals are having the problems. Some of the tools that facilitate this quantification are fecal egg counts, fecal egg count reduction tests, DrenchRite test, and the FAMACHA system.

Fecal egg counts are conducted by mixing a known quantity of stool into a known quantity of flotation solution and examining the resulting mix microscopically in a special egg counting slide. The result is the number of worm eggs per given quantity of stool and serves as a measure of the number of adult egg laying worms that are present in the animal. This is also an indicator of how much pasture contamination is occurring, but it doesn't give any indication of the health status of the animal.

The fecal egg count reduction test measures the effectiveness or resistance to specific parasiticide drugs. To conduct this test a sample containing at least 10 randomly selected animals serves as a control, while 10 other animals are treated with a given drug. It is important that all animals in the test be of similar age, sex, and condition. After 10 to 14 days, pooled stool samples are taken from both groups and fecal egg counts are done on both. If the drug is effective the treated group will have at least a 95% reduction in fecal egg count as compared to the control group. Reductions less than 95% indicate the severity of the resistance of the parasites on your farm to that drug. It is possible to test several drugs simultaneously with the addition of more animal groups. Once you have the required equipment, consisting of a microscope and McMasters counting slide, the test is very inexpensive. You can either have it performed by any veterinary clinic or do it yourself with minimal training. This test will help you determine which drugs to avoid, which to use, and which to save for the future.

The DrenchRite test was developed in Australia and is currently being conducted at the University of Georgia, College of Veterinary Medicine. For this test a pooled stool sample is collected from a minimum of 10 animals and sent to the lab. There the parasites are hatched and the efficacy of the various drugs is measured on the worms in a laboratory environment. The results are then reported back to you for all the various drugs tested. This is an accurate and simple measure of the parasiticide resistance status of your

herd. The lone drawback is that it is somewhat expensive, but it may well save significant losses and wasted drug expense in the long run.

The FAMACHA system was developed in South Africa as a way to determine which individuals needed to be treated for parasites. It compares the color of the animal's mucous membranes, such as the inside of the eyelids, to a standardized color chart. By detecting anemia in the individual you can treat only those animals that are in danger of clinical disease or death. By keeping a record of the findings on the individuals within the herd you can recognize which goats are perpetual problems and should be culled, and which goats are relatively trouble free and should be perpetuated. This is a good test for the barber pole worm, but doesn't address the problem of other worms which do not suck blood, but may be lesser problems by robbing the goat of nutrition.

Conclusion

Today's major challenge for goat producers is to provide a parasite safe environment for their goats while minimizing the development of parasiticide resistance. Achieving these goals requires an understanding of the parasites, selection of the right goats, and incorporating the right management practices. Your local veterinarian can be your ally in combining these considerations into the right program for your operation.

DHI Training

Ms. Eva Vasquez
Langston University

STANDARD OPERATING PROCEDURES FOR DAIRY GOAT PRODUCTION TESTING

Effective January 1, 2004

CONTENTS

STANDARD OPERATING PROCEDURES

1.0 SCOPE & APPLICATION

1.1 This Standard Operating Procedure (SOP) is applicable to the systematic collection of data documenting milk yield including the measuring milk fat and protein for participants in DHI. The application of these procedures is to provide the framework for a uniform, accurate record system to be used for (1) making farm management decisions; (2) educational programs and research, including the genetic evaluation of does and sires; (3) breed association(s); and (4) the promotion and sale of animals.

2.0 SUMMARY OF PROGRAM

2.1 Sampling should be done in accordance with the National DHIA Uniform Operating Procedures (UOP). All UOP procedures, unless specific to dairy cows only, are to be followed. For purposes of compliance, the use of the terms “cows and heifers” is synonymous with “goats and kids”.

2.2 Procedures outlined in this document are specific to dairy goat production testing only. These basic and minimum standards are to be uniformly followed. They serve to ensure that records will provide the accuracy, uniformity, and integrity essential to dairy goat production records.

3.0 AUTHORITY

3.1 A Memorandum of Understanding exists between the ADGA and the Agricultural Research Service of the United States Department of Agriculture (USDA) to ensure the flow of DHIA records for industry purposes including genetic evaluation programs.

4.0 RESPONSIBILITY

4.1 DHIA dairy goat test supervisors and herd owners as well as persons in their employ are individually and collectively responsible for adherence to these Procedures.

4.2 To participate in this dairy record keeping program, herdowners must agree to conform to these procedures, registry requirements, the NDHIA Uniform Operating Procedures and the associated Code of Ethics.

5.0 DEFINITIONS

5.1 **Dairy Goat -** any goat from which milk production is intended for use or sale, or which is kept for raising replacement dairy kids and is an integral part of the dairy herd.

5.2 **Test Supervisor (TS) –** Any person authorized to collect milk weights and samples for inclusion in the Goat Genetic Evaluation Program (interchangeable with ‘tester’, ‘field sampler/technician’ or ‘supervisor’).

5.3 **Group Testing** – Must meet registry requirements. Each member of the test group is trained to perform supervisor responsibilities when weighing and sampling milk in the herds of other group members. All group testing is conducted under the jurisdiction and supervision of the DHIA.

6.0 PERSONNEL QUALIFICATIONS

6.1 All Test Supervisors are required to be approved by the DHIA of record prior to engaging in any field collection activities.

6.2 Training should be done in accordance with the Council on Dairy Cattle Breeding (CDCB) QCS Field Service requirements with the following being specific to dairy goat testing.

7.0 MINIMUM PERSONNEL TRAINING REQUIREMENTS

7.1 The minimum requirements for new test supervisors (TS) to test non-commercial herds (as determined by the herd's DHIA) without immediate supervision include demonstrated knowledge of (1) barn and parlor techniques, (2) data entry, (3) the *Code of Ethics* and *Uniform Data Collection Procedures, and (4) the Standard Operating Procedures for Dairy Goat Testing*. Commercial herds must have testers meeting the criteria of the CDCB auditing guidelines.

7.2 Documentation of the initial training must include (1) the name and date of training of the new TS, (2) the name and credentials of the trainer, and (3) a list of the topics covered during the training.

7.3 Continuing Education (CE) or refresher sessions should be provided in accordance with the CDCB Auditing guidelines. In addition, newsletters, videos, attendance at an ADGA annual meeting training session can serve as meeting CE requirements. Documentation must include (1) the name of each TS, (2) the name and credentials of the trainer, and (3) a list of the topics covered during the training.

7.4 TS other than those approved to test cowherds or commercial herds (as determined by the herd's DHIA) must obtain CE or attend an initial or a refresher session every 3 years. This is an exception to the CDCB auditing guidelines as it applies to those testers supervising herds using 'pail and scale' techniques. This exception is allowed as this type of test plan is subject to little change over time. Documentation of CE/Refresher must include (1) the name of each TS, (2) the name and credentials of the evaluator, (3) a list of the topics covered during the evaluation, and (4) a performance assessment based upon the CE/Refresher information provided.

8.0 EQUIPMENT AND SUPPLIES

8.1 Equipment needed for collection of dairy goat milk samples includes:

- sample vials or whirl paks*
- approved meter*, or
- sampling device (dipper) and scale*
- sample preservative
- field data sheets

*The appropriate sampling and measuring devices must be of proper composition. See Section 10 for SOP Meters and Scales

9.0 SAMPLE COLLECTION – PREPARATION

9.1 Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.

9.2 Obtain necessary sampling and/or weighing equipment.

9.3 Coordinate with herdowner and partner agencies, if appropriate.

10.0 SAMPLE COLLECTION - METHOD OPTIONS

10.1 Meters **-** All portable weighing and sampling devices being used for the generation of certified data must be of a National DHIA approved type. Meters for goat milk sampling must be calibrated in conformance to manufacturer specifications.

GOAT METERS

Manufacturer	Device	ICAR Approved	DHIA Approved
Tru-Test Limited - New Zealand	Goat Meter model 50000		Yes
Waikato - New Zealand	Goat Meter		Yes

10.2 Scales being used for the generation of milk weights to be included in the *Goat Genetic Evaluation Program* must meet the following weight tolerance ranges at each specified weight:

Pounds	Minimum	Maximum
1	0.9	1.1
2	1.9	2.1
5	4.8	5.2
10	9.7	10.3
20	19.4	20.6

10.3 All scales must be checked for calibration by a certified meter technician or an individual approved by the DHIA prior to being placed in active service. The field technician or the herdowner may own Scales. Approved individuals must calibrate scales using certified weights.

10.4 Scales should be identified with a unique identification number.

10.5 All scales must be submitted for an approved routine calibration check by a certified meter technician or an individual approved by the local DHIA on an annual basis.

10.6 All scales receiving repairs that may have affected accuracy must be checked for calibration by a certified meter technician or an individual approved by the local DHIA before returning to active service.

10.7 Each scale must be identified with a tag, sticker, engraving, or other marking indicating the last calibration year and meter center used.

10.8 Documentation of scales must include (1) the make and unique identification number of the scale, (2) the meter technician's or approved individual's name, (3) the meter center used, (4) the date of calibration check, and (5) the final calibration check readings.

10.9 Dip Sampling must be done in a manner that assures a representative sample from the entire milk volume collected.

11.0 SAMPLE HANDLING AND PRESERVATION

11.1 Use pre-preserved sample vials.

11.2 Samples should be kept at room temperature and out of direct sunlight.

11.3 Keep samples in control of the tester – ***EXCEPTION*** – for group tests, samples may also be in control of the group leader, or person designated to ship the samples/data to the laboratory.

11.4 Record all pertinent data on a field data sheet.

11.5 Samples should be shipped so that they arrive at the lab no later than 6 days after the test is performed.

12.0 DATA COLLECTION AND RECORDS MANAGEMENT

12.1 When a breeding date is available, and a doe freshens less than 10 days prior to the expected kidding date, it will be considered a normal kidding and the record initiated will be used for buck and doe evaluations. Does freshening 10 days or more prior to the expected kidding date, whether in milk or dry, will be coded as abnormal and the record initiated will not be used for buck and doe evaluations.

12.2 If a doe aborts while in milk and has carried a kid less than 80 days, her current record will continue without interruption. If a breeding date is not available, and the doe aborts while in milk for less than 240 days, her current record shall continue without interruption. Except for specific situations stated above, the current record shall end and a new lactation will begin.

12.3 Verification tests may be a required condition of test type plan or registry recognition level. It is the herdowner's and/or test supervisor's responsibility to arrange for such tests dependent on registry or regional requirements. Verification testing should be done in accordance with registry policies.

12.4 All data and information must be documented on field data sheets

12.5 Minimum Suggested Record Retention

- Field Sheets – 2 years
- Record Center sheets – 2 years
- Verification Sheets – 2 years

13.0 QUALITY CONTROL (QC) AND QUALITY ASSURANCE (QA)

All field QC requirements of the ADGA QA Project must be followed.

14.0 REFERENCES

Dairy Goat Registry Guidelines, 2003
Uniform Operating Procedures, June 2002
California DHIA, Dairy Goat QC Program
Council on Dairy Cattle Breeding, Auditing Guidelines, June 2002

Collaborative project of California DHIA & the American Dairy Goat Association

Drawing Goats

Mr. Kenneth Williams

Science Illustrator

Science Graphics and Design

Drawing goats or any other subject depends on accurate observation and correct proportional placement of shapes and lines. So what does this mean and how do we do it?

There are many ways to draw. Some methods work better than others if you are new to drawing, or have trouble maintaining accurate proportions. The method discussed here relies on relating key shapes and lines to each other to achieve an accurate likeness. This method can be used with any object. Although this technique may seem complicated when written, in practice it becomes relatively easy. Measurement lines and boxes need not be drawn on paper but can visualized as you work out the drawing.

Remember! It is almost always best to start with large shapes, work towards smaller shapes, and finish with the details. If the large shapes are out of proportion the drawing will not look right regardless of how well it is finished.

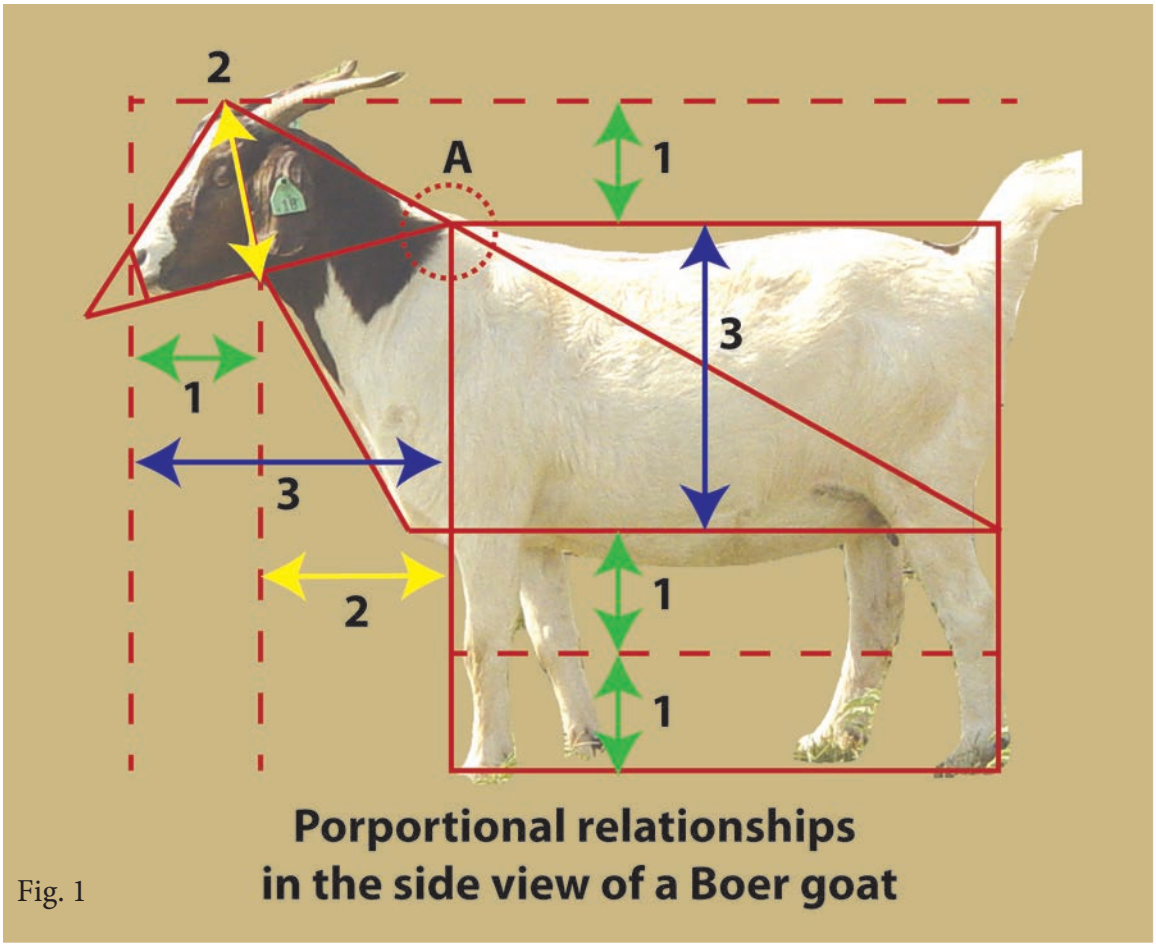


Fig. 1

Begin by developing a frame work of lines, a scaffold" on which to build the drawing. It is often easiest to work from a large geometric shape. Squares work well because we all

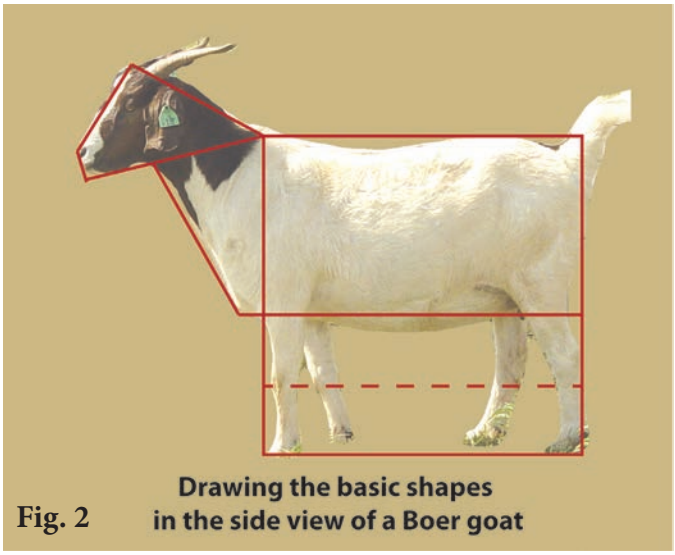


Fig. 2 Drawing the basic shapes in the side view of a Boer goat

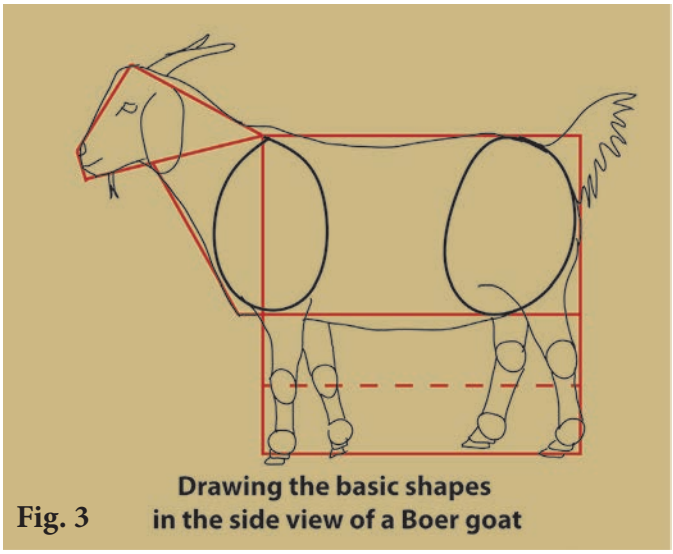


Fig. 3 Drawing the basic shapes in the side view of a Boer goat

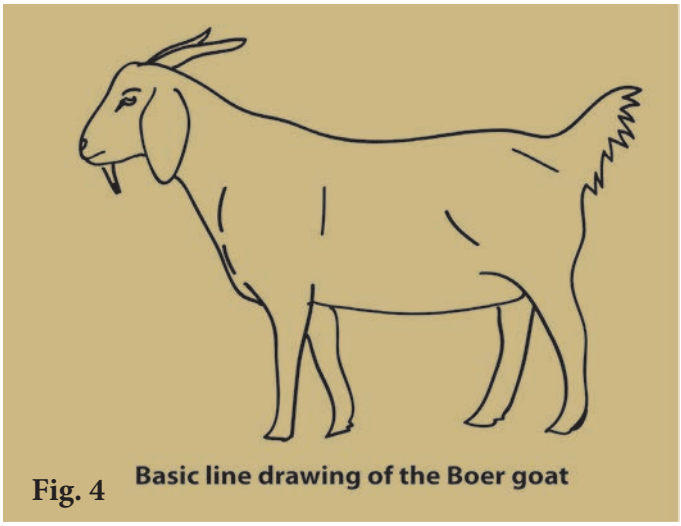


Fig. 4 Basic line drawing of the Boer goat

can draw something resembling a square and can see it in our minds (**figure 1**).

A square neatly boxes in the body of the goat and provides reference points for making other measurements. Some goats may be a bit longer than a square but by using this easily constructed shape we can determine how much of a fraction of the square to extend the body shape.

Observe that the body fills somewhat more than half the square. The legs occupy the lower half of the square. Dividing the lower half of the square once again (arrow 1) establishes the approximate location of the knees. The distance from the knees to the ground is also about the same distance as the distance from the top of the square to the top of the head and the distance from the tip of the nose to the junction of the neck and the lower jaw. The distance from the lower jaw to the top of the head is about the same as the distance from the front legs and the intersection of the neck and jaw (arrow 2). Further examination shows that the distance from the tip of the nose to the front legs is about equal to the depth of the body (arrow 3). By extending a line from the lower right hand corner of the rectangle that encloses the body to the top of the goat's head, we establish the slope of the neck.

Several lines come together at point A. We can check proportion and alignment by noticing that a line from A to the ground runs just in front of the knee and ends near the point of the hoof. Also check the angle formed by the jaw line and top of neck. Point A is also the pivot point of the neck. If you want to lower or raise the angle of the neck, this is where to begin.

The finished goat drawing will be in proportion when we have accurately located these positions and relationships. This is the first step and also the most difficult when drawing a goat or any other object. Spend most of your drawing time getting this stage right before drawing details (**Figure 2**).

Add ovals representing the front shoulders and hips. The oval representing the hips is angled slightly forward to count for the slope of the rump **figure 3**. Connect the two ovals by drawing the back line and the belly line.

Add small ovals locating the knees and ankles. Then connect them with lines to fore the legs. It does not have to be exact at this stage.

Locate the position of the tail and draw it in. Its shape is not critical to the drawing.

Refine the shape of the head and neck. Note the location of the horns. It is important to find the correct location where horns attach to the skull. The length and shape of the horns is not critical to the drawing. Locating facial features will be discussed below.

Further refine the shape of the body, legs and head. Your drawing should now look about like this, perhaps without facial features as in **figure 4**.

To draw the goat in a different position, such as browsing from a tree or lying down, you must establish a different set of proportional relationships. However, this becomes easier by knowing how the side view is assembled.

The "scaffolding" technique works with any thing that you draw and soon becomes second nature. It will become unnecessary to actually draw the lines as you will be able to see geometric shapes and lines in the object and follow in your mind where they line up with other parts of the drawing. You can relate key lines found in one part of the drawing to objects found in another part. For example, you might note that a line of trees passes through a goat just above the back line. The same line of trees may pass through another goat at knee level and also through a tree stump at root level. By placing these elements in line with the tree line you are assured that the objects will be correctly placed.

