WELCOME

We deeply appreciate your attendance at this 24th Annual Goat Field Day of the E (Kika) de la Garza American Institute for Goat Research of Langston University. The Field Day is one of the most important things we do each year. The primary purpose of the Field Day is for education and extension in areas of greatest interest to clientele of the Institute. Thus, please share your thoughts with us on today's activities and suggestions for the Field Day next year. In addition to extension and education, the Field Day provides an excellent opportunity for the staff of the Institute to meet other people that work with goats. Such interaction helps make our program the most appropriate it can be for the people it serves. The proceedings of the Field Day is a very useful tool for the Institute beyond impact realized from the program today. First, there are reports on Field Day presentations. After this information, there are highlights of research, extension, and international activities of the Institute in the past year. This section is an aid to assess our recent progress, display current activities, and contemplate future directions to be followed. This year's general theme is "Breeding for the Future in the Dairy and Meat Goat Industries" and the sub-theme is "Globalization/Internationalization of Goat Production". Here is the exciting program planned for today that has developed from your input.

The morning program consists of:

- **Performance Programs - Your "Genetic Toolbox"** *Ms. Lisa Shepard*
- **Breed Evaluation for Commercial Meat Goat Herds: A Research Update** *Dr. Richard Browning, Jr.*

The afternoon workshops are:

- **Using your Genetic Resources** *Ms. Lisa Shepard*
- **Using On-Farm Performance Testing** *Dr. Richard Browning, Jr.*
- **Dairy Goat Production in China** *Dr. Jun Luo*
- **Dairy Goat Production in Mexico** *Dr. Ignacio Tovar-Luna*
- **Goat Production in Jordan** *Dr. Laith al Rousan*
- **Goat Production in Central and Eastern Africa** *Mr. Juvenal Kanani*
- **Basic Goat Husbandry** *Mr. Jerry Hayes*
- **Basic Herd Health** *Dr. Lionel Dawson*
- **Nutrition for Health and Production** *Dr. Steve Hart*
- **Internal Parasite Control** *Dr. Dave Sparks*
- **Pack Goats** *Mr. Dwite Sharp*
- **External Parasites** *Dr. Justin Talley*
- **Goats from a Professional Buyer's Viewpoint** *Mr. Mike and Ms. Katie Pershbacher*
- **DHI Training** *Ms. Eva Vasquez*
- **Tanning Goat Hides** *Dr. Roger Merkel*
- **USDA Government Programs** *Mr. Dwight Guy*
- **Fitting and Showing for Youth and Adults** *Ms. Kay Garrett*
- **Fun Tent** *Ms. Sheila Stevenson*
- **Poster, Speech, & PowerPoint Contests/Workshops** *Mr. Dennis Howard*

On behalf of the staff of E (Kika) de la Garza American Institute for Goat Research, we thank you for your continuing interest and support.

Tilahun Sahlu
Director, E (Kika) de la Garza American Institute for Goat Research

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Performance Programs – Your "Genetic Toolbox"

Ms. Lisa Shepard
Performance Programs Coordinator
American Dairy Goat Association

The dilemma facing breeders is not so much how to gather genetic information, but rather how to take advantage of the data that have already been collected. This is where ADGA is trying to make a difference. With the help of a USDA-AIPL and the internet, The American Dairy Goat Association has assembled a variety of tools to assist in genetic improvement of dairy goats. These tools include performance testing, linear appraisal, genetic evaluations, indexes which include identifying superior genetics, a young sire development program and DNA testing for identity and alpha s-1 casein. All of these items other than casein testing are included on ADGA's performance pedigrees, the "plans" so to speak in constructing a breeding program geared towards genetic improvement.

With several tools available, selecting the right one depends on the breeder's goals. Producers have the information to make a more accurate selection of breeding stock than ever before. Because of this, the responsibility and the opportunity for breed improvement are directly upon breeders. The seedstock breeder, hobbyist and the commercial producer can all benefit from selecting seed stock based on fact --not just guesswork as the "eye" sees it. Every breeder can gain insight into the genetics of their selected breeding stock and can maximize genetic progress for economically important traits by using these aids.

Generally the first things to grab are the basics. With performance programs, the basics are production and type information. Without these two fundamentals in place, the rest of the tools cannot be utilized.

PRODUCTION TESTING has been available to producers for many, many years. From the Dairy Herd Improvement Handbook of 1985, the following is still pertinent. The herd is managed through DHI and provides:

- Performance goals. Information describing "what is desired".
- Descriptive information. Information describing "what is".
- Diagnostic information. Information describing "what is wrong".
- Predictive information. Information describing "what if".
- Prescriptive information. Information describing "what should be".

DHI is a nationally recognized system for evaluating dairy records. There are various options available from management only to recognition from the registry. At ADGA, the **ADVANCED REGISTRY** and **STAR** volumes track generations of collected record information. 305 day and extended records are documented and are available on performance pedigrees. Recognition programs exist within the registry to identify breed leaders in volume, and components and screen with *M designation based on published minimums.

Information obtained from DHIR includes: • Values for each milking doe & total herd • Completed & projected records • Customized features including reproduction, health records, & young stock programs • Somatic cell count • Persistency • Interface with type scores • Sire/dam/doe genetic values • Action lists • Selection objectives

Careful breeding decisions result in ADGA registered animals having records that are consistently higher than the national averages.

BREED	MILK LBS		FAT % and LBS		PROTEIN % and LBS	
	DHIR	ALL	DHIR	ALL	DHIR	ALL
ALPINE	2439	2122	3.2 / 78	3.3 / 70	2.9 / 69	2.9 / 61
LAMANCHA	2231	1877	3.9 / 87	3.7 / 69	3.1 / 69	3.0 / 56
NIGERIAN DWARF	806	NA	6.6 / 53	NA	4.3 / 34	NA
NUBIAN	1795	1338	4.8 / 85	4.6 / 62	3.7 / 66	3.8 / 51
OBERHASLI	2208	1786	3.7 / 81	3.6 / 64	2.9 / 64	3.1 / 55
SAANEN	2470	2032	3.3 / 81	3.3 / 67	2.9 / 71	3.0 / 60
SABLE	<25 does	NA	NA	NA	NA	NA
TOGGENBURG	2302	1843	3.0 / 68	3.2 / 59	2.7 / 62	3.0 / 55

ADGA's LINEAR APPRAISAL PROGRAM is one that has evolved from classification to appraisal and is the other basic program in the toolbox. This system evaluates individual type traits that affect structural and functional durability in order to take full advantage of the potential for genetic improvement through selection. ADGA's linear system evaluates each animal & trait individually, evaluates each trait from one observed biological extreme to the other, Includes traits that have economic importance and are at a minimum, moderately heritable, and applied uniformly.

The linear appraisal system includes 13 primary traits, one secondary trait, as well as structural categories scored by the appraiser to evaluate functional conformation on mature does and bucks. An optional youngstock program as well as scoring of bucks is also available.

The final categories are determined by using the information from the separate linear traits along with the structural categories as they relate to functional type. The final score is then a mathematically derived score using the weight of the ADGA scorecard areas against the percentage applied in each category.

Crucial for this program in terms of genetic evaluation are 1) evaluation of defined heritable traits of functional importance, 2) Use of numerical scores from one biological extreme to the other, 3) scoring all contemporaries in the herd, 4) evaluation while the animals are still young and as they mature, 5) scoring without knowledge of sires or previous scores, and then 6) analysis at AIPL.

Appraisers are selected based on criteria found in the ADGA guidebook and in 'pre-training' sessions where individuals may be evaluated as to their readiness to be an appraiser. They are then trained rigorously, evaluating hundreds of animals both in front of a committee as well as in the field under the direction of senior appraisers. Each year, all appraisers must attend a refresher course. The expected outcome of the refresher session is that our appraisers are able to score animals independently and come within points of each other.

The purpose of a good dairy goat is to produce milk with ease and comfort, while maintaining good health, over many lactations. ADGA's linear program is one that is important in shaping this kind of dairy goat, animals that are the right type in combining form and function. 40,000+ does have been evaluated since 2000.

GENETIC EVALUATIONS for milk, fat, and protein yields are calculated annually in July and December and evaluations for type from linear information provided by ADGA are calculated in December. These evaluations are provided to regional computing centers, the dairy goat association, and the general public through web access. Data flows from the farms through the regional centers to the Animal Improvement Programs Laboratory. Pedigree correlation is provided by ADGA to AIPL.

Genetic evaluations are reported as (P)redicted (T)ransmitting (A)bilities (PTA's). A PTA is the genetic merit that an animal is expected to contribute to its offspring and is based on milk records from the Dairy Herd Improvement program and from linear appraisal data.

For yield, the numbers you see reported are actual pounds over the current average. For type, PTA's are reported as a standard deviation using the final score. PTA's have two purposes: to rank animals for genetic merit and to estimate genetic differences between animals. A doe with a PTA of 150 for milk is expected to produce daughters averaging 50 lbs per lactation higher production as mature does than daughters of a doe with a PTA of 100. The doe with a 150 lb PTA would rank higher than the doe with the PTA of 100. Only animals of the same breed can be compared. For type, a genetic evaluation of each linear trait with regard to predicted transmittal to offspring as well as final score is provided in the type evaluation. As the scorecard and biologic scale are applied to all breeds uniformly, evaluations are carried out similarly irregardless of breed.

Procedures used to calculate PTA's account for environmental conditions, relative amounts of information from records, pedigree and progeny, and heritability, among other factors. PTA's are compared to a genetic base or zero point, updated every 5 years and determined by average genetic merit of does born in that given year.

Genetic evaluations are important because they:

- provide a tool for uniform genetic comparison
- maximize the accuracy of prediction of genetic values and animal rankings
- are an essential tool for selection as well as planning breedings
- are a marketing tool that increases the economic value of the evaluated animals and their offspring
- once evaluations are provided, then all sorts of other tools become available for use.

ELITE RANKINGS – ELITE SIRE AND DOE LISTS are generated with the yield evaluations. These percentile rankings of dairy goats are based on Milk Fat Protein dollars (MFP$), which may one of the single most useful numbers published in the genetic evaluation. It is important as the MFP$ combines the traits for commercial milk production, weighted for economic value in a manufacturing milk market. The economic values used for calculating MFP$ are the same for dairy goats as for dairy cattle. Goat milk most likely has a higher economic value than cow milk, but the relative weighting in the formula is still useful.

For bucks to qualify for elite status, they must be in the top 15% of bucks with evaluation information on recent daughters. Does must be in the top 5%. PTA files are screened to locate does apparently alive before elite lists are produced. A breeder interested in production need only look at Rank Percentile to know about the choices that are available.

THE ADGA PERFORMANCE SUMMARY VOLUME is the blueprint in the toolbox. This information comprises the sire summaries, combining Production Testing records and Linear Appraisal scores, is printed by breed and has daughters listed underneath their sires. In addition, almost all of this information is also found online at adgagenetics.org although in a different and generally easier to use format.

Bucks are listed in alphabetical order, followed by a list of daughters with current DHIR and/or Linear Appraisal information, and sons who qualified for AR or ST awards. A buck can have up to six (6) lines of information, each daughter up to four (4). Fewer lines appear if there is insufficient data available.

For a buck to receive a USDA production summary, he must have at least five daughters with records. If all five daughters are in the same herd, there must also be daughters of another buck in that herd with current records, otherwise no USDA summary is made. USDA calculates type summaries for any buck with at least one daughter appraised.

An example of the information is as follows.

1. L0101010 *B ADGA'S SIRE EXAMPLE 0265629 AMERICAN DAIRY GOAT ASSOCIATION NC

2. BEST OFFICIAL RECORD AVG 9 28 01-07 161 1199 43 3.8 ETA 2:1 150 ETA 1:2 93

3. ALL OFFICIAL ME AVG 7 30 2266 87 3.7

4. USDA PROD: H 7 D 30 L 63 R 59 PTAM -45 PTAF 3 PTA% 0.03 PTAP -2 PTA%P 0.02 PCTILE 24

5. USDA TYPE: FS 0.4 ST 4.3 SR 0.2 DY –0.6 RA 1.3 RW 2.0 RL 0.2 FA 0.6 RH 1.6 RA 0.3 MS 0.8 UD 0.4 TP 0.5 TD 2.2 16 DAUS FS 85

6. CURR APPR: 1-04 FS 87 V E V ST47 SR29 DY31 RA33 RW35 RL30 FA RH RA MS UD TP TD STCTG + + + V + E E

7. DAUS: ADGA'S JANE DOE 3*M AR42 CL42 L0202020 0265629 AMERICAN DAIRY GOAT ASSOCIATION NC

8. CURR LACT: 2-00 304 1699 65/3.8 59/3.5 B DAM AR41 L0102010 PTI 2:1 141 PTI 1:2 180

9. CURR APPR: 2-10 FS 78 A + + A ST12 SR14 DY36 RA23 RW20 RL32 FA29 RH40 RA22 MS24 UD40 TP6 TD16 STCTG A A + V F V + V

10. USDA PROD L 3 R 41 PTAM 1 PTAF –1 PTAP 2 PTA%P 0.01 PCTILE 55

11. SONS: +B ADGA'S JOHN DOE L0201020 0265629

LINE 1: Buck's registration number; award designations, if any; buck's registered name; production testing volume reference number, prior classification/linear volume reference number; owner's ADGA ID, name, and state of residence.

LINE 2: Best Official Records Average: number of herds; number of daughters; average age at freshening; average number of days in milk; average pounds (actual) of milk; average pounds (actual)

butterfat; average percent (%) butterfat; PTI 2:1 and 1:2 or ETA 2:1 and 1:2.

LINE 3: All Official ME (Mature Equivalent) Average: number of herds; number of daughters whose records were used in this calculation; average pounds of milk; average pounds of butterfat; average percent (%) butterfat.

LINE 4: USDA Production Summary: H = number of herds; D = number of daughters; L = number of lactations; R = reliability; Predicted Transmitting Abilities for milk, PTAM; butterfat, PTAF; percent butterfat, PTA%; protein, PTAP; percent protein, PTA%P; percentile ranking within the breed.

LINE 5: USDA Type Summary with Predicted Transmitting Ability for final score (FS) and standard deviations for the individual linear appraisal traits; ST = stature; SR = strength; DY = dairyness; RA = rump angle; RW = rump width; RL = rear legs, side view; FA = fore udder attachment; RH = rear udder height;

RA = rear udder arch; MS = medial suspensory ligament; UD = udder depth; TP = teat placement; TD = teat diameter. This line ends with the total number of daughters appraised or classified (old system) and their average adjusted final score.

LINE 6: Buck's 2003 linear appraisal scores: age at appraisal; final score; major category breakdowns (General Appearance, Dairy Character, Body Capacity); stature; strength; dairyness; rump angle; rump width; rear legs (side view). Last are the scores for structural categories (STCTG): head; shoulder assembly; legs, front; legs, rear; feet; back; rump.

Daughter Information

LINE 7: CH or GCH designation, if any; doe's registered name; star milker designation, if any; reference to last Production Testing and/or Linear Appraisal volumes in which the doe appeared; doe's registration number; owner's ADGA ID number, name, and state of residence.

LINE 8: Current lactation: age at freshening; days in milk (305 or less); pounds milk; pounds butterfat; percent (%) butterfat; pounds protein; percent (%) protein; method of qualifying for a *M (B = both milk and butterfat, M = milk only, F = butterfat only); reference to volume in which the dam last appeared (AR volume reference only); dam's registration number; doe's PTI 2:1 and 1:2, or ETA 2:1 and 1:2, or PTAP. (NOTE: It is possible to have more than one "current" lactation appearing on a doe.)

LINE 9: 2003 linear appraisal scores: age at appraisal; final score; major category breakdowns (General Appearance, Dairy Character, Body Capacity, Mammary System); stature; strength; dairyness; rump angle; rump width; rear legs (side view); fore udder attachment; rear udder height; rear udder arch; medial suspensory ligament; udder depth; teat placement; teat diameter; structural category (STCTG) scores for: head; shoulder assembly; legs, front; legs, rear; feet; back; rump; udder texture.

LINE 10: USDA Production Summary: L= number of lactations; R = reliability; Predicted Transmitting Ability for milk, PTAM; butterfat, PTAF; percent butterfat, PTA%; protein, PTAP; percent protein, PTA%P; percentile ranking within breed.

Son Information

LINE 11: Award designations, registered name, registration number, owner's ADGA ID (membership) number, name, and state of residence. (NOTE: For a buck's son to be listed, he must have qualified for a +B or ++B designation based on his own daughters' current production information.)

THE PRODUCTION TYPE INDEX (PTI) can be generated once the PTA's are known. These PTA's for yield and type are then combined into a Production-Type Index (PTI) that represents the merit of the traits evaluated for the animal. Fat Corrected Milk, based on an accepted conversion formula for milk represents production, and PTA for adjusted final score at appraisal represents type.

Two PTI's, each weighted differently are provided by ADGA. One has yield weighted twice as much as type (2:1) and the other weights type over yield (1:2), which allows the breeder to choose the emphasis. PTI's are a relative index, the numbers are relative to breed averages, and again, comparisons should not be made between breeds due to breed constants used in production. In order for a doe to have a PTI, she must have at least one completed DHI production record and have been type evaluated. A buck must have a sire summary for production and type, which requires at least 5 daughter records from the DHI program and at least one daughter with type information.

PTI index rankings are available online at both the ADGA member site and adgagenetics.org

THE YOUNG SIRE DEVELOPMENT PROGRAM is based on the PTA and PTI information. Merging the efforts of the herdowners participating in DHI and Linear Appraisal programs, the Sire Development

committee provides a powerful tool in selecting young bucks for use in the breeding programs based on ETA for young bucks. ETA's, which are the basis for screening in the ADGA-SDP are the Estimates of a young buck's Transmitting Ability before he has daughters that are of an age to contribute information regarding yield and type, and are based on production and type information of his ancestors. ETA's are also weighted, emphasizing either yield over type, or type over yield.

The ETA calculation uses the PTI's of the sire and dam and subtracts a Qualifying Level (QL) that is set for each breed by a calculation developed by the Sire Development Committee. The current QL's for each breed are listed in the current SD pamphlet and on the ADGA website. New QL's are set annually.

Each year, a list is compiled for bucks registered in each quarter that qualifies with a positive ETA in one or both of the two weightings.

Careful selection is the key in deciding whether to use young sires for genetic improvement. The young sires won't replace the top proven bucks, but the best young sires certainly can equal the lower ranking bucks for genetic progress and eventually, with systematic use, will replace the proven bucks as genetic progress continues.

These merit type indexes (PTI and ETA) are easy to use for selection of sires and does. Animals with the highest values for the index chosen for use represent the best combination of traits to use in your breeding program. Consistent use of the top bucks and does will enable excellent genetic progress and still allow choices based on other qualities such as diversity, kidding ease, and secondary selection on other specific traits.

THE SUPERIOR GENETICS PROGRAM builds on the PTI indices. For Superior Genetics (SG), the animal must be in the top 15% (85th percentile ranking or higher) of their breed according to the Production/Type Index (PTI) ranking at least once during the life of the animal. The current listing starts with the 2005 PTI rankings as 2005 was the program's starting point. To qualify, the ranking may be just in one area (PTI 2:1 or PTI 1:2) or in both areas, however for smaller breeds, a negative PTI ranking even if in the top 15% will not be recognized. Once earned, the SG or SGCH becomes a permanent prefix to the animal's name and replaces show prefixes that may have already been a part of the animal's name.

PTIs generally change twice per year, after the genetic evaluations are run by USDA. New SG will appear at those times. Once earned, even though the ranking may drop, the SG designation remains. The PTI calculation relies on breed constants for fat % and standard deviations for fat corrected milk so are only applied to distinct breeds and not Experimentals.

DNA TYPING is a tool to safeguard the investment into building a breeding program. ADGA provides an opportunity to identify & record genetic information at a reasonable cost. Benefits of DNA typing include:

- Permanent record of identification linked to ID & tattoo;
- Protects Registry Integrity;
- Invaluable for identifying later progeny through parentage verification;
- Increases an animal's worth & the value of the herd information.

In addition, alpha s-1 casein testing is available. Knowing the specific genetic polymorphism at goat casein loci on breeding stock allows the breeder to set up breeding and selection programs targeted towards the improvement of cheesemaking yield by selecting for high expression alleles, or selecting for animals with low levels which may be of benefit to those with milk sensitivities.