Aligning facial features

The head is shown in profile in **figure 5**. The triangle and lines extending from it represent the head and neck shapes previously drawn. Begin positioning facial features of the head by dropping a line vertically down from the rear, base of the horn (**1**). The ear also begins here.

The most critical feature to properly place is the eye. The right edge of the eye aligns with the back edge of the horn (**2**). The left edge of the eye aligns about half way between the left edge of the horns and the beginning of the slope of the skull towards the nose (**3**). The upper eye lid is placed about 1/3 of the distance from between lines **A** and **B**. The lower edge of the eye is placed a little more than 1/2 the distance found between lines **2** and **3** or expressed differently, the eye is about 2 times as long as it is wide. Roughly draw the eye in this location.

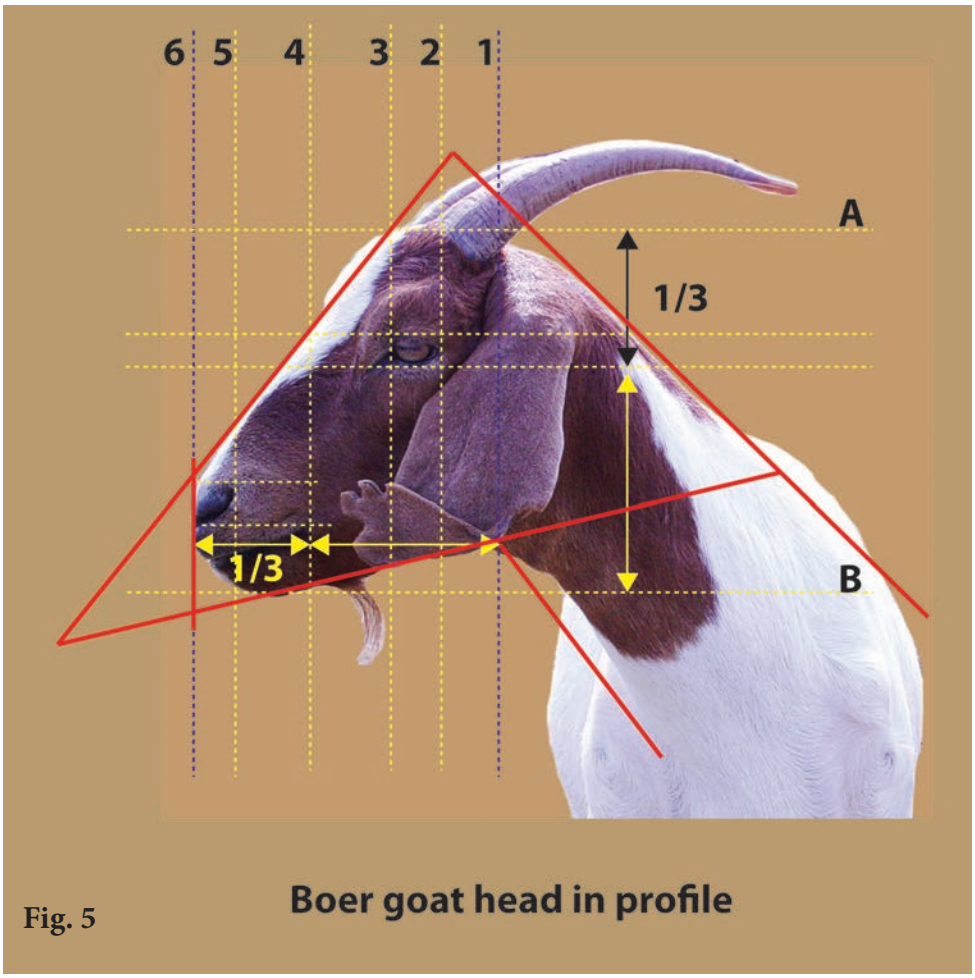


Fig. 5 Boer goat head in profile

Ear length and shape are variable and not critical to the drawing other than correct placement of the top of the ear.

The mouth extends about 1/3 of the distance (line **4**) between the nose line **6** and line **1**.

The nose is about 1/3 the length of the mouth (lines **5 and 6**).

The beard is located on the lower jaw just behind the corner of the mouth. Beard length and position is not critical to the proportionality of the drawing.

The main features are now placed correctly and the drawing can be roughed in as shown in **figure 6**. Use straight or rough curved lines to begin developing the head shape.

Further define the head shape. Add horns, ears, beard and outlines of facial features figure 7.

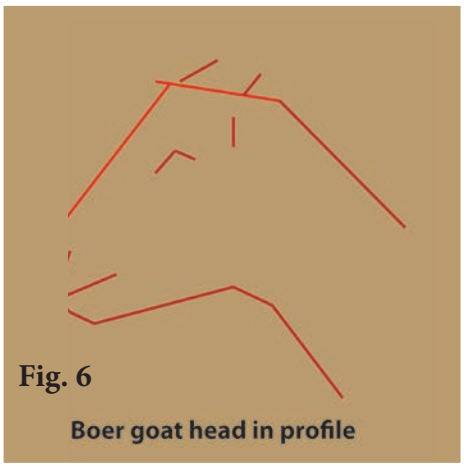


Fig. 6 Boer goat head in profile

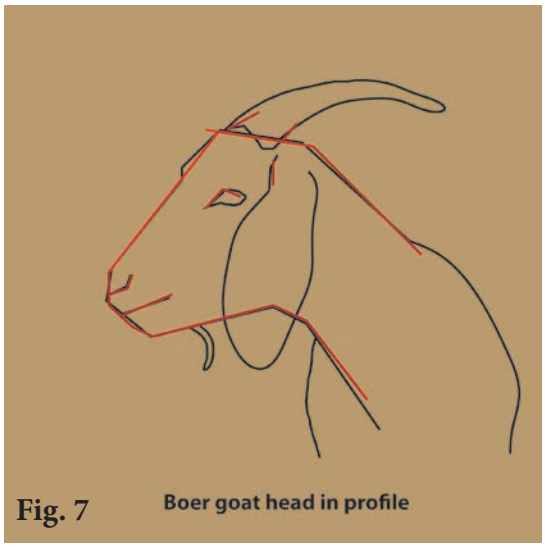
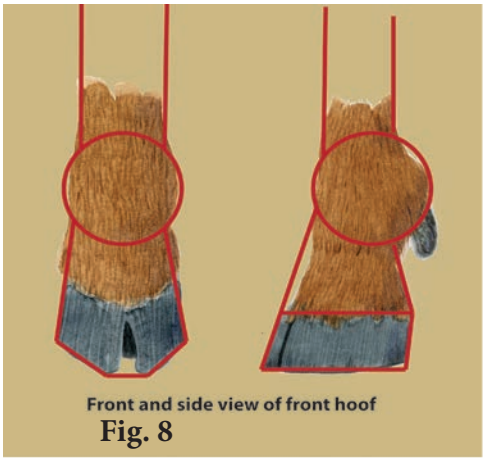


Fig. 7 Boer goat head in profile

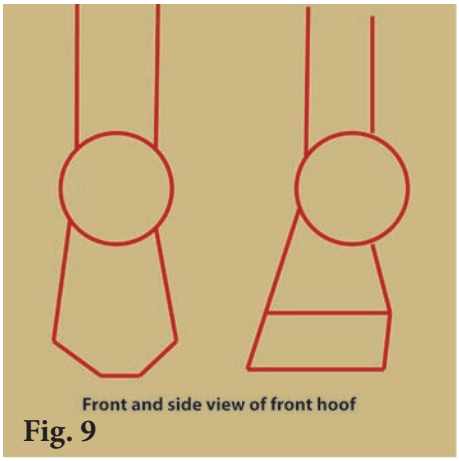
Addition details

Hooves

Hooves can be a difficult part of the goat to draw for some. The easiest solution is to draw the goat with plenty of grass around the feet. However, if the hoof is closely observed you will see that it is an easy construction to make See **figures 8 and 9**. A circle just a bit larger than the leg forms the ankle. A wedge shaped form attaches to the circle to make the hoof. The hoof is split in the front and dew claws can be seen above and to the back side of the ankle.



Front and side view of front hoof
Fig. 8



Front and side view of front hoof
Fig. 9

Horns

Goat horns are of many shapes and sizes. The horns often have a relatively flat side near the top and this can be illustrated by curving the striations or rings in the horn at a sharp angle **figure 10**. General the underside is shaded and the top catches the sunlight and is often left white in a drawing. The horn can have many colors besides basic grey. Close observation will reveal browns, violets, blues and pink colors.

Fig. 10

Eyes

Eyes are the focus of most portraits whether they are animal or human. Care must be given to produce a realistic effect. When drawing goats at a distance the eye need only be indicated by a line or two. Follow the steps in **figure 11** when drawing the eye in detail. Remember to leave plenty of highlighting in the eyeball and on the lids to represent the moisture found in the eye. An eye without highlights looks as though the goat is dead.

Use a smooth bristol paper to get the smoothest tones in the eyeball.

When drawing dark goats the eye can be emphasized by lightening the hair color around the eye (**figure 12**).

Steps to drawing the goat eye in graphite pencil

This series of drawings was done on smooth bristol paper. Pencils used were 2H, HB, 2B. A chisel point was used to lay in areas of shading and a sharp point was use for hair and detail. Darkest areas were first covered in 2B. HB and then 2H were applied on top of the 2B to strengthen and smooth the dark areas. Areas were lightened with adhesive putty. A kneaded earser will work almost as well.

Step1:
Roughly sketch the eye shape. Curves can be simplified by using straight lines at this stage. Add a highlight area at the top of the eye that is to remain white. Add an additional light area at the bottom of the pupil. It is light here because light passes through the upper part of the eye and exits near the bottom. Sketch lightly at this stage.

Step 2:
Round, smooth and refine the eye shape. Apply the darkest values to the eye. Darken the pupil, eye rim and tear tract.

Step 3:
Apply shading to eyeball and tear tract. Shade darkest at the top of the eyeball, the corners and the begining of the tear tract.

Step 4:
Apply shading to the eye lid. Shade heaviest in the corners leaving a light area near the center. Shade the lower rim near the bottom to indicate roundness. Shade around the eye in the direction of the hair tracts.

Step 5:
Apply very short hair strokes around the eye. Add pigmented and light areas underneath the eye.

Step 6:
Smooth shading and hair. Adjust final values. Add eye lashes if desired. Be careful with lashes. Overdoing lashes can ruin an otherwise good drawing.

Fig.11

Figure 12. Color drawing of a Boer goat's eye Illustrating highlights and refractions in the pupil. Also note the varieties of color in the horns.

Ears

Goat ears come in a variety of shapes mostly depending on breed. Some shapes are distorted by injury. In general, there are "floppy" ears and "perky" ears. Many "perky" eared goats have dark skin pigment inside the ear that should show in drawings. Hair can be dense here as well. This can be illustrated by indenting the paper surface with an indenting tool, 6H or harder pencil or even your fingernail, where hairs will show (**figure 13**). Do this before pencil is applied.

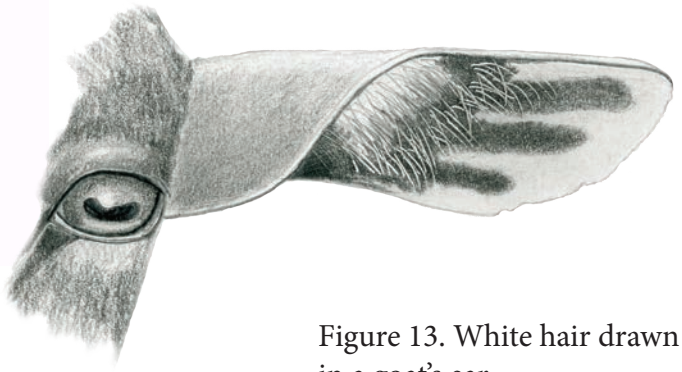


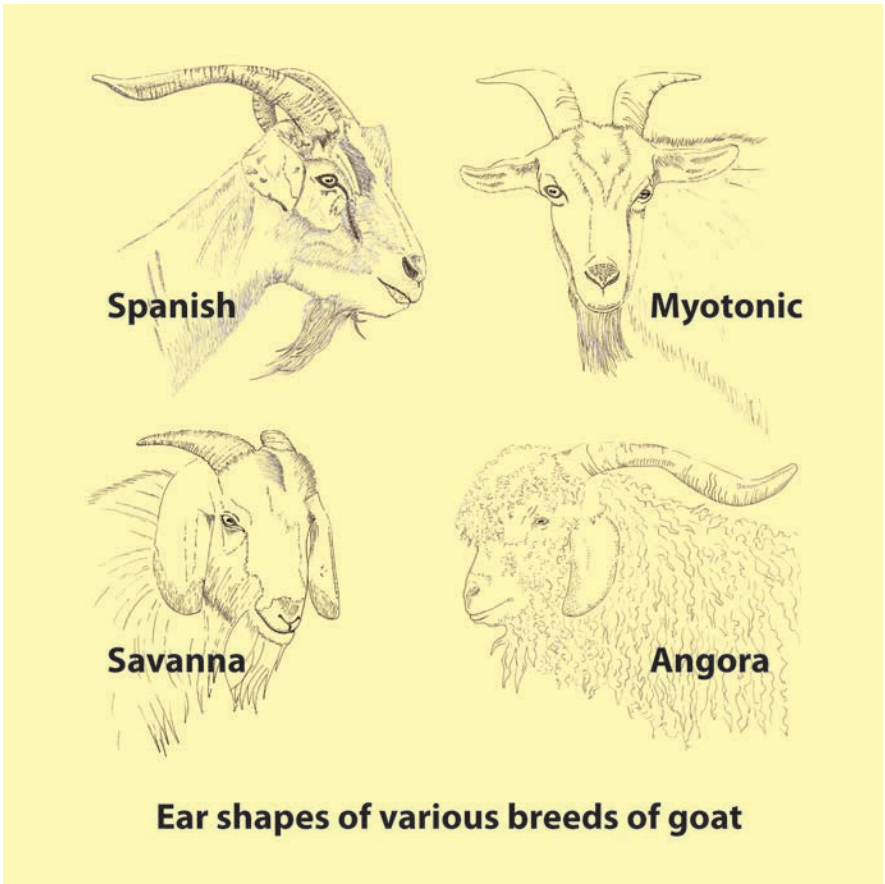
Figure 13. White hair drawn in a goat's ear.

Floppy ears may have veins that stand out and should be included in close up drawings.

It often helps to darken the ears or body hair around the ear to provide contrast and make the ear easily seen. It may only be necessary to darken an edge to provide needed contrast.

Nose and mouth

The nose is usually black but may be shades of grey. An area of pink skin is often seen where the top of the nose grades into the goats hair. It has a slightly roughened texture and may be shiny with moisture in places. Vellum bristol paper was used to capture the texture of the nose and short hairs of the face. The most common mistake in making nostrils of any kind is turning them into black holes. Begin the top of the nostril very dark then shade to lighter tones for a more realistic effect (**figure 14**).



Ear shapes of various breeds of goat

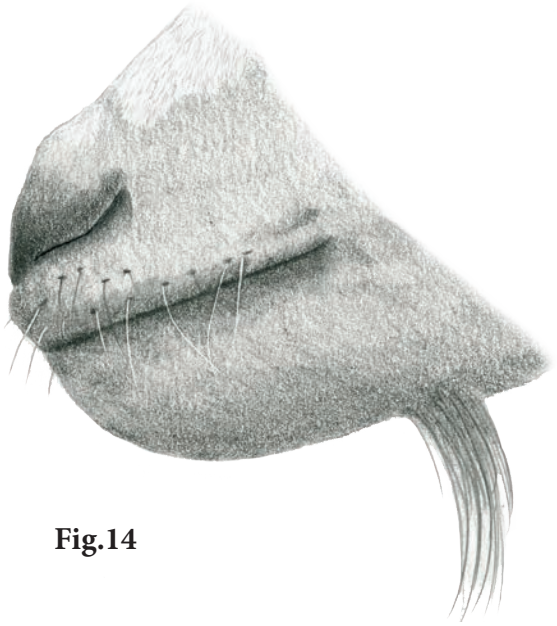


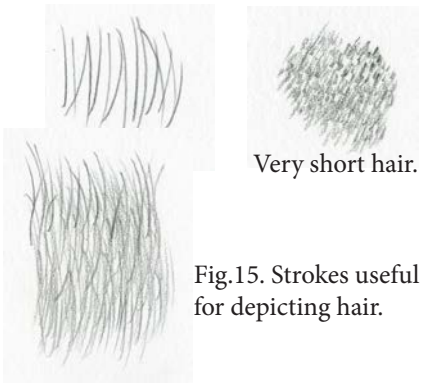
Fig.14

The mouth begins with a dark, shadowed line where the lips meet. The line shades to lighter tones in the lips. After an initial light outline is developed, and before any tone is applied to the goat; use an indenting tool to portray a few whiskers around the mouth. Be careful to not over work them. Too many whiskers can turn into a moustache.

Begin the beard with some smooth dark tone applied to the upper area. Use long strokes of a 2H pencil to add hair lines over and well beyond the toned area.

Hair

Hair is made by making a series of closely spaced lines with a back and forth rolling motion of the hand. Start by making an up flick stroke followed by a down flick (**figure 15**). Do not make straight rows or the hair will look like a lawn. Overlap the following row and continue until you have covered the area. Go back over with long strokes to smooth out the hair. Use short strokes for short hair. Follow lines of hair growth as shown in **figure 16**.



Very short hair.

Fig.15. Strokes useful for depicting hair.

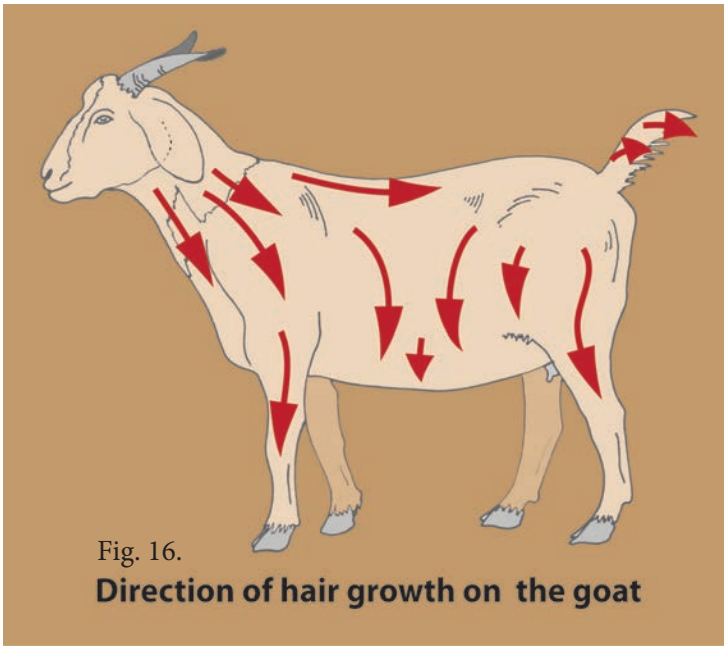


Fig. 16.
Direction of hair growth on the goat

Drawing Goats on location

Drawing goats on location will become faster and more assured after practicing the drawing techniques discussed in this article. Understanding the relationships of body features to each other will make rapid sketches easier. When sketching in the field begin with simple gesture drawings that capture the movement and pose of the animal . Do not become concerned with detail. **Always draw what you see**. Not what you think it should look like. All goats will not fit into a square all the time.

Although a goat may be seen and drawn from an almost infinite variety of view points, there are some goat poses that are very characteristic and common. Some examples are given below. See if you can determine how they might fit into a square or other geometric shape. Also look for structures that line up and help to keep the drawing in proportion.

Fitting and Grooming for Youth Market Doe Shows in Oklahoma

Ms. Kay Garrett
GG's Boer Goats
www.ggsgoats.com kewlkay@hotmail.com cell: 918-686-3257

- **Remember** – ***ALWAYS SAFETY FIRST*** – Never use anything that does not appear safe. If you don't think something is right, stop and ask someone before you do it. Better to be safe than sorry.
- Never leave an animal tied up alone or on the stand alone. Learn how to tie a quick release knot. We suggest the slip knot.
- Never wash an animal in cold weather without the ability to dry them and warm them up quickly. Always wash and completely dry your animal before you start clipping to preserve the life of your clipper blades and a smoother clipping job.
- Until you feel confident in your ability to trim, never start out on your show animal, practice on an older animal or an animal that won't go to the show ring.
  - Equipment: Foot trimmers, clippers and shampoo. The rest of what we use is nice to have.
    * Halter
    * Grooming Stand
    * Clippers with #10 blade and 5/8" blade (Andis or Oster blades. I think Wahl's are coming out with a line comparable to the Andis and Oster)
    * Brushes and shedding comb
    * Coat finisher
- Start about 6 weeks out before your first show to get your animal into condition.
  - We condition our animals by worming, vaccinating, treating with a parasite control and good feed and hay. We suggest worming with Cydectin (1 cc per 10 pounds), vaccinating (CDT – Covexin 8, follow label), parasite control (Cylence 1 cc per 25 pounds along the back). We recommend and use Honor Show Feeds and high quality alfalfa hay.
- About a week before the show, wash your animal and trim it's feet. This will give the animal time to adjust to it's new "shoes" (feet). A couple of days before the show, rewash and finish trimming.
- A rule of thumb, if you cut long at first, then you can trim out faults. If you start short, you have no way to correct mistakes.
- We start with a # 10 and trim the wild hairs on the following places:
  - Ears
  - Chest floor
  - Front legs, dew claw, pasterns and hoof band
  - Belly
  - Tail
  - Hip
  - Hock
- We will change blades and use the 5/8 blade on the belly and hip depending on the hair length, type and quality. We will also use the shedding blade along the neck, topline and hip to smooth it out.

Fitting and Grooming for Youth Market Wether Shows in Oklahoma

Ms. Kay Garrett
GG's Boer Goats
www.ggsgoats.com kewlkay@hotmail.com cell: 918-686-3257

- **Remember** – ***ALWAYS SAFETY FIRST*** – Never use anything that does not appear safe. If you don't think something is right, stop and ask someone before you do it. Better to be safe than sorry.
- Never leave an animal tied up alone or on the stand alone. Learn how to tie a quick release knot. We suggest the slip knot.
- Never wash an animal in cold weather without the ability to dry them and warm them up quickly. Always wash and completely dry your animal before you start clipping to preserve the life of your clipper blades and a smoother clipping job.
  - Equipment: Foot trimmers, Lister Stablemate clippers and shampoo. Some other equipment that we like to use:
    - Halter
    - Grooming Stand
    - Slick sweater
    - Body blanket
    - Small clippers with #10 blade for small areas
      - Head, Feet, Trim legs, Horn base, Tail
- The wethers are completely slick shorn above the hocks. It is not wise to leave hair on the wethers. Leaving lots of hair on wethers make the wethers to appear fat and overly conditioned and finished when the judge handles them and analyzes them at a show.
- To trim below the hocks and tail, be very careful. You do not want to slick shear the legs. You only need to trim up the wild hair. You want to leave as much hair on as possible. You do not want the animal to appear "deer like". You will want to trim the hoof band and slick up the tail. The head needs to be slick sheared paying special attention under the chin and around the horns. Leave no hair on in the head area. I suggest using a small clipper such as the doe clippers around the head, leg and tail area with a number 10 blade. The tail should be trimmed up close but not completely sheared.
- Keep the blades oiled every 10 minutes or every time you switch sides on an animal.
- If the weather is cold, be sure to cover up your animal with blankets and slickies and use a heat lamp if necessary.
- Never, Never, Never, Never, Never, Never, Never, Never, Never, Never, Never, Never trim a doe in this fashion unless you plan on showing her with wethers for her show career. She will not compete in a regular doe show if she is slick sheared.
- Some suppliers that we use and are reputable dealers.
  - Outback Laboratories - www.outbacklabs.com - 405-527-6355
  - Hoegger Caprine Supply - 1800-221-4628 – www.thegoatstore.com
  - Jeffers – 1800-533-3377 – www.jefferslivestock.com
  - Mid-State – 1800-835-9665 – www.midstatewoolgrowers.com

Show Ring Etiquette

Ms. Kay Garrett and Dr. Terry Gipson

Showing livestock has been a pastime for rural youth for many generations and showing goats is one of the fastest-growing youth livestock activities. Goat shows provide an opportunity for youth to exhibit the superior animals that thay have raised or taken care of. However, having a top-quality animal is important but just as important is the youth's ability to handle and highlight that animal.

In addition to the satisfation that a youth has in exhibiting a top-quality animal, there are added benefits of the goat show. Prize money can help with the feed bill and other expenses. Networking with other youth and adult goat producers can yield invaluable tips on goat management and caregiving. Lastly but not least, the relationship that deveolps between the youth and their goat will last a lifetime.

Working your goat several weeks or months in advance of the show will ensure that your goat is properly trained to lead and follow your instructionsIn order to properly show your goat, follow the simple instructions below.

Consult your organization or the show organizers to make sure that you are dressed properly.

Make sure that your goat is clean and well. Never show a sick goat.

Pay attention and listen for your class to be announced.

Bring your animals to ring side immediately and checked-in to avoid any delays in the show.

When it comes your time to enter the show ring make sure you have your animal is under control. Many judges will watch the exhibitors and their animals as they enter the show ring. First impression count.

You should walk on the left side of your animal, holding the neck chain or collar in your right hand. Watch the judge and pay attention to what he or she is saying. Do not talk to the judge unless you are asked a question. Sometimes the judge will motion for you to enter the show ring or the judge may simply look from the goat in front of you to your goat. That is your sign to enter the show ring. If neither of these occurs, wait until the goat in front of you is a proper distance into the show ring before entering. You can guage this distance by looking at the spacing between the animals in front of you.

When you enter the ring, walk in a clockwise direction. Make sure to keep your animal between you and the judge at all times. Figure 1 shows you how to cross in front of your animal when the judge is in the ring. This will keep your animal in front of the judge as you walk by them. When the judge calls for you to stop walking, make sure you leave enough room for the judge to walk between the animals.

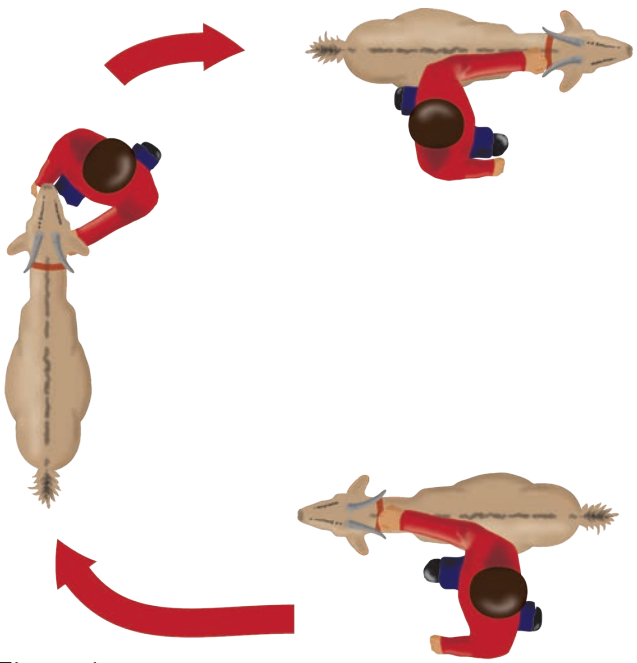


Figure 1

Figure 2

Figure 2 shows the correct way an animal should be positioned. Place the front and rear legs squarely under the animal and spread slightly.

To position the legs, grasp each one above the knee and place the leg in the correct position. Always set the legs nearest the judge first (Figure 3).

Stretch the hind legs slightly, this will help to accentuate body length and level the rump if needed.

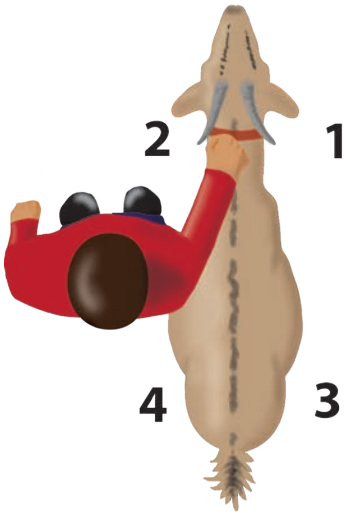


Figure 3

If your animal moves out of position or the judge asks you to change places, lead your animal forward out of the line, then back through the line following steps describe the making a circle and return to judge's position in the show the indicated position. When performing this maneuver, make sure you give the animal plenty of turning room (Figure 4).

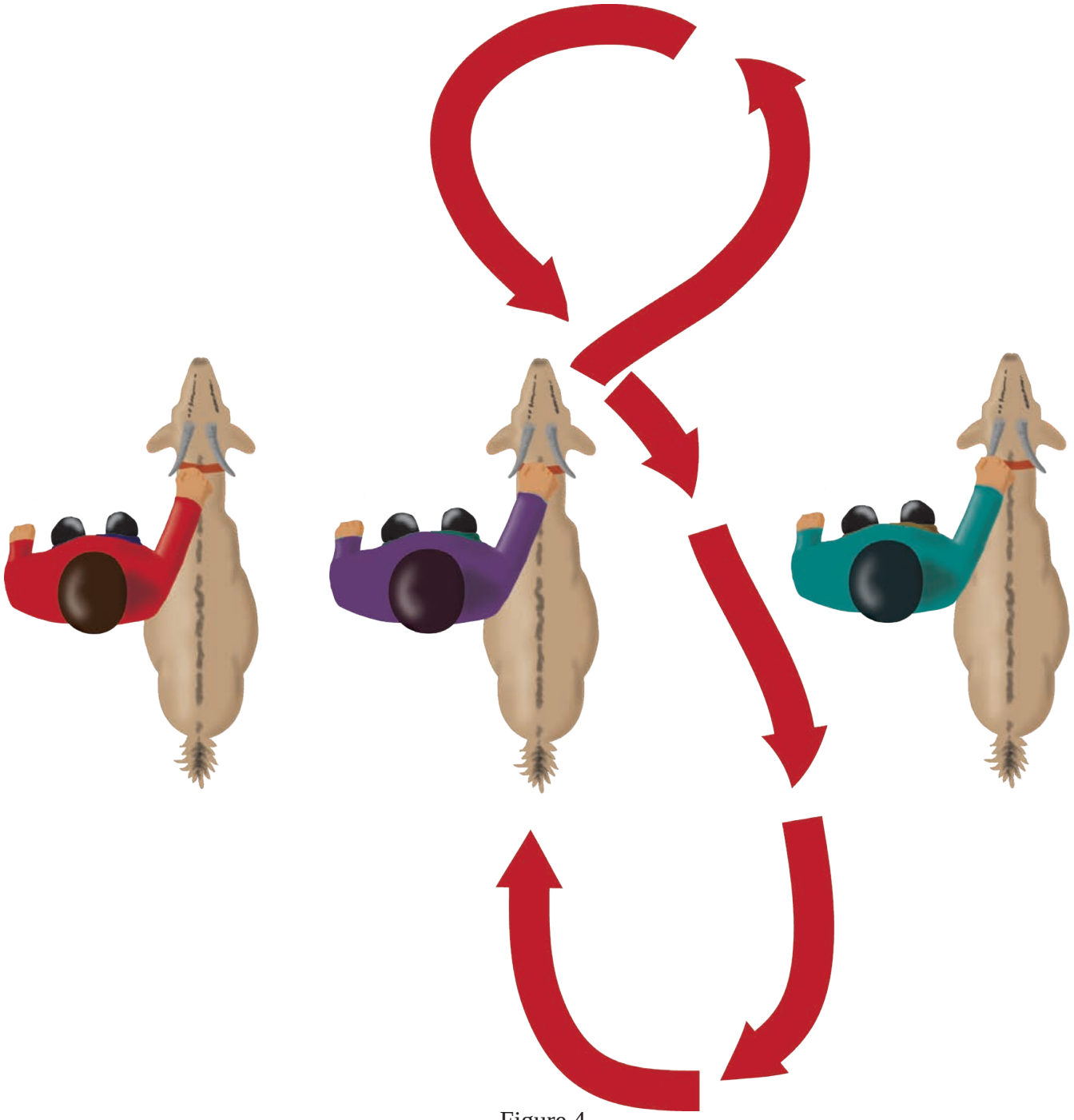


Figure 4

Position your animal in the lineup will depend on the position of the judge. These following steps describe the judge's position in the show ring. If the judge is positioned in front of the animals, move the animal out of line and walk toward the judge. Place the animals in the position indicated by the judge and set the animal up (Figure 5).

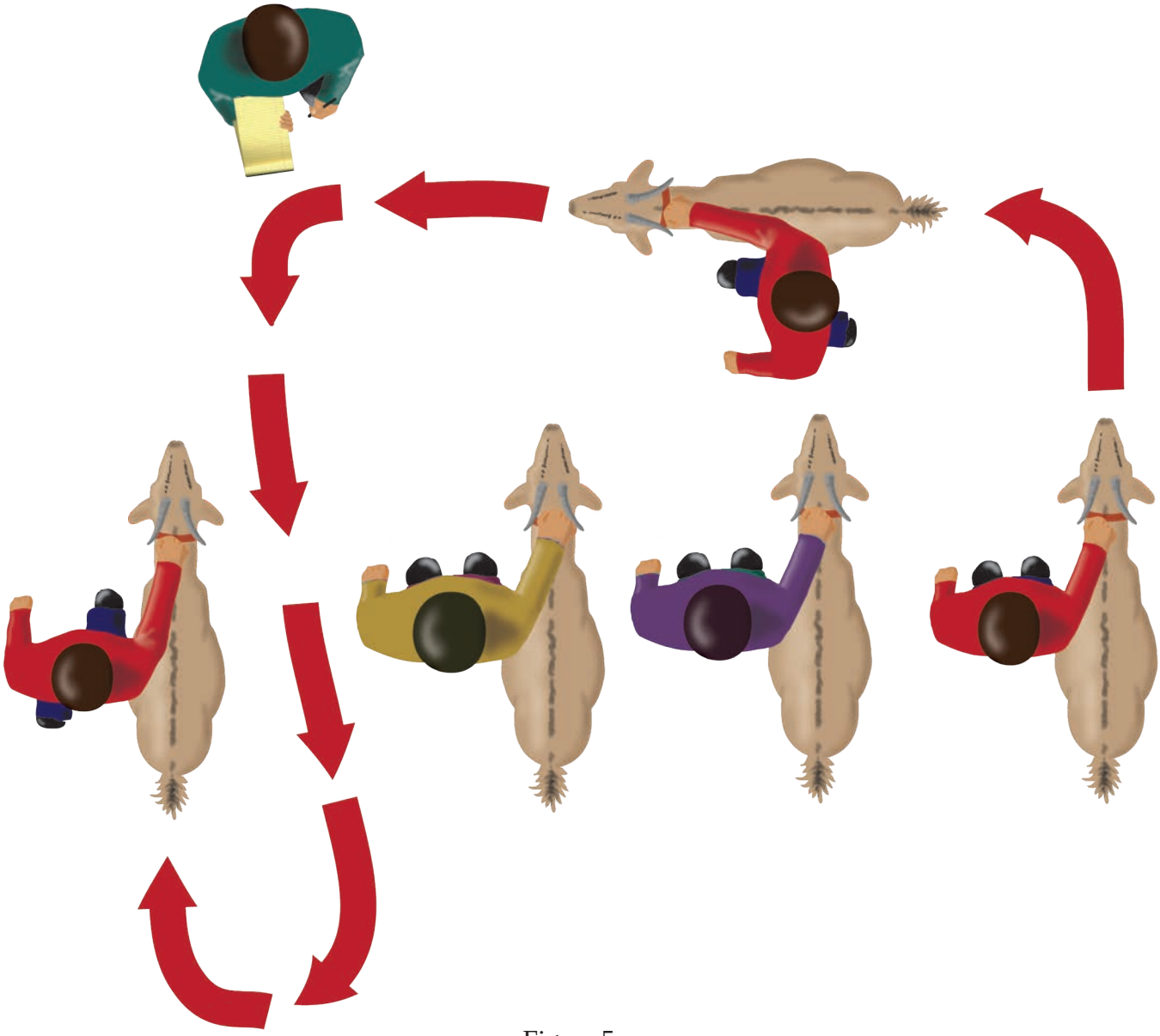


Figure 5

If the judge is positioned behind the line of animals, move the animal out of place and circle toward the front of the line. Place the animal in the position indicated by the judge and set the animal up (Figure 6).

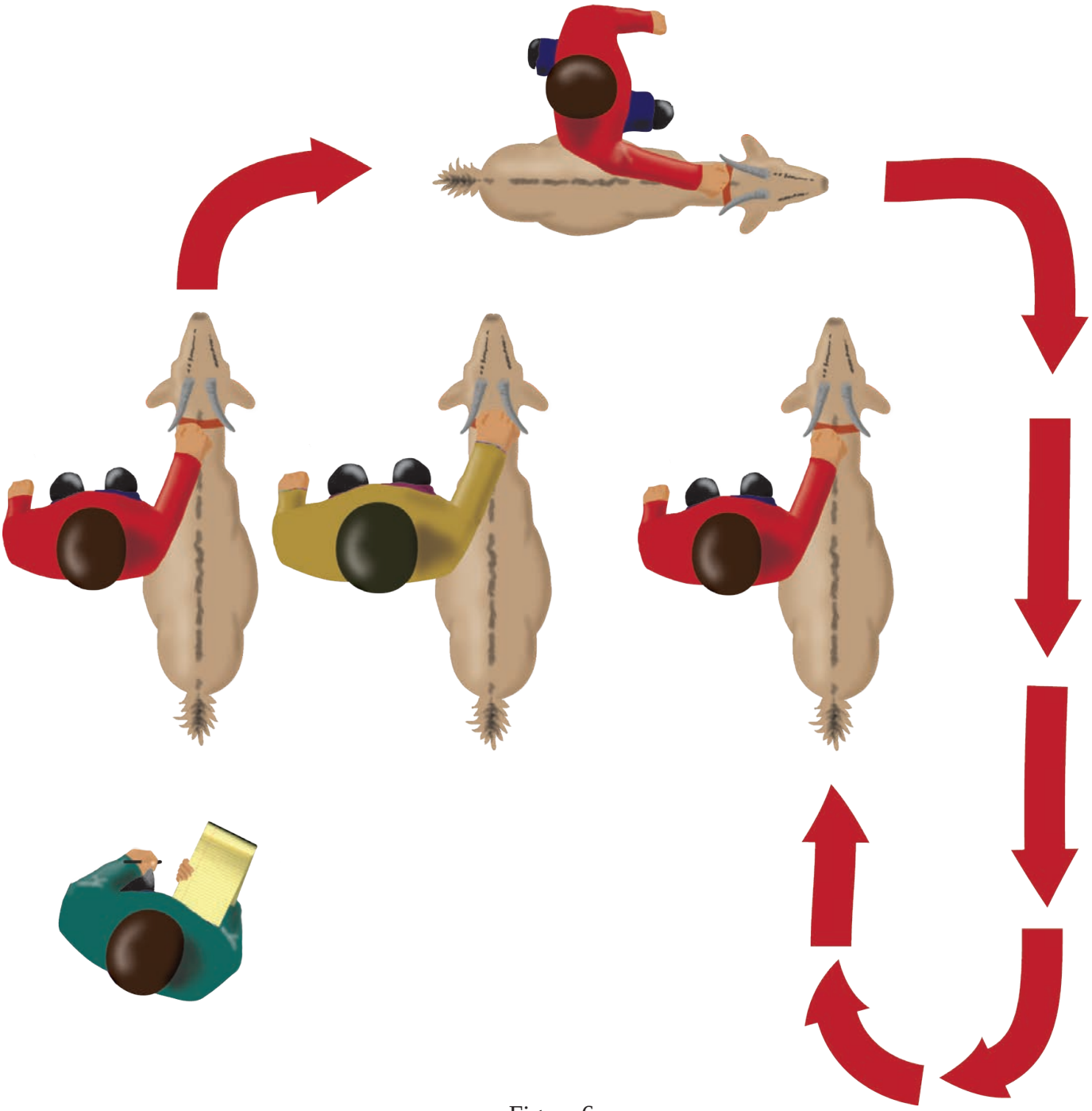


Figure 6

If animals are lined up in a head to tail fashion and there is a change in the position by the judge, the number 1 animal is led out of the line and the number 2 animal would move up. The number 1 animal moves into the new position (Figure 7).

The number 1 animal follows the number 2 animal and circle one behind the other clockwise through the line and back to the requested position.

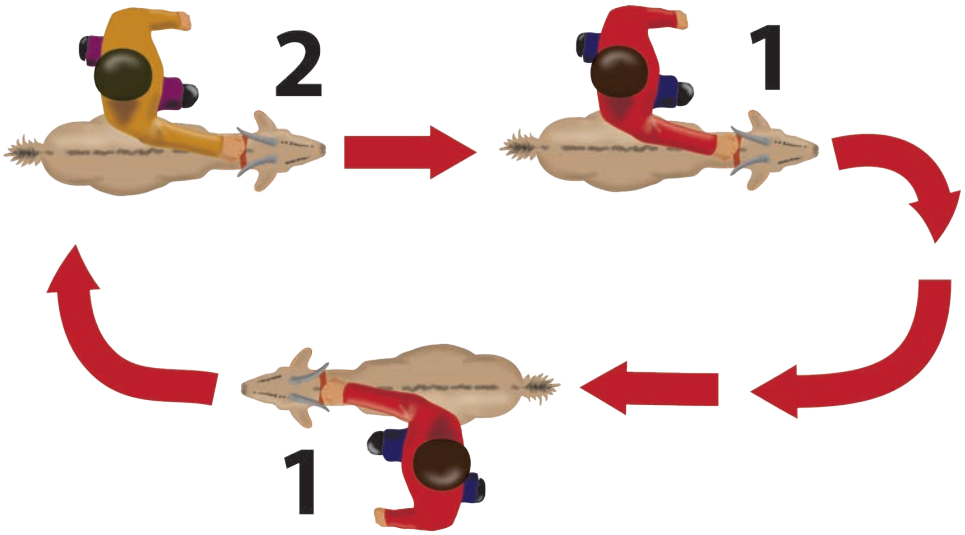


Figure 7

If animals are side by side and there is a change in position by the judge, both animals are led forward and turn right (Figure 8).