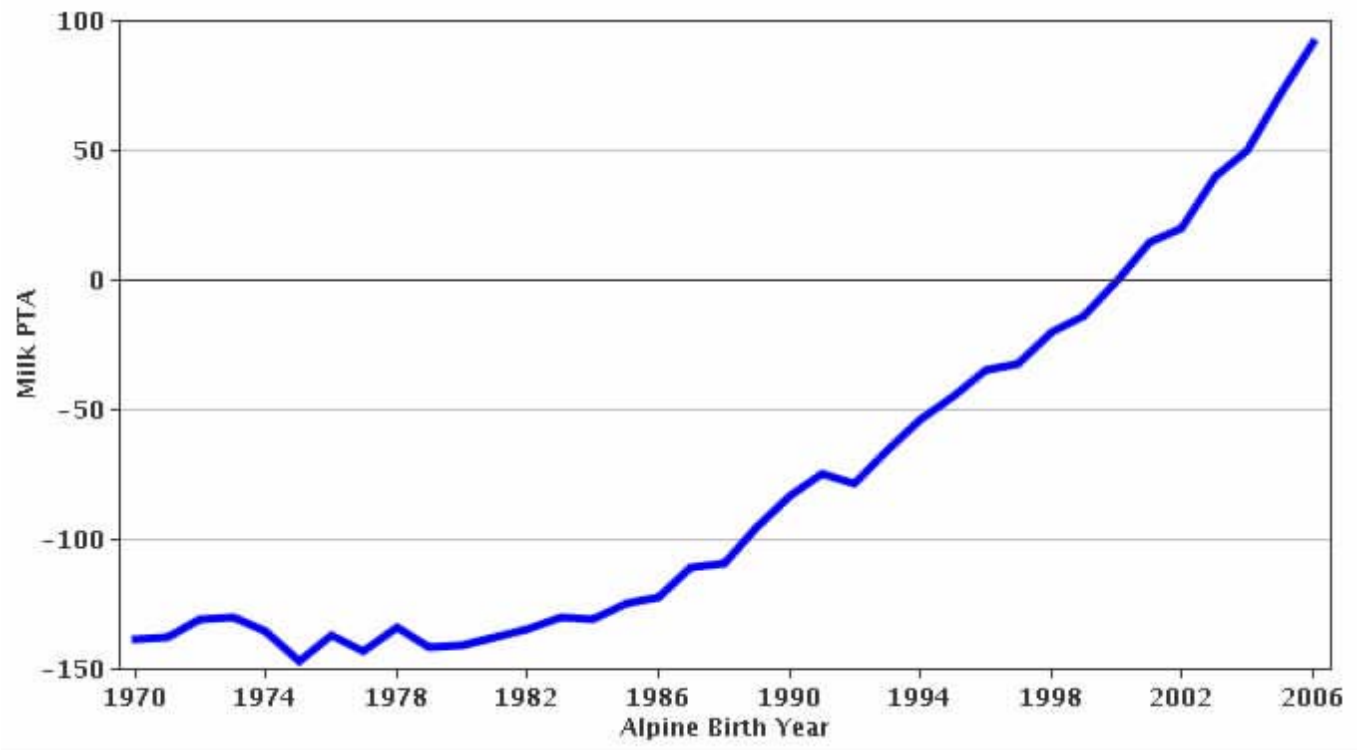
The test is designed to detect low level variants for casein - E, F, and N. High level variants are then reported as A or B, which represent several specific alleles.

BENEFITS to the use of performance program tools and the construction of a successful genetic improvement program are:

- target traits of the population will have been moved in the desired direction,
- the population will have a national database with information that can be used for current and retrospective studies,
- objective decisions can be made on genetic, management, economics, and other issues,
- realistic projections as to genetic improvement, management, and economic plans can be based on a reliable source of information, and
- the population will show progress in all aspects related to genetic improvement.

Genetic improvement is permanent and cumulative, so it is a sustainable and cost-effective method of directing and stabilizing dairy goat performance according to each breeder's goals. Accumulating data on pedigree, production, type and auxiliary traits from as many herds as possible provides for greater precision in evaluations. Accurate performance records, visual trait assessments and pedigree are needed to develop a complete portrait of our individual herds. These tools are a form of quality assurance for the selection of breeding animals.

WHEN THE COLLECTED INFORMATION IS USED CONSISTENTLY, GENETIC IMPROVEMENTS CAN BE MADE RAPIDLY AND PREDICTABLY.



Genetic trend in milk production for the Alpine Breed – Courtesy of USDA-AIPL

Mid-project (Three-Year) Research Report: Breed Evaluation of Meat Goats for Doe-Kid Performance when Managed on Southeastern US Pasture

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Introduction

Doe herd reproductive output is a major determinant of profitability in a commercial meat goat enterprise. Reproductive merit is important to consider when evaluating a new breed. Breed effects on maternal performance among meat goat breeds has received little research attention (Shrestha and Fahmy, 2007). Boer and Kiko importations in the mid-1990s created new opportunities for U.S. goat producers to infuse unique germplasm into breeding programs. The Boer goat is a breed developed in the semi-arid region South Africa for meat production (Casey & Van Niekerk, 1988). Boer is the predominant meat goat genotype in the U.S. today. The Kiko is a composite goat breed developed for meat production in humid New Zealand (Batten, 1987). Non-descript landrace goats commonly referred to as "Spanish" goats evolved from stock brought to the New World by Spanish explorers in the 1500s (Shelton, 1978; Mason, 1981). Spanish goats in the U.S. are mostly found in semi-arid, south-central Texas and represented the primary source of goat meat before Boer goats were imported.

Maternal breed affects kid performance among various sire breeds (Goonewardene et al., 1998; Ward et al., 1998); however, such studies have not included doe reproductive performance. In a pilot study (Browning et al., 2004), Kiko does had higher reproductive output than Boer does.

In the southeastern U.S., efficient meat goat production is difficult because warm, humid pasture conditions are optimum for gastrointestinal parasites and hoof pathogens. Internal parasites represent the greatest threat to goat productivity, health, and survival (Kaplan et al., 2004). Internal parasites and lameness are also costly in terms of time, labor, and materials needed for prevention and(or) treatment. Work at this research station is evaluating reproductive rates and health indicators of Boer, Kiko, and Spanish does and progeny growth rates under the environmental conditions of the southeastern United States.

Methodology

Animals. Boer (n = 81), Kiko (n = 64), and Spanish (n = 59) straightbred does were managed together on pasture over three years. The Boer, Kiko, and Spanish doe groups were each represented by a broad sampling of seedstock farms and sires. Does were between 1.5 and 6 years old with age and parity balanced across breeds. Service sires included 11 Boer, 9 Kiko, and 8 Spainsh bucks representing a diverse sampling of genetic lines within each breed. The study herd was managed on the Tennessee State University research station in Nashville, Tennessee, USA (36°17'N, 86°81'W). Nashville is in the humid, subtropical southeastern region of the United States, sits 183 m above sea level, and has a 30-year annual precipitation amount of

1222 mm. The 12-month precipitation amount during the study was 1434 mm for Year 1, 1338 mm for Year 2, and 978 mm for Year 3.

Animal Management. Does were managed on tall fescue (*Festuca arundinacea*) and bermudagrass (*Cynodon dactylon*) pastures supplemented with orchardgrass hay (*Dactylis glomerata*) for *ad libitum* consumption and 1 lb/d of a commercial concentrate (16% CP, 69% TDN, as-fed) medicated with monensin. The concentrate was fed for eight months from breeding to weaning. Stocking rates were approximately 6 does per acre. Does were exposed for 45 days each fall to Boer, Kiko, and Spanish bucks in single-sire mating groups as part of a complete three-breed diallel mating scheme and kidded on pasture in March and May. A total of 157 Boer, 152 Kiko, and 150 Spanish doe matings occurred across the three years. Dams and kids were weighed at birth and at weaning (3 months). Does were dewormed twice each year, including individual doe anthelmintic treatments at kidding. Additional dewormings were administered to does displaying clinical signs of internal parasitism. Fecal samples were collected from a subset of lactating does at weaning to determine fecal egg count by McMaster technique as an indication of internal parasite burden. Does were also treated individually for hoof scald/hoof rot upon observation of lameness. Kid records included 781 birth weights and 635 weaning weights. Kids were not creep-fed, vaccinated, or dewormed as a group before weaning and buck kids were left intact. Culling of does from the research herd was involuntary.

Statistical Analysis. Data were tested using MIXED model ANOVA procedures of SAS (SAS Institute, Cary, NC, USA). Fixed effects in the models included breed of doe, service sire breed, month of parturition and production year. The interaction of sire breed and dam breed was added to models for analysis of kid weight data at birth and weaning with weaning weights adjusted to a 90-day basis. Kid sex and litter size were also included in the kid weight models. Animal within breed of doe was specified as a random term in the mixed effects models. Fecal egg counts (FEC) were log-transformed for statistical interpretation. Binary responses such as successfully weaning kids and doe attrition from herd were also analyzed using MIXED models. Probability levels less than 0.05 for the F-statistic indicated significant main effect or interactive term effects. The Tukey-Kramer means separation test was used to compare least squares means for all traits (alpha = 0.01).

Results

Doe traits. The proportion of doe matings resulting in at least one live kid at birth was lower ($P < 0.01$) for Boer (82%) than for Kiko and Spanish does (96% and 93 ± 3%). At kidding, Spanish dams were lighter ($P < 0.01$) than Boer and Kiko dams (97.9 vs. 115.5 and 113.3 ± 2.4 lbs). Litter size and litter weight at birth were similar among Boer (2.06 ± 0.1 kids, 15.00 ± 0.64 lbs), Kiko (2.02 ± 0.1 kids, 14.23 ± 0.66 lbs), and Spanish dams (2.08 ± 0.1 kids; 14.43 ± 0.64 lbs). Maternal breed did not affect litter traits at birth. However, Boer does lowered levels of fertility as expressed by parturition rates.

The proportion of exposed does resulting in at least one live kid weaned was lower ($P < 0.01$) for Boer does (72%) than for Kiko and Spanish does (88 ± 4% each). Spanish dams at weaning were lighter ($P < 0.01$) than Boer and Kiko dams (97.9 ± 2.6 vs. 115.3 and 114.2 ± 2.9 lbs). Dams generally maintained their body weight during the three-month preweaning period. Reproductive performance and production efficiency as characterized by litter traits at weaning were consistently lower ($P < 0.01$) for Boer does than for Kiko and Spanish does (Table 1). Postpartum weight loss does not seem to explain the differences expressed between the dam breeds for reproductive output at weaning.

Internal parasitism and hoof infections are constraints to efficient goat production in wet climates. A larger proportion ($P < 0.01$) of Boer does experienced lameness and internal parasitism (71 ± 5% and 50 ± 5%) than Kiko does (31% and 17%) and Spanish does (39% and 24%). Geometric mean FEC for Boer, Kiko, and Spanish does were 523, 331, and 223 ± 45 eggs/g, respectively and differed ($P < 0.01$) between each

breed. Annual attrition rates due to deaths and involuntary culling were greater ($P < 0.01$) for Boer does (21 ± 4%) than for Kiko (7%) or Spanish does (8%).

Health indicators may help to explain the lower reproductive rates of the Boer does. The need for frequent anthelmintic and hoof treatments in Boer-influenced herds is a common remark of producers in the southeastern United States. Doe genotypes with enhanced hardiness would benefit these producers. Internal parasite resistance has been demonstrated in other doe breeds (Baker et al., 1998). Spanish and Kiko does showed hardiness when exposed to conditions conducive to internal parasitism and lameness. Spanish does performing at levels similar to the Kiko was unexpected. It was thought that Spanish does would perform more like Boer does given their similar dry climate origins. In computer simulations, reproductive traits under excellent forage conditions were similar for Boer and Spanish does or tended to favor Boer, whereas reproductive output under poor forage conditions were higher for Spanish does (Blackburn, 1995). The separation of Spanish and Boer does in the current project under semi-intensive pasture management concur with Blackburn (1995) for moderate to low forage conditions. Kiko and Boer does differences agree with the earlier exploratory project at this research station (Browning et al., 2004). Reasons for poor reproductive performance and generally poor fitness of the Boer does are not clear. Blackburn (1995) and van der Waaij (2004) each suggested that large, fast growing breeds may be at a disadvantage in limited resource environments. Unimproved goats were more disease resistant than Boer goats in South Africa (Ramsay et al., 1978).

Kid traits. Sex and litter size affected birth and weaning weights. Birth and weaning weights were heavier ($P < 0.01$) for male kids compared with female kids and kid weights decreased ($P < 0.01$) with increasing litter size.

The interaction of sire breed by dam breed was significant ($P < 0.01$) for kid birth weight (Figure 1). Among straightbred kids, Boer kids were heavier ($P < 0.01$) than Kiko and Spanish kids, the latter two did not differ. Within Boer dams, Boer-sired kids were heavier ($P < 0.01$) than Kiko-sired kids with Spanish-sired kids intermediate and not different from the other two. The same relationships were true within the Kiko dams. When born to Spanish dams, Boer-sired kids were heavier ($P < 0.01$) than kids of the other two sire breeds.

The sire breed by dam breed interaction was significant ($P < 0.01$) for weaning weights (Figure 2). Among straightbred kids, Kiko kids were heavier ($P < 0.01$) than Boer and Spanish kids, the latter two did not differ. Within Boer sires, kids were heavier ($P < 0.01$) from Kiko dams than from Boer or Spanish dams, the latter two did not differ. Within Kiko-sired kids, Kiko dams produced heavier weaning weights ($P < 0.01$) than Spanish dams; weights from Boer dams were intermediate and not different from the other two. The same was true for Spanish-sired kids.

Sire breed influenced birth weights within dam breed with kids out of Boer sires generally exhibiting larger weights. However, dam breed modulated weaning weights within sire breed with Kiko dams having the most positive effect. The weight advantage of Boer-sired kids at birth was not maintained through weaning, an observation also reported by Goonewardene et al. (1998). The inability of Boer straightbred kids or Boer-sired kids to maintain a weight advantages from birth to weaning brings into further question the suitability of Boer goats for commercial meat goat production in the southeastern U.S. or under limited input, semi-intensive management. Speculation provides a variety of explanations as to why Kiko dams improved weaning weights across different sire breeds.

Estimated weaning weight heterosis levels at this mid-point of the research project were 6.28% for Boer-Kiko matings, 5.66% for Boer-Spanish, and 0.03% for Kiko-Spanish. Heterosis values for meat goat weaning weights involving Boer crosses are not readily available in the scientific literature. The ability Boer goats to generate hybrid vigor in should be explored further as this may provide some direction on how they may be effectively used in commercial meat goat production systems.

Conclusion

Reproductive output of the doe herd significantly impacts profitability and sustainability of a commercial meat goat operation. Boer does were less fit and with lower reproductive output than Kiko or Spanish does under these research conditions. Poor fitness in a doe herd results in reduced production levels, higher maintenance costs, and(or) higher attrition rates. Semi-intensive pasture management environments are dynamic and often less than ideal. Widespread use of Boer germplasm without sufficient research to characterize breed strengths and weaknesses under restricted-input management programs can prove commercially detrimental in the long-term. Spanish and Kiko does exhibited general hardiness and appeared better suited for commercial meat goat production on humid, subtropical pasture.

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Table 1. Litter traits at weaning as influenced by breed of doe after three years of observation.

	Breed of doe			
Trait	Boer	Kiko	Spanish	s.e.
Per doe weaning kids				
Litter size, kids/dam	1.55 [b]	1.65 [ab]	1.80 [a]	0.06
Litter weight, lbs	56.5 [b]	64.9 [a]	62.0 [ab]	2.2
Litter weight / doe wt, %	52 [b]	61 [ab]	67 [a]	2
Per doe exposed to bucks				
Litter size, kids/dam	1.12 [b]	1.44 [a]	1.57 [a]	0.09
Litter weight, lbs	40.7 [b]	56.8 [a]	53.9 [a]	3.3

[ab] Means with different letters differ significantly

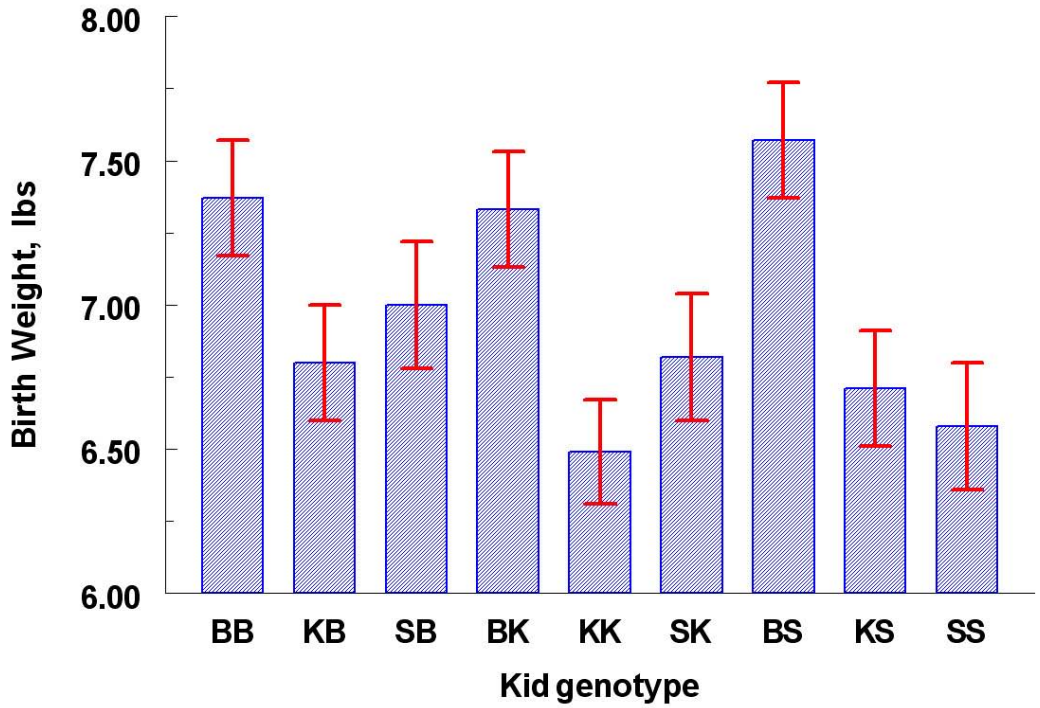


Figure 1. Birth weight (LSM ± s.e.) for meat goat kids out of Boer (B), Kiko (K), and Spanish (S) parental stock after three years of observation. First letter of kid genotype represents sire breed. Second letter represents dam breed.

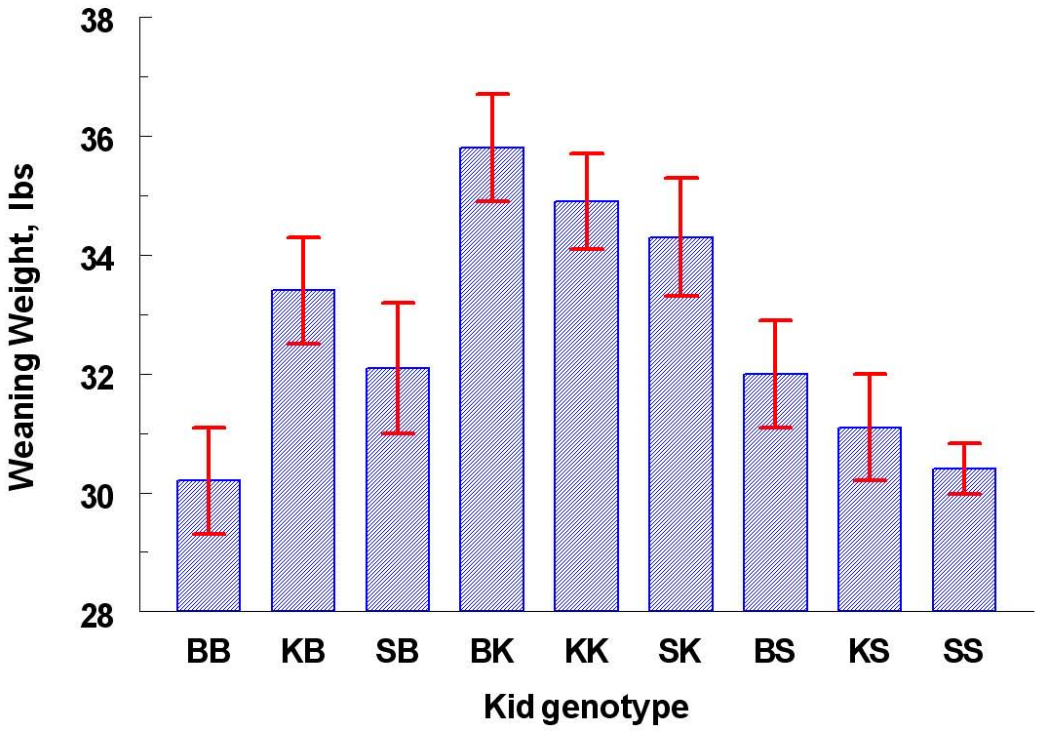


Figure 2. Weaning weight (90-day adjusted; LSM ± s.e.) for meat goat kids out of Boer (B), Kiko (K), and Spanish (S) parental stock after three years of observation. First letter of kid genotype represents sire breed. Second letter represents dam breed.

Using Your Genetic Resources

Ms. Lisa Shepard
Performance Programs Coordinator
American Dairy Goat Association

In today's world, we expect resources to be easily accessed and user friendly. In the previous discussion this morning, I've included the key to the hardcopy Performance Summaries put out by ADGA. The workshop will be using the resources available on the internet which meet our expectations of current, easy to access and easy to use.

I'll be spending most of the time on what is offered at the adgagenetics.org website, but there are a couple of other resources with some slightly different offerings at other websites.

The general **ADGA WEBSITE** contains a variety of articles to help with the various genetic programs available to dairy goat breeders. How to put your herd on test, Top Ten qualifying levels, preparing for linear appraisal, schedules, elite doe and sire lists, Top Ten lists, FAQ on superior genetics, PTI articles, DNA and Casein testing articles, and Somatic Cell information are some of the topics covered. In addition, there are links to other places where information can be found, such as how to read the ADGA performance pedigree.

The member area of the website also has a look up feature that provides the current genetic snapshot as well as lifetime totals, *M recognition, final category scores and show championship designation.

The ADGA member portion does require a personal identification number (PIN) in order to access the information.