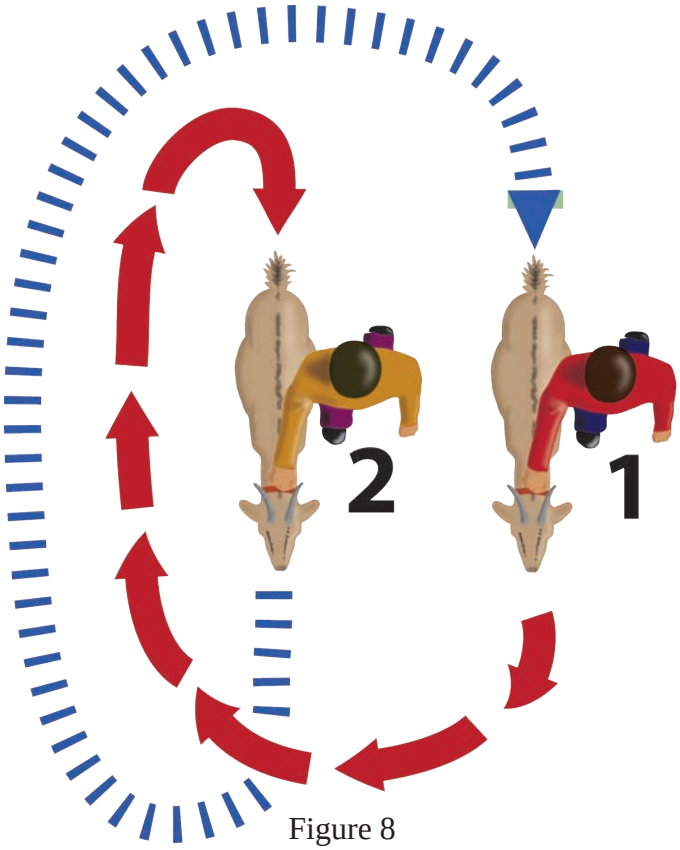


Figure 8

If the judge wants to compare two animals (Figure 9a) side by side, the butterfly pattern is used. A. Shows the animals walking away from the judge. B. Shows the turning of the animals, C. Shows the return of the animals toward the judge, D. Shows the turning of the animals, E. Shows the turning of the animals away from the judge, F. Shows the return of the animals to the original position in the line (Figure 9b).

a

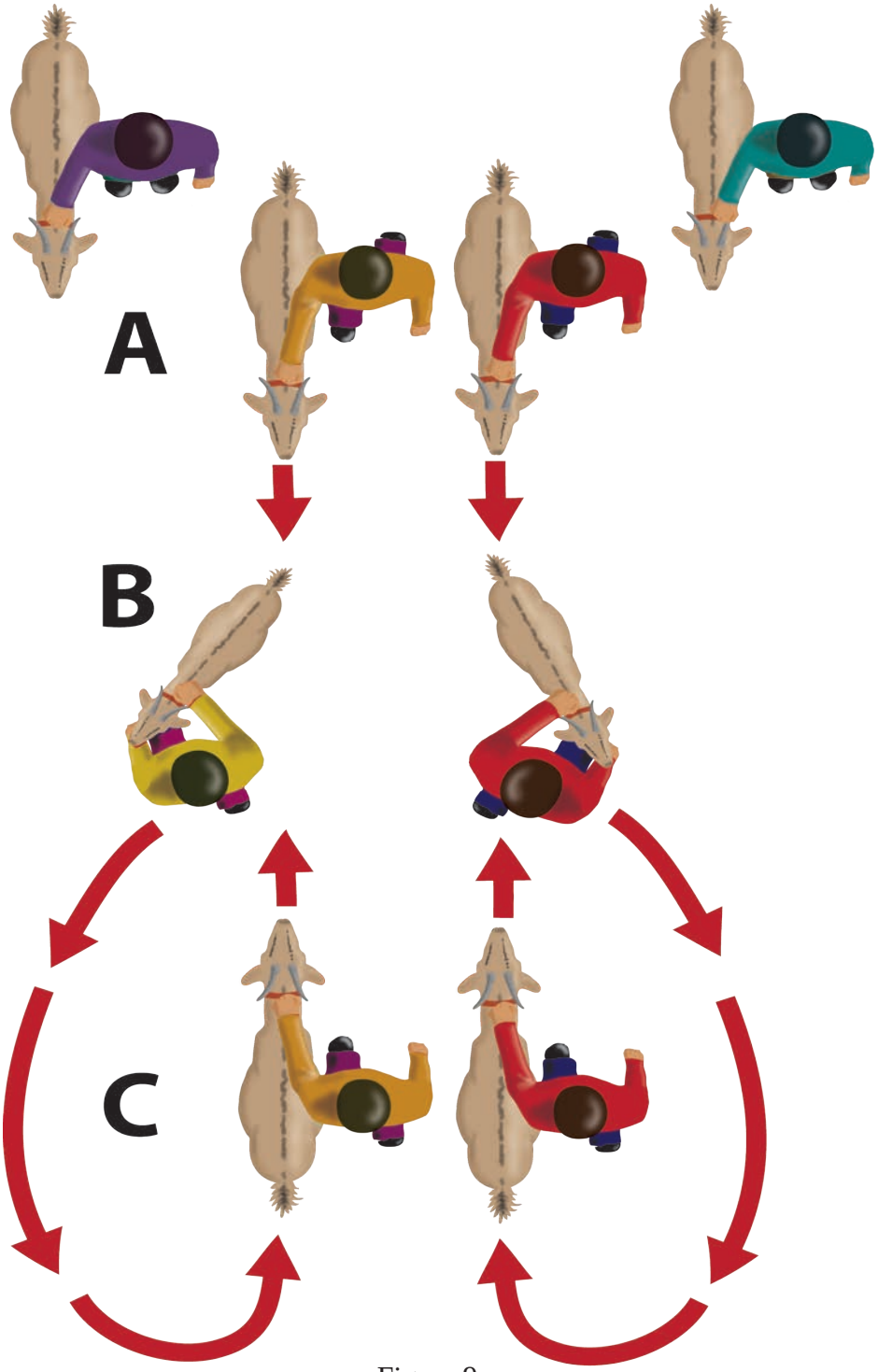


Figure 9a

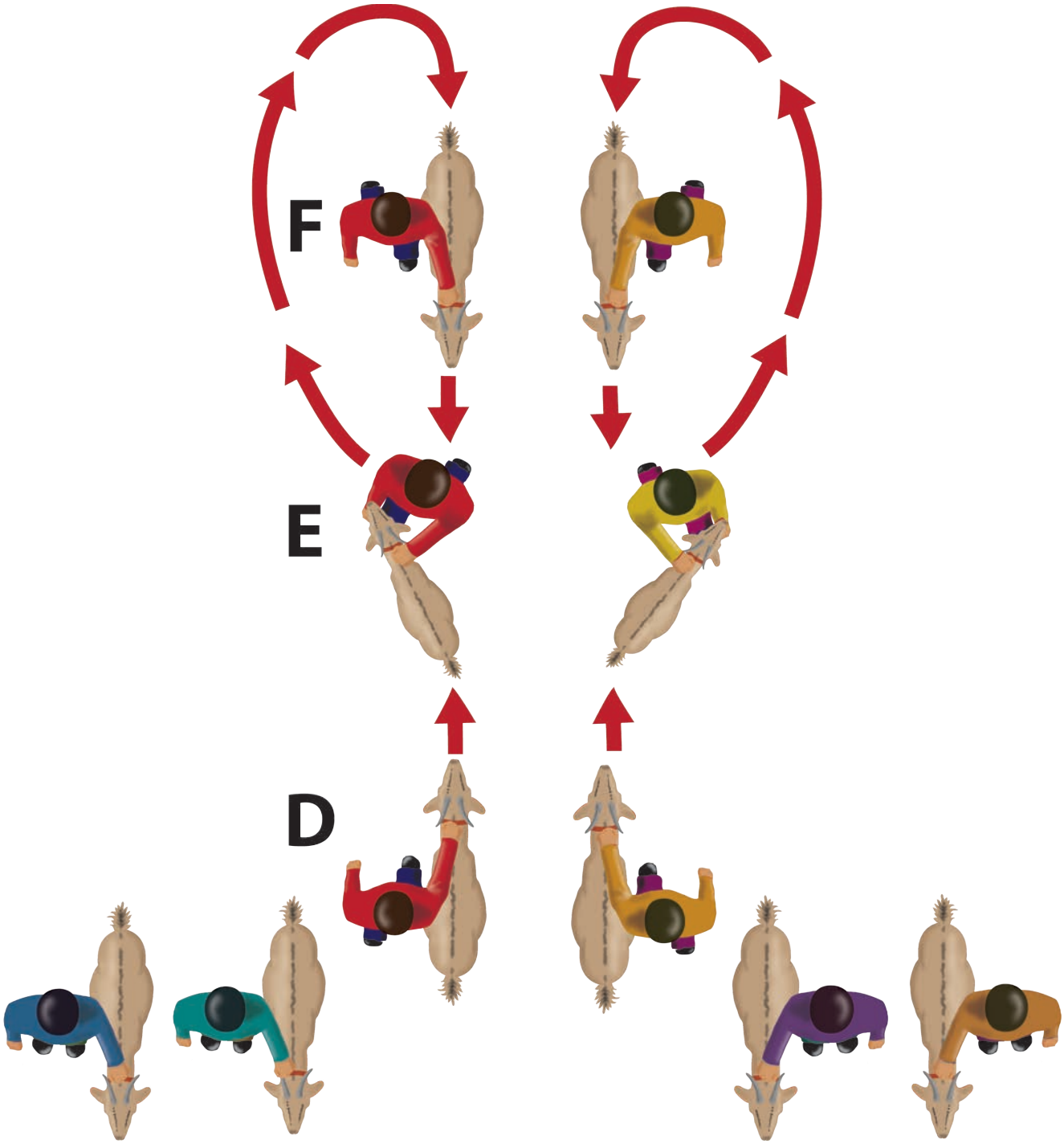


Figure 9b

When the judge wishes to check the animal, more control over your animal can be achieved by raising the front leg opposite from you (Figure 10).

Figure 10

Some judges will watch the animals on the move therefore, you have a chance to cover up some faults when you set up your animal. If the animal is a little steep in the rump, stretch the hind legs as you set up. It will also help to pinch the third vertebrae in front of the hip bones. If the animal has a sway in the back move the hind legs up and under the body and hold the animal's head lower to cover up this fault. If you want to strengthen the topline, tickle the tummy.

After the judge places the animals, he or she will give the reasons of the placing. If you have any questions about the placing, ask the judge before leaving the show ring.

CURRENT PROGRAM SUMMARY

E (Kika) de la Garza American Institute for Goat Research
Langston University
Langston, Oklahoma 73050

- **EXTENSION OVERVIEW**
- **INTERNATIONAL OVERVIEW**
- **RESEARCH OVERVIEW**
- **USDA/CSREES PROJECTS**
- **EXPERIMENTS**
- **ABSTRACTS**
- **ARTICLE SUMMARIES**
- **VISITING SCHOLARS, GRADUATE STUDENTS, AND INTERNS**

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Research Overview

Dr. Arthur Goetsch
Goat Research Leader

There has been and is a wide array of research areas addressed by our program. All major types of goats produced in the US are considered, i.e., ones raised for meat, milk, and(or) fiber, both cashmere and mohair. The increasing demand for goat meat and decline in the mohair industry in recent years have resulted in an expansion of research topics with meat goats, but because the future is unknown, all goat industries will continue to receive attention. The Institute has and will in the future conduct research to increase levels and efficiencies of goat production, enhance utilization of goat products, and improve use of goats for specific purposes such as vegetation management. There is intent to increase economic returns to those raising goats or processing their products, as well as providing other benefits such as enhanced sustainability of livestock production systems.

A large proportion of the Institute's research program is made possible by grants, many of which are through USDA programs. Although dissemination of information generated from all of these projects occurs, some entail strong extension components. Likewise, there are projects listed in our international section that entail significant research components.

To provide an idea about our research program since the last Field Day, listed below are research projects and experiments we have been involved with in 2012, abstracts for 2013, and summaries of scientific articles that were published in 2012 or currently are "in press."

Standard Abbreviations Used

BW = body weight
CP = crude protein
dL = decaliter
DMI = dry matter intake
kg = kilogram
M = mole
MEI = ME intake
mm = millimeters
ng = nanogram
OM = organic matter
SE = standard error
wt = weight
vs = versus
cm = centimeters
d = day
DM = dry matter
g = gram
L = liter
ME = metabolizable energy
mL = milliliter
mo = month
NDF = neutral detergent fiber
P = probability
TDN = total digestible nutrients
vol = volume
µ = micro

Current Research Projects

Title:	Factors Influencing Goat Production and Products in the South-Central U.S.
Type:	USDA NIFA Evans-Allen
Project Number:	OKLXSAHLU2012
Period:	2012-2017
Investigators:	T. Sahlu, A. L. Goetsch, R. Puchala, R. C. Merkel, T. A. Gipson, S. P. Hart, S. Zeng, and Z. Wang
Institution:	Langston University
Objective:	Study goat feeding and management, relevant health issues, and milk product technologies in order to increase the level and efficiency of goat productivity for increased profitability from goat production and lower costs to consumers of goat products.

Title:	Impact of Sub-Clinical Mastitis on Production and Quality of Goat Milk and Cheese
Type:	USDA 1890 Institution Capacity Building - Research
Project Number:	OKLXSTEVEZENG2007
Period:	2007-2012
Investigators:	S. S. Zeng[1], D. Bannerman[2], and L. Spicer[3]
Institutions:	[1]Langston University, [2]USDA ARS Bovine Functional Genomics Laboratory, and [3]Oklahoma State University
Objectives:	1) Assess prevalence of subclinical mastitis in dairy goats during a year-round lactation in Oklahoma 2) Quantify and qualify losses in milk yield and cheese production associated ith subclinical mastitis test the impact of major types of CNS bacteria 3) Test the impact of major types of CNS bacteria species causing IMI (S. epidermidis, S. simulans, S. caprae, and S. chromogenes) on the inflammatory response in milk and to relate it to caseinolysis, coagulation properties, and cheese yield 4) Study the mechanism by which CNS affects caseinolysis and in turn the coagulation properties 5) Investigate changes in PL and SCC of milk caused by subclinical mastitis and their effects on milk coagulation, and cheese yield and texture

Title:	Boer Goat Selection for Residual Feed Intake
Type:	USDA 1890 Institution Capacity Building - Research
Project Number:	2008-38814-02661
Period:	2008-2012
Investigators:	T. A. Gipson[1], A. L. Goetsch[1], R. Puchala[1], T. Sahlu[1], and C. Ferrell[2]
Institutions:	[1]Langston University and [2]USDA ARS Meat Animal Research Center, Nutrition Research Unit
Objective:	1) Determine and demonstrate efficacy of use of residual feed intake to achieve genetic progress in improving efficiency of feed. utilization without elevating mature size or body fatness compared with selection based on growth rate. 2) Characterize relationships between residual feed intake and animal activities, feeding and social behaviors, and energy expenditure, and assess potential means of prediction of residual feed intake at an early age.

Title:	Establishing a Pilot Tannery and Capability for Goat Leather Research at Langston University
Type:	USDA 1890 Institution Capacity Building - Research
Project Number:	2008-38814-02520
Period:	2008-2012
Investigators:	R. C. Merkel[1] and C. K. Liu[2]
Institutions:	[1]Langston University and [2]USDA ARS Eastern Regional Research Center
Objective:	1) Establish a pilot tannery and capability for goat leather research at the LU campus 2) Determine the effects of goat breed, diet and age upon skin chemical composition and the mechanical properties of resulting leather 3) Evaluate environmentally friendly tanning methods on U.S. goat skins

Title:	Effects of Selected Nutritional Components on Immunity to Haemonchus in Goats
Type:	USDA 1890 Institution Capacity Building - Research
Project Number:	OKLXWANG10
Period:	2010-2014
Investigators:	Z. Wang[1], A. L. Goetsch[1], S. P. Hart[1], T. Sahlu[1], and G. Chen[2]
Institutions:	[1]Langston University and [2]Oklahoma State University
Objectives:	Investigate immune regulation by H. contortus and reversing this regulation by nutritional components in small ruminants

Title:	Establishing a Langston University Testing Center for Electric Fence Modifications of Cattle Barb Wire Fence for Goat Containment
Type:	USDA 1890 Institution Capacity Building - Research
Project Number:	OKLXGOETSCH10
Period:	2010-2014
Investigators:	A. L. Goetsch[1], T. A. Gipson[1], T. Sahlu[1], and J. Burke[2]
Institutions:	[1]Langston University, and [2]USDA ARS Dale Bumpers Small Farms Research Center
Objectives:	Develop a repeatable method of testing effectiveness of the various means of cattle fence modifications with electric fence for goat containment

Title:	Sustainable Small Ruminant Production Through Selection for Resistance to Internal Parasites
Type:	USDA 1890 Institution Capacity Building - Integrated Extension and Research
Project Number:	OKLXSAHLU12
Period:	2012-2015
Investigators:	T. Sahlu[1], A. L. Goetsch[1], T. A. Gipson[1], S. P. Hart[1], Z. Wang[1], J. M. Burke[2], R. Mateescu[3], and E. DeVuyst[3]
Institutions:	[1]Langston University, [2]USDA ARS Dale Bumpers Small Farms Research Center, and 3Oklahoma State University
Objectives:	1) Determine early progress in selection of small ruminants for resistance to internal parasitism 'on-station' and 'on-farm' 2) Characterize changes performance due to selection; develop and implement a new second generation central sire performance test for small ruminants at Langston University 3) Develop early-life genetic indicators of resistance and assess changes in physiological conditions affected by selection 4) Evaluate economic and management considerations of whole herd/flock selection; disseminate potential benefits of selection and associated economic and management considerations for adoption by small ruminant producers

Title:	Handbook for Livestock Research on Smallholder Farms in Developing Countries
Type:	USDA Scientific Cooperation Research Program
Period:	2012-2014
Investigators:	A. L. Goetsch[1], T. A. Gipson[1], R. C. Merkel[1], G. Abebe[2], A. Patra[3], D. Zhou[4], K. Al-Qudah[5], M. Huerta-Bravo[6], T. Sahlu[1], A. Degen[7], W. Getz[8], and Y. Tsukahara[1,9]
Institutions:	[1]Langston University, [2]Hawassa University, [3]West Bengal University and Animal and Fishery Sciences, [4]Northeast Institute of Geography and Agroecology, [5]Jordan University of Science and Technology, [6]Universidad Autónoma Chapingo, [7]Ben-Gurion University of the Negev, [8]Fort Valley State University, and [9]Kyoto University
Objectives:	A handbook for livestock research on smallholder farms in developing countries will be developed. Emphasis will be given to experimental design and data analysis. Input will be received from experts in different areas of the world (i.e., Ethiopia, India, China, Jordan, and Mexico), including regional cultural and social considerations.

2012 Experiments Active

Title:	Effects of emodin on cytokine expression in peripheral blood mononuclear cells stimulated by Haemonchus contortus antigen in vitro
Experiment Number:	RZ-11-20
Project Number:	OKLXWANG10
Investigators:	R. Zhong, Z. Wang, A. L. Goetsch, T. Sahlu, and D. Zhou
Objectives:	Determine whether emodin can alter cytokine expression in PBMC stimulated by H. contortus L3 antigen

Title:	Effects of the number of animals per pen and time of automated feeder access on feed intake, efficiency of feed utilization, and feeding behavior by yearling Boer wethers
Experiment Number:	YT-12-01
Project Number:	OKLX-SAHLU
Investigators:	Y. Tsukahara, A. L. Goetsch, T. A. Gipson, R. Puchala, and T. Sahlu
Objectives:	Determine effects of the number of animals per pen (maximal potential average feeder access per animal of 2 and 4 hours) and time of automated feeder access (continuous, night, and day) on feed intake, efficiency of feed utilization, and feeding behavior by yearling Boer wethers.