A few suggested ADGA links:

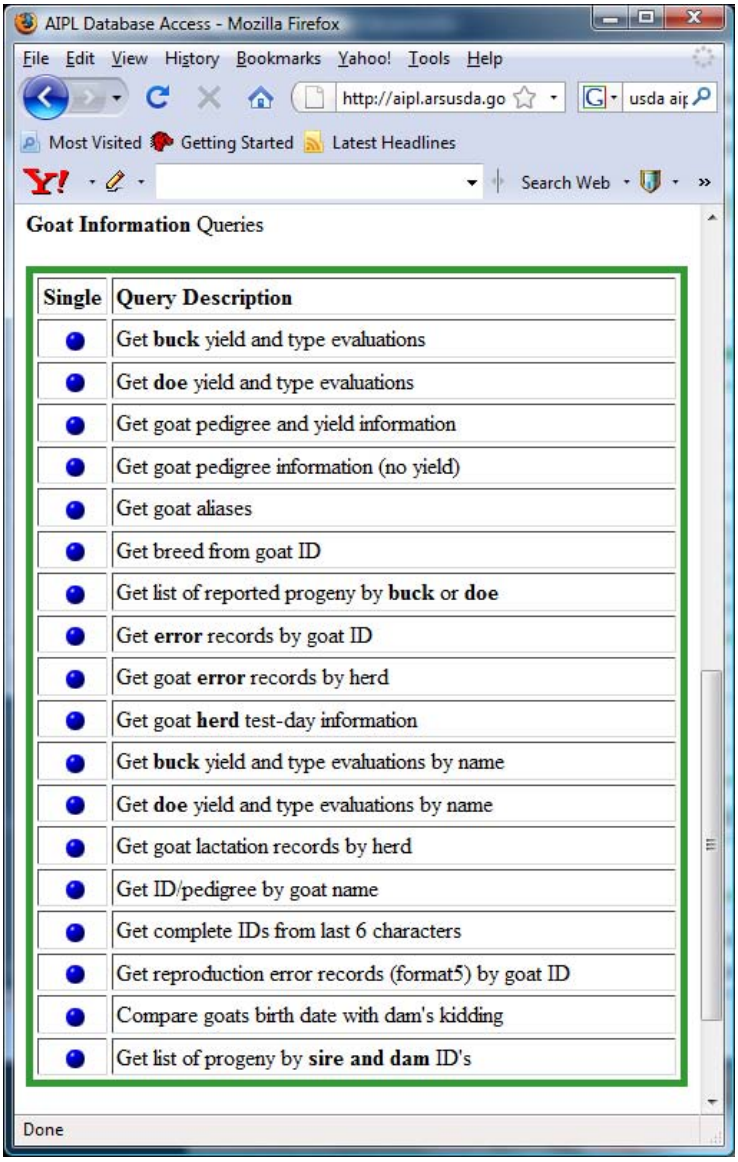
- http://adga.org/dna.htm
- http://adga.org/sg_faq.html
- http://adga.org/DHIR/GoingOnTest96.pdf
- http://adga.org/SD/genetic_abc.pdf
- http://adga.org/somatic_cell.pdf
- http://adga.org/as1_casein_announcment.html
- http://www.caldairygoats.com/readperfped.htm
- http://www.caldairygoats.com/data_collection_rating.htm

THE VETERINARY GENETICS LABORATORY (VGL) provides animal parentage verification, identification, forensics services, genetic diagnostics and genetic disease research as a self-supporting unit of the School of Veterinary Medicine at the University of California, Davis. VGL is internationally recognized as a pioneer and expert in DNA based animal testing. VGL also offers an extensive animal forensics service program, diagnostic tests for genetic diseases, and support for genetic research in domestic species, primates and wildlife.

Tests	Info	Form
DNA Typing - Parent Verification		
Alpha-S1 Casein		
Freemartin		
Karyotyping		

Web link: http://www.vgl.ucdavis.edu/services/faqservices.php for FAQ

THE ANIMAL IMPROVEMENT PROGRAMS LABORATORY is the lab that houses the section that ADGA works with on genetic and pedigree information and is in the Animal Research Service. ARS has about 1,200 research projects. The National Agricultural Library and the National Arboretum are also part of ARS. ARS is devoted to research implementation and information delivery. Regulatory function was removed f from ARS 30+ years ago.



As an ADGA partner in providing genetic evaluation information pedigree information (not one bit of ownership information) and linear scores are provided to AIPL. In return, genetic information on milk production and type traits are provided using the laboratory resources to provide this complex statistical information as all known relatives are taken into account when determining the predicted transmitting abilities of these qualities. Accuracy of pedigree relationship is critical.

Pedigrees and a variety of other queries are available. The following menu appears describing the various queries.

As you can see from this menus, pedigree information, progeny information, genetic evaluation information and milk test information is available.

Of assistance to those on production testing, there are queries to help find if there are errors in the data being provided to AIPL. This can be looked up by animal ID or by herdcode.

In addition, there are queries that provide the same information only using name information rather than ID.

A limitation of AIPL is that it is for the most part, individual snapshots of each animal's information. Ways to compare animal information or to look up based on desired goats is not part of this website's offerings.

We'll go through a couple of the more popular queries.

Pedigree and Yield is probably the most used feature. Information on pedigree is provided along with test day information on all monitored lactations. For those on test, the data collection rating is tracked on this query.

Lac	Fresh	DIM	Herd	CtrlNo		Proc_Date	Mod_Date	DRPC
1	2005/03/04	291	93100624		301	2006/02/14	2008/08/27	10

LT	Mk	LI	TC	TC2	OS%	PC	Opn	Bth	NTD
0	10	0	0		23	0	204	1	10

	Milk	Fat	Prot	SCS	
Std	3130	112		82	3.25
DCR		99	95	95	96
Act	3150	116		86	2.95
PER		0.28	0.20	-0.11	0.54
Rel		88	80	68	62

	DIM	Milk	Fat%	Prot%	SCS	Freq	Test Date
1	5	7.3	5.6	4.2	2.2	2	2005/03/08
2	32	12.2	3.5	2.6	2.7	2	2005/04/04
3	60	11.7	2.7	2.5	4.9	2	2005/05/02
4	95	10.4	2.8	2.2	2.2	2	2005/06/06
5	etc.						

Evaluations are updated as they become available and both the yield and type information are supplied on a single page as follows:

Output from "Get doe yield and type evaluations"

Doe Yield Evaluation

Information shown is from the 0811 run.

0811
ENUSA000001261835

Doe	Sire	Dam	Birth	DRPC	Ctrl #	Herd
EN001261835	EN001065862	EN000930291	2003/04/11	10	301	93100624

Kidding	DIM	MFP$	Pctile	Inbred %
2008/02/23	248	+24	89	4

Trait	PTA	Rel	Herds	Lact	PTA %	Mean
Milk	+213	.50	1	4		3566
Fat	+8.0			-.00	136	
Protein	+5.0	.50	1	4	-.06	101

Doe Type Evaluation

Information shown is from the 0711 run.

Doe	Appraisals	Eval Date
ENUSA000001261835	1	0711

Trait	PTA	Rel
Final Score		+0.5 .40
Stature	+1.1	.60
Strength		+0.8 .43
Dairyness		-0.1 .39
Teat diameter		+0.1 .49
Rear Legs		-0.5 .36
Rump Angle		+0.1 .45
Rump Width		+1.1 .47
Fore Udder Att		+0.6 .39
Rear Udder Ht		-0.4 .41
Rear Udder Arch		+0.1 .35
Udder Depth		-1.6 .41
Susp Lig		+0.2 .46
Teat Placement		+0.3 .48

Various other queries are useful, especially to those on test. We'll look through those during the workshop, but they can assist with making sure records are being sent, records are accurate, and that test day characteristics are accurately represented.

Goat lactation curves, genetic trends, presentations and articles can also be found at this site.

In summary, USDA-AIPL calculates annual genetic evaluations of dairy goats from yield data collected through the National Cooperative DHI Program and from type and pedigree data supplied by the American Dairy Goat Association (ADGA). Evaluations for type have been calculated since 1986 for final score and since 1989 for linear type traits.

Evaluations are computed for Alpines, Experimentals, LaManchas, Nubians, Oberhaslis, Saanens, and Toggenburgs and for crossbred animals from these breeds. Only animals with registered sires are evaluated.

Web links:

http://aipl.arsusda.gov/reference/goat/goatsfs.html

http://aipl.arsusda.gov/reference/goat/laccurv.htm

http://aipl.arsusda.gov/eval/summary/goats.cfm

But the website that has generated the most excitement is the **ADGA GENETICS** web application.

ADGA provides this same pedigree information on this site as is given to AIPL along with additional registry known information such as SG designation, polled, black, DNA on file and buck collection on file. ADGA provides the production/type index numbers as well from their own formulas for this calculation.

COI is a built in function on the website. Genetic evaluation information as provided by AIPL is included on the site as well as being provided on the AIPL site.

The site is the product of a cooperative effort between the ADGA, AIPL-USDA and Gene Dershewitz as a public service to the dairy goat world.

The web application provides tools to help dairy goat owners make informed herd management decisions. The application combines registry data from ADGA and production and type evaluation data from USDA.

The site is organized into several sections.

Pedigrees	Search for individual animals registered with the American Dairy Goat Association (ADGA). This can be done by herdname, full registered name, partial name or registration number. The registration database is updated at the beginning of each month.
Planning	"Try out" breedings electronically before really doing the deed. Planned pedigree, Estimated Transmitting Ability (ETA) and coefficient of inbreeding are calculated based on your choice of Sire and Dam.
PTI/ETA	Search for top animals based on 2 calculated indices: Production Type Index (PTI) and Estimated Transmitting Ability (ETA).
Production	Search through Predicted Transmitting Ability (PTA) data modeled by AIPL USDA from years of DHI production test records for dairy goats. Want to improve milk production? This is the tool to use.
Type	AIPL USDA has distilled years of ADGA linear appraisal data into Predicted Transmitting Ability (PTA) values for each trait. Use this tool to find sires that have shown to make linear trait improvements.

Unlike the AIPL or member site, information can be searched, sorted and viewed in many different ways.

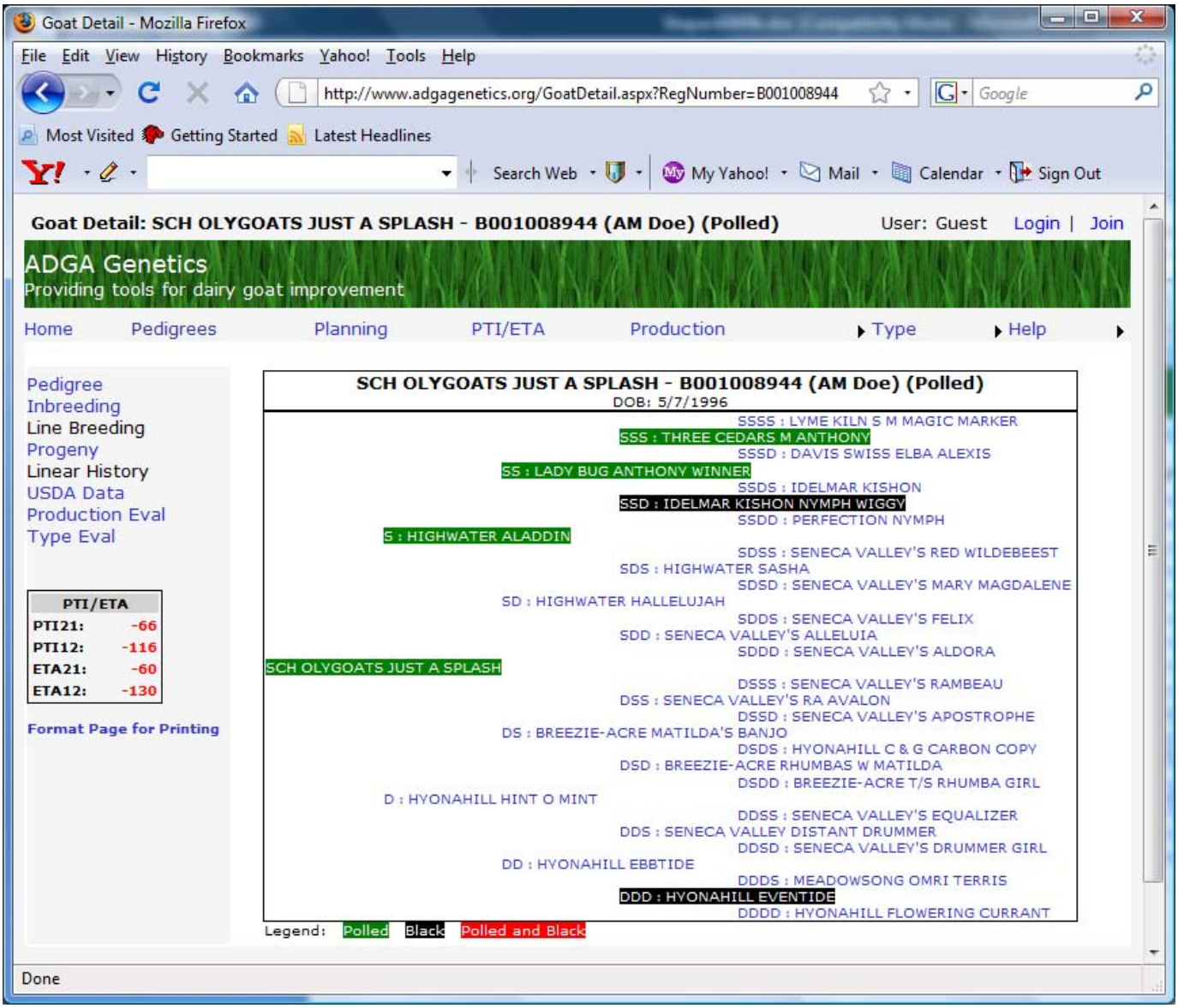
Filters appear directly below the page header when necessary. From the help section, Filters have the following features:

- They are made up of a combination of drop down lists, textboxes and buttons that allow you to set search criteria for the current page.
- Some filters may automatically refresh results when a new value is selected.
- They are by default set to the least restrictive values (return the most results). You can narrow your search and number of results returned by changing the filter values.
- Filter values, once set, are remembered across different pages for your current browser session.

Search Results generally appear in tables in the Content Area just below any filters that may be present. Here are some features that are common to most results tables:

- All columns are sortable by clicking any column heading. Clicking the same column a second time will sort results in the opposite direction based on the column clicked.
- A registered name can be clicked to take you to the Goat Details page for that animal.
- Results are displayed up to 20 records per page. If more than 20 records are returned for your filter settings, a page navigation control will be visible just under your results.

Several views are available, including pedigree, inbreeding, linebreeding, progeny, linear history, USDA Data, Production and Type evaluations. The one used most often is the goat detail page which includes information on polled and black animals in Oberhasli and Toggenburg as well as pedigree information and any genetic rankings.



Web Link: www.adgagenetics.org

Use of On-Farm Performance Testing to Enhance the Meat Goat Herd Enterprise

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What is On-Farm Performance Testing?

Performance testing is the comparative evaluation of animals for production traits of economic importance. Reproduction, growth, and carcass merit are the traits of primary economic importance in meat animal industries, including meat goats. However, pedigree and visual appraisal for conformation have been the primary basis of animal selection in most meat goat herds. Most herd expenses are directed towards doe management. Does are expected to become pregnant, deliver live newborns, and raise multiple kids with good growth to weaning. **Reproduction is generally viewed as the most important trait of meat animal production in terms of determining enterprise profitability for commercial producers.** Reproductive output in a meat goat herd is defined as litter weight weaned per doe exposed to the buck. On-farm performance testing includes the comparative evaluation of does for reproductive output, the evaluation of individual kids for weight gain, and in multi-sire breeding programs, herd sire comparisons for progeny performance.

One method of meat goat testing is the 'central buck test' where young herd sire prospects from various farms are brought to a designated test site to compare growth rates and possibly other traits such as carcass merit. Test diets are based on various levels of concentrate and forage and are generally classified as a feedlot/grain test or a pasture/range test. Buck tests allow seedstock producers to compare their sire prospects with young bucks from other farms under identical environmental conditions. Participation can be viewed as a value-added activity as placing well on a buck test may increase the value of an individual buck or the genetics of a herd in general. One limitation of the buck test is that it does not provide information on doe reproductive merit, that trait of utmost economic significance. Doe reproductive merit requires on-farm record keeping within the breeding herd.

On-farm performance testing is commonplace to assess female productivity in other livestock industries where profit is a primary objective. Calving rates and weaning weights are two of several traits recorded and used for selection decision-making in beef cattle herds. In dairy goats, milk yield is a routinely measured doe performance trait. A similar emphasis on record-keeping for performance traits has not been applied in purebred or commercial meat goat programs. Objective, accurate recording of doe herd performance allows producers to make better selection and culling decisions and to measure performance responses to management changes. Producers can assess the production return (i.e., litter weight weaned) from the expenses incurred for doe management.

How Can an On-Farm Performance Test Be Implemented?

Performance records should be easy to use. Records can be handwritten in a notebook or on index cards. Alternatively, records can be maintained electronically on computer spreadsheets or herd management software. Electronic records allow easy handling of data for analysis, particularly for herds with large sets of data accumulated over several years. However, a hand calculator and a little time are all that may be required for processing data from smaller herds using handwritten records. Under any scenario, proper record keeping is essential to a successful performance testing program. Each animal in the breeding herd should have a separate record.

Animal identification. For each herd member to have a separate record, proper animal identification is required. Ear tags and tattoos are common forms of ID for meat goats. Assign every herd member a unique and permanent ID number. Numbers can be assigned to kids at birth when collecting early data such as birth weights, litter sizes, and neonatal deaths. Newborn kid data need to be matched with the correct doe. In herds with many does kidding together on pasture or range, it can sometimes be a challenge to tell which kids belong to which does. Rejected kids, early newborn deaths, and the occasional swapping of kids by does make it important to properly and adequately ID kids soon after birth, preferably within 12-24 hours.

Scales. Scales are needed to implement a performance testing program. Body weight is undeniably important as a measure of meat animal performance as well as for some aspects of general herd management. A small hand-held scale is sufficient to record birth weights. A larger livestock scale is needed for weaning weights. Scales may be bought, borrowed, or rented depending on the needs and resources of individual operations. A weight tape or other means of estimating body weight are NOT acceptable. A scale should be periodically checked to ensure that it is accurate and precise when weighing animals.

Contemporary Groups. A contemporary group is a set of meat goat kids born and raised together under the same conditions. Objective genetic evaluation requires factors like age, nutrition, and location to be identical for all kids. Kids in a contemporary group are ideally born within a 60-day period and managed together from birth to weaning. Dams should also be managed together from kidding to weaning. Data from kids born outside the 60-day window or managed differently (e.g., on show circuit, bottle babies, kept in separate pastures) are excluded from the group. Contemporary groups for kids weaned at three months old are planned 8-10 months earlier at the start of breeding. Breeding seasons should not extend beyond 6-7 weeks to assure that kids will be within the 60-day age range at weaning. If breeding occurs year-round, then the manager will need to group kids based on birth date to form meaningful contemporary groups. In essence, properly constructed contemporary groups will minimize environmental effects that can affect kid performance.

What Should Be Recorded?

Body Weight. Primary traits to record in a meat goat herd are 1) the number of kids born and weaned for each doe exposed to bucks, 2) kid birth and weaning weights, and 3) dam weight at weaning. Birth weight is the starting point to determine preweaning growth rate. Recording birth weight also facilitates recording the birth date, identification of the dam, and tagging the newborn with a unique ID number. Newborn weights should be recorded within 24 hours of birth.

Record weaning weights at around 90 days of age. Weaning weights are usually recorded on one calendar date for a group of kids that vary in ages. The ages within a contemporary group of kids at weaning should deviate from 90 days by no more than 28 days. It is also useful to weigh the dams when the kids are weaned. Dam weights are used to calculate the efficiency of doe production. If the producer prefers an earlier weaning weight, then 60 days can be the target date. Similarly, a later date such as 120 days can be used. If a management scheme is to wean buck kids earlier than doe kids, all kids can be weighed when the

bucklings are weaned. The 90-day recommendation is used in an effort to move towards an industry-wide standard such as the 205-day benchmark for beef cattle weaning weight assessments and the 305-day standard for dairy goat evaluations. If a producer prefers to wean kids at an older age, then kids can be weighed at a 90-day point and left on the does until the desired weaning age at which time the producers can then record the actual herd weaning weight.

Litter Size. For each doe exposed to the buck, record the number of live births and the number of kids weaned. Note stillborns in a doe's file, but do use them for litter size and they need not be weighed. Artificially-raised kids are not credited to the dam for weaning litter size or weight. In cases when a doe adopts a kid from another doe, the adopted kid can be credited to the 'foster' dam for weaning data. Failure to birth or wean a kid following buck exposure are recorded as zero (0) for the doe. It is important that does that do not wean a kid, regardless of the reason, be included in the records for whole-herd evaluation. The reason why an individual doe does not wean a kid should be recorded (e.g., did not cycle, did not get pregnant, aborted, kids died, etc.)

How Are Individual Animals Evaluated

Kid Evaluation. Kid weight comparisons can be biased because ages vary in a contemporary group of kids at weaning. It is NOT necessary to weigh every kid when it turns 90-days-old. All kids will be weaned on one day. However, recognize that on that single weigh date a 79-day-old kid cannot be expected to weigh as much as a 112-day-old kid. Therefore, weaning weights are converted to a standard 90-day age basis. Two equations are used to generate 90-day weights. First calculate average daily gain (ADG):

ADG = (weaning weight - birth weight) ÷ weaning age

After the average daily gain is determined, the second equation gives the 90-day weight:

90 Day Weight = (ADG x 90) + birth weight

When birth weight is not recorded, ADG cannot be determined. In the absence of a recorded birth weight, replace the previous equations with the following equation based on weight per day of age:

90 Day Weight = (weaning weight ÷ weaning age) x 90

Adjustments to the 90-day weights are required because litter size and age of dam can affect weaning weight. On average, weaning weights decrease as litter size increases and young does wean lighter kids than mature does. Multiply 90-day weights by the appropriate correction values (Table 1) to get adjusted 90-day weights. Buck kids are typically heavier than doe kids, but sex of kid adjustments are not required because comparisons are made within single sex groups (i.e., buck kids are compared only to other buck kids and doe kids compared to other doe kids).

Table 1. Adjustment values for 90-day meat goat kid weaning weights

Effect	***Group***	***Value***
Litter Size, *born & weaned*	1 & 1	1.00
	1 & 2	1.14
	2 & 1	1.04
	2 & 2	1.18
	3 & 1	1.08
	3 & 2	1.23
	3 & 3	1.27
Age of Dam, *years*	1	1.10
	2	1.09
	3+	1.00
Sex of Kid	Buck	1.00
	Doe	1.11
	Wether	1.08

Values courtesy of David R. Notter, Ph.D., Virginia Tech

An additional step is generating weaning weight ratios. Within each sex group, individual kid weights are compared to the group average to produce ratios for relative evaluations. Ratios show the deviations of kid weaning weights from the contemporary group average. A ratio is calculated with the following equation:

WWT Ratio = (90 day kid weight ÷ 90 day herd weight average) x 100

A ratio of 100 is equal to the group average. A kid with a weight ratio of 122 is 22% heavier than the group average. Conversely, a kid with a ratio of 91 is 9% lighter than the group average.