Title:	Evaluation of the efficacy of colostrum replacer in dairy kids
Experiment Number:	YT-12-02
Project Number:	OKLX-SAHLU
Investigators:	S. P. Hart, L. J. Dawson, S. Genova, and D. Haines
Objective:	Evaluate the efficacy of Land O'Lakes Colostrum Replacement as an antibody product for replacement of maternal colostrum in newborn kids

Title:	Development of a model to evaluate methods of modifying cattle barb wire fence with electric fence strands for goat containment - exposure of Boer and Spanish does to a fence only of barb wire between Latin square periods
Experiment Number:	YT-12-04
Project Number:	OKLXGOETSCH10
Investigators:	Y. Tsukahara, A. L. Goetsch, T. A. Gipson, J. Hayes, R. Puchala, and T. Sahlu
Objectives:	General: Determine appropriateness of conditions in a method to be developed for evaluating efficacy of electric fence additions to cattle barb wire fence for goat containment Specific: Determine effects of a washout treatment of exposure to a fence of barb wire only between measurement periods of a 5 × 5 Latin square on behavior of Boer and Spanish does in evaluation pens with different electric fence strand treatments

Title:	Development of a model to evaluate methods of modifying cattle barb wire fence with electric fence strands for goat containment - effects of breed, method of adaptation, and repeated exposure to electric fence strands on behavior of Boer and Spanish kids in evaluation pens with a complete randomized design
Experiment Number:	YT-12-06
Project Number:	OKLXGOETSCH10
Investigators:	Y. Tsukahara, A. L. Goetsch, T. A. Gipson, J. Hayes, R. Puchala, and T. Sahlu
Objectives:	General: Determine appropriateness of conditions in a method to be developed for evaluating efficacy of electric fence additions to cattle barb wire fence for goat containment Specific: Determine effects of different pre-trial or pre-treatment adaptation procedures on behavior of Spanish and Boer kids in evaluation pens with different electric fence strand treatments as well as use of a repeated measurement period after a relatively long interval

Title:	Effects of level of a source of brackish groundwater on feed intake, digestion, and efficiency of energy utilization by Boer and Spanish goat wethers
Experiment Number:	YT-12-07
Project Number:	OKLX-SAHLU
Investigators:	Y. Tsukara, R. Puchala, T. Sahlu, and A. L. Goetsch
Objectives:	Determine effects of level of a source of brackish groundwater on feed intake, digestion, and efficiency of energy utilization by Boer goats

Title:	Investigation of efficacy of Rumatel and Valbazen for control of anthelmintic resistant worms
Experiment Number:	SH-12-08
Project Number:	OKLXSAHLU12
Investigators:	S. P. Hart, T. A. Gipson, Y. Tsukahara, A. L. Goetsch, and T. Sahlu
Objectives:	Determine if feeding Rumatel for an extended period of time will remove resistant worms from animals and if Valbazen is necessary to achieve the desired level of efficacy

Abstracts

2013 National Meetings of the American Society of Animal Science (Journal of Animal Science, Volume 89 ESupplement 2; the American Society of Animal Science has copyright ownership and the Journal of Animal Science is the source of this information), July, 2013. Indianapolis, Indiana

Effects of stocking rate and physiological state of meat goats grazing grass/forb pastures on forage intake, selection, and digestion, grazing behavior, and performance

A. R. Askar[1,2], R. Puchala[1], T. Gipson[1], K. Tesfai[1], G. D. Detweiler[1], A. Asmare[1], A. Keli[3], T. Sahlu[1], A.L. Goetsch[1]

[1]American Institute for Goat Research, Langston University, Langston, OK.
[2]Animal and Poultry Nutrition Department, Desert Research Center, Cairo, Egypt
[3]Department of Animal Production and Pastoralism, National School of Agriculture, Meknes, Morocco

Effects of forage conditions with different stocking rates (SR) on performance and grazing behavior of goats could vary with animal physiological state, as influencing nutrient demand and usage. Boer goat does with 2 kids (D; 1 mo after kidding), growing wethers (G; 4 mo initial age), and yearling wethers (Y; 14 mo initial age) grazed 0.4-ha grass/forb pastures, with 1 animal per type in each pasture for a low SR and 2 for a high SR. The experiment started in late spring and was 114 d with 4 periods (P1-4). Forage mass was 2,517, 2,433, 2,506, and 2,452 kg/ha for the low SR and 2,680, 1,932, 1,595, and 1,393 kg/ha for the high SR in P1, P2, P3, and P4, respectively (SE=335). Botanical composition of the diet based on n-alkanes was similar among animal types (P>0.10). Likewise, chemical composition of forage samples did not differ between animal types (P>0.10), with averages of 11% CP and 53% NDF. Digestibility of OM based on C31 (hentriacontane) was greater (P<0.05) for the low than high SR (66.1 vs. 62.3%). Intake of ME was 1,015, 855, and 692 kJ/kg BW0.75 for D, G, and Y, respectively (SE=57.4) and greater for the low than high SR in P1 (1,204, 789, 682, and 445 for high SR and 1,732, 767, 683, and 531 kJ/kg BW0.75 for low SR in P1, P2, P3, and P4, respectively; SE=93.5). There was an interaction (P<0.05) between animal type and period in ADG (13, -12, -44, -8, 83, 25, -28, 73, 127, 51, -43, and -7 g; SE=21.5) and time spent grazing (7.5, 5.3, 7.4, 8.6, 78.6, 5.6, 10.0, 9.1, 4.8, 5.9, 8.4, and 9.5 h/d for D-P1, D-P2, D-P3, D-P4, G-P1, G-P2, G-P3, G-P4, Y-P1, Y-P2, Y-P3, and Y-P4, respectively; SE=0.88). Rate of ME intake was greater (P<0.05) for D vs. G and Y (49.5, 21.9, and 33.9 kJ/min for D, G, and Y, respectively; SE=5.68) and differed (P<0.05) among periods (57.5, 45.3, 24.8, and 12.9 kJ/min in P1, P2, P3, and P4, respectively; SE=5.17). In conclusion, with this forage of moderate nutritive value, there were no findings suggesting that levels of forage mass above 1,400 kg/ha would improve performance of meat goats of different physiological states.

Effects of level and length of supplementation on carcass amounts and percentages of ash, N, water, total fat, and energy

R. C. Merkel, T. A. Gipson, Z. Wang, and A.L. Goetsch

American Institute for Goat Research, Langston University, Langston, OK

Spanish (S; 28 - 40 wk of age) and Boer (B; 33 - 46 wk) wethers were used to determine effects of level and length of supplementation on carcass amounts and concentrations of ash, N, water, fat and energy. The experiment had 110 and 108 d periods (PR). Wethers resided on pastures with free-choice access to alfalfa hay and supplementation (SL) with 0.5 or 1.5% BW (DM basis; L and H, respectively) of a pelleted diet (16% CP and 60% TDN). Five S and 6 B were harvested initially, and 12 per breed (BR) and SL were harvested after PR 1 and 2. There were BR differences (P < 0.05) in initial BW (33.3 and 23.7 kg), carcass weight (15.4 and 10.9 kg) and amounts of ash (0.71 and 0.45 kg), protein (3.49 and 2.24 kg), fat (3.31 and 2.16 kg), and energy (211 and 137 MJ) for B and S goats, respectively. On a carcass basis B goats had a lower (P < 0.05) level of water (51.3 and 55.2%) but more energy than S goats (13.6 and 12.2 MJ/kg). H goats had greater (P ≤ 0.05) ash (0.97 and 0.87 kg), protein (4.1 and 3.5 kg), and water (12.7 and 11.5 kg) than L goats. H goats in PR2 had greatest (P < 0.05) amounts of fat (4.04, 3.65, 6.31, and 4.19 kg; SEM = 0.321) and energy (255, 227, 340, and 243 MJ for 1H, 1L, 2H, and 2L, respectively; SEM = 15.3), with corresponding differences in % carcass fat and energy/kg carcass. B goats had greater (P < 0.05) amounts of ash

(1.03 and 0.80 kg), water (13.7 and 10.5 kg), fat (5.79 and 3.32 kg), and energy (327 and 206 MJ) than S goats. Carcass protein was greater in B goats in PR1 than PR2 and greater than amounts in S goats (4.58, 4.01, 3.37, and 3.17 kg for 1B, 2B, 2S, and 1S, respectively; SEM = 0.177; $P < 0.05$). Carcass protein percentage was lowest ($P < 0.05$) for H goats in PR2 (20.1, 18.8, 16.0, and 16.9%, for 1B, 1S, 2B, and 2S, respectively). The differences in component amounts are in accord with those seen in carcass weight (23.6 and 20.4 kg for H and L; 25.5 and 18.5 kg for B and S; 20.3 and 23.8 kg for PR 1 and 2, respectively). In summary, SL and PR led to increased weights of carcass components and B goats appeared to accumulate fat in the carcass to a greater extent than S goats.

Effects of adaptation and meat goat breed in a method to evaluate electric fence additions to barb wire fence for goat containment

Y. Tsukahara, A. L. Goetsch, T. A. Gipson, J. Hayes, R. Puchala, and T. Sahlu

American Institute for Goat Research, Langston University, Langston, OK

Forty Boer (B) wethers (150 ± 2.7 d of age and 20 ± 0.7 kg BW initially), 40 B doelings (163 ± 1.5 d and 22 ± 0.4 kg), 33 Spanish (S) wethers (162 ± 1.7 d and 18 ± 0.6 kg), and 42 S doelings (163 ± 1.6 d and 15 ± 0.4 kg) were used to investigate effects of adaptation treatment (AT) on behavior when exposed to barb wire fence with different electric strand treatments. Breeds were divided into 2 sets with 5 groups of 3 to 4 animals. Five 2.4 × 3.7 m evaluation pens had 1 side with barb wire strands at 30, 56, 81, 107, and 132 cm from the ground. Fence treatments (FT) were electrified strands (6 kV) at 15 and 43 (LH), 15 and 23 (LM), 15 (L), 23 (M), and 43 cm (H). After all animals experienced evaluation pens without electric strands (NES), the AT were conducted with weekly exposures to evaluation pens: wk 1 - 1 strand at 0 kV, wk 2 - LH, wk 3 - LH, and wk 4 - NES for 1 set of each breed (BC and SC); wk 1 - NES, wk2 - 1 strand at 0 kV, wk 3 - L, and wk 4 - NES for the other set of B (BU); wk 1 - 1 strand at 0 kV, wk 2 - LH, wk 3 - LH, and wk 4 - LH for the other set of S (SU). The AT were designed based on initial behavior to achieve similar results with BU and SU and, presumably, differences between BC and SC. After AT, each group was exposed to 1 FT in period 1 and 7 wk later in period 2. The percentage of animals exiting evaluation pens differed ($P < 0.01$) among AT (5.5, 39.9, 60.6, and 0.0% for BC, BU, SC, and SU, respectively; SE = 1.18) and FT (9.1, 2.8, 15.4, 62.4, and 22.6% for LH, LM, L, H, and M, respectively; SE = 1.39). Period affected ($P < 0.05$) animals shocked without exit (4.2 and 12.6% in period 1 and 2, respectively; SE = 2.81) and ones exiting with shock (14.5 and 1.3%; SE = 3.47), but did not affect exit. In conclusion, use of the same AT for B and S resulted in different behavior when exposed to FT later and BU affected pen exit as anticipated. However, SU was highly prohibitive to exit regardless of period and would not be suitable for a method of evaluating different electric fence strand modifications of barb wire fence for goat containment.

Effects of levels of Boer goats and Dorper sheep on feed intake, digestibility, growth, and slaughter characteristics in the central highlands of Ethiopia

T. Mekonnen[1], K. Kefelegn[2], G. Abebe[3], and A. L. Goetsch[4]

[1]Sirinka Agricultural Research Center, Sirinka, Ethiopia
[2]Haramaya University, School of Animal and Range Sciences, Haramaya University, Haramaya, Ethiopia
[3]Ethiopia Sheep and Goat Productivity Improvement Program, Addis Ababa, Ethiopia
[4]American Institute for Goat Research, Langston University, Langston, OK

Twenty-seven male goats (6-9 mo) and 27 male sheep (3-5 mo) were used in 90-d experiments. Animals were indigenous or Local goat and sheep genotypes of the central highlands of Ethiopia (LG and LS, respectively) and crossbreds of Local with 25 and 50% Boer (B) goats or Dorper (D) sheep. Grass hay (9% ash, 6% CP, and 64-67% NDF) was consumed ad libitum supplemented with 2% BW (DM basis) of concentrate (46% noug seed cake, 28% wheat bran, 24% sorghum grain, and 2% salt; 8% ash, 24% CP, and 24% NDF). Initial BW was 18.1, 20.8, and 24.9 kg for Local, 25%B, and 50%B, respectively (SE=0.77) and 14.8, 20.3, and 17.9 kg for Local, 25%D, and 50%D, respectively (SE=0.74). Total DMI ranked ($P<0.05$) LG < 25%B < 50%B (675, 763, and 891 g/d) and LS < 50%D < 25%D (810, 1120, and 980 g/d for LS, 25%D, and 50%D, respectively). Goat ADG was greatest ($P<0.05$) for 50%B (32, 32, and 53 g for LG, 25%B, and 50%B, respectively) and of sheep was least ($P<0.05$) for LS (89, 132, and 126 g for LS, 25%D, and 50%D, respectively). Empty BW of goats at slaughter (17.6, 20.7, and 24.3 kg) and

hot (9.0, 10.9, and 12.8 kg) and cold carcass weights (8.7, 10.4, and 12.3 kg for LG, 25%B, and 50%B, respectively) ranked ($P<0.07$) LG < 25%B < 50%B. Slaughter BW of sheep was 22.8, 32.7, and 31.8 kg for LS, 25%D, and 50%D, respectively (SE=1.04). Likewise, hot (10.3, 16.6, and 15.3 kg) and cold carcass weights (9.9, 16.2, and 14.9 kg for LS, 25%D, and 50%D, respectively) were lowest for LS ($P<0.05$). In addition to the difference between 25%B and LG, these results show potential for greater meat yield with 50 vs. 25%B, which would be due to both the greater level of heterosis and higher level of B breeding. The findings also depict considerable opportunity for increased meat production by crossbreeding with D. However, greater benefit was not realized with 50 than 25%D as expected. Nonetheless, the results provide an example of marked improvement in performance possible with 25%D and, presumably, there would be little or no difference in adaptation to harsh production conditions between LS and 25%D.

Effect of a cellulase enzyme additive on hay intake and fiber digestion in goats

S. P. Hart

American Institute for Goat Research, Langston University, Langston, OK

Thirty-six Spanish, Boer, and Boer × Spanish wethers (6 months of age, 25.0 ± 5.5 kg BW) were used to test the effect of a cellulose/hemicellulase enzyme additive on intake and fiber digestion. Wethers were blocked by BW and breed and randomized to 4 pens with Calan headgates to measure individual intake. Wethers were fed a chopped low quality grass hay (4.8% CP, 48.4 ADF, and 75.3 NDF) at 115% of average intake over the previous 3 d. Two pens of goats were offered a test supplement containing the enzymes and two were offered the control supplement. The supplement was composed of 5% of a mineral mix containing trace minerals, 8% liquid molasses, 43% soybean meal, and 44% ground corn. The enzyme preparation (69% distillers dried grains, 30% urea, and 1% enzymes) was incorporated into the supplement at the 2% level. The supplement was fed at 5.5 g/kg BW, resulting in 8.8 g of enzyme preparation/100 kg BW. Blood and ruminal fluid samples were collected prior to the morning feeding in wk 4 of the study for blood urea nitrogen and rumen ammonia. Following the 12-wk intake study, intake was reduced in half the pens to 80% of intake in week 12, fecal bags were fitted on animals, and fecal and ort samples were collected 5 days for determining digestibility. Data were analyzed with Proc MIXED of SAS. Rumen ammonia and blood urea nitrogen were similar for control and enzyme treatments (6.8 vs. 7.1 mg/dl, SE = 0.38, $P > 0.20$; 13.8 vs. 15.2 mg/dl, SE = 2.3, $P > 0.20$). Hay intake was similar for control and enzyme treatments (2.63% vs. 2.83 % of BW, $P > 0.20$; 58.8 vs. 63.0 g/kg BW0.75, $P > 0.20$). Dry matter digestibility and protein digestibility were similar (52.8 vs. 53.5%, SE = 1.1, $P > 0.20$; 79.4 vs. 78.4%, SE = 0.8, $P > 0.20$). Neutral detergent fiber digestibility and acid detergent digestibility also were similar (49.8 vs. 50.6%, SE = 1.5, $P > 0.20$; 26.9 vs. 25.5%, SE = 3.3, $P > 0.20$). The cellulose and hemicellulase additive did not improve intake of low quality grass hay or increase fiber digestibility in goats.

Effects of conditions between periods of studies to evaluate electric fence additions to barb wire fence for goat containment

Y. Tsukahara, A. L. Goetsch, T. A. Gipson, J. Hayes, R. Puchala, and T. Sahlu

American Institute for Goat Research, Langston University, Langston, OK

Forty Boer (B, 3.7 ± 0.23 yr and 52 ± 1.4 kg) and 40 Spanish (S) does (3.0 ± 0.21 yr and 36 ± 0.7 kg) were used to evaluate effects of treatments between periods (IT) of a Latin square (LS) on behavior (e.g., pen exit and shock) when exposed to pens with barb wire fence and different electric fence strand additions. Breeds were split into 2 sets with 5 groups of 4 does. Five 2.4 × 3.7 m evaluation pens had 1 side of barb wire strands at 30, 56, 81, 107, and 132 cm from the ground. Fence treatments (FT) were electrified strands (6 kV) at 15 and 43 (LH), 15 and 23 (LM), 15 (L), 23 (M), and 43 cm (H). For adaptation, there was weekly short-term exposure to test pens with different electric fence strand additions (B: wk 1 - no electric strands (NES), wk 2 - NES, wk 3 - 1 strand at 0 kV, wk 4 - 1 strand at 2.5 kV, wk 5 - NES; S: wk 1 - NES, wk 2 - 1 strand at 0 kV, wk 3 - 1 strand at 3 kV, wk 4 - 1 strand at 4 kV). The adaptation scheme differed between breeds based on initial behavior to prevent very low or high levels of exit during the experiment. Behavior was assessed 1 h every 2 wk in the 5 × 5 LS with different FT. In the week between measurements, 1 set of each breed was exposed to a NES test pen (IT-Y) and other sets were not (IT-N). It was thought that periodic exposure to IT-Y might refresh memory of potential pen exit depending on the particular FT. There were

interactions (P < 0.05) in pen exit between IT and period (28, 38, 18, 0, and 18% with IT-Y and 45, 13, 0, 0, and 0% with IT-N in period 1, 2, 3, 4, and 5, respectively; SE = 4.9), fence treatment (5, 8, 15, 40, and 33% with IT-Y and 5, 3, 18, 23, and 10% with IT-N for LH, LM, L, H, and M, respectively; SE = 4.9), and breed (8 and 32% with IT-Y and 15 and 8% with IT-N for B and S, respectively; SE = 3.8). The IT also affected (P < 0.05) does receiving a shock (18 and 10%; SE = 2.4). In conclusion, exposing goats to barb wire fence without electric strands between measurement periods did have some desirable effects but, overall, was not adequate for use of a LS design to evaluate effectiveness of various electric strand additions for goat containment.

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GIS grid Analysis of utilization of adjacent pastures by two herds of goats

T. A. Gipson[1], S. P. Hart[1], and R. Heinemann[2]

[1]American Institute for Goat Research, Langston University, Langston, OK
[2]Kiamichi Forestry Research Station, Oklahoma State University, Idabel, OK

A 15.8-ha pasture was stocked with 36 Spanish goats and 12 Angus cows (GC), and a 14.1-ha pasture was stocked with 36 Spanish goats without cattle (GO) to observe spatial patterns. The pastures consisted of fescue, bermudagrass, various Panicum such as switchgrass, bahiagrass, and broomsedge bluestem, but areas were reverting to woody plant species such as sapling-sized trees of pecan, elm, and honey locust. GPS collars used recorded a fix every 5 minutes in the first 2 weeks. A GIS point-in-polygon analysis using a 10 × 10 m grid was conducted for each pasture. The GO had greater explored space compared with GC. Of the grids explored, GO had a higher percentage with a density of 100 or more fixes than did GC, indicating a wider area of methodical exploration or habituation. Goats in GO preferred pasture locations closer to the water point than did GC; however, GC came to the water point earlier than did GO. The favored location in the morning for each pasture was near the water point in the eastern intersection of the pastures. During the remainder of the day GC favored the southwestern-most corner of their pasture near a central fence line. In the afternoon, GO preferred the location near GC but also had a favorite location shaded by trees in the center of the pasture. The spatial behavior of the groups of goats appeared to be influenced by each other, and presence of cattle may have inhibited GC from fully exploring their pasture.

Different supplement treatments for lactating meat goat does grazing grass/forb pastures

A. L. Goetsch, G. D. Detweiler, Z. Wang, J. Hayes, K. Tesfai, and T. A. Gipson

American Institute for Goat Research, Langston University, Langston, OK

Lactating meat goats grazing 0.4-ha grass/forb pastures were used to determine effects on performance of different supplement treatments. Boer does with one or two kids were used in a study with four 4-week periods starting 22 days after birth. Treatments were no supplementation, access to a 20% protein supplement block, and placement in a supplement pasture with mimosa (Albizia julibrissin) trees for 6 hours 1 day/week or twice weekly for 3 hours/day. Forage mass was high and forage samples averaged 15 protein. Treatment did not affect doe average daily gain (ADG), although that by kids in the first three periods differed between type of supplement and frequency of supplement pasture access. Spanish does nursing two kids were used in a study with three 4-week periods starting 66 days after kidding. Access to supplement pastures was for 24 hours 1 day/week or 2 days for 6 hours/day. Forage mass was relatively low (i.e., 750 to 1,530 kg/ha) and, thus, grass hay was supplemented. Forage composition was similar to that earlier. Kid ADG in periods 1 and 2 was not affected by treatment. Doe ADG was increased by supplementation and greater with access to mimosa trees than the supplement block, which resulted from effects in period 3 after weaning rather than earlier. In conclusion, use of the supplement block was not beneficial, and infrequent access to supplement pastures had relatively small effects on average daily gain, perhaps because forage availability and nutritive value were not severely limiting.

Efficacy of a bovine colostrum replacement product for goat kids

S. P. Hart[1], S. Genova[2], D. M. Haines[3], and B. Bah[1]

[1]American Institute for Goat Research, Langston University, Langston, OK
[2]Boren Veterinary Teaching Hospital, Oklahoma State University, Stillwater, OK
[3]Department of Veterinary Microbiology, Western College of Veterinary Medicine and The Saskatoon Colostrum Co., Saskatoon, Saskatchewan, Canada

When adequate doe colostrum is not available for neonatal goat kids an alternative source of colostrum is necessary. The objective of this study was to determine the efficacy of a commercially available bovine colostrum replacement product (Land O'Lakes Colostrum Replacement manufactured by The Saskatoon Colostrum Co., Ltd., Saskatoon Canada) in neonatal goat kids. Goat kids were removed from the doe at birth and a jugular blood sample taken for analysis of serum IgG. The colostrum replacement was reconstituted with water. Kids were fed reconstituted colostrum replacement at 10% of their body weight divided into three feedings over a 16-hour period. Six hours after the last feeding another blood sample was collected for determination of serum IgG. Kids were observed for 10 minutes after each feeding for any adverse reactions. After the three feedings of colostrum kids were fed a milk replacer and offered starter feed. Health and weight gains were compared to other kids fed heat-treated goat colostrum up to 3 weeks of age. Postfeeding level of IgG was much greater than prefeeding, and the level post-feeding was the same for both colostrum treatments. There were no cases of scours or off-feed conditions. Weight gain was similar for both treatments as well. In conclusion, the bovine colostrum substitute resulted in satisfactory blood levels of IgG and kids that were equally healthy to cohorts and gained similarly.

Effects of level and length of supplementation on body weight and harvest characteristics of yearling Boer and Spanish wethers

R. C. Merkel, T. A. Gipson, Z. Wang, and A. L. Goetsch

American Institute for Goat Research, Langston University, Langston, OK

Yearling Spanish and Boer wethers were used to determine effects of level and length of supplementation on body weight and harvest characteristics. The experiment started in January, with wethers residing in four pastures primarily with warm season grasses. Alfalfa hay was given free-choice and a pelleted diet was supplemented at 0.5 or 1.5% of body weight. Wethers were harvested at the beginning of the study and after 110 and 218 days. Live and carcass weight were greater initially for Boer than for Spanish wethers. Average daily gain was greater for Boer vs. Spanish wethers in the first part of the study but was similar thereafter. Body weight was greater with the high than low level of supplementation, as was also true for weight of the carcass and noncarcass components. Digestive tract and mass relative to empty body weight were similar between breeds. Liver mass was lower for the high vs. low level of supplementation and less at the end of period 2 than 1. Mass of internal fat was increased by the high level of supplementation in period 2 but not period 1. In summary, advantages of Boer in body weight and carcass weight were similar after period 1 and 2, breed had little effect on noncarcass components relative to empty body weight, and a long feeding period was required for effect of the high level of supplementation on mass of internal fat.

Ruminal methane emission by Boer and Spanish does supplemented with garlic

R. Puchala, Z. Wang, A. L. Goetsch, and T. Sahlu

American Institute for Goat Research, Langston University, Langston, OK

Twenty Boer (B; 2-7 yr of age and 48.5 ± 2.2 kg) and 20 Spanish (S; 4-6 yr of age and 39.3 ± 1.5 kg) does were used to examine effects of garlic on ruminal methane emission and heat production. Ten does of each breed were randomly allocated to control (C) and garlic (G) treatments. All does received 200 g/d (as-fed basis) of a concentrate mixture consisting of 54.4%

ground corn, 26.0% soybean meal, 12.9% molasses, and 6.7% mineral and vitamin sources. The G does also received 20 g/d (as-fed basis) of garlic powder. For at least 2 mo does grazed grass/forb pastures in the summer. Thereafter, sets of 4 does consisting of 1 doe per treatment (CB, CS, GB, and GW) were sequentially placed in metabolism crates for 2 wk, continued to receive supplements, and were fed coarsely ground alfalfa hay free-choice. Gas exchange was measured on the last day for 24 h in an indirect, open circuit respiration calorimetry system with 4 metabolism cages fitted with head-boxes. There were no interactions between breed and supplement treatment ($P > 0.05$). Alfalfa hay DMI during the calorimetry measurement period was greater ($P < 0.05$) for G vs. C (781, 742, 934, and 853 g/d for CB, CS, GB, and GS, respectively; SEM = 29). Ruminal methane emission was less ($P < 0.05$) for G than for C in g/d (12.0, 10.8, 8.5, and 6.4, respectively; SEM = 0.56) and relative to intake of DM (15.2, 14.6, 9.1, and 7.6 g/kg; SEM = 0.44) and GE (4.31, 4.12, 2.58, and 2.14% for CB, CS, GB, and GS, respectively; SEM = 0.124). Treatment did not affect ($P > 0.05$) respiratory quotient (1.012, 1.004, 1.003, and 0.994), heart rate (73, 72, 72, and 70; SEM = 1.6), heat production (450, 444, 447, and 432 kJ/kg BW0.75; SEM = 10.7), or the ratio of heat production:heart rate (6.18, 6.19, 6.18, and 6.21 kJ/kg BW0.75 per heart beat for CB, CS, GB, and GS, respectively; SEM = 0.056). In conclusion, supplementation with garlic decreased ruminal methane emission and increased DMI by Boer and Spanish does consuming alfalfa hay.

Effects of meat goat breed, gender, and conditions before and between measures on behavior in pens with barb wire and electric fence strands

Y. Tsukahara, T. A. Gipson, G. D. Detweiler, T. Sahlu, A. L. Goetsch

American Institute for Goat Research, Langston University, Langston, OK

Growing meat goats of 4 types (Boer (B) wethers and doelings, 25 ± 1.0 and 22 ± 0.7 kg; Spanish (S) wethers and doelings, 17 ± 0.3 and 16 ± 0.2 kg, respectively) were used to evaluate conditions for a method to test efficacy of electric fence strand addition to barb wire fence for cattle to contain goats. Animals were allocated to 8 sets of 20, consisting of 5 groups/set and 1 animal type/group. There were 5 2.4 × 3.7 m test pens consisting of 3 sides of metal panels and 1, adjacent to a pasture with abundant vegetation, of barb wire strands at 30, 56, 81, 107, and 132 cm from the ground. Fence treatments were electric strands at 15 and 43 (LH), 15 and 23 (LM), 15 (L), 23 (M), and 43 cm (H) at 6 kV. Adaptation procedures entailed 4 sequential weekly exposures to test pens: no electric strands, 1 strand at 0 kV, LH, and LH. Two preliminary treatments were imposed the week before the first observation period in wk 1: barb wire with no electric strands vs. LH. All sets were observed for 1 h in wk 1, and 4 sets were exposed to the same fence treatment in wk 6. During the 5 wk between observations, sets were exposed to 2 washout treatments while on pasture: without or with electric strands at ≥ 6 kV situated next to concentrate feeders. There were no effects of gender, preliminary, or washout treatments ($P > 0.05$). The % of animals exiting test pens differed ($P < 0.05$) among fence treatments in wk 1 (25, 47, 38, 66, and 84%; SE = 7.7) and in wk 1 and 6 (6, 22, 22, 63, and 81% for LH, LM, L, H, and M, respectively; SE = 4.9) and between breeds in wk 1 (34 and 70%) and in wk 1 and 6 (28 and 50% for B and S, respectively). The % receiving a shock was similar among fence treatments in wk 1 and in wk 1 and 6, although for the latter analysis the value was greater ($P < 0.05$) in wk 1 vs. 6 (11 vs. 1%). In conclusion, dissimilar behavior of B and S is a consideration for the testing method being developed and adaptation procedures employed appeared generally conducive to use of an experiment with one observation period, whereas repeated observations would necessitate evaluation of other washout treatments.

Anthelmintic efficacy of medicinal herbs in goats infected with nematode parasites

R. Z. Zhong[1,2], Z. Wang[2], D. Zhou[1], A. L. Goetsch[2], S. Hart[2], and T. Sahlu[2]

[1]Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun, China
[2]American Institute for Goat Research, Langston University, Langston, OK

Thirty high-percentage Boer does (2.9 ± 0.12 yr; 48 ± 1.9 kg BW) naturally infected with Haemonchus contortus from grazing pasture of Langston University were allocated to 5 groups and moved to a barn to investigate anthelmintic efficacy of three medicinal herbs, Rheum palmatum L. (rhubarb; R), Meliae cortex (melia bark; M), and Quisqualis indica L. (rangoon creeper; Q). Does were given ad libitum access to grass hay and water, along with 200 g/d per doe of a concentrate-based pelleted

supplement. Treatments were control (C), R, M, Q, and a 1:1:1 mixture of the three herbs (RMQ). The herbs in powder form were mixed with water at 20 g/100 mL just before drenching. After being acclimated for 7 d, does were drenched with 100 mL of water alone or with the respective herbs at 20 g/d for 10 d. Fecal samples were collected on d 0, 3, 6, 9, 13, and 16 after the start of drenching for worm egg count (FEC). Blood samples were taken on d 0 and 13 for measuring packed cell volume (PCV). Initial FEC was 2,208, 3,933, 3,025, 2,350, and 3,033/g for C, R, M, Q, and RMQ, respectively (SEM = 425.2; $P > 0.05$). After 10 d of treatment, none of the herbs showed anthelmintic effects. The FEC on d 16 was 1,350, 3,058, 1,525, 825, and 2,067/g for C, R, M, Q, and RMQ, respectively (SEM = 332.9, $P > 0.05$). Change in PCV was 1.8, 20.1, 9.1, 10.7, and 13.3% for C, R, M, Q, and RMQ, respectively (SEM = 1.68). Compared with C, the PCV value increased in does treated with R and RMQ ($P < 0.05$); however, the increases may have been due to scouring in response to treatment with R. In conclusion, these herbs were not effective anthelmintics for the most problematic internal parasite of goats, H. contortus, in much of the US.

Summaries of Recent Journal Articles
(2012 and In Press)

Effects of concentrate supplementation on growth performance of Arsi-Bale and Boer × Arsi-Bale male goats consuming low-quality grass hay

Mohammed, S., M. Urge, G. Animut, K. Awigechew, G. Abebe, and A. L. Goetsch

Tropical Animal Health and Production 6:1181-1189. DOI:10.1007/s11250-01100056-2. 2012

Eighteen Arsi-Bale (Local) and 18 Boer × Arsi-Bale (Crossbred) male goats, initially approximately 10 months of age, were used in a 12-wk experiment to investigate potential interactions between genotype and nutritional plane in growth performance, carcass and skin characteristics, and mass of non-carcass components. Grass hay (6.7% crude protein and 71.9% neutral detergent fiber) was consumed ad libitum supplemented with 150, 300, or 450 g/day (dry matter; Low, Moderate, and High, respectively) of a concentrate mixture (50% wheat bran, 49% noug seed cake, and 1% salt). Initial body weight was 20.7 and 14.0 kg for Crossbred and Local goats, respectively (SE = 0.36). Hay dry matter intake was greater ($P < 0.05$) for Crossbred vs. Local goats (461 and 429 g/day) and similar among concentrate levels (438, 444, and 451 g/day for High, Moderate, and Low, respectively; SE = 4.7). Average daily gain was greater ($P < 0.05$) for Crossbred than for Local goats (36.6 and 20.8 g) and differed ($P < 0.05$) among each level of concentrate (43.7, 29.6, and 12.8 g for High, Moderate, and Low, respectively). Dressing percentage was similar between genotypes (41.1 and 41.1% live body weight for Crossbred and Local goats, respectively; SE = 0.59) and greater ($P < 0.05$) for High vs. Low (43.5 vs. 38.7% live body weight). Carcass weight differed ($P < 0.05$) between genotypes (9.23 and 6.23 kg for Crossbred and Local goats, respectively) and High and Low (8.80 and 6.66 kg, respectively). Carcass concentrations of physically dissectible lean and fat were similar between genotypes and High and Low concentrate levels. There were few differences between genotypes or concentrate levels in other carcass characteristics such as color and skin properties. Relative to empty body weight, mass of most non-carcass tissues and organs did not differ between genotypes. However, with the Low concentrate level mass of omental-mesenteric fat was greater ($P < 0.05$) for Local vs. Crossbred goats (1.06 vs. 0.54% empty body weight, respectively). In conclusion, growth performance and carcass weight advantages from crossing Boer and Arsi-Bale goats were similar with a low-quality basal grass hay diet regardless of level of supplemental concentrate.

Effects of small ruminant type and level of intake on metabolism

Asmare, A., R. Puchala, K. Tesfai, G. Detweiler, L. Dawson, A. Askar, Z. Wang, and A. L. Goetsch

Small Ruminant Research 102:186-190. 2012

Boer (BG) and Spanish goat (SG) and Rambouillet sheep (RS) wethers, ≥ 2.5 yr of age, consumed grass hay ad libitum (AL) or in restricted amounts (RI). Initial BW was 50, 74, and 40 kg for BG, RS, and SG, respectively. Intake of ME was 276, 230, and 281 kJ/kg BW0.75 for BG, SG, and RS (SE = 10.2) and 209 and 316 kJ/kg BW0.75 for RI and AL, respectively (SE = 7.7). Change in BW was lowest ($P < 0.05$) among animal types for RS (-0.18, -0.29, and -0.14 kg/day for BG, RS, and SG, respectively). Digestibility of NDF was similar among animal types. Total energy expenditure (EE) in kJ/kg BW0.75 was greatest ($P < 0.05$) among animal types for BG (363, 335, and 335 kJ/kg BW0.75 for BG, RS, and SG, respectively) and similar between levels of intake. Energy expenditure in MJ/day by the portal-drained viscera (PDV) (1.43, 1.25, and 1.17 MJ/day; SE = 0.118) and liver (1.16, 1.14, and 1.08 MJ/day; SE = 0.149) was similar among animal types. Both PDV (1.44 vs. 1.12 MJ/day) and liver EE (1.50 vs. 0.76 MJ/day) were greater ($P < 0.05$) for AL vs. RI. Net fluxes of ammonia N across the PDV (3.1, 2.4, and 3.0 g/day, SE = 0.50; 2.9 and 2.7 g/day, SE = 034) and liver (-4.1, -3.5, and -3.8 g/day for BG, RS, and SG, respectively (SE = 0.63); -4.3 and -3.2 g/day for AL and RI, respectively (SE = 0.48)) were similar among animal types and between levels of intake. Net flux across the PDV of UN was greatest among animal types ($P < 0.05$) for RS (-4.0, -1.4, and -3.6 g/day for BG, RS, and SG, respectively) and similar between intake levels (-3.5 and -2.5 g/day for AL and RI, respectively; SE = 0.47). Net flux of UN across the liver was similar among animal types (3.1, 3.3, and 5.2 g/day for BG, RS, and SG, respectively; SE = 1.34) and between intake levels (5.2 and 2.5 g/day for AL and RE, respectively; SE = 1.02). In conclusion, some findings indicate that with limited nutritional planes of this experiment, sheep were less able to reduce EE than goats, which may have involved differences in extra-splanchnic tissue metabolism. Likewise, N recycling appeared less extensive for sheep vs. goats, but to a magnitude less than to impact fiber digestion.

Conditions to test electric fence additions to cattle barb wire fence for goat containment
Goetsch, A. L., G. D. Detweiler, R. Puchala, T. Sahlu, and T. A. Gipson
Journal of Applied Animal Research 40:43-55. 2012

Two experiments were conducted to determine appropriateness of conditions in a method being developed for evaluating efficacy of different electric fence additions to cattle barb wire fence for goat containment. In Experiment 1, two 6 × 6 Latin squares (LS), each with 24 yearling Boer goat doelings previously exposed to electric fence, were conducted. After overnight fasting, groups of four doelings were placed in 2.4 × 2.4 m pens without forage. One pen side was five strands of four-point barb wire (non-electrified) at 31, 56, 81, 107, and 132 cm from the ground adjacent to a pasture with abundant vegetation. One LS had periods 2-3 days in length and the other 7 days. Electric fence treatments for each square were addition to barb wire fence of four electric fence strands 15, 28, 43, and 58 cm from the ground at low voltage of 4-4.5 kV (4S-LV); two strands at 15 and 43 cm and high voltage of 8.5-9 kV (2S-HV); two strands at 15 and 43 cm and low voltage (2S-LV); one strand at 15 cm and low voltage (1S-LH-LV); 1 strand at 43 cm and low voltage (1S-HH-LV); and 1 strand at 23 cm and high voltage (1S-MH-HV). Percentages of doelings exiting (6 and 4%) and shocked in 2 h (15 and 16% for 7 and 2-3 days, respectively) were low and did not differ between period lengths. The percentage of doelings exiting in 2 h was not affected by fence treatment. Period of squares affected ($P < 0.05$) the percentage of doelings shocked (54, 25, 4, 6, 0, and 4% for periods 1, 2, 3, 4, 5, and 6, respectively). Experiment 2 was with 30 Boer and 30 Spanish growing doelings in the same study area. Because of less than anticipated shock and exit in Experiment 1, some conditions were changed, including a defined period of exposure to electric fence, training for pen exit before the experiment, and longer fasting (24 or 36 h). Fence treatments were those of Experiment 1 but without 4S-LV and with slightly lower voltage. Doelings were divided into three sets of 20 and used in a completely randomized design (CRD), and one set continued repeated exposure to the different fence treatments in a 5 × 5 LS. Thereafter, period 1 was repeated in period 6. For the CRD approach, the percentage of doelings exiting in 1 h was greater than 90%. With the LS method the percentage of doelings exiting also was similar among fence treatments but was 75, 70, 40, 70, and 75% for 2S-HV, 2S-LV, 1S-LH-LV, 1S-HH-LV, and 1S-MH-HV, respectively. With a comparison involving doeling sets used in the LS, the percentage of doelings shocked was lower ($P < 0.05$) in period 6 vs. 1 (5 vs. 50%), although there was no difference with doelings not used in the LS. In conclusion, results were not promising for successful use of a LS approach, and large differences between experiments in levels of shock and exit indicate need for further change in conditions.

Optimum duration of performance testing for growth, feed intake, and feed efficiency in growing Boer bucks
Hu, W., T. A. Gipson, S. P. Hart, L. J. Dawson, T. Sahlu, and A. L. Goetsch
Small Ruminant Research 104:114-121. 2012

Central performance testing of meat goats has increased in popularity recently, but minimum test duration has not been ascertained to ascertain accurately performance traits.. This study was conducted to determine the minimum length of time required for accurate evaluation of growing Boer bucks for ADG, DMI, DMI/BW0.75, and feed efficiency as assessed by ADG:feed intake and residual feed intake. Data were collected from 425 bucks in Langston University tests lasting 84 d from 2000 to 2009. Bucks averaged 111 ± 25 d of age and 27 ± 8 kg BW at the beginning of the test, consumed a pelletized 50% concentrate diet ad libitum, and were weighed weekly. Daily feed intake was determined with Calan gates (American Calan, Inc., Northwood, NH) or automated MK3 FIRE (Feed Intake Recording Equipment, Osborne Industries Inc., Osborne, KS). Weekly data of five performance traits were analyzed using the MIXED procedure of SAS with a repeated-measures model. Residual variance relative to that at 84 d (%) for the goats fed with Calan gates was 358, 293, 235, 193, 153, 127, 116, and 107% for ADG, 184, 173, 161, 149, 136, 123, 113, and 106% for DMI, 374, 317, 256, 203, 161, 137, 118, and 107% for DMI/BW0.75, 445, 320, 225, 162, 135, 124, 111, and 105% for ADG:feed intake, and 174, 154, 143, 128, 113, 107, 103, and 102% for residual feed intake at 28, 35, 42, 49, 56, 63, 70, and 77 d, respectively. Residual variance relative to that at 84 d (%) for the goats fed with FIRE was 286, 221, 192, 174, 154, 134, 125, and 110% for ADG, 111, 113, 111, 112, 111, 107, 106, and 105% for DMI, 176, 155, 144, 130, 120, 110, 110, and 110% for DMI/BW0.75, 373, 258, 216, 171, 134, 119, 114, and 106% for ADG:feed intake, and 114, 101, 103, 95, 94, 92, 98, and 103% for residual feed intake at 28, 35, 42, 49, 56, 63, 70, and 77 d, respectively. Under either Calan gates or FIRE feeding conditions, the duration of Boer buck performance tests could be decreased from the standard 84 to 63 d with little loss in accuracy.

Effects of form of leftover khat (Catha edulis) on feed intake, digestion, and growth performance of Hararghe Highland goats

Wallie, M., Y. Mekasha, M. Urge, G. Abebe, and A. L. Goetsch
Small Ruminant Research 102:1-6. 2012

Khat (Catha edulis) is a lucrative cash crop in many African countries and other areas of the world. Leftover khat can be used as a feedstuff for ruminants, although seasonal production limits the extent of utilization. Practical methods of feed conservation to preserve nutritional value would be beneficial. Thus, a study was conducted to investigate effects of feeding different forms of leftover khat on intake, digestion, and growth performance of a tropically adapted indigenous goat genotype of eastern Ethiopia. Twenty-four (six per treatment) individually housed Hararghe Highland yearling male goats with an initial body weight of 18 ± 0.4 kg were used in an on-station experiment, and 32 similar yearlings with an initial body weight of 19 ± 0.4 kg were employed under on-farm conditions. The on-farm experiment occurred at two villages, with four farmer groups (two farmers per group co-managing animals) per village. Four animals in each farmer group were subjected to each of the four different treatments. Experiments were 90 days in length, with inclusion of a subsequent 10-day period on-station to determine digestibility. Khat in fresh, dry, and silage forms was fed at 1.5% body weight (dry matter; DM), whereas control animals did not receive khat. Animals on-station consumed grass hay ad libitum and those on-farm grazed/browsed surrounding areas. Grass hay DM intake on-station was greater ($P < 0.05$) without than with khat (528, 358, 387, and 368 g/day; SE = 20.3), although total DM intake was increased by feeding khat regardless of form (528, 649, 622, and 639 g/day for control, fresh, dry, and silage, respectively; SE = 22.9). Digestibility of organic matter was increased ($P < 0.05$) by feeding each form of khat (62.3, 75.7, 75.2, and 72.4% for control, fresh, dry, and silage, respectively; SE = 1.63). Nitrogen balance was increased by fresh and ensiled khat ($P < 0.05$) (-0.54, 2.07, 0.80, and 0.86 g/day for control, fresh, dry, and silage, respectively). Average daily gain (ADG) was increased by khat regardless of form on-station (13, 49, 33, and 39 g; SE = 4.6), and on-farm ADG was less for control than for fresh and dry forms ($P < 0.05$) (32, 56, 47, and 42 g for control, fresh, dry, and silage, respectively SE = 2.0). The ratio of ADG:DM intake on-station was lower for control than for fresh ($P < 0.05$) and silage ($P < 0.05$) (26, 76, 54, and 61 g/kg for control, fresh, dry, and silage, respectively; SE = 7.6). In conclusion, feeding leftover khat to Highland goats consuming low to moderate quality forage-based diets can increase growth performance. Khat can be preserved for use as a feedstuff throughout the year by drying or ensiling without marked effect on performance.