Table 2. Doeling Weaning Records

KID ID	DAM	SIRE	Litter Type	BWT	WWT	AGE	ADG	Dam ADJ	Litter ADJ	90-d WWT	WWT Ratio
5011	607	447	2-2	7.1	36.2	109	0.27	1	1.18	36.7	92
5018	427	251	1-1	10.4	52.3	107	0.39	1	1	45.6	108
5022	256	250	2-2	6.6	39.0	107	0.30	1	1.18	40.0	100
5044	261	251	3-2	6.0	48.5	105	0.41	1.09	1.23	56.9	135
5107	622	456	2-2	5.4	33.8	103	0.28	1	1.18	35.7	89
5112	640	251	3-3	5.0	39.2	103	0.33	1	1.27	44.3	110
5173	411	251	2-2	6.5	34.7	82	0.34	1	1.18	44.1	105

Table 2 provides an example of how records can be used to assess kid performance for weaning weight. Based on actual weaning weight (WWT), kid #5018 was the heaviest at 52.3 pounds. In a pen of kids, the 5018 doeling would probably standout as being the largest based on visual appraisal. However, note that the kid was the only single in the group. Using the formulas and correction factors provided earlier, the 90-day adjusted weights (90-d WWT) and contemporary group ratios (WWT Ratio) are determined. After adjustments for age of kid, litter size, and age of dam it is revealed that in genetic terms, the best kid for weaning weight was actually kid #5044. She had an adjusted weight of 56.9 pounds and was 35% heavier than the group average; this kid was out of a two-year-old doe, born a triplet, and weaned a twin. Although a big kid, #5018 had some non-genetic advantages (e.g., mature dam, single kid) that contributed to a heavier weight. If a producer was to simply select the heaviest kids without accounting for correction factors, a producer might unknowingly select single kids as doe replacements that could lead to an increasing number of single kid-producing does in the herd. These types of record assessments will be more important when selecting kids as replacement breeding stock than for kids destined for the meat market.

Sire Evaluation. In herds using multiple sires, kid weights and ratios can be used to compare sires for progeny performance if each kid's sire is known. Buck and doe kid ratios may be combined for sire evaluations. Adjusting doe kids to a buck kid weight equivalent (Table 1) may be used to combine buck and doe kid weight records for sire evaluation.

Table 3. Sire Evaluation

TSU Sire Evaluation (2004-07)

Sire	Kids	90-d Wt	Ratio
249	53	43.1	101
286	20	39.9	102
307	11	37.5	99
456	29	43.3	103
470	24	44.4	108
471	26	34.1	89
601	80	39.1	93
614	54	42.3	103
657	16	45.2	112

Table 3 provides an example of how sires within a breeding program can be evaluated. These bucks were all mated to does of similar quality and have between 11 and 80 progeny weaning weights across up to eight contemporary groups. Two buck can be selected from the table for comparison. Kids from Buck #470 have an average 90-d weight of 44.4 pounds and average 8% heavier than contemporaries, whereas kids from Buck #471 have an average 90-d weight of 34.1 pounds and average 11% lighter than contemporaries. On visual appraisal both bucks selected (each a '100% NZ Kiko' sire) look to be of similar quality. However, the kids from #470 are 10 pounds heavier, on average than kids from #471. The 10-pound difference per kid can be significant for a commercial producer selling market kids by the pound. If kids are selling for $1.30/lb, what would be the difference in cash return for a trailer-load of kids sired by #470 versus #471? How about if kids are selling for $0.90/lb or $1.70/lb? The management costs are no different, only the choice of sire has impacted herd productivity and cash returns. Without recording kid weaning weight data, sire differences would go undetected. Although pedigree and appearance may suggest the quality of a buck, **the true value of a buck is in how well his kids perform**. Some of the best-looking bucks (on registration certificate or standing in the pen) have been shown to produce poor growing kids upon progeny testing and visa versa for bucks that do not 'look' very attractive. Care must be taken when comparing sires that they are mated to does of similar quality and that kids are of the same contemporary group or are linked to a common 'reference' sire. Objective selection and culling decisions within the sire battery can be made using progeny performance records such as those presented in Table 3.

Doe Evaluation. For each dam, add the weights of all kids she weaned. Actual or 90-day weights can be used for doe evaluations. Actual weights are preferred because they credit the ability of does to breed early and raise kids for a longer period of time, weaning off more weight on average compared to does bred later in the season. When comparing young and mature does, correct kid weights for age of dam (Table 1). A sex of kid correction can also be made to put doe kids on a buck kid weight equivalent for unbiased litter weight evaluation. Litter size corrections are NOT made to kid weights for doe evaluation. Do not exclude those does that fail to raise a kid to weaning. Zero (0) is recorded for litter weight weaned of does not weaning a kid.

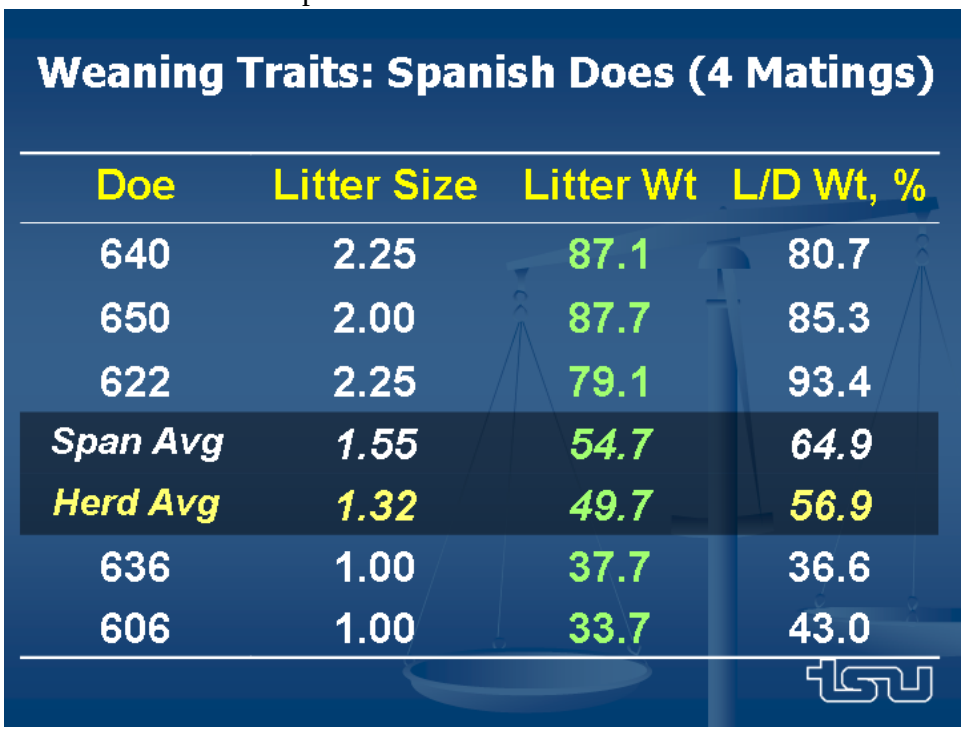
Litter size at birth and weaning should be assessed for each doe. After two or three production years, a certain average number of kids weaned by does should be expected such as 1.5 kids weaned per buck exposure. Doe production efficiency can be measured by how much total litter weight a dam is able to wean relative to her own body weight. A heavier doe (e.g., 150 pounds) requires more management inputs than a lighter doe (e.g., 100 pounds). However, the heavier doe may or may not be able to convert the greater inputs into a correspondingly heavier litter weaning weight. If dams are weighed when kid weaning weights are recorded, the following equation can provide the efficiency of doe production:

Doe Production Efficiency = (litter weaning weight ÷ dam weight at weaning) x 100

Nutritional resources are used by does for self-maintenance, reproduction to produce kids, and milk production to raise kids. In young does, growth must also be supported. Forage and feed inputs may be available in limited or unlimited supply to does and usually represent the primary expense of herd management. Doe production efficiency values vary widely, ranging from less than 50% to over 100%. Does with consistently higher production efficiency values within a given set of environmental/ management conditions are considered better converters of management resource inputs to marketable litter weight weaned; these does are more efficient, profitable herd members.

Tables 4 and 5 illustrate how kid weaning weights can be used to help evaluate doe performance. Records indicate that Does #640, 650, and 622 have consistently produced at levels higher than the population averages, whereas Does #606 and 636 have been poor performers. In Table 4, the top three does average twins weaned per year, weaned 25 pounds or more compared to the population average, and produced about 80% of their body weight. In contrast, the bottom two does only wean one kid per year, weaned 15 to 20 pounds or less that the population average, and only produce about 40% of their body weight. Table 5 shows the cumulative production over four years in the herd where the top end does produced over 100 pounds more that the herd average and 170 pounds more than the bottom end does. Management costs are equal for all of the does in the test herd. However, depending on the market price of kids, profitability would be more probable with the twin-bearing dams than the single-bearing dams. If the annual doe cost was $50 and kids sold for $1.25/lb, the average doe in the herd would be profitable. However the top-end does would be very profitable while the bottom-end does would represent a financial loss. Profit and loss values would, of course, change as annual doe management costs and market prices of kids vary from year to year. Tables 4 and 5 demonstrate the potential impact of reproductive performance as measured by litter size weaned to influence profit and loss in a breeding meat goat operation. It should be recognized; however, single-bearing does may not be a liability under specific management circumstances such as in very low input, extensive production systems where costs are low enough for single-bearing does to be profitable.

Table 4. Annual Doe Reproductive Performance



Weaning Traits: Spanish Does (4 Matings)

Doe	Litter Size	Litter Wt	L/D Wt, %
640	2.25	87.1	80.7
650	2.00	87.7	85.3
622	2.25	79.1	93.4
Span Avg	*1.55*	*54.7*	*64.9*
Herd Avg	*1.32*	*49.7*	*56.9*
636	1.00	37.7	36.6
606	1.00	33.7	43.0

*L/D Wt = Litter weight weaned / dam weight at weaning

Table 5. Four-Year Doe Reproductive Output

Lifetime Weaning: Spanish Does (4 Yrs)

Doe	Kids	Weight	Wt Diff.
640	9	348.4	+ 129.6
650	8	348.4	+ 129.6
622	9	316.4	+ 97.6
Span Avg	*6.2*	*218.8*	*0*
Herd Avg	*5.3*	*198.8*	
636	4	150.8	- 68.0
606	4	134.8	- 84.0

*Wt Diff = Difference in 4-year weight weaned of doe compared to Spanish doe group average

Nevertheless, while litter size at weaning is a good indication of doe performance, litter weight weaned provides a better measure of doe reproductive output. Relatively low-performing does should be identifiable within a couple of production years. On-farm performance testing allows for the identification of high- and low-performing does and subsequent selection and culling decisions.

A variety of management choices may be implemented to increase doe reproductive rates or kid preweaning growth rates. However, added cash return from the increased weaning yields must be greater than the increased cost of the new management procedure to justify the management change. For example, a management decision may be to implement a creep-feeding program. To be justified, the price received for the extra pounds weaned must more than off-set the added management costs associated with creep-feeding. Conversely, a management change to lower input costs should not lead to a significant drop in doe herd performance leading to a loss of net income per doe. In any case, it is very difficult to determine the economic impact of a change in herd management without a system of on-farm performance record-keeping to assess changes in herd productivity in response to changes in management.

Should Other Traits Besides Weaning Traits Be Recorded?

Other production-related traits may be of interest to meat goat producers. Growth rates after weaning can be evaluated on-farm when goats are retained to heavier post-weaning market weights or when developing replacement breeding stock. Keep detailed health records on each animal. Periodic evaluation of records is recommended for traits associated with internal parasitism, lameness, abortions, mortalities and other health concerns to help in making selection and culling decisions and reviewing herd management procedures. Although the primary focus has been on preweaning kid growth and doe reproductive output, evaluation of other performance traits is encouraged in meat goat herds.

Summary

On-farm performance testing of the doe herd is important in commercial meat goat operations expecting good doe-kid performance with minimal management inputs. On-farm performance testing is important in seedstock operations that expect to provide genetics to commercial meat goat producers. Each producer will set herd-specific performance levels for animal selection and culling. Procedures described here are for within-herd animal evaluation and not meant to compare animal across different herds. Performance records, when used with visual appraisal and pedigree, facilitate improvement for economically important traits. Performance records allow for the evaluation of management procedures and how management changes affect performance. Performance records, when coupled with financial records, provide the basis of assessing the economic status of an enterprise and the likelihood of making a profit or incurring a loss annually. Performance and financial targets should provide direction to breeding programs. On-farm performance testing helps to achieve herd goals.

Dairy Goat Production in China

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Introduction

Goat is one of the most extensively distributed domestic animals in the world, the number of dairy goats in the developed and developing countries accounted for 30.9% and 19.1% of the total goat population, respectively (Olivier *et al.*, 2005). The development of dairy goat industries depends on the competition with cow milk production. Although dairy goat products are generally in specific markets, their profitability and competitive advantage affect their relative price and unique organization of the goat production system. Most of the world human population in developing countries has access to goat milk, a survey shows that probably less than 5% of the total milk is traded, thus, the statistical data may not display an exact view of the economical importance of this sector, and goats in the developing regions in the world played a significant roles in food and economic security, research on dairy goats increased in recent years, so does it in China. Dairy goat production in China demonstrated a great perspectives, the paper will summarize the dairy goat production of China to provide information for the goat producers and scientists involved in the small ruminant research.

History Of Dairy Goat

With the long history of goat rearing, China has the rich resources of goat breeds and ranked the first in the total number of goats. According to the Annals of Sheep and Goat Breeds in China (Compiling committee of Annals of Sheep and Goat Breeds in China, 1989), there are 23 goat breeds in China, in 1995, Nan Jiang Huang goat was recognized as the first new meat goat breeds with the best meat performance in China after evaluation of China Agriculture Ministry (Pu *et al.*, 2002), therefore, at present, the total number of goat breeds in China increased to 24 breeds including dairy, meat, cashmere, skin and dual purposes goat breeds, besides, 25 local goat breeds and imported goat breeds were not listed in the Annals of Sheep and Goat Breeds in China (Xu *et al.*, 2003). Due to the vast territory and diversified ecological conditions in China, the distribution and production of goats characterized by the distinctive regional patterns, dairy goats were reared mostly in the rural area, cashmere goats centralized in the cold mountainous region of northern China, meat goats distributed extensively in various climatic and geographic conditions.

Although the goat had been raised in China for thousands of years and people used milk from local milking goat as food, the commercial dairy goat production is more or less 100 years. At the beginning of 20th century, the war-torn China was not able to develop the animal husbandry, much less dairy goats. It was recorded that in 1920's missionary of Christian and Catholic church from Europe and United States of America brought along the goats for their own consumption, meantime, the bucks were used for the crossbreeding with local goat to improve the production level, and smallholders in the goat-keeping area started the selection themselves, with the increase of milk production, the dairy goat industry was gradually formed. After 1949, Chinese government took a series of measures to develop the animal husbandry, the dairy goat industry has grown rapidly since then, and the number of dairy goats increased from 170,000 in 1949 to 3.22 million in 1988, milk production from 17,700 ton to 529,000 ton accordingly, the annual growth rates averaged 7.8% and 9.2%, respectively. From 1989, the dairy goat in China developed steadily with a moderate increase, the rapid growth of dairy cattle industry restricted the dairy goats development to some extent especially in the relatively developed regions, the shift of production purpose i.e., milk or meat affected the dairy goat industry

as well, however, the functional goat milk received the consumers attention in last few years, the dairy goat industry was revitalized and the number of dairy goat increased to nearly 5.8 million in 2008.

Dairy Goat Numbers And Distribution

It is estimated that total goat number in China is 21.7% of the total goat number in the world (Olivier *et al*., 2005), and the goat number and gross production in China rank the first for many years. The statistics on goats are not very reliable since they are generally not based on the actual census, and the numbers of dairy goats are even more difficult in this aspect due to definition and the changing of subsidy policies etc. According to the latest production data, there are now approximately 5.8 million dairy goats in China which mainly distributed in Shaanxi, Shandong, Henan, Liaoning, and Hebei province etc., as the biggest dairy goat production base in China, Shaanxi province kept 2.4 million goats in 2007, and 30% milk of this province was from dairy goats. The dairy goats had been extended to 28 provinces of China, the concentration in the several provinces is evident, the regions producing large amount of grains kept most numbers of dairy goats, the number of goats in each province do not reveal the importance of goats in some areas because the regional difference was not considered within provinces, for example, dairy goats in Shaanxi province are mainly in Weinan prefecture where dairy goats are the important income source of farmers. In the southern provinces such as Guangdong, Fujian, and Zhejiang, the higher fresh goat milk consumption resulted in a seasonal characteristics of dairy goat production, the milking goats were trucked to the south in the spring from northern provinces, the milk was sold at a higher price, all goat will be slaughtered in the beginning of winter after the lactation, this production model was considered as short-sighted measures of animal husbandry, therefore, the numbers of dairy goats in southern China are quite small.

Dairy Goat Breeds

The number of dairy goat breeds including Saanen, Toggenburg, and Nubian was introduced into China since 1920's and has been kept successfully, so far, various breeds of dairy goats had been officially recognized, but the main dairy goat breeds are Xinong Saanen dairy goats, Guanzhong dairy goats, Laoshan dairy goats, Henan dairy goats, Yanbian dairy goats etc., all breeds are white and short haired animals.

Xinong Saanen dairy goat

The leading high producing dairy goat breed in China, this breed was selected from a small herd of Saanen goat imported from United States of America in 1936 by Chinese National Association of the Mass Education, the goat herd was soon forced to move to Northwest Agricultural College (currently the Northwest A&F University) in Shaanxi province following the breakout of anti-Japanese war, the systematic selection of dairy goats started from 1944 by famous professor Liu Yingwu, Xinong Saanen dairy goat was formally recognized in 1981. Typical dairy conformation and high milk production attracted the great attention of producers, the large body size manifested by the "4-long" characteristics, i.e., long-head, long-neck, long-trunk and long-leg. The milk yield in 300 days lactation period averaged over 800 kg (1,762 lbs) with the highest daily milk yield of 10.8 kg, the milk fat, protein and dry matter percentage are 3.43%, 3.28%, and 11.40%, respectively; kidding rate is around 200% with dominant twins and triplets, the high quality bucks and does can be used up to 9 or 10 years old. Xinong Saanen dairy goats can adapt extensive climate in China, though the regions between the north of Yangtze River and south of Yellow River have the best climate conditions for efficient production.

Guanzhong dairy goat

With the largest population in China, Guanzhong dairy goat was crossbred by Xinong Saanen dairy goat and local white goat since 1970, the breed was officially approved by Breed Evaluation Committee of Shaanxi province in 1990. The breed mainly distributed in the central area of Shaanxi province and had

been sold to 20 provinces of China. Due to the similar genetic background, the conformation of Guanzhong dairy goats looks like Xinong Saanen dairy goats with only a little smaller body size. The milk yield in 280 days lactation period ranged between 400 kg to 700 kg (881 to 1,542 lbs), the milk fat, protein and dry matter percentage are 3.50%, 3.52%, and 12.90%, respectively; kidding rate is around 178%. All milking goats were culled for meat purpose with the average dressing percentage of 45.5%. The breed could adapt the harsh conditions and display the strong resistance to common diseases.

Laoshan dairy goat

Laoshan dairy goat distributed in Jimo, Qingdao, and Yantai areas of Shandong province where the rich natural and feeds resources provide the superior conditions for dairy goat, this area has the longest history of dairy goat-keeping. At the beginning, the Saanen goats brought by preachers crossbred with the local small-sized white goats, the Laoshan dairy goat was gradually formed after many years selection for high milk production and large body size, this breed was officially approved as the dairy goat breed in 1991. With the compact and strong conformation, Laoshan dairy goats are white-haired with a large percentage of hornless, the milk yield in 270 days lactation period ranged between 450 kg to 800 kg (991 to 1,762 lbs), the milk fat percentage is around 4%, kidding rate is around 170%. Laoshan dairy goat demonstrated the better adaptability to the humid climate conditions.

Dairy Goat Rearing And Management

In China, dairy goat feeding is quite extensive to minimize the costs, the main production models are as following:

Tethering system (partly grazing)

The dairy goats are mostly kept in the agricultural production areas with limited pastures, local farmers have a long-standing traditions of keeping dairy goats either for home consumption or making money, each family usually possess 1 to 5 milking goats, children and elders often take care of goats, the tethering dairy goats browse the grass on the ridge of the field while farmers work in the cropland, this is the most popular and low cost way of keeping dairy goats, which is suitable for the small scale production. The disadvantages of partly grazing system are the contradiction of destroying trees and crops and death caused by inappropriate rope setting.

Goats in this system depend solely on the grass in the late spring through fall, high producing does may be supplemented with corn and wheat bran mixture in the peak lactation during the summer time; goats receive small amount of concentrate mixture except for the corn stalks and crop residues during winter and early spring, few smallholders store the roughage for dairy goats whole year. Family kitchen wastes were fed sometimes in the production system, but the caution must be exercised.

Confined system (zero grazing)

With the growing dairy goat business, the confined feeding system emerged to meet the requirements of large scale and intensive production, the numbers of large scale dairy goat farms increased significantly in recent years, the average herd size for each smallholder is about 30-50 goats, the record-keeping and breeding plans could be implemented in the farm to improve the milk production of does. With the concomitant increase of herd size, the machine milking stations were constructed in the village to milk goats to make sure the milk quality, this system is beneficial to controlled mating, disease control, and high milk yield etc., however, the investment for such system was relatively higher, and the feeding and management are more labor costing.

The main roughage for the dairy goats includes corn silage, corn stalks, peanut vine and bean stalk and pod etc., the roughage needs to be stored for winter use, concentrate mixture must be supplemented all year around to obtain the higher productivity.

Milk Processing

The total goat milk production constitutes 4% of China's total milk production. Per capita milk consumption of China in 2007 is 27.9 kg (61.5 lbs) which was significantly lower than the annual milk consumption in the world (100 kg = 220 lbs), and even lower than that of developing countries (40 kg), therefore, the Chinese dairy industry and milk market still have a great development potentials, many years experience of dairy enterprises in China has proven that dairy cattle production can not provide adequate milk without the dairy goat industry, goat milk is an important supplement of dairy production, particularly for the residents in underdeveloped rural area and hilly mountainous region, rearing dairy goats can efficiently increase the farmer's income and improve the nutrition status of people and finally realize the strategic objectives of poverty alleviation.

At present, the goat milk in China was mainly used to produce milk powder and drinking milk, very small amount of goat milk was used for cheesemaking in the pilot dairy plant or institute, you hardly find other forms of products from goat milk. The lack of diversified goat milk products also affected the dairy goat industries and the development of goat milk products suitable for Chinese consumers are needed in the future dairy goat industry in China. However, in the last few years, with the further understanding of medical function of goat milk, consumers have gradually accepted the goat milk and its products, minority of investors had turned their attentions to the industrialization of dairy goat production and development of new milk products.

Research And Extension

Since 1970, different funding agencies in China had funded a number of projects in dairy goat research and extension covering the broad areas of nutrition, breeding, reproduction, milk processing, disease control and management etc., the ongoing projects for dairy goats are listed as it follows:

- Construction of Reproductive Breeding and Production Technology System for Dairy Goat Industry in China, funded by China Ministry of Agriculture;
- Network Analysis of Genes of Fatty Acid Metabolism in Mammary Gland of Dairy Goats, funded by China Ministry of Science and Technology;
- Research and Demonstration of Efficient Ecological Feeding Technology of Dairy and Meat Goats, funded by Department of Science and Technology of Shaanxi Province;
- Study on key Technology of Feeding and Management of Dairy Goat Kids, funded by Department of Science and Technology of Shaanxi Province.

Meantime, the extension works are very active, extension specialists and professors gave the scheduled training lectures to farmers and technicians, several breeding farms of dairy goat are responsible for the supply of high quality semen and breeding stocks. Due to the wide involvement of family members in the dairy goat production, a similar goat extension program as in United States of America should be developed in China to accelerate the pace of industrialization of dairy goat.

Prospects

Dairy goat production in China had been stabilized for number of years, in last few years, due to the favorable goat milk market, dairy goat industry received unprecedented attentions, highly productive dairy goats were used to crossbreed the native goat for dual purpose production, dairy goat industry gradually increased with the growing numbers of large scale farms and got on the right track of sustainable develop-

ment, however, we must keep a clear mind to the problematic issues in the development process of dairy goats, and the attention should be paid to the ecological environment protection, reasonable utilization of goat feed resources, increase of the feeding and management, improving of individual production performance, adjustment of production mode and varieties of goat products, competitiveness in the consumer market, and finally make China goat industry a sustainable animal agriculture with great emphasis on economic, social, and ecological benefits.

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Goat Production in Jordan

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Introduction

About 8000 B.C., goat was the first animal species to be domesticated by the Sumerians in Mesopotamia. Goat had a strong impact on all phases of the Sumerian's life. Goat was considered by ancient people as a holy entity for worship at the side of gods. In modern times, goats play an important economic role in farming, providing food for farmers in mountains, arid and semiarid areas (Hatziminaoglou and Boyazoglu 2004). Goats have spread all over the world adapting very well for diverse environments. The goat is found under a wide range of climatic conditions. Apart from thriving in arid desert areas it is known to succeed in tropical rain forests, being the domesticated animal with the largest ecological distribution. As an example, 88% of the world's goat population is located in Asia and Africa and mostly (80%) in the tropics and sub-tropics. In Sub-Saharan Africa most of the goats are located in arid (38%) and semi-arid (26%) agro-ecological zones. A similar situation is depicted, showing that goat is the animal best suited to harsh environments. Many breeds are represented and herds are distributed over a wide range of systems of production and husbandry conditions. They are the principal ruminants in many scrublands and are a part of traditional extensive grazing systems in many countries.

Goat is well-adapted animal to the diverse environmental conditions in Jordan. Goats are easy to keep and efficient in utilization of low-quality roughage. Due to their unique biological and structural features, goats can be raised successfully in zones with poor grass vegetation such as highland, mountains, deserts, semi-deserts and steppes lands. Its population in Jordan was about 650,000 in 1998, and contributes about 9.6% and 16.9% of total milk and red meat production, respectively (Ministry of Agriculture, 1998). However, goats in Jordan had received little attention from research compared to other livestock in the country.

Goat flock ranged from 22 goat (35-62) for pure goat flocks to 67 goats (53-97) for mixed flocks with sheep where goat accounting to 45% of the flock. Goat spent 9-10 hours daily browsing in the range. The flock stays in the same range for one week and may extend to one month or more, it depends on the availability of pasture and water. Supportive feed usually provided for goats for three months during winter and for 5-6 months in drought seasons. The range consisted of green fodder and natural vegetation (shrubs and herbage) extended mostly from mid January to late April (ACSAD, 1997)

Goat Breeds in Jordan

Goat is well-adapted animal to the diverse environmental conditions of Jordan. It is efficient in utilization of low-quality roughage (Knights and Gracial, 1996). Due to their unique biological and structural features, goats can be successfully raised in zones with poor vegetation such as mountains, deserts, semi-deserts and steppe lands.

Goat in Jordan belongs to several breeds and their crosses. These breeds are Shami (Damascus) goat, Mountain Black goat, Dhaiwi goat, and Desert goat. Crossbred goat tends to have been produced from continuous crossing between Mountain and Shami goats. It is assumed that Jordanian native goat breeds are present in extended areas of adjacent countries to Jordan. These breeds vary in their color, body weight, size, morph structural characteristics, shape of horns and presence or absence of horns and wattles.

Shami goat

Shami is originated in Syria and it is imported to Jordan due to its high productivity of milk and twins (Sawalha, 1998). It is called by other names such as Damascus, Balani, and Damanscence (Al-Khoury, 1997; Devendra and Mcleroy, 1982). In addition, it is present in Palestine, Iraq, Lebanon and Cyprus (Al-Khoury, 1997; Devendra and Burns, 1983; Devendra and Mcleroy, 1982; Harb and Khaled, 1984; Hassan and Shaker, 1990). Shami goat was found in all different locations of Jordan. Because of its well known high productivity, the governmental stations distributed the Shami goat to many farmers in all locations of the country (Ministry of Agriculture, 1998).

Shami goat is the heaviest goat breed of Jordan, where it has an average mature body weight of 56 kg (123 lbs) and a range of 33-100 kg (73 to 220 lbs).

Its head tends to be similar to that of Mountain goat breed; medium sized. It tends to be polled and wattles are present among 33% of its population. However, its horns shapes were found to be similar to that of Mountain and Dhaiwi goat breeds. Nose shape of Shami goat tends to be convex, largely convex and very largely convex. Ears were large or medium in size. However, small and trace ears could be noticed among its individuals. Shami goat in Jordan usually appeared in dark brown and irregular random mixture of different colors. However, other colors could be seen among goats of this breed. Generally brown, dark brown and white in color, with convex nose shape and long ears. Its udder tend to be well developed, similar to Mountain goat udder.

Mountain Black goat

Mountain Black goat is also known in Jordan as Mountain, Black and Balady (Local) goat. It is indigenous in Jordan and other Middle Eastern countries such as Syria, Palestine, Lebanon and Iraq (Devendra and Mcleroy, 1982; Devendra and Burns, 1983; Harb and Khaled, 1984). This breed of goat is known by other names such as Mamber and Syrian Mountain (Devendra and Mcleroy, 1982; Al-Khoury, 1997). This breed presents in all locations of Jordan.

The mean value of mature body weight of Mountain breed is 46 kg (101 lbs) and ranges from 25 to 70 kg 55 to 154 lbs).

The head of Mountain goat was medium in size. Horns and wattles present in 60% and 35% of the population, respectively. Horns of adult males are strong, moderately heavy, long, homonymously twisted and projecting sideways or backward and outwards, while females have lighter, scimitar shaped and backward curving horns, and also twisted homonymously.

Nose shape of Mountain goat tends to be straight and slightly convex. Ears were large or medium in size. However, small and trace ears could be noticed among some individuals. Nearly the same descriptive status of the head and its related characteristics for Mountain goat were reported in Jordan and Syria (Al-Khoury, 1997; Harb and Khaled, 1984; Hassan and Shaker, 1990).

Mountain goat usually appeared in black (45%) white (20%) and dark brown color (23%). However, gray and random unrepeated mixed colors could be seen in this goat breed. Udders of Mountain goat tend to be well developed (70%). However, spherical udder could be seen among Mountain goat.

Dhaiwi goat

Dhaiwi breed presents mainly in southern provinces of Jordan, which is also found in the extended area of Egyptian Sinai and Palestinian Negev (Devendra and Burns, 1983; Hassan, 1993). Dhaiwi breed is also called Black Bedouin or Bedouin goat.

Dhaiwi was the lightest breed among all goat breeds of Jordan; it had an average weight of 32 kg (70 lbs) with a range of 20 to 39 kg (44 to 86 lbs).

Individuals of this breed tend to have small head with straight nose. Eighty percent of Dhaiwi does have horns. So that it could be considered as a horned breed. Dhaiwi horns are Homonymously twisted in both sexes. Males have simple or partially twisted backwards or divergent sweep horns, whereas females usually have finer and backward sweeping horns. Wattles present only in 30% of its population. Most individuals of Dhaiwi breed have trace and small ears. The most apparent colors are black and black mixed with red or gray on abdomen, limbs, ears and face areas of animals. Does of this breed have both well developed (55%) and spherical (45%) udder.

Desert goat

Desert breed was recorded from northern Badia, which is also known in Syria where it was found in the extended Badia (Al-Khoury, 1997).

Desert breed had mean mature body weight of 40 kg (88 lbs) with a range from 26 to 46 kg (57 to 101 lbs). So, it has a heavier body weight than Dhaiwi goats.

Similar to Mountain goat, Desert goat had head of medium size. Nose shape of this breed was found to be mainly straight (80%) and semi-straight (20%), which is similar to Dhaiwi goat. Most population of Desert goat had horns (80%). In contrast with all other native goat breeds of Jordan, horns of Desert goat have heteronymously twisted horns. Horns of males and females grow up and backwards with outward direction, which then turned inward at their tips. Wattles were found only in 25% of the individuals of Desert goat. Similarly, most individuals of this breed had medium (40%) and trace (27%) ears. However, other types of ear could be seen in Desert goat.

Most of the Desert goats have black colors (65%). Dhaiwi goats have black mixed with red or gray batches on face, ears, limbs and abdominal areas of the body (15%). Other colors such as white, dark brown and gray could be found also but with lower frequencies.

Udder shape is either spherical (56%) or well developed (44%). Generally, similar description of Desert goat in Syria was reported (Al-Khoury, 1997).

Goat Production Systems

Goat production systems are diverse in Jordan. The major system is the traditional, which consists of the following:

Extensive Production System:

Practiced by nomads who make use of the seasonal rangelands of the deserts and semi-deserts under constant search of grazing and water. Goats in this system are small in number but serve as the main milk supplier for family consumption. This system might be divided into the following two sub-systems:

1. Migratory Pastoral System: where goats compose 1-10% of large size flocks of sheep or sheep and camels (200-500 head) in desert areas
2. Alternative pastoral system: where goats are kept in pure flocks or mixed with sheep. Flocks are of small size (30-100 head), are grazed alternatively on riverside or sahels and desert ranges.

Semi-Extensive Production System:

Practiced by semi-nomads who live in permanent residential basis or camps and dwellers in villages surrounding arid, desert and desert coastal regions. Flock owners have a relatively permanent base ground where flocks graze for more than half of the year and migrate long distances to another part of the region for the remainder of the year.

The system consists of two subsystems:

1. Pastoral-agro tribal semi-migratory: where flocks are of 200-300 heads of sheep and goat ratio doesn't exceed 5% in steppe regions.
2. Pastoral-agro familial semi-sedentary where flocks are usually of goats only, commercial, of large size (200-500 head) , bred as an integral activity to the economic life of the family.

Semi-Intensive Production Systems:

This system is practiced by village dwellers and residential centers who may or may not own the agricultural land in dry, semi-dry, semi-humid regions, and coastal plains around cities and riverine lands. Goats are bred in pure flocks in accordance with the following three sub-systems.

1. Stable Rural Agro-Pastoral System: Where village small holdings of goats (2-10) are herded in a combined village flock which makes intensive use of grazing on village communal lands, shrubs and crop residues and provides staple food for the families
2. Stable Family Farming System: This system is based on keeping dairy goats in flocks of 5-50 heads around cities and large towns. The system makes use of the permanent fodder crops, concentrates, and crop residues. It serves in providing milk for families and urban population in the arid regions.
3. Restricted Family Domestic System: It is based on keeping penned dairy goats in flocks of 2-40 heads according to the ability of the owner in purchasing feed-stuffs under restricted pastoral and housing conditions. Grazing in this system might be restricted to irrigation banks and roadsides (ACSAD, 1997: Harb and Khaled, 1985: Alkhory, 1996).

Rapid Rural Appraisal

To better understand goat farmers needs and concerns. A rapid rural appraisal (RRA) was conducted in Bani Kanank (Irbid location) to address goat farmer's needs and concerns. This activity was part of a project titled Multinational Approaches to Enhance Goat Production in the Middle East. However; Twenty three goat farmers participated in this event, seven of them were goat farmer's leaders. The main results of this (RRA) according to goat farmers needs and concerns were:

1. State Subsidizing of goat feed (mainly barley) as it was few years ago.
2. The need of State program for goat flock Vaccinations.
3. Milk processing and marketing of goat milk production.
4. Need for Extension programs specially Vet. Services and Monitoring of goat flock for the whole District (feed and feeding, health care including drugs, new breeds and high quality buck).
5. Need for a distinguished and specified range-land areas for goat flocks.
6. Establishing Cooperative association that can facilitate goat product including milk processing (milk pasteurization, cheese production) and marketing.
7. Goat farmers look forward for better care from the government specially (Ministry of Agriculture) for the goat production sector as the case of sheep and Cattle production sectors.

Selected and Brief Research Activities Conducted through (MERC) Project

PROJECT No. PCE-G-00-00-00029-00

PROJECT TITLE: MULTINATIONAL APPROACHES TO ENHANCE GOAT PRODUCTION IN THE MIDDLE EAST

I. Technical Progress

1) Research Objectives

1) Characterize goat production systems of the Middle East region and distribute improved goat genotype

2) Increase knowledge of goat milk properties and develop new technologies for production of goat milk products in the Middle East

3) Transfer appropriate available and developed technologies for goats to Middle East Farms / Householders. In particular regarding proper milk hygiene and processing.

Progress in Milk Processing:

At the Jordanian location the activities were continued to collect milk sample for milk characterization and also for cheddar cheese production and characterization as shown in Tables 1, 2, 3, 4, and 5. On the other hand, data were generated to characterize milk obtained from three goat breeds (Shami, Local and Mixed).

Table 1: Chemical composition of goat milk during three milking seasons

Moisture %	Protein %	Fat %	Lactose %	Ash %	Total solid	Non fat solids
First season						
86.1	2.7	4.9	5.4	0.9	13.9	9.0
86.6	2.6	5.0	5.1	0.7	13.4	8.4
86.4	2.5	5.2	5.2	0.7	13.6	8.4
Second season						
85.9	2.8	4.5	6.0	0.8	14.1	9.6
86.4	2.9	4.5	5.3	0.9	13.6	9.1
86.2	2.8	4.4	5.7	0.9	13.8	9.4
Third season						
86.4	2.5	5.0	5.3	0.8	13.6	8.6
86.6	2.7	4.7	5.2	0.8	13.4	8.7
86.5	2.6	4.8	5.2	0.9	13.5	8.7

Table 2: Chemical composition of cheddar cheese from goat milk

Moisture %	Protein %	Fat %	Lactose %	Ash %	Total solid	Non fat solids
First season						
21.2	30.5	33.2	6.9	8.2	78.8	45.6
20.8	30.7	24.3	15.8	8.4	79.2	54.9
20.2	30.8	25.7	14.9	8.4	79.8	54.1
Second season						
19.7	29.1	29.9	13.2	8.1	80.3	50.4
18.2	30.7	32.2	10.5	8.4	81.8	50.6
16.7	31.4	32.7	10.8	8.4	83.3	50.6
Third season						
20.7	30.7	27.8	12.5	8.3	79.3	51.5
18.2	30.4	31.6	11.5	8.3	81.8	50.2
19.4	30.6	29.7	12.0	8.3	80.6	50.9

Table 3: Evaluation of Cheddar cheese from goat milk

Color (20)	Appearance (15)	Taste (30)	Texture (15)	Aroma (20)	Total (100)
First season					
16.0	12.5	27.7	11.7	15.3	83.3
18.0	10.0	23.0	11.0	15.5	77.5
19.5	9.0	19.5	9.5	12.0	69.5
Second season					
18.7	17.0	25.0	10.3	15.0	86.0
19.0	8.5	16.5	5.0	12.5	61.5
18.0	10.5	25.0	9.5	17.5	80.5
Third season					
16.0	9.5	26.5	10.0	15.5	77.5
10.5	4.5	13.0	7.0	12.5	47.5
16.5	11.0	24.5	11.0	16.5	79.5

Table 4: Milk microbiological analysis of three goat breeds for three milking seasons

Goat breed	Semester	TPC	Yeasts	Molds	Staph	Aureus	Strept	Enterobac	Teriacea	E.coli	Coliforms	Salmonella	Shigella
	1	172916.7	33083.33	0	2013	-	1697.6	68800	-	0	-	-	
Shami (red)	2	409263.2	793423.2	1368.4	1894.21	-	4776.8	2766302	-	357.9	-	-	
	3	270666.7	639586.7	3658.3	3460.8	-	2770.8	650	-	51.7	-	-	
	1	186363.6	43606.4	9.1	2322.7	-	4360.9	73181.8	+	0	+	-	
Local (Black)	2	222388.9	516835.6	4166.7	2195	-	5355.6	36427.8	+	118.3	-	-	
	3	126230.8	122646.2	8661.5	2840.8	-	2816.9	6545.2	+	93.1	-	-	
	1	378363.6	3084.5	9.1	1649.1	+	1020.9	23909.1	-	0	-	-	
Mixed	2	47000	140000	0	640	-	1200	0	-	0	-	-	
	3	202600	157800	7500	2824	-	5248	7200	+	94	-	-	

Table 5: Milk chemistry of three goat breeds for three milking seasons

Goat Breed	Parity	Protein %	Fat %	Lactose %	Ash %
	1	23.70	44.34	25.99	5.218
Shami (red)	2	18.28	39.81	35.56	5.021
	3	17.29	35.12	34.91	5.522
	1	24.61	44.55	25.88	4.953
Local (black)	2	20.63	44.50	34.35	5.536
	3	22.72	34.99	40.48	6.049
	1	25.55	35.28	34.08	5.230
Mixed color	2	17.60	34.40	41.60	6.400
	3	18.93	29.78	44.93	6.356

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Goat Production in México - Overview of the Industry and Its Production Practices

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Introduction

Goat production in México since the beginning has been associated with poverty because only low income families who live in rural areas were the only ones that raise goats with the purpose to make a profit or to obtain food from them (meat, milk, skins, etc.). However, the last 40 to 30 years up to day, this perception has been changing in some areas, especially in the region of La Laguna (includes part of sates of Coahuila and Durango) and El Bajio (includes part of states of Guanajuato and Queretaro), where one can find productive units completely confined and using the most update technology available in the market, which belong to middle class or wealthy people who has made significant investment in modern facilities and animals with high genetic merit imported from The United Sates or frozen semen from France. However, these efforts have changed a small proportion of goat industry in México, but the majority still continues under extensive grazing condition with no technology and low production traits. The objective of this paper is to present a broad description of how goats are raised in México and the importance of goat production in México.

Goat Breeds and Population

Goat population in México was integrated for centuries by the offspring of those animals brought by Spaniards 500 years ago without introducing new blood, which became the native or "Criollo" goat, although very few and isolated importations were made by particular producers with no significant effect on changing the genetics of Mexican goat population. However, the last 40 years and specially the last 25 years a significant introduction of new goat breeds have been taking place, by both private and Federal or State governmental efforts. In this regard in the seventies, the Federal Government through the Agricultural and Livestock Secretary's Office, established in La Laguna area, a large goat breeding center in northern México, in Tlahualilo Durango (Montaldo, 2008). The breeds in that breeding center were Alpine, Nubian, Saanen, and Toggenburg which were used to procreate genetic material which was spread out in most central and northern México. Along with this program, private producers have continue up to day, importing pure breed animals (females and bucks) of those breeds with the objective of improving their own flocks and have offspring to sell animal with "high genetic potential" to smaller producers. As a result of these efforts, a significant proportion of goats in México are highly bred with one of those breeds depending on the productive goals. The results have not been always as expected, especially with producers whose flocks are raised under very rough conditions, where exotic breeds obviously are not adapted (Escarño et al., 2008). However, despite having unsuccessful results in some areas, isolated government efforts keep trying to implement breeding programs to improve goat production in behalf of producers to improve their life (Escareño et al., 2008; Pastor et al., 2008).