Use of global positioning system collars to monitor spatial-temporal movements of co-grazing goats and sheep and their common guardian dog

Gipson, T. A., T. Sahlu, M. Villaquiran, S. P. Hart, J. Joseph, R. C. Merkel, and A. L. Goetsch
Journal of Applied Animal Research 40:354-369. 2012

Goats and sheep often graze together and guardian dogs are commonly used for protection from predators. The objective of this experiment was to characterize how goats, sheep, and guardian dogs interact spatially when grazing the same pasture by use of global positioning system (GPS) collars as an unobtrusive means of behavior monitoring. In 2002 and 2003, three meat goats and two sheep in a group of 12 of each species were randomly chosen and, along with a guard dog, fitted with GPS collars. Minimum distance traveled between consecutive 30-min fixes and distance between any two animals at the same fix time were calculated using spherical geometry. In 2002, the dog traveled the least between fixes during the day but more at night than either goats or sheep. However, in 2003 there was not a significant species difference in distance traveled in 24 h or during the day or night. All species traveled significantly more during day than night but none were stationary at night. Distance among goats and between sheep tended to be greater during day than night; distance between goats and sheep was greater than the distance among goats or between sheep. Hence, goats and sheep interacted as two separate entities rather than as one large herd/flock. Distance between the dog and goats was closer than between the dog and sheep, indicating a clear preference of the dog for goats that could relate to a difference in previous exposure to the two species. In summary, based on these findings protection by a guardian dog would be greater for a small group of goats than sheep and much greater than for a mixed species group. Or, with a large group of grazing animals the number of dogs required for a certain level of protection would rank goats < sheep < mixture of goats and sheep.

Effects of different fresh-cut forages and their hays on feed intake, digestibility, heat production, and ruminal methane emission by Boer × Spanish goats

R. Puchala, G. Animut, A. K. Patra, G. D. Detweiler, J. E. Wells, V. H. Varel, T. Sahlu, and A. L. Goetsch
Journal of Animal Science 90:2754-2762. 2012

Twenty-four yearling Boer × Spanish wethers were used to assess effects of different forages, either fresh (Experiment 1) or as hay (Experiment 2), on feed intake, digestibilities, heat production, and ruminal methane emission. Treatments were (1) Sericea lespedeza (Lespedeza cuneata), a legume high in condensed tannins (CT; 20 and 15% in fresh forage and hay, respectively) (SER), (2) SER supplemented with polyethylene glycol (25 g/d) (SER-PEG), (3) alfalfa (Medicago sativa), a legume low in CT (ALF), and (4) sorghum-sudangrass (Sorghum bicolor), a grass low in CT (GRASS). Experiments were 22 d, which included 16 d for acclimatization followed by a 6-d period for fecal and urine collection and gas exchange measurement (last 2 d). Intake of OM was 867, 823, 694, and 691 g/d (SEM = 20.1) with fresh forage and 806, 887, 681, and 607 g/d with hay for SER, SER-PEG, ALF, and GRASS, respectively (SEM = 46.6). Apparent total tract N digestion was greater for SER-PEG vs. SER ($P < 0.001$) with fresh forage (46.3, 66.5, 81.7, and 73.2%; SEM = 1.71) and hay (49.7, 71.4, 65.4, and 54.8% for SER, SER-PEG, ALF, and GRASS, respectively; SEM = 1.57). Intake of ME was similar among treatments with fresh forage (8.24, 8.06, 7.42, and 7.70 MJ/d; SEM = 0.434), and with hay was greater for SER-PEG than for ALF ($P < 0.03$) and GRASS ($P < 0.001$) (8.63, 10.40, 8.15, and 6.74 MJ/d for SER, SER-PEG, ALF, and GRASS, respectively; SEM = 0.655). The number of ciliate protozoa in ruminal fluid was lowest for SER with fresh forage ($P < 0.01$) (9.8, 20.1, 21.0, and 33.6 × 105/ml; SEM = 2.76) and hay ($P < 0.02$) (6.3, 11.4, 13.6, and 12.5 × 105/ml for SER, SER-PEG, ALF, and GRASS, respectively; SEM = 1.43). Methane emission as a % of DE intake was lower ($P < 0.01$) for SER vs. ALF and GRASS with fresh forage (6.6, 8.3, 9.4, and 9.2; SEM = 0.64) and hay (4.3, 4.9, 6.4, and 6.7 for SER, SER-PEG, ALF, and GRASS, respectively; SEM = 0.38). In summary, methane emission in this short-term experiment was similar between a legume and grass low in CT as fresh forage and hay. The CT in SER markedly decreased N digestibility and elicited a moderate decline in ruminal methane emission. Supplementation with PEG alleviated the effect of CT on N digestibility but not ruminal methane emission presumably because of different modes of action. In conclusion, potential of using CT-containing forage as means of decreasing ruminal methane emission requires further study, such as with longer feeding periods.

Methane emissions by goats consuming Sericea lespedeza at different frequencies

R. Puchala, G. Animut, A. K. Patra, G. D. Detweiler, J. E. Wells, V. H. Varel, T. Sahlu, and A. L. Goetsch
Animal Feed Science and Technology 175:76-84. 2012

Twenty-four yearling Boer (87.5%) × Spanish wethers (32.5 ± 0.36 kg body weight) were used in a 32 d experiment to assess effects of frequency of feeding condensed tannin (CT)-containing Sericea lespedeza (SL; Lespedeza cuneata) on ruminal methane emission. Fresh SL (153 g/kg CT) was fed at 1.3 times the metabolizable energy requirement for maintenance every day (1SL), other day (2SL), fourth day (4SL), and eighth day (8SL), with alfalfa (Medicago sativa) offered at the same level on other days. Ruminal fluid for microbial assays was collected 1 d after SL feeding and at the end of the feeding interval (short and long interval samples, respectively). Dry matter intake was not affected by frequency of SL feeding. Daily ruminal methane emissions increased at a decreasing rate (Linear and Quadratic; $P<0.01$) as frequency of SL feeding decreased (6.3, 7.4, 10.5, 12.0 g/d for 1SL, 2SL, 4SL, and 8SL, respectively), but emissions on days when SL was fed were not affected by SL feeding frequency (6.3, 6.4, 6.7, 7.0 g/d, respectively). There were carryover effects of feeding SL on ruminal methane emissions. For example, with 8SL ruminal methane emission did not reach a maximum until day 5 to 6, or 4 to 5 days after SL was first fed. Energy in ruminally emitted methane relative to digestible energy intake increased linearly ($P<0.05$) as frequency of SL feeding decreased (49, 48, 66, 81 kJ/MJ for 1SL, 2SL, 4SL, and 8SL, respectively. The number of protozoa in the short interval sample was not affected by frequency of feeding SL (5.2, 5.3, 5.7, 6.5 × 105/ml), whereas the number in the long interval sample increased at a decreasing rate (Linear $P<0.01$; Quadratic $P=0.02$) as frequency of SL feeding decreased (6.5, 10.4, 18.4, 20.5 × 105/ml for 1SL, 2SL, 4SL, and 8SL, respectively). In vitro methane emissions (3 wk incubation in serum bottles for methanogens; indicative of methanogen presence and activity in ruminal fluid) was lower for short than for long samples (19.0 and 24.2 ml, respectively) and increased linearly ($P<0.05$) as frequency of SL feeding decreased (19.3, 19.3, 23.0, 24.8 for 1SL, 2SL, 4SL, and 8SL, respectively). In conclusion, the influence of CT containing SL on ruminal methane emission was immediate and short-lived, and the effect appeared attributable to activity of methanogenic bacteria and possibly ciliate protozoa.

Effects of stocking rate and physiological state of meat goats grazing grass/forb pastures on forage intake, selection, and digestion, grazing behavior, and performance

A. R. Askar, T. A. Gipson, R. Puchala, K. Tesfai, G. D. Detweiler, A. Asmare, A. Keli, T. Sahlu, and A. L. Goetsch
Livestock Science (In press; available March 21 at http://dx.doi.org/10.1016/j.livsci.2013.02.015). 2013

Effects of forage conditions with different stocking rates on performance and grazing behavior of goats could vary with animal physiological state, as influencing nutrient demand and usage. Therefore, Boer goat does nursing two kids (D; 1 month after kidding), growing wethers (G; 4 month initial age), and yearling wethers (Y; 14 month initial age) grazed 0.4-ha grass/forb pastures, with one animal per type in each pasture (four per stocking rate; SR) for a low SR and two for the high SR. The experiment started in late spring and was 114 days in length, with four periods of 33, 28, 30, and 23 days (P1, P2, P3, and P4, respectively). Data were analyzed by mixed models with a repeated measure of period. Forage mass was 2517, 2433, 2506, and 2452 kg/ha for the low SR and 2680, 1932, 1595, and 1393 kg/ha for the high SR in P1, P2, P3, and P4, respectively (SE=335.1). Botanical composition of the diet determined from n-alkane concentration in simulated grazed forage samples and feces was similar among animal types (P>0.10). Likewise, chemical composition of forage samples did not differ between animal types (P>0.10), with average dietary levels of 11% CP and 53% NDF. Digestibility of OM, determined from the concentration of the n-alkane hentriacontane (C31) in forage samples and feces, was greatest for growing wethers (P<0.05; 63.5, 67.2, and 62.0% for D, G, and Y, respectively) and greater (P<0.05) for the low than high SR (66.1 vs. 62.3%). Intake of ME estimated from digestibility and fecal output was 1015, 855, and 692 kJ/kg BW0.75 for D, G, and Y, respectively (SE=57.4) and greater for the low than high SR in P1 (1204, 789, 682, and 445 for high SR and 1732, 767, 683, and 531 kJ/kg BW0.75 for low SR in P1, P2, P3, and P4, respectively; SE=93.5). There was an interaction (P<0.05) between animal type and period in ADG (13, -12, -44, -8, 83, 25, -28, 73, 127, 51, -43, and -7 g; SE=21.5) and time spent grazing (7.5, 5.3, 7.4, 8.6, 78.6, 5.6, 10.0, 9.1, 4.8, 5.9, 8.4, and 9.5 h/d for D-P1, D-P2, D-P3, D-P4, G-P1, G-P2, G-P3, G-P4, Y-P1, Y-P2, Y-P3, and Y-P4, respectively; SE=0.88). Rate of ME intake was greater (P<0.05) for D vs. G and Y (49.5, 21.9, and 33.9 kJ/min for D, G, and Y, respectively; SE=5.68) and differed (P<0.05) among periods (57.5, 45.3, 24.8, and 12.9 kJ/min in P1, P2, P3, and P4, respectively; SE=5.17). In conclusion, with this forage of moderate nutritive value, levels of forage mass above 1400 kg/ha would not be of benefit to performance of meat goats regardless of physiological state with different nutrient requirements.

Supplements of lactating meat goat does grazing grass/forb pastures

A. L. Goetsch, G. D. Detweiler, Z. Wang, J. Hayes and T. A. Gipson
Journal of Applied Animal Research (In press). 2013

Lactating meat goats grazing 0.4-ha grass/forb pastures were used to determine effects on performance of different supplement treatments. Boer does (32) with one or two kids were used in a study with four 4-wk periods (PR) starting 22 ± 2.0 days after birth. Two groups were subjected to treatments of no supplementation (CO), access to a 20% crude protein (CP) supplement block (SB), and placement in a supplement pasture with mimosa (Albizia julibrissin) trees for 6 h 1 day/wk (1X) or twice weekly for 3 h/day (2X). All groups received access to the same mineral-vitamin supplement. Available forage dry matter (DM) in non-supplement pastures averaged 3477, 3448, 3353, 2802, and 2423 kg/ha initially and after PR 1, 2, 3, and 4, respectively; hand-plucked forage samples averaged 15 and 67% CP and neutral detergent fiber (NDF), respectively. Treatment did not affect doe average daily gain (ADG) (-23, -42, -23, and -15 g; SE = 11.5), FAMACHA© score, or fecal egg count, although kid ADG in the first three PR differed ($p < 0.05$) between type of supplement and frequency of supplement pasture access (121, 111, 120, and 134 g for CO, SB, 1X, and 2X, respectively; SE = 3.3). Spanish does (32) nursing two kids were used in a study with three 4-week PR starting 66 ± 0.8 days after kidding. The same CO and SB treatments were employed, but access to supplement pastures was for 24 h 1 day/wk (1X) or 2 days for 6 h/day (2X). Forage DM averaged 1530, 842, 791, and 750 kg/ha initially and after PR 1, 2, and 3, respectively), and 0.6 kg/day (as fed) per doe of grass hay (7 and 67% CP and NDF, respectively) was fed after PR 1. Hand-plucked forage samples averaged 14 and 64% CP and NDF, respectively. Treatment did not affect doe or kid FAMACHA© score. Kid ADG in PR 1 and 2 was not affected by treatment. Doe ADG was affected by supplementation ($p < 0.05$) and supplement type ($p < 0.09$) (-44, -33, -23, and -12 g; SE = 5.5), which resulted from effects ($p < 0.05$) in PR 3 after weaning (-87, -69, -16, and -2 g for CO, SB, 1X, and 2X, respectively; SE = 14.3). In conclusion, use of the SB was not beneficial, and infrequent access to supplement pastures had relatively small effects on ADG, perhaps because forage availability and nutritive value were not severely limiting.

Effects of conditions of an experimental model to evaluate different methods of adding electric fence strands to barb wire fence for cattle to also contain goats

Y. Tsukahara, G. D. Detweiler, T. Sahlu, T. A. Gipson, and A. L. Goetsch

Journal of Animal Science (In press). 2013

Growing meat goats of 4 types (Boer (B) and Spanish (S) of both wethers and doelings) were used to evaluate conditions for a method of testing efficacy of electric fence strand additions to barb wire fence used for cattle to also contain goats. Animals were allocated to 8 sets of 20, with each set consisting of 5 groups. There was 1 goat of each of the 4 types in a group. Five 2.4 × 3.7 m evaluation pens consisted of 3 sides of metal panels covered with plywood and 1 of barb wire strands at 30, 56, 81, 107, and 132 cm from the ground. Evaluation pens were situated adjacent to a pasture with abundant vegetation. Fence treatments (FT) were electric strands at 15 and 43 (LH), 15 and 23 (LM), 15 (L), 23 (M), and 43 cm (H) at 6 kV. For adaptation, there were 4 weekly and sequential exposures to evaluation pens: no electric strands, 1 strand at 0 kV, LH, and LH. Then, 2 preliminary treatments were imposed in the week before the first observation period, which were barb wire with no electric strands vs. LH. During the 1 wk between measurement periods, sets were exposed to 2 interval treatments while on pasture: without or with 2 electric strands at 6 kV positioned next to supplemental troughs. All animal sets were used for measurements in wk 1 in a completely randomized design (CRD). Four of the sets were used in 5 × 5 Latin squares (LS) in weeks and periods 1 to 5. All animal sets were exposed to the same FT in period 6 as in period 1. Measurement periods entailed observation with a video surveillance system for 1 h. There were no effects or interactions involving gender and few and minor effects and interactions of preliminary and interval treatments. The percentage of animals exiting evaluation pens differed ($P < 0.05$) among FT with the CRD approach in wk 1 (25, 47, 38, 66, and 84%; SEM = 8.0) and with repeated measures in wk 1 and 6 (6, 22, 22, 63, and 81% for LH, LM, L, H, and M, respectively; SEM = 4.9) and between breeds in wk 1 (34 and 70%) and 1 and 6 (28 and 50% for B and S, respectively). For the LS approach, FT affected exit (31, 23, 16, 35, and 30%; SEM = 5.3), and breeds differed ($P < 0.05$) as well (12 and 43%). Exit decreased as period advanced (60, 35, 23, 10, and 8 % for 1, 2, 3, 4, and 5, respectively; SEM = 5.3). In conclusion, breed should be considered in the model being developed. A LS approach was not suitable, but a CRD experiment after these adaptation procedures appears to be a promising approach.

Visiting Scholars (2012)

Dr. Zewie Sun
Native of China
Research Project: Effects of Selected Nutritional Components on Immunity to Haemonchus in Goats (OKLXWANG10)

Dr. Yoko Tsukahara
Native of Japan
Research Project: Establishing a Langston University Testing Center for Electric Fence Modifications of Cattle Barb Wire Fence for Goat Containment

Extension Overview

Dr. Terry A. Gipson
Goat Extension Leader

The year 2012 was a busy year for the Langston Goat Extension program. The goat extension specialists have answered innumerable producer requests for goat production and product information via the telephone, letters and e-mail, have given numerous presentations at several state, regional, national and international goat conferences for potential, novice and veteran goat producers, and have produced quarterly newsletters. They have also been busy with several major extension activities. These activities include the annual Goat Field Day, Langston Goat Dairy Herd Improvement (DHI) Program, grazing demonstrations, and various goat workshops on artificial insemination, tanning hides, and on internal parasite control.

Goat Field Day

In 2012, our annual Goat Field Day was held on Saturday, April 28, at the Langston University Goat Farm. That year's theme was State of the Goat Industry and our featured speakers were Dr. Katherine Marshall and Mr. Tom Boyer. Dr. Katherine Marshall, DVM, is an analytical epidemiologist with the USDA/APHIS Veterinary Services Centers for Epidemiology and Animal Health (CEAH) in Fort Collins, Colo. She has been the minor species commodity specialist with the National Animal Health Monitoring System (NAHMS) since 2000 and was responsible for the NAHMS Sheep 2001, Goat 2009 and Sheep 2011 studies. Prior to her work with CEAH, she completed a residency in preventive medicine and served two years as an epidemic intelligence service officer with the Centers for Disease Control in both Atlanta, Ga., and Honolulu, Hawaii. She also held positions as a field veterinary medical officer in the states of Washington and Hawaii. Marshall completed her master's degree at the London School of Hygiene and Tropical Medicine in England and her DVM at Colorado State University and worked in private practice in Hawaii after graduation. Mr. Tom Boyer is a third generation rancher and sheep man who was born in Coalville, Utah. He and his wife Carrie, along with their daughter Maren, reside on the home ranch [Boyer Land and Livestock] on which he was born. Tom and his wife Carrie [also a third generation sheep producer] are the instigators of the Boer flock known across the nation as Chalk Creek Boers. They also are originating partners in NUSAA [acronym for Namibia, SA and Australia] with Dirk Louw [Namibia] and Geoff and Ceilia Burnett Smith [Australia] which resulted in the importation of 10 does, 10 bucks and 136 embryos in 2007. They also have a flock of show wether goats. In addition to the goats, they have a flock of registered Rambouillets that has produced several national champions and which also provides commercial rams in the western US. Tom is currently President of the American Goat Federation, Vice President of the Utah Woolgrowers Association and sits on the Board of Trustees for the Appraisal Foundation. He served as the National President of the American Society of Farm Managers and Rural Appraisers in 2005-6 and has held numerous other leadership positions including President of the American Rambouillet Sheep Breeders Association, Vice President of the International Boer Goat Association, the co-founder [along with Carrie] and first President of the Mountain States Meat Goat Association. Our ever-popular goat milk cheesemaking workshop was scheduled on Friday April 27, 2012 (the day before our annual goat field day April 28) and Mr. Neville McNaughton, President of Cheez-Sorce, L.L.C. in Davisville, MO was once again our distinguished Invited Instructor for the workshop. Mr. McNaughton is an internationally renowned cheese entrepreneur, creator, designer, evaluator, marketer and writer in the world of cheese. He has hosted cheesemaking workshops, judged cheese contests and designed cheese plants in the U.S. as well as internationally. He demonstrated basic principles and practical skills of making authentic Chèvre, St. Maure and/or Valencay using our own Grade-A goat milk. Milk quality, cheesemaking facilities and marketing strategies were also discussed.

The afternoon workshops included:

- Neglected Biosecurity and Strategic Use - learn about ways to keep your farm and your animals safe with Dr. Katherine Marshall.
- Zoonotic Diseases of Importance for Producers - diseases that every producer should know about and tips to identify them with Dr. Katherine Marshall.
- American Goat Federation and What it Can Do for the Goat Producer - learn more about the American Goat Federation, membership services, and the various avenues it promotes goats with Mr. Tom Boyer.
- Internal Parasite Control - sustainable internal parasite control program with Dr. Steve Hart.
- Basic Herd Health - herd health program including vaccinations, injection sites, and approved drugs with Dr. Lionel Dawson.
- Cheesemaking Overview - basics of cheesemaking with Mr. Neville McNaughton.
- Goat Farm Budgeting - basics of budgeting and financial recordkeeping with Mr. Roger Sahs.
- Nutrition for Health and Production - calculation of energy, protein and feed intake requirements with Dr. Steve Hart.
- Goat Reproduction - basics of goat reproduction and techniques and equipment for artificial insemination in goats with Dr. Dave Sparks.
- DHI Training - supervisor/tester training for dairy goat producers including scale certification with Ms. Eva Vasquez.
- USDA Government Programs - overview of USDA Natural Resource Conservation Service's work with goats and its cost-sharing program with Mr. Dwight Guy.
- Pack Goats - basic goat training as a pack animal and equipment needs with Mr. Dwite Sharp.
- Mortality Composting - basic composting techniques and equipment for disposing of goat mortalities with Dr. Roger Merkel.
- Fitting and Showing for Youth and Adults - tips and pointers on fitting and show ring etiquette with Ms. Kay Garrett.
- Fun Tent Youth Activity: Ms. Sheila Stevenson hosted a full day of activities for youth ages 5-12 in the Fun Tent.