Most goats in México (73%) are owned by very low income families "Ejido Peasants" who live in rural areas, around 20% are owned still by poor people but near the urban areas and/or in irrigation districts, and 5 to 7% are concentrated in confined conditions. Although goat production contributed with only 1.25% of the total value of animal production in México in 2007 (SAGARPA, 2007), it is estimated that around 400 thousand families (one million and a half people) depend from goats, whose primary or complementary activ-

ity is raising goats (SAGARPA, 2008). The states of Puebla, Oaxaca, San Luis Potosi, Guerrero, Coahuila, Zacatecas, and Michoacán, are the ones which had the highest percentage of goat population in 2005 (15.7, 13.0, 8.2, 7.6, 6.9, 6.2, 5.1%, respectively). Goat inventory in México, showed a slightly decreased from 1996 to 2005 (Table 2), from 9.57 to 8.87 million. The states in which the major changes occurred are Coahuila, San Luis Potosí and Zacatecas. Although goat population slightly decreased last 15 years, both meat and milk production have increased significantly, which is evidence of improvement in management practices and using animals with higher genetic potential.

México territory, base on goat population, can be divided in four major regions (Figure 1). **Northern** region integrated by the states of Tamaulipas, Coahuila, Nuevo Leon, Chihuahua, San Luis Potosi, and Zacatecas, with around 35% of goats. **South** or **Mixteca** region includes the sates of Guerrero, Oaxaca and Puebla with 36% of the goats. **Central** region including the states of Hidalgo, Jalisco, Michoacan, México, and Queretaro with 19% of the goats, and the **California** region including the sates of Baja California, Baja California Sur, Nayarit, Sinaloa and Sonora with only 5.5% of the goat inventory in 2005, this distribution most likely has been maintained up to day.

Goat Production Systems

Goat production in México can be categorized into three mayor production systems: extensive, semi-intensive, and intensive (Amendola, et al., 2000), although there are some small variations within each of them depending on the region.

Extensive systems include most goats in México and have very low production traits (Table 2). According to Hernández (2000) and UAS (2004) these systems are characterized by 1) predominantly small flocks less than 100 animals, although one can find blocks over one thousand animals, 2) feeding is based on grazing and browsing native vegetation during the day (6 to 10 hours), following regular routs and keeping the animals overnight in rudimentary shelters, 3) supplementary feeding is rare and when occurs include crops residues and sometimes chopped cactus and/or agave, 4) males run with the flock all year around resulting in high consanguinity, 5) no artificial weaning and high mortality rates of kids, 6) no or very low illness treatment or prevention, 7) lack of specific marketing channels, usually selling to middlemen or animals are brought to auctions places, 8) almost no technical assistance and access to credit, 9) variable weaning rates (53 to 90%), 9) low daily live weight gain, average 50 g/day, and adult weights ranging from 35 to 45 kg, 10) first mating occurs at 12 to 18 months, and 11) milk production from 100 to 140 kg in lactation between 180 to 210 days (Nagel, et al., 2008). In addition, care of animals in extensive systems is in charge of family members, and in some areas women play a significant role in it if not all (Baer, et al., 2008; Gonzalez et al., 2008; Espinosa et al., 2008). The products of this productive system are veal kids (cabrito), which are sold at around 45 to 90 days of age, and culled goats. Milk is obtained only during a short period of time after selling the kids, and part of it if not all, is used to make cheese for self-consumption.

Semi-intensive systems are concentrated nearby urban areas and/or irrigation districts. An important number of goats in El Bajio and La Laguna regions are raised under this production system. Number of animals per productive unit varies from 20-35 to 150-200 heads (Torres, 2008). The production traits are higher compared to extensive systems (Table 2). Producers have more access to technical assistance and are more opened to adopt new management innovations. Goats are grazed in crop residues, along the roads or even in cultivated prairies. In a study carried out in Guanajuato (Espinosa et al., 2008) was found that the proportion of producers using technological practices was low at the beginning of the survey: disease treatment 30%, forage conservation 10%, concentrate supplementation 30%, mastitis and pregnancy diagnosis less than 20%, and economical and technical records less than 20%. However, after three years of technical assistance, all 230 producers significantly implemented new technologies in their blocks and even families became more conscious of protecting the environment. This production system produces around 75% of

milk in La Laguna region (Torres, 2008) and 60% in El Bajío (Espinosa et al., 2008). The products of this system are veal kid (cabrito), milk, culled animals and breeding stock, which are sold to smaller producer at a reasonable price. Manure is used as fertilizer or to make compost.

Intensive systems comprise no more than 2% of total goat population, but contributes with around 15 to 20% of total production. Number of goats per productive unit varies from 200-300 to 1000-1200 or more animals. Production traits are significantly higher than the previous two productive systems (Table 2). This system is localized mainly en El Bajio (Guanajuato and Queretaro) and in La Laguna (Coahuila and Durango). Goats under this system in El Bajio includes around 10% or less, but contributes with 40% of production (Espinosa et al., 2008), and in La Laguna, includes around 5% of goats and produces around 20% of the production in the region (Torres, 2008). This system characterizes by having pure breed animals, high number of goats in a very small area, stratified by gender, physiological stage, age and weight. Feeding programs reasonable well planed based on current Feeding Standards like NRC (1981), NRC (2007), INRA (1989), or nutrient requirements calculators available in the Web like that developed by scientists at The E (Kika) de la Garza American Institute for Goat Research, which is available in English (http://www2.luresext.edu/goats/research/nut_calc.htm) or in Spanish (http://chapingo.uruza.edu.mx/cabrasesp/calc/nutreqgoats/html). These types of systems are more mechanized. The facilities, in most cases fairly well planned, and in some of them have air-conditioning for the raising section. Kids are raised artificially with milk or milk replacer (Ahedo et al., 2008; Galvan-Golzalez, 2008) using manual or automatic dispensers. Goats are milked twice daily with milking machine, and in some of them making used of the most sophisticated milking units available in the market with computerized recording programs. Producers have access to technical assistance. Breeding is carefully performed keeping good records, and in some of them using estrous synchronization and artificial insemination. Producers are more organized and have more control on marketing channels. Products of this system are veal kids (cabrito), milk, culled animals and breeding stock. Manure is used to make compost and used as fertilizer. Price of replacement animals can go up to 5 to 7 hundred US dollars for bucks, and up to 200 or more for females, depending on the breed and availability.

Meat Production

Meat production increased 41% from 1980 to 2007, although goat inventory showed a slightly decrease during the same period of time. The states with the highest meat production in 2007 were Coahuila, Oaxaca, Puebla, San Luis Potosí, Guerrero, Zacatecas, and Guanajuato. The states of Puebla and San Luis Potosí characterized by important production of meat in the eighties, showed a slightly decrease by 2007, while Oaxaca, another relevant meat producer in 1980, only had a very small increase. The state of Chihuahua showed the greatest decrease, from 9.3 to 3.2% over the same period of time. The Northern region contributed with 41.5% of meat production fallowed by the South, Central, California Gulf, and others regions with 25.6%, 20.8%, 7.6%, and 4.4, respectively, in 2007. The unit price of meat has increased significantly from 1980 to 2007 (Table 1), however it is still far to make good profits. Sale price of cabrito varies throughout the year, and can rank from 15 to 30 - 40 US dollars depending on availability. Many of the small producers besides selling goats to obtain some money to cover other needs, their goats are like a saving account which is available for unexpected situations in the family or for special moments in their life.

Cabrito and culled animals are the goats commercialized for meat, although in the states of Jalisco, Zacatecas and Aguascalientes young animals are raised and sold for meat as well. Cabrito is cooked as a typical dish in Northern México, and the city of Monterrey is the main consumer. Grown animal is cooked for another typical Mexican dish named “Birria” which is very popular in all over the country but especially in the central area, which includes the states of Aguascalientes, Guanajuato, Jalisco, Michoacán, San Luis Potosí, and Zacatecas. The cost for a cabrito meal varies from city to city, but can go from 20 to 35- 45 US dollars, while a “birria” meal can go from 5 to 8-10 US dollars depending on the region.

Milk Production

Milk production in México in 1980 was around 279 million litters, but decreased to 124 million liters by 1990. However by 2007 it increased up to 167 million liters. In the eighties, goat milk came from the states of Coahuila, San Luis Potosí, Oaxaca, Zacatecas, Puebla, Tamaulipas, Nuevo León and Guerrero, with 9.8%, 9.7%, 8.5%, 8.4%, 6.9%, 6.1%, 5.9% and 5.6%, respectively. However, milk production by 2007 became concentrated in three states Coahuila, Durango (La Laguna) and Guanajuato (El Bajio), both regions contributing with 72% (121 million liters) of the total milk produced in México. La Laguna produced 97 million liters (58%) and El Bajio 24.1 million (14%) in 2007. La Laguna increased its production 255% (whole state of Coahuila: 27.4 to 56.8 million litters, 9.8% and 33.9%, respectively; Durango: 10.6 to 24.1 million liters, 3.8% and 24.1%, from 1980 to 2007, respectively. Meanwhile, El Bajio went from 10.4 to 24.1 million liters (3.7% and 14.4%, respectively) in the same period of time. The states of Oaxaca, Puebla, San Luis Potosi, Guerrero and Zacatecas produced the major proportion of milk in the eighties, but these states have become the highest meat producers by 2007. Northern region, supplied most milk production in 2007 comprising 70%, followed by the Central region with 20%, California Gulf with 2.5% and 6.4% by the others.

Milk Production in La Laguna increased in 216% from 1980 to 2007 (Table 3; 37 to 80.1 million liters, respectively). Out of the total milk production in 1980, 90.1% came from semi-extensive systems, and only 0.31% from intensive systems. However in 2008, still 75.6% was produced in semi-extensive units, but intensive systems with or without little grazing produced closed to 18% of total yield (Torres, 2008). It is estimated that around 60% of milk is destined for cheese and 40% for different kinds of candy. Goat milk in México is also processed, although no records are available, for other products like cosmetics, soap, shampoo, body creams, condensed milk, flan, gelatin and yogurt (Espinosa et al., 2008). Value of goat milk, like goat meat, has increased significantly the last 25 years (Table 1).

Goat Research in México

Despite of low if not the least contributor to total animal production in México, it is necessary to be aware of the importance of the role that goat production plays for those families who depend from it. The Mexican Government destines little resources to support research to find out ways to improve productivity of goat flocks which would allow those families to increase their income to have a better and more decent life. Livestock research centers (INIFAP: National Research Institute for Agriculture, Forestry and Livestock) at its different locations, Federal and State Universities and other research centers across México, continue to look for a better understanding and identify those limiting factors that hold down goat flocks production. Twenty four years ago, the Mexican Association of Goat Production (AMPCA) was created with the purpose to improve our understanding of goat production in México. Unfortunately isolated efforts have been made so far, and little progress has been accomplished. Twenty three annual meeting have been held so far by AMPCA, and the papers presented have been focused on breeding, reproductive management practices, feeding practices, industrialization and marketing practices, health and illness treatment, etc. However, there is still much need of research well designed and carefully performed following strictly scientific methodologies in order to make intelligent suggestions to resolve the problematic faced by Mexican goat producers..

California	Central	Gulf	North	South
Baja California	Aguascalientes	Campeche	Chihuahua	Guerrero
Baja California Sur	Guanajuato	Chiapas	Chohuila	Puebla
Nayarit	Hidalgo	Tabasco	Durango	Oaxaca
Sonora	Jalisco	Quintana Roo	Nuevo Leon	
Sinaloa	México	Veracruz	Tamaulipas	
	Michoacan	Yucatán	San Luis Potosí	
	Queretaro		Zacatecas	

Figure 1. Regions of México.

Table 1`. Goat population and goat meat and milk production in México

	Goat population, animals			Meat production, tons				Milk production, thousand of liters			
State	1996	2000	2005	1980	1990	2000	2007	1980	1990	2000	2007
National	9,566,691	8,704,231	8,870,312	30,305	36,102	38,760	42,873	279,701	124,391	131,177	167,423
Aguascalientes	36,500	25,873	20,375	234	459	278	136	1,591	-	-	
Baja California	41,083	39,945	20,398	369	431	355	246	2,161	-	345	471
Baja California Sur	123,000	118,439	113,056	608	368	469	479	5,202	2,577	3,337	2,350
Campeche	2,101	1,646	4,835	4	-	12	25	32	-	-	-
Coahuila	914,700	507,264	615,623	1,006	3,842	4,124	5,154	27,365	36,373	42,782	56,770
Colima	24,866	10,992	11,307	118	144	52	58	1,193	22	1	2
Chiapas	-	-	5,359	189	199	-	-	1,249	253	-	-
Chihuahua	269,263	202,953	236,480	2,831	1,757	906	1,384	12,414	11,626	4,600	10,499
Distrito Federal	780	930	64	83	43	6	-	411	-	-	-
Durango	290,228	303,053	332136	780	1,334	1,571	1,669	10,646	6,755	24,264	40,294
Guanajuato	497,997	496,006	506,473	1,016	1,383	2,029	2,182	10,385	20,767	23,732	24,097
Guerrero	663,690	695,311	672,575	1,534	3,358	3,388	3,319	15,578	2,434	3,545	-
Hidalgo	324,548	298,227	269,780	1,351	763	1,313	1,424	10,359	1,883	586	36
Jalisco	289,354	305,568	261,771	1,981	1,799	2,199	2,148	13,232	7,500	6,323	6,360
México	163,070	175,711	129,937	657	1,741	659	570	6,263	-	-	-
Michoacan	446,992	457,146	456,817	1,712	1,610	2,315	2,475	10,361	3,958	3,589	3,754
Morelos	23,865	30,652	32,883	130	167	294	349	1,154	901	-	-
Nayarit	92,314	119,412	160,228	76	223	416	567	866	364	96	-
Nuevo Leon	543,286	379470	363,29	1,042	1,300	1,284	1,493	16,483	5,816	5,452	5,139
Oaxaca	1,052,238	1,096,562	1,154,964	2,923	2,986	4,008	4,174	23,676	2,669	-	-
Puebla	1,264,314	1,423,541	1,392,177	3,030	1,957	3,402	3,496	19,340	1,166	1,244	1,409
Queretaro	106,718	97,472	97,587	473	389	212	136	4,772	1,902	956	505
Quintana Roo	2,200	5,511	3,902	5	-	10	10	49	-	-	3,804
San Luis Potosí	1,074,276	724,196	729,612	2,472	6,494	3,365	2,716	27,046	10,713	3,269	-
Sinaloa	152,976	159,566	160,249	594	613	1,600	1,635	2,390	1,274	-	-
Sonora	65,668	27,776	36,250	229	278	233	341	2,668	305	485	1,395
Tabasco	-	-	-	46	-	-	-	378	-	-	-
Tamaulipas	255,595	249,955	272,989	1,087	445	1,325	2,027	17,161	225	202	-
Tlaxcala	45,537	69,020	110,974	166	312	227	651	1,115	535	1,166	117
Veracruz	118,538	131,598	147,986	1,270	345	551	653	10,654	484	835	3,416
Yucatan	-	-	69	20	-	-	-	150	-	-	2,005
Zacatecas	681,064	546,436	550,005	2,267	1,364	2,159	3,356	23,357	3,889	4,368	5,001
Unit price, pesos*				0.04	4.32	15.34	18.91	0.01	1.17	3.46	4.70

* Unit price for meat refers to live animal, exchange rate: 1 dollar = 13 pesos, 1 gallon = 3.875 liters, 1 pound = 0.454 kg.

SAGARPA, 2008

Table 2. Production traits of goats in La Laguna México

Trait	Extensive	Semi-intensive	Intensive
Fertility. %	46-50	70-80	80-95
Kidding per year	1	1	1.5
Puberty, months	14	12	8
Prolificacy, %	1-1.1	1.2-1.3	1.5-1.7
First service, months	14	12	8-9
Weight at first service, kg	30-35	35-40	35-40
Age at first kidding, months	19	17	12-13
Weaning age, days	45-90	45-60	35-45
Birth weight, kg	1.5-2	2.5-3	3-3.5
Daily gain, g/day	40-50	70-80	100-120
Slaughter age, days	45-90	45-60	35-45
Slaughter weight, kg	4.5-6	6-8	7-12
Carcass yield, %	48	48-50	48-55

Torres, 2008

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Goat Production in Central and Eastern Africa

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Introduction

Goats are a particularly valuable livestock species in developing countries because of their ability to utilize many types of forages and tolerate unfavorable climates. Goats play a vital role in the rural economy of many countries in central and eastern Africa (Rwanda, Burundi, Uganda, Tanzania, Kenya, DRC, Congo, Cameroon, CAR, Sudan, Ethiopia, Nigeria, Chad, Gabon, and Somalia). However, the contribution of goat to the people and economies of developing countries is obscured by several factors combining to give an underestimate of their true value. Most goats kept in developing countries are inaccurately estimated in number. Cattle are likely to be counted while goat number maybe most often approximated. Goat producers themselves are most often involved in informal market systems which lead to underestimation of goats' contribution to the rural and national economy. Furthermore, goats are usually kept by poorer people that are accorded low status and low priority in national economy even if differences exist between countries. Lastly, their eating behavior (higher degree of feed selectivity and preference of young leaves versus old materials; shrubs and forbs versus grasses) attracted some people to wrongly accuse goat as environmental destructor and prejudice has been build up against them in some area of the world and little attention in terms of policy development and research has been paid to goats.

Current Status of Goat Production in Central and Eastern Africa

Goat population in eastern and central Africa compared to the rest of the world

Goat population is estimated to be about 744 millions goat in the World. About 30% of world goat population is found in Africa. Up to 89% of the 21% of goat population is located in 14 countries of Central and Eastern African regions. The table 1 & 2 below show present goat population estimates in World by area and goat distribution in 14 countries of central and eastern African region.

Table 1. Goat population estimates by geographical areas

Area	Population (million)	Percentage of total population (%)
Asia	513.4	69.6
Africa	172	21.0
South America	23	4.8
North America	16	1.7
Europe	14.7	2.0
Former Soviet Union	7.9	1.1
Oceanic	1	0.3
Total	**744**	**100**

The table above shows that the majority of the goats are kept in arid and semi-arid lands of Africa, Asia, America, and Europe.

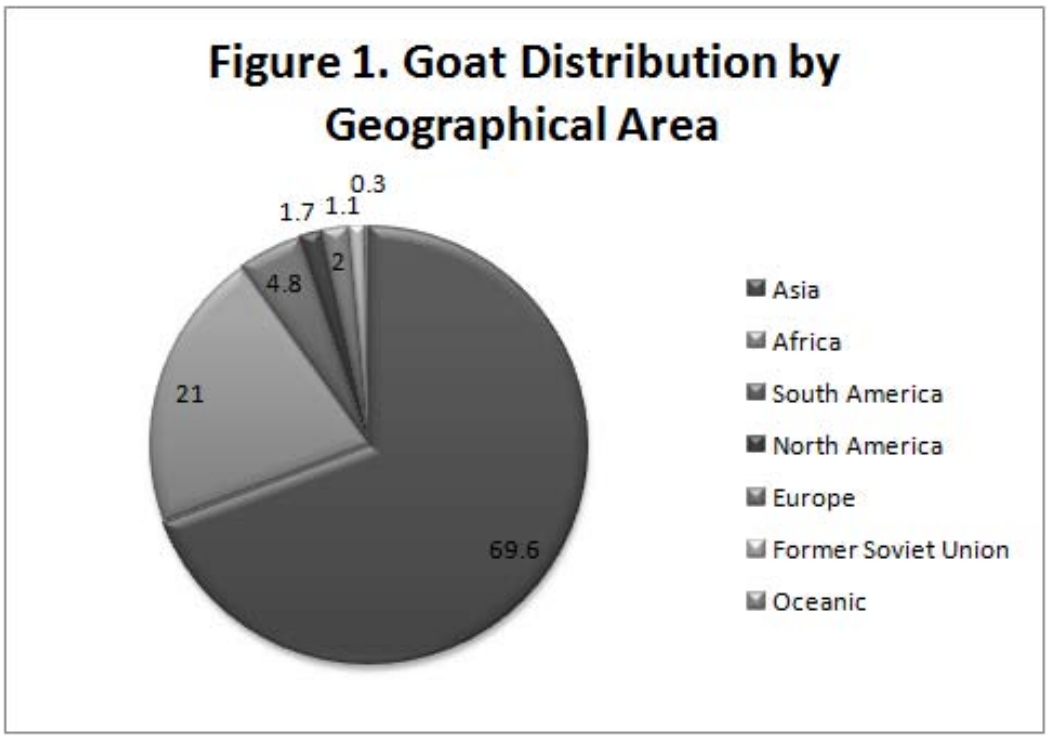

Table 2. Goat distribution by countries in eastern and central Africa

Country	**Number of goat (10^3)**	**Source**
Kenya	9.000	Ministry Agr. (2002)
Rwanda	2.828	Ministry Agr. (2006)
Uganda	9.300	Ministry Fin. (2001)
Burundi	750	FAO (2002)
DRC	4.915	FAO (2002)
Congo Brazza	294	FAO (2002)
Cameroun	4.400	FAO (2002)
Central African Republic	2.921	FAO (2002)
Tanzania	11.650	FAO (2002)
Sudan	38.540	Kamal. (2008)
Nigeria	27.000	FAO (2002)
Chad	5.550	FAO (2002)
Gabon	90	FAO (2002)
Ethiopia	23.325	Tibbo et al. (2004)
Somalia	12.700	FAO (2002)
Total	**153.263**	

Livestock production has been an integral part of farming systems Rwanda and in other East and central African countries for centuries. The data shown in the above table provide a picture of 14 countries of central and eastern Africa. About 70% of Africa goat population is located in 14 countries of central and eastern Africa. The 5 more contributing countries by descending order are Nigeria, Sudan, Ethiopia, Kenya, Tanzania, Uganda, and Cameroon.

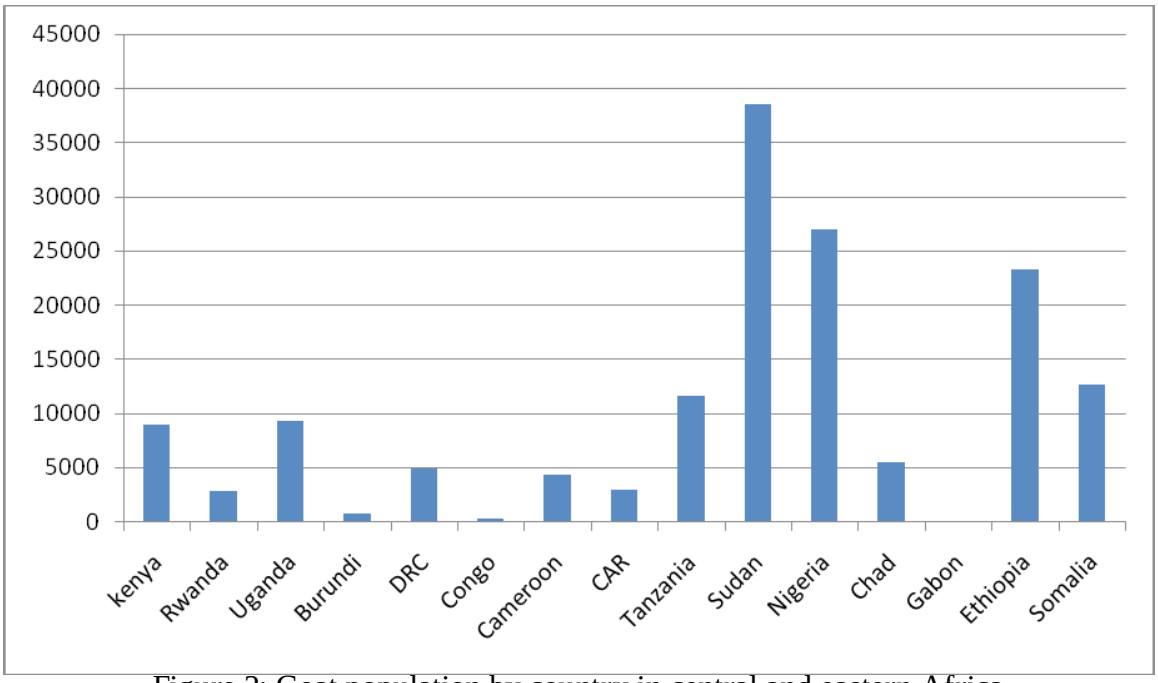

Figure 2: Goat population by country in central and eastern Africa

Goat contribution to the welfare of developing countries and in particular those of central and eastern Africa

Goats are raised largely by low income households while high income farmers raise cattle. Large animals (cattle) are highly valued relative to small ruminants. Goats were raised primarily for consumption on special occasions or for sale when cash needed for tea, sugar, maize meal, or clothes. Goats are exchanged for the economic necessities, while the large animals bring high social status to their owners. Sheep and goats are kept by some farmers as a dietary supplement, being a more convenient form of meat supply than beef. In some countries, during dry season when cattle did not get enough fodder to produce sufficient milk, goats are also milked. Skins are sold or worn by women or children, traded in exchange for steers, or given away as part of a dowry or at a ceremonial event. In summary, goats play a secondary role in the society, most of the attention going to the large animals.

In the humid tropics where cassava and other tuber are the staple crops, goats play a role in providing the necessary protein to the diet in terms of meat. For this reason, there is still much potential for increasing meat production throughout the humid tropics. One option for increasing the meat supply is trough improving and investing in goat production. Goat meat is accepted by consumers, and the initial investment and financial loss trough animal mortality is low. Goats can be fed crop residues and by-products which are not utilized efficiently by other livestock species. However, more researches on the possibilities for increasing goat production in the humid tropics are needed.

Goat breeds in Central and Eastern Africa

Breeds are classified by Origin, Body size, Color coat, Ear sharp and length, Function, Height of withers. Breeds in Africa come from within African countries, Asia, and Europe. So goats are either indigenous (local breeds) or exotic breeds (imported). Some of African breeds are considered exotic in other countries in Africa or outside Africa. The table below presents breeds in each of the twelve countries of the central and eastern Africa.

Table 3. Main local and exotic breeds by country

Country	**Indigenous (local breeds)**	**Exotic breeds (imported) within**
Rwanda	Common local goat	Boer, Galla, Anglo-nubian, Alpine, Saanen, Toggenburg,, Spanish, and crossbred with exotic and local breeds
Burundi	Common local goat	
DRC	West African Dwarf	
Uganda	Mubende, Small East African, Kigezi, Karamoja,	
Tanzania	East African small goat	
Kenya	Galla and East African small goat	
CAR	West african Dwarf	
Cameroon	West african Dwarf, sahelian goat, pygmy goat,	
Sudan	Nubian, sudandesert, nilotic dwarf, Tegri	
Ethiopia	Begait, Afar, Arsi-Bale, Woyto-Guji, central	
Congo	West african Dwarf, Sahelian goat	
Nigeria	Sahel or desert goat (west African long-legged	
Tchad	West african Dwarf, Sahelian goat	
Gabon	West African dwarf goat	

Production systems

In most countries of eastern and central Africa, goat production ranks first among ruminants in terms of numbers, although in terms of total meat output they are second to cattle. The figures indicate that goat and sheep production is a major economic activity in terms of the number of people employed and as a source of revenue, especially in the main producing areas of sub region. Most of the goats are kept under extensive pastoral, ranching systems. In high potential areas, a zero-grazing, tethered or stall-fed system is often used. Although a great potential for exploiting a variety of goat genotypes exists, the realization of such potential still remains elusive in most countries of the eastern and central Africa. There are four common grazing systems in central and eastern Africa. A number of factors including culture, tradition, land size, and number of goat determine the system practiced.

1. Tethering system
2. Extensive grazing system
3. Zero-grazing
4. Semi-intensive system

The main types of feed resources for goat in central and eastern Africa are forage grasses, legumes, shrubs and forbs, crop residues and agriculture by-products. Concentrate feed are rarely used in goat feeding because they are either expensive or not available.

Challenges and constraints to goat production in central and eastern Africa

Goat production in central and eastern Africa suffers from several challenges. The following constraints to goat development must be analyzed and their solutions sought. Goat production in central and eastern Africa , like in many other developing countries of the tropics , are constrained by: (a) management related issues (e.g. inadequate husbandry), (b) inadequate and ready supply of the most appropriate type of breeding stock and how they can be improved, (c) lack or poor supply of inputs, including drugs, feed, water, etc., (d) unavailability of appropriate markets and poor market organization, (e) poor infrastructure and lack of efficient information networks, (f) poor public policy on the environment, especially on the administration of animal health policies and controlling disease, (g) decreasing size of farm-lands to allow for alternative

options that can be exploited economically, (h) insecurity and livestock rustling among pastoral communities, (i) frequent drought and lack of preparedness for such calamities.

Other common constraints include lower performances due high abortion rate and mortality rates of young, uncontrolled breeding leading to low conception rates, low birth weight, limited information on local breeds and genetic characteristics of existing goat population. The only attempt to improve the productivity of goat have concentrated on the importation of exotic breeds and crossing them with indigenous types. In most cases, this approach has been unsatisfactory because there were no accompanying measures such as the restructuring of the small ruminant industry by investing in nutrition, health services, and market, and goat farmer training on good management practices.

Goat Production in Rwanda

Introduction

Rwanda is a small landlocked rural country with a land area of 26,338 km^2 at an altitude ranging from 1,000 to 4,500 m above sea level. It has few natural resources and minimal industry. It is the most densely populated country in Africa with a population estimated at of 8 128 553 inhabitants (2002 population census) and an average population density of 321 persons per km^2, one of the highest in Africa. At a growth rate of 2.9%, the population is expected to rise to 14 million by the year 2020. There is, therefore, considerable demographic pressure on agricultural land with over 58% of households having holdings of less than 0.5 ha. Family farms are continuously sub-divided into increasingly smaller plots, fields are over cropped, marginal lands (including marshlands) and pasturelands have been converted to arable lands. The issue of land and farm size is therefore, central to the issue of livestock feed production and has great influence on livestock production in the country.

The major challenge facing the livestock sector is to satisfy the rise in general demand for livestock products by the increasing human population at the technological level that the natural resource base can sustain without destroying the environment. For the farmers to benefit from an environmental friendly integrated agricultural system, a comprehensive outreach program linking farmers, extension and researchers is necessary in order to facilitate the smooth transfer of the new technologies within the context and limitations of the existing agricultural systems in Rwanda.

It is apparent that the problems facing goat production in Rwanda are many, but the practical issues of feeds and feeding; regardless of the system of production comes to the forefront in the new thinking mentioned above, justifying the current government option of deserving goat for meat production. The current annual increase of meat and milk consumption in Rwanda is due to rises in population and possibly in national income.

Goat population in Rwanda

Table 4. Rwanda goat population in 2006 compared to other species

Species	**Number**	**Livestock unit (LU)**	**Percentage (%)**
Cattle	1.154.024	577.012	54.4
Goat	2.828.442	282.844	26.7
Sheep	810.469	81.047	7.6
Swine	476.149	95.230	9.0
Poultry	1.921.709	19.217	1.8
Rabbit	517.237	5.172	0.5
Total		**1.060.522**	**100**

Source: MINAGRI (2007) L.U. Conversion factors: Cattle (0.5), sheep and pig (0.1), pig (0.2), poultry and rabbit (0.01)

Table 5: Contribution of goat industry in Rwanda on annual meat consumption in 2006

Species	Meat (kg)	%
Cattle	1.137.000	44.7
Goat	**689.760**	**27.1**
Sheep	252.000	9.9
Swine	352.920	13.8
Rabbit	32.190	1.3
Poultry	81.132	3.2
Total	**2.545.002**	**100**

Source: MINAGRI (2007).

Goat breeds raised in Rwanda

Goat population in Rwanda is made up by common local goat which constitutes more than 90% of the total goat population and some imported exotic breeds (Boer, Galla, Alpine, Saanen, Toggenburg) that constitutes less than 10%.

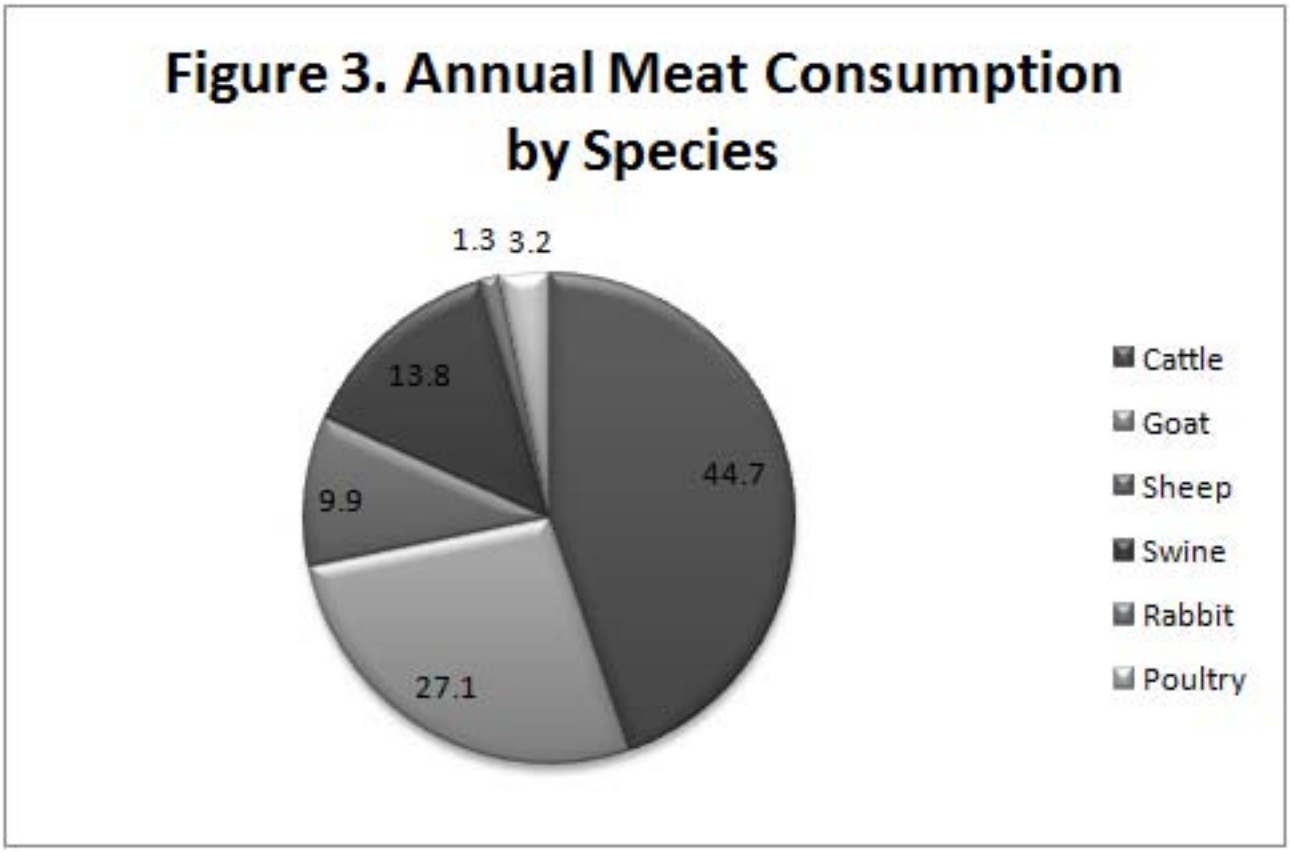

Table 6: Breed characteristics and main attributes

Breed name	Characteristics	Main function
Common local goat	Possibly cross-bred between Guinean dwarf goat and east African dwarfs goat Small size, height (50-56 cm for female and 58-68 cm for male, hair short and fine , ear short and small,	Mainly for meat, but milk maybe used to treat malnourished children
Alpine	Introduced in Rwanda for the first time from Switzerland	Mainly for milk production
Saanen	Introduced in Rwanda for the first time from Switzerland	Mainly milk production
Toggenburg	Introduced in Rwanda for the first time from Switzerland	Mainly milk production
Boer	Imported from South Africa	Mainly meat production
Galla	Imported from Kenya	Mainly meat production

Economic roles of goat in Rwanda

Goats are important because they require low initial capital, maintenance costs, are able to use marginal land and crop residues, produce milk and meat in readily usable quantities, and are easily cared for by most family members. Small ruminants are prolific and need only short periods to increase flock sizes after catastrophes or in periods of high prices and thus off take rate can respond to price increases. The basic principles of economics in goat farming are based on the following: smaller size animal, cost less than cattle, require less feeds, present fewer risks, and have quick return.

Practical Implication of Current Status of Goat Industry in Central and Eastern Africa

In line with the global predictions on increased food demand and given the current rate of population growth, the consumption of food and agricultural products especially those of animal origin, will have to increase at a rate of >4% per year in order for the demand to be met. The increased demand must be met mainly from goat meat and other small livestock species that an increase in potential arable land is limited. The goat is the preferred livestock species in the because of its high prolificacy compared to cattle and its tolerance to unfavorable climate. Current and future goat development efforts must, therefore, adequately address the following challenges:

1. What goat genotypes should be kept, under what production system?
2. What baskets of technologies, including husbandry, health management, product marketing and value addition options need to be put in place to make the local and exotic genotypes sustainable and profitable?
3. How would the appropriate genotypes and the supportive technologies be packaged, promoted and disseminated to reach the desired targets of livestock farmers and in large enough numbers to realize the desired impact?
4. The institutional frameworks and support instruments need to be in place to support the preferred and appropriate goat development programs for these to be sustainable?

Meat Goat Herd Health Procedures and Prevention

Dr. Lionel Dawson
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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.*

Internal Parasite Control for Meat Goats

Dr. Dave Sparks
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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.

Meat Goat Nutrition

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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 allows 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 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. 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 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, 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 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 on 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. It 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) 50 - 1000 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 - 80 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) 0.1 - 10 ppm

The only well accepted biological function of cobalt is as a component of vitamin B12. Rumen microbes utilize cobalt for growth and produce vitamin B12. 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 - 3 ppm

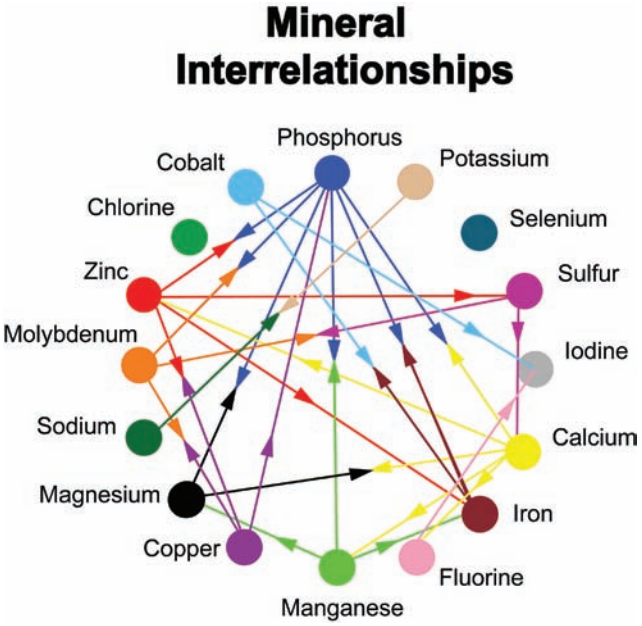
Molybdenum deficiencies are very rare. Toxicity occurs above 3 ppm due to reduced copper absorption, resulting in a copper deficiency. The copper level must be four times the molybdenum level to overcome this effect. High dietary levels of molybdenum are usually related to soil content. Molybdenum (as 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

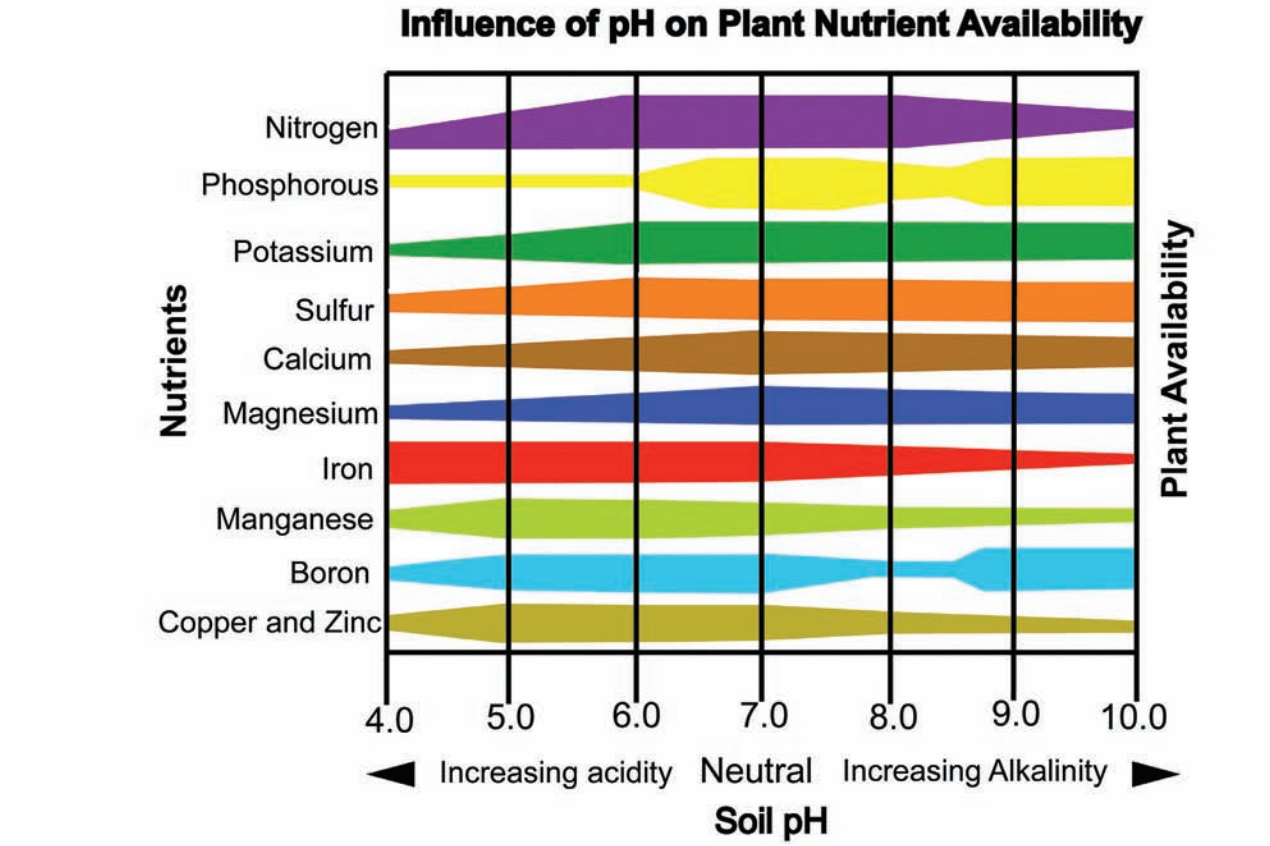
Plants are a major source of minerals for the goat, requiring all minerals that goats require except iodine. However, plant requirements for minerals, such as cobalt and selenium, may be much lower than the level required for animals. Some soils are inherently deficient in some minerals such as iodine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

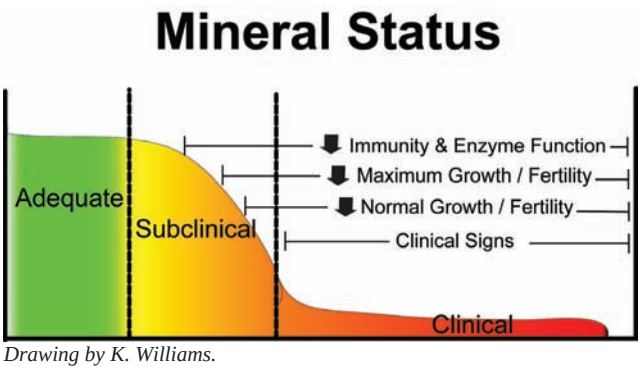
Current approximate wholesale costs for supplying 100% of mineral needs of a 150 lb goat for various minerals in 1 year are as follows:

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 2.0 or less.

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, Nigerian dwarf, 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 adequately large 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 2.8 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. 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 body condition or even increase it 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

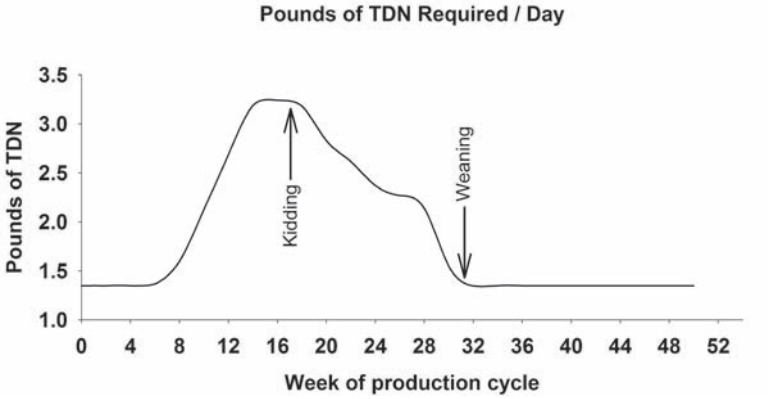
Creep feeding is a method of providing feed for the kids only. This is accomplished by fencing around a feeder and using a creep gate that has holes about 5 inch wide by 1 ft high. These holes are small enough so that kids can enter the feeder, but adults are excluded because they are too big to go through 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.

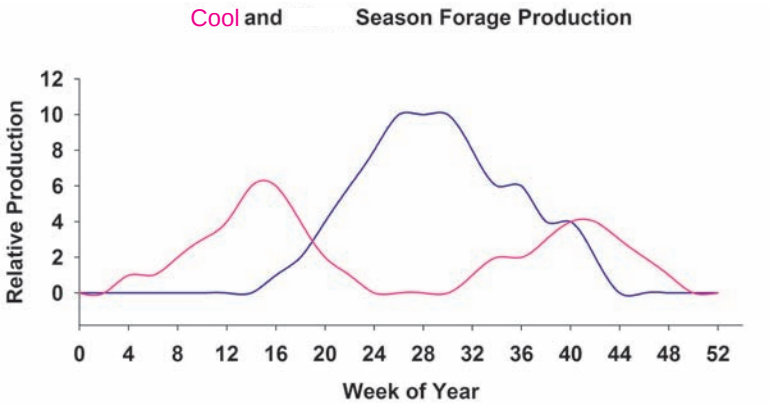
An alternative to grain-based creep feeds that is used in the beef cattle industry is to creep graze calves, using a creep gate that allows calves access to ungrazed high quality pasture. This may have application for goats using high quality pastures (crabgrass or sudangrass that is planted for the 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 20 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.

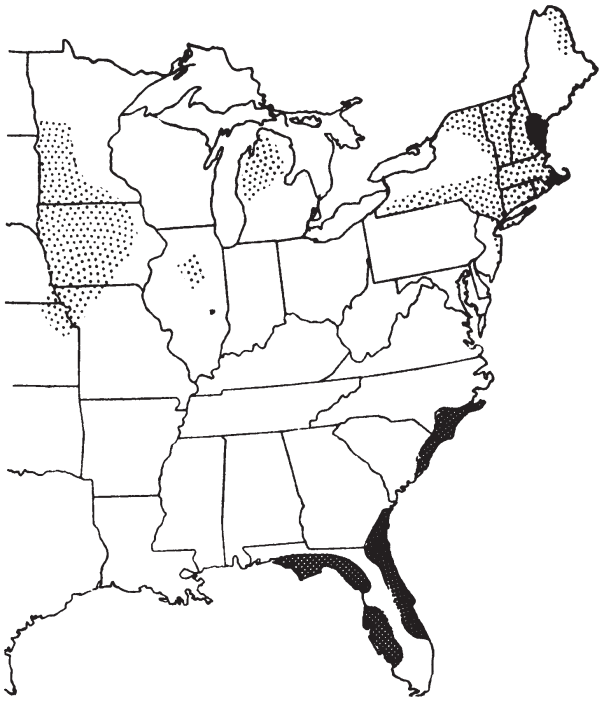
Enterotoxemia is caused by bacteria in the intestine that grow rapidly and produce an endotoxin in response to high levels of starch (grain) in the diet. Animals are in extreme pain from the effect of the endotoxin and often die quickly. Vaccination will help prevent this disease.

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 μg/ 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.

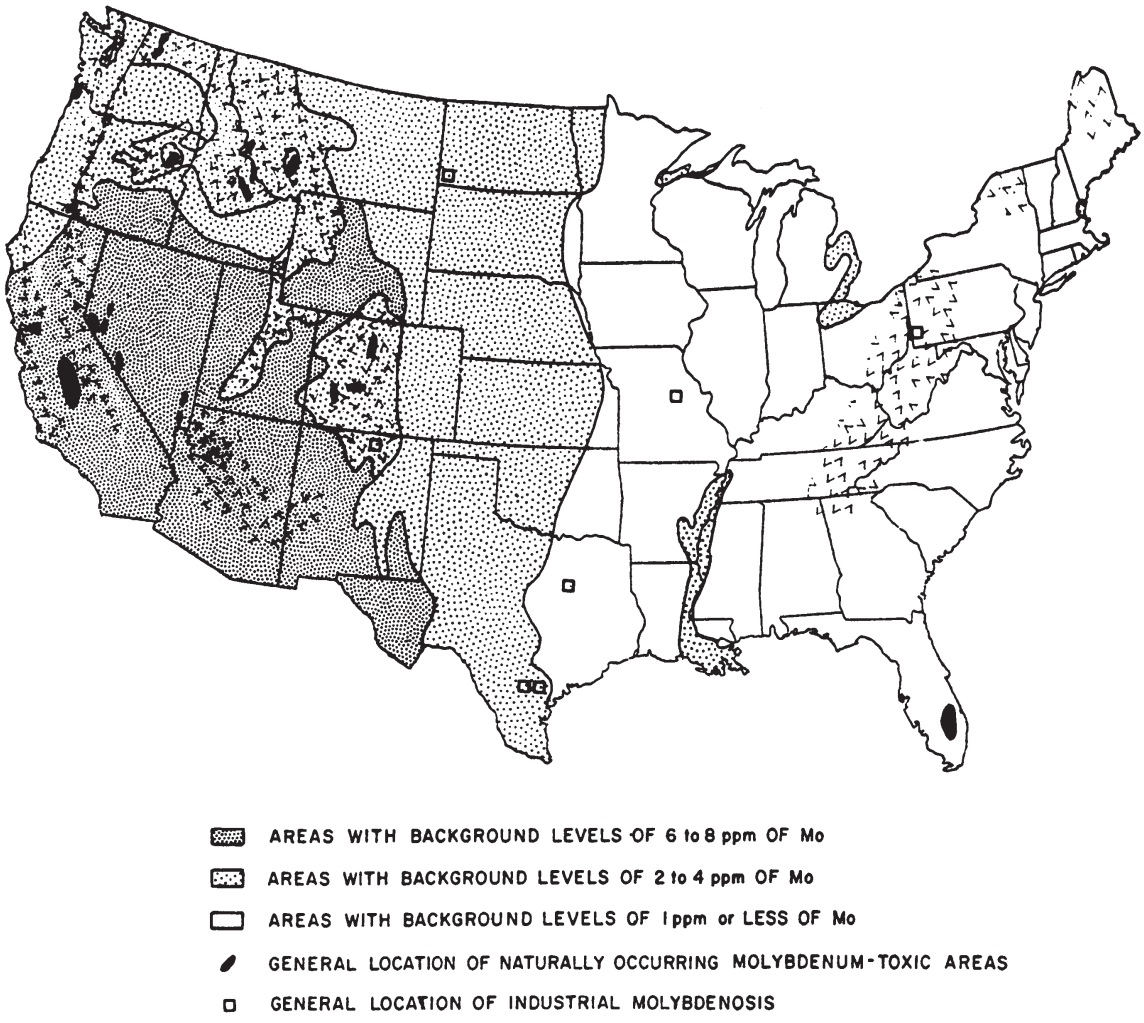


Figure 6. Generalized regional pattern of molybdenum concentration in legumes of the United States (ppm = 1 μg/ g^{-1}). From Kubota, 1977, by courtesy Marcel Dekker, Inc.

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

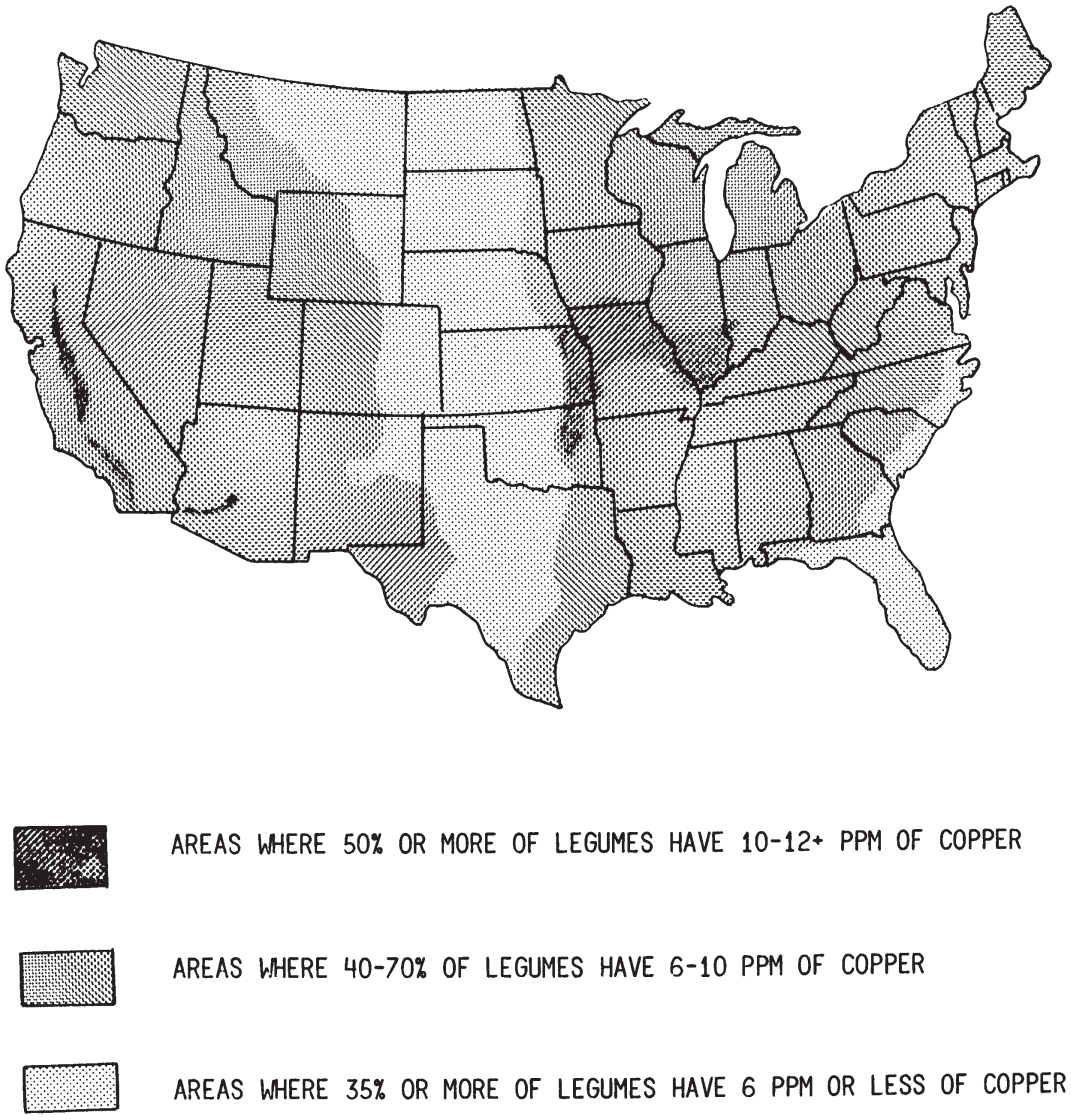


Figure 7. Generalized distribution of copper concentration in legumes of the United States (ppm = 1 μg/ g^{-1}). From Kubota, 1983a, by permission Amer. Society of Agronomy.

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

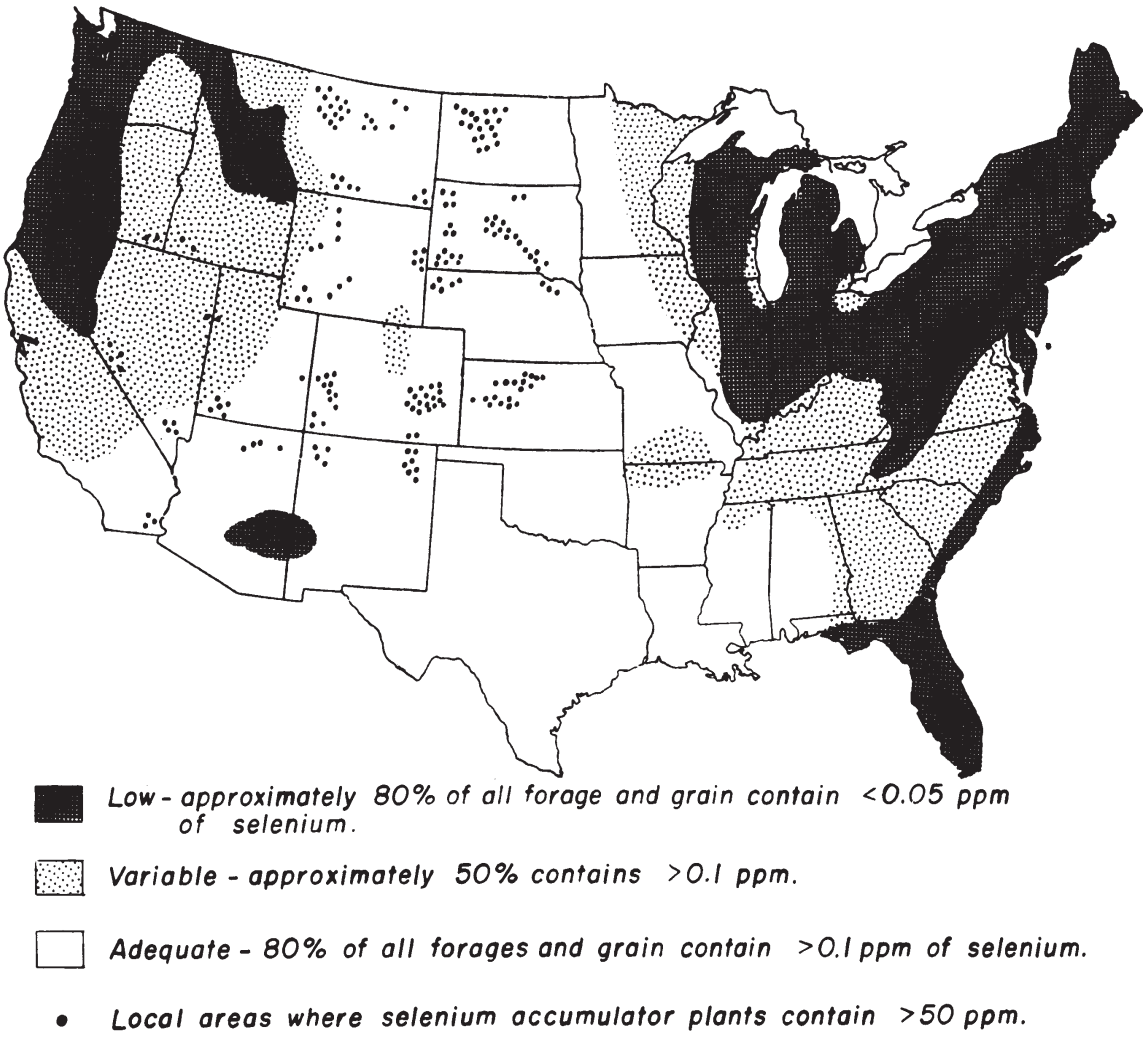


Figure 8. Geographical distribution of low-, variable-, and adequate-Se areas in the United States (ppm = 1 μg/g). From Kubota and Allaway, 1972, by permission Soil Science Society of America.

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.

External Parasites of Goats

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Introduction

Arthropod pests limit production in the goat industry in many ways. External parasites feed on body tissue such as blood, skin, and hair. The wounds and skin irritation produced by these parasites result in discomfort and irritation to the animal. Parasites can transmit diseases from sick to healthy animals. They can reduce weight gains and milk production. In general, infested livestock cannot be efficiently managed.

Lice

Lice (Order: Phthiraptera) are wingless, dorsally flattened, permanent ectoparasites of birds and mammals. Over 3000 species have been described, mainly parasites of birds. Lice infest a wide range of domestic livestock, including pigs, cattle, goats, and sheep, and cause a chronic dermatitis (pediculosis), characterized by constant irritation, itching, rubbing, and biting of the hair or fleece. Goat lice are host specific and only attack goats and their close relatives such as sheep.

Lice are divided into two main groups: the Anoplura (sucking lice) and Mallophaga (chewing or biting lice). Biting lice have chewing mouthparts and feed on particles of hair, scab and skin exudations. Sucking lice pierce the host's skin and draw blood. Louse-infested animals may be recognized by their dull, matted coat or excessive scratching and grooming behavior. The irritation from louse feeding causes animals to rub and scratch, causing raw areas on the skin or loss of hair. Weight loss may occur as a result of nervousness and improper nutrition. Milk production is reduced up to 25 %. Also, the host is often listless and in severe cases, loss of blood to sucking lice can lead to anemia.

Lice are generally transmitted from one animal to another by contact. Transmission from herd to herd is usually accomplished by transportation of infested animals, although some lice may move from place to place by clinging to flies. Lice are most often introduced to herds by bringing in infested animals.

Goat lice can be controlled by both production practices and chemical intervention. Providing a high-energy diet can be an effective louse control strategy. If possible, it is important to keep animals in un-crowded conditions and to spot-treat or quarantine any infested individuals until they have been successfully deloused. Most louse populations on animals vary seasonally, depending on the condition of the host. Louse populations on livestock are typically greater during the winter months and reach peak activity in late winter and early spring. Animals under stress will usually support larger louse populations than found under normal conditions. Insecticides are usually best applied in late fall. Control of louse infestations is needed whenever an animal scratches and rubs to excess. Louse control is difficult with just a single insecticide application since they will not kill the louse eggs. A second application is needed 2 weeks after the initial treatment to allow the eggs to hatch.

There are 3 principle species of biting lice and 3 principle species of sucking lice that can attack goats.

Biting Lice

The goat biting louse (*Bovicola caprae*), Angora goat biting louse (*B. crassipes*), and *B. limbata* are the three main species that can be found on goats (Figure 1). All three species live on the skin surface and feed on hair, skin, and detritus. Eggs hatch in 9-12 days and on average, the entire life cycle is completed in 1 month. Biting lice of goats are distributed worldwide with winter populations being the most severe. Opti-

mal control can be achieved with a residual insecticide spray with re-treatment in 2 weeks after the initial treatment.

Figure 1. Goat biting louse, *Bovicola caprae* (left), Angora goat biting louse *B. crassipes* (center), and *B. limbata* (right). Credits: K.C. Emerson Entomology Museum, Stillwater, Oklahoma and http://www.ento.csiro.au

Sucking Lice

Three species of blood-sucking lice are found on goats: the goat sucking louse (*Linognathus stenopsis*), African goat louse (*L. africanus*), and sheep foot louse (*L. pedalis*) (Fig. 2). The goat sucking louse can be dispersed over the entire body of goats and the African goat louse is usually dispersed around the head, body, and neck regions. Both the goat sucking louse and the African goat louse are bluish-gray in appearance. The sheep foot louse is an occasional pest of goats and can be found on the feet or legs of the animal. These blood-feeding lice species cause the most severe damage. Excessive feeding causes scabby, bleeding areas that may lead to bacterial infection. Mohair on Angora goats may be damaged to the extent of reduction in value of 10-25 percent. Control can be obtained utilizing the same methods described for biting lice.

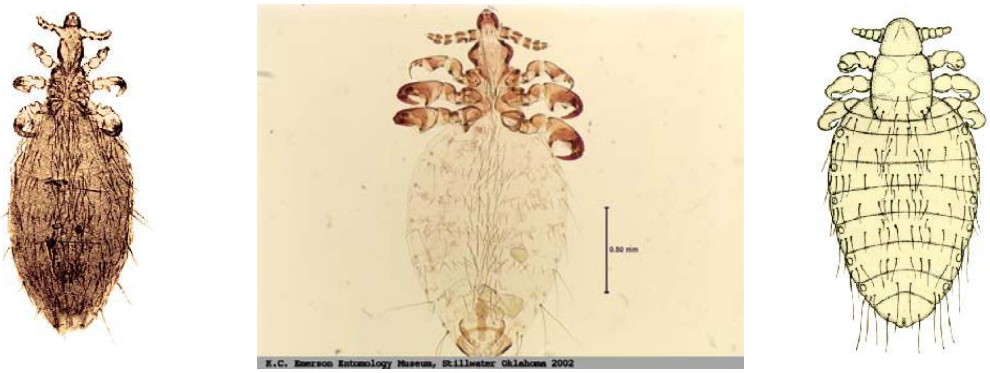

Figure 2**.** Goat sucking louse, *Linognathus stenopsis* (left), African goat louse, *L. africanus* (center), and sheep foot louse, *L. pedalis* (right). Credits: K.C. Emerson Entomology Museum, Stillwater, Oklahoma and http://www.ento.csiro.au

Nose Bot Fly

The nose bot fly exhibits a unique quality by depositing live larvae (maggots) (Fig. 3), not eggs as in the case of other fly species, in the nostrils of goats. Larvae migrate to the head sinuses and, after development, migrate back down the nasal passages, dropping to the ground where they complete development. Migration of the bot larvae to and from the head sinuses causes nasal membranes to become irritated and secondary infections can occur at the irritation sites.

Infested animals exhibit symptoms such as discharge from nostrils, extensive shaking of the head, loss of appetite and grating of teeth. Another sign of a nose bot infestation is the presence of blood