Goat DHI Laboratory

The Langston Goat Dairy Herd Improvement (DHI) Program operates under the umbrella of the Texas DHIA. In February 1998, the Langston DHI program became the first DHI program to introduce forms and reports in goat terminology to dairy goat producers in the United States. A national Dairy Herd Improvement Association (DHIA) has been in existence for a number of years. However, until 1996 DHIA catered only to cow dairies. The Langston DHI program has been very popular with dairy goat producers and has grown significantly since its establishment in 1996. Goat producers are now able to get records for their animals that reflect accurate information with the correct language. Currently we are serving a 29 state-area that includes a majority of the eastern states. Currently, we have 81 producer herds in these 29 states enrolled in the Langston Goat Dairy DHI Program. In 2012, the DHI laboratory processed more than 8,000 samples. Langston University continues to serve the very small-scale dairy goat producer. The average herds size on test with Langston University is 10 animals. This is significantly smaller than the herd size average for the five other processing centers.

For those interested in becoming a Langston goat DHI tester, training is available either in a formal classroom setting or through a 35-minute video tape (see additional information in the YouTube section). Every tester is required to attend the DHI training session or view the tape and take a test. Upon completion of the DHI training, the milk tester can start performing monthly herd tests.

Goat Newsletter

To date, the Goat Extension program published four issues of the 8-page Goat Newsletter in 2012. Interest in the newsletter has grown and we currently have over 2,400 subscribers to our free quarterly Goat Newsletter and the subscription list continues to increase every year. The Goat Newsletter is mailed to every state in the nation and to 10 countries overseas. Ninety-seven percent of the mailings go to American households. At least one newsletter is mailed to a household in every state in the nation. Fifty percent of the newsletters are mailed to Oklahoma households. An additional thirty percent of the newsletters are mailed to households to state adjacent to Oklahoma.

Artificial Insemination Workshop

The use of superior sires is imperative in improving the genetic composition of breeding stock. Artificial insemination has long been used in the dairy cattle industry and is a simple technology that goat producers can acquire. However, opportunities for goat producers to the necessary skills via formal and practical instruction are not widespread. Langston University has instituted a practical workshop for instruction in artificial insemination in goats. Producers are instructed in the anatomy and physiology of the female goat, estrus detection and handling and storage of semen. Producers participate in a hands-on insemination exercise. An understanding of the anatomy and physiology enable the producer to devise seasonal breeding plans and to troubleshoot problem breeders. An understanding of estrus detection enables the producer to effective time inseminations for favorable conditions for conception and to effectively utilize semen. An understanding of semen handling and storage enables the producer to safeguard semen supplies, which can be scarce and costly. The experience of actually inseminating a female goat enables the producer to practice the knowledge that they have gained. The acquisition of these inseminating skill will allow producers the use of genetically superior sires in their herds that they normally would not have access to. It also allows producers to save money by conducting the inseminating themselves instead of hiring an inseminator. In 2012, two AI workshops were held in September and October at the Langston University campus and an additional 28 participants were trained.

Meat Goat Production Handbook

The first edition Meat Goat Production Handbook is sold-out and the revision of the second edition is underway. Even though Langston University has taken the lead in this revision project, this handbook is not the product of one person nor of a single university. Our collaborating project institutions/organizations, which include Alcorn State University, American Boer Goat Association, American Meat Goat Association, Florida A&M University, Fort Valley State University, Kentucky State University, Langston University, Prairie View A&M University, Southern University, Tennessee Goat Producers Association, Tennessee State University, Tuskegee University, United States Boer Goat Association, University of Arkansas Pine Bluff, and Virginia State University. Handbook contributing institutions/organizations include Allen Veterinary Clinic, American Boer Goat Association, American Meat Goat Association, BIO-Genics, Ltd., Bountiful Farm, Cornell University, Fort Valley State University, Kentucky State University, Langston University, Law Office of Wheeler and Mueller, Louisiana State University, Louisiana State University AgCenter, NCAT / ATTRA National Sustainable Agriculture Information Service, North Carolina State University, Oklahoma State University, Texas A & M University, United States Boer Goat Association, and Virginia State University.

Controlling Internal Parasites Workshop

Internal parasites (Barberpole worm, Haemonchus contortus) is the leading cause of death in goats in the Southern US, accounting for as many deaths as the total of the next three leading causes of death in goats. Several factors contribute to the high mortality caused by internal parasites.

Goats which originated in dry areas where there was no internal parasite challenge have been brought to the humid South where there is great parasite challenge. Only a few animals have good genetic resistance against internal parasites. In addition, goats are forced to graze rather than browse which provides greater opportunity to consume infective larvae and especially so when animals overgraze. Producers are not familiar with monitoring animals for signs of parasitism and do not understand how animals get infected. In addition internal parasites have developed a high level of resistance to dewormers from the overuse of dewormers in goats. To address these concerns, Langston developed a parasite workshop to educate producers about internal parasites. It includes 3 hours of lecture on biology of the parasite, pasture management to avoid worms and monitoring parasite infection using the FAMACHA chart which assesses the degree of anemia. This is a cooperative effort with OSU Extension Veterinarian who addresses dewormer resistance and correct use of dewormers. Producers get hands-on instruction in use of the FAMACHA card, taking fecal samples and running fecal egg counts.

YouTube Channel

Created in 2005,YouTube is a video-sharing website on which users can upload, view and share videos. YouTube now has over 120 million videos, including movie clips, TV clips, and music videos, as well as amateur content such as video blogging and short original videos. The Goat Program at Langston University has created its own YouTube channel (https://www.youtube.com/user/taglu01) The following are the YouTube videos that are available and you can quickly access them on a mobile device by using the QR (2D barcode) to the right. Additional videos will be added to the channel in the future

Artificial Insemination (AI) in Goats (length 8:47)

This video describes the steps involved in artificial insemination in goats.

AI Kit (length 6:28)

This video describes the equipment needed for artificial insemination in goats.

Basic Hoof Care (length 10:48)

This video explains basic hoof care for goats.

Body Condition Scores in Goats (length 2:11)

This video describes how to evaluate body condition score in goats.

Buck Effect (length 1:53)

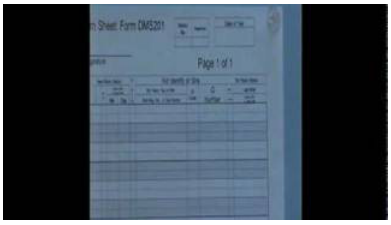
This video describes the buck effect and its use in estrus synchronization.

Estrous Synchronization in Goats (length 5:08)

This video explains estrous synchronization for artificial insemination in goats.

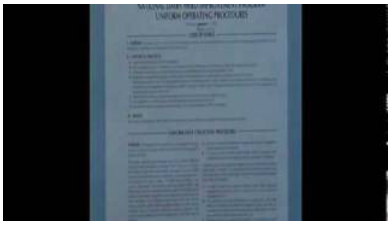
Langston DHI Tester Training - Part 1 (length 9:24)

This video describes how to conduct proper DHIA testing procedures for milk sampling.



Langston DHI Tester Training - Part 2 (length 9:48)

This video describes how to conduct proper DHIA testing procedures for milk sampling.



Langston DHI Tester Training - Part 3 (length 9:19)

This video describes how to conduct proper DHIA testing procedures for milk sampling.

Langston DHI Tester Training - Part 4 (length 8:28)

This video describes how to conduct proper DHIA testing procedures for milk sampling.

Semen Tank (length 6:39)

This video explains semen tank handling and semen storage for artificial insemination in goats.

Signs of Does (female goats) in Estrus (length 0:35)

This video shows an example of signs of estrus (flagging) in goats.

Nutrient Requirements of Goats

Under a research project which developed equations for energy and protein requirements for goats, as well as prediction of feed intake, an extension sub-project developed a website calculation system for "Nutrient Requirements of Goats" (http://www2.luresext.edu/goats/research/nutreqgoats.html). Most calculators were based on studies of the project reported in a Special Issue of the journal Small Ruminant Research. For calculators with score inputs (i.e., grazing and body conditions), pictures are available to aid in determining most appropriate entries. Realistic examples are given, as well as discussion of appropriate and inappropriate usage. However, for the experienced user there is an option to hide text and examples and to view only inputs and outputs.

In 2005, a calculator for calcium and phosphorus requirements was added to the existing calculators for metabolizable energy, metabolizable protein, and feed intake for suckling, growing, mature, lactating, gestating, and Angora goats. Also in 2005, the interface of the calculators was unified into a single calculator with the English measurement system used. This will encourage the use of the calculators by American producers. The least-cost ration balancer was modified so that it incorporates the least-cost feed percentage into the diet. Also, calculators are equipped with printable version commands to obtain inputs and outputs in hard copy format. In 2007, the calculators were continued to be updated.

In summary, for nutrient requirement expressions to be of value, they must be readily accessible and reasonably simple. Therefore, a web-based goat nutrient requirement system was developed based on findings of a recent project. It is hoped that this system will enjoy widespread usage and enhance feeding practices for goats.

Tanning Goat Hides

People express interest in tanning skins for a variety of reasons. Some sheep and goat producers wish to tan skins of animals they raise. Other people are hunters who wish to tan deerskins. Reasons for this interest include: wanting to use as much of the animal as possible, disliking the waste of an animal's skin; ownership of an exceptionally pretty goat that they wish to tan after harvest for home use; learn new skills; wish to use tanning skills on other mammals such as deer; wishing to learn "old-time" skills, and some producers see a source of potential income through tanning goat skins and selling handicrafts. Some attendees already tan skins but want to expand their knowledge. All of these producers wish to learn to tan skins. There is no other tanning skins course in the nearby area. Langston University instituted a tanning goat skins course

that teaches tanning skills to persons wishing to tan skins as a hobby. The workshop uses readily available chemicals and all processes are done by hand. Thus, it is a low cost process that producers can try at home. The hands-on nature of the course whereby participants work with actual skins in most of the tanning steps ensures skill transfer. This format allows students to work with and learn from each other and receive practical knowledge of the tanning process that will help them when trying tanning skins at home. In 2012, two tanning goatskins workshops were held at Langston University in March and in November.

Internet Website

http://www2.luresext.edu

Capabilities of the new web site include a document library with the complete proceedings of the annual Goat Field Day for the past three years and the quarterly newsletter for the past several years. Both the proceedings and newsletters are also available in portable document format (pdf), which allows for the viewing and printing of documents across platform and printer without loss of formatting.

Information, recent abstracts and scientific articles of completed and current research activities in dairy, fiber and meat production are available for online viewing and reading. Visitors will be able to take a Virtual Tour of the research farm and laboratories, complete with digital photos and narrative. Visitors will also be able to browse a digital Photo Album. Visitors will also be able to subscribe to our free quarterly newsletter online. Visitors will be able to test their knowledge of goats with the interactive goat quiz which covers nearly all aspects of dairy, fiber and meat goat production. For those questions that are lacking in the interactive quiz database, visitors will be able to submit a question to be included in the database. Visitors will be able to read about research interests of faculty and will be able to contact faculty & staff via email.

Web-based Training for Meat Goat Producers

Meat goat production is one of the fastest growing sectors of the livestock industry in the United States. New producers, as well as some established ones, have an expressed need for current, correct information on how to raise goats and produce safe, wholesome products in demand by the public. As the meat goat industry grows and evolves, a quality assurance program is essential. Such a QA program ensures the production of a wholesome product that satisfies consumers and increases profit for the meat goat industry.

Langston University was awarded funding by the Food Safety and Inspection Service of USDA to develop training and certification for meat goat producers. Langston University organized and led a consortium of 1890 universities and producer associations in this project. The consortium identified the subject topics most pertinent and pressing for the instructional modules. The consortium then identified experts on the selected subject topics and pursued these experts as module authors. These authors represent the most qualified persons in their field in academia as well as in the industry. Langston University translated the sixteen instructional modules into web pages with accompanying images, and pre- and post tests for those producers wishing to pursue certification. All modules are also available in pdf for easy printing and the introductory module is available as a podchapter for downloading and listening on your favorite mp3 player. The web-site (http://www2.luresext.edu/goats/training/qa.html) was unveiled in late 2005.

Even though this web-site (http://www2.luresext.edu/goats/training/qa.html) was only unveiled in 2007, more than 1,500 producers have enrolled for certification and 266 have completed the certification process. These instructional materials will best serve meat goat producers in assisting them to produce a safe, wholesome, healthy product for the American consumer. Funding source for this project was USDA/FSIS/OPHS project #FSIS-C-10-2004 entitled "Development of a Web-based Training and Certification Program for Meat Goat Producers."

State/Country	***Number Certified***
UNITED STATES	
AL	5
AR	8
AZ	1
CA	6
CO	2
CT	1
FL	20
GA	13
IA	3
IL	5
IN	7
KS	7
KY	6
LA	3
MA	1
MD	1
MI	5
MN	3
MO	12
MS	2
MT	2
NC	6
NE	3
NH	1
NJ	2
NV	3
NY	4
OH	6
OK	28
OR	6
PA	4
SC	5
SD	2
TN	11
TX	26
VA	9
VT	1
WA	3
WI	2
WV	4
WY	3

State/Country	***Number Certified***
CANADA	
AB	2
BC	4
MB	2
ON	2
BOTSWANA	1
INDIA	1
MALAYSIA	4
MEXICO	1
PAKISTAN	1
SAUDI ARABIA	1
SOUTH AFRICA	1
SURINAME	1
UK	1
ZIMBABWE	2
Total	***266***

Current Extension Projects

Title: Enhancing Capabilities of Socially Disadvantaged and Underserved Farmers via Low Literacy Materials in English and Spanish

Type: USDA 1890 Institution Capacity Building Grants Program

Project Number: OKLX-GIPSON10

Period: 2010-2013

Investigators: T.A. Gipson[1], R.C. Merkel[1], M. Simon[2], J. Fernandez Van Cleve[3]

Institution: [1]Langston University; [2]Kentucky State University; [3]University of Puerto Rico - Mayaguez

Objective: 1) utilize existing core chapters from the Meat Goat Production Handbook to develop a low-literacy training manual for meat goat production;
2) translate the low-literacy meat goat production training manuals into Spanish;
3) develop supplemental explanatory and "how to" demonstration materials to the English and Spanish manuals in video format (DVD and web-based) for use by extension agents, outreach specialists and individual farmers.

Title:	Training Farmer Educators on Goat Mortality and Butcher Waste Composting, A Regional Approach
Type:	USDA 1890 Institution Capacity Building Grants Program
Project Number:	OKLXMERKEL10
Period:	2011-2014
Investigators:	R.C. Merkel[1], T.A. Gipson[1], M. Mackinzie-Jakes[2], A.B. Yousuf[3]
Institution:	[1]Langston University; [2]Florida A&M University; [3]Virginia State University
Objective:	1) host project collaborators and 1890 extension leaders to discuss mortality and offal composting 2) establish mortality composting teaching demonstration sites 3) train CES, NRCS and other outreach personnel and farmer group leaders in composting animal mortality and butcher waste 4) publish a manual on small-stock mortality composting 5. Develop a training module on mortality composting 6. Write a chapter on mortality and butcher waste composting

Title:	Extension Education Delivery Tools for Dairy Goat Producers: A Web-Based Certification Program and E-Book
Type:	USDA 1890 Institution Capacity Building Grants Program
Project Number:	OKLXMERKEL11
Period:	2010-2013
Investigators:	R.C. Merkel[1], T.A. Gipson[1], S. Hart[1], Y. Park[2], C.M. Mikolayunas[3]
Institution:	[1]Langston University; [2]Fort Valley State University; [3]University of Wisconsin
Objective:	1) develop scientific-based content for a dairy goat web-based certification program and e-book 2) design and construct a web-based certification program based upon the developed content 3) develop a printed handbook based on the web-based program 4. Develop an e-book version of the handbook

Title:	Rehabilitation of Under-Utilized Forest Land by Goats for Economic Benefits
Type:	USDA Renewable Resources Extension Act Program
Project Number:	OKLXRREA
Period:	2010-2013
Investigators:	T.A. Gipson[1], R.C. Merkel[1], S. Hart[2], B. Heinemann[3]
Institution:	[1]Langston University; [2]Kiamichi Forestry Research Station (Oklahoma State University)
Objective:	1) compare the biological treatment using goats in a pine forest to control invasive species with traditional methods of invasive species control and with no treatment and 2) monitor the beneficial and harmful insect populations on plant and animal species

International Overview

Dr. Roger Merkel
International Program Leader

Goats and goat products are part of the livelihood of a majority of the world's population and are an important resource for poor farmers in many countries of the world. Part of the mission of the American Institute for Goat Research is to effect positive change in goat production throughout the world. To fulfill this aspect, the Institute has developed and maintains many strong ties with research and academic institutions around the world. In addition to collaborative work with foreign institutions, the Institute has hosted visiting scientists from over 20 foreign countries to conduct research activities. Training for foreign livestock workers and scientists as well as for U.S.-based persons who will travel and work overseas are other ways in which the Institute is active in the international arena.

International research and training, hosting foreign scientists, and training those who will teach others are internationally-focused activities that give the Institute unique opportunities to not only increase knowledge of foreign production systems and constraints, but also to positively impact agricultural development in foreign countries and help alleviate poverty and hunger. General objectives of the Institute's international program are to: 1) increase our knowledge of goat production systems worldwide and current constraints to increased production; 2) build human capacity through training foreign scientists and agricultural workers in goat production, thereby allowing them to more effectively carry out their missions of teaching, research, and extension; 3) increase Langston University and the Institute's involvement in agricultural development and impact on human welfare; and 4) enhance the Institute's knowledge of development and development issues.

2012 Projects

Title:	Handbook for Livestock Research on Smallholder Farms in Developing Countries
Type:	USDA Scientific Cooperation Research Program
Period:	2012-2014
Investigators:	A. L. Goetsch[1], T. A. Gipson[1], R. C. Merkel[1], G. Abebe[2], A. Patra[3], D. Zhou[4], K. Al-Qudah[5], M. Huerta-Bravo[6], T. Sahlu[1], A. Degen[7], W. Getz[8], and Y. Tsukahara[1,9]
Institutions:	[1]Langston University, [2]Hawassa University, [3]West Bengal University and Animal and Fishery Sciences, [4]Northeast Institute of Geography and Agroecology, [5]Jordan University of Science and Technology, [6]Universidad Autónoma Chapingo, [7]Ben-Gurion University of the Negev, [8]Fort Valley State University, and [9]Kyoto University
Objectives:	A handbook for livestock research on smallholder farms in developing countries will be developed. Emphasis will be given to experimental design and data analysis. Input will be received from experts in different areas of the world (i.e., Ethiopia, India, China, Jordan, and Mexico), including regional cultural and social considerations.
Current Status:	Initial draft developed and sent to collaborators for input.

Title:	Enhancing Capacity for Research, Extension, and Teaching Activities with Small Ruminants of Bunda College of Agriculture in Malawi and Egerton University in Kenya
Type:	USAID, with administration by USDA Foreign Agricultural Service
Period:	2012-2014
Investigators:	T. Sahlu, A. L. Goetsch, T. A. Gipson, K. Tesfai, L. J. Dawson, and S. Zeng
Objectives:	Bunda College of Agriculture: 1) improve the analytical capacity of the Department of Animal Science animal nutrition laboratory of BCA to determine the nutritive value of livestock feedstuffs, inclusive of equipment and supply procurement and associated training and 2) increase knowledge in areas of animal science to enhance the quality of undergraduate and graduate student teaching and increase capacity for research and extension activities. Egerton University: 1) create capacity at EGU in artificial insemination of goats, encompassing use of fresh and frozen semen and to collect and store frozen semen, by establishing an artificial insemination center and provide relevant training; 2) import live animals of three dairy goat breeds to use in natural breeding and artificial insemination for multiplication of purebreds as well as crossbreeding in a community development program; and 3) provide training in areas of animal science relative to management of exotic dairy goat breeds, such as breeding and record-keeping, health and internal parasite management, preparation of teaser bucks for heat detection, and dairy goat product technology.
Current Status:	Bunda College of Agriculture: Laboratory equipment and supplies have been ordered and arrangements are being made for shipping to Malawi and initial training activities. Egerton University: Animal procurement activities in South Africa have commenced and arrangements are being made for transportation and initial training activities.

2012 Technical Assistance Visits

Institute scientists also travel abroad to conduct technical training activities and workshops. The most recent example of these activities was in July of 2012, when Drs. Lionel Dawson and Terry Gipson traveled to Lilongwe, Malawi at the invitation of CNFA and Small Scale Livestock and Livelihoods Program (SSLLP). The former is the implementer of the Farmer-to-Farmer (F-t-F) program for Malawi and the latter was the host organization. The SSLLP is a local non-governmental organization that provides poor families in Malawi with the means to combat poverty in a sustainable and long-term manner. Drs. Dawson and Gipson conducted in a three-day Artificial Insemination workshop at Bunda College of Agriculture, where we trained 14 governmental and university personnel.

In August of 2012, Dr. Terry Gipson traveled to Bougouni, Mali at the invitation of Winrock International and the Farmers Cooperative of Bougouni. The former is the implementer of the F-t-F program for Mali and the latter was the host organization. While in Bougouni, Dr. Gipson conducted a basic goat husbandry training. One of the biggest concerns that producers had was the feeding of animals, especially during the dry season when grazing areas have been depleted. To tackle this problem, Dr. Gipson demonstrated the treatment of crop residues, such as corn stover, with urea to increase the digestibility for goats during the dry season. It was noted that other crop residues, e.g., sorghum stover or rice straw, could also be used. Mali grows sugar cane and molasses is available; however, the trainers could not find any molasses in the market at this time of the year to use in making urea molasses blocks as supplements for goats, especially during the dry season. So they experimented with molasses substitutes but advised the farmers' cooperative that molasses be used when available. Both of these adaptive technologies are well-documented through our past Ethiopia Sheep and Goat Productivity Improvement Program (UMB at http://www.esgpip.org/PDF/Technical bulletin No.1.pdf and ammoniation at http://www.esgpip.org/PDF/Technical bulletin No.2.pdf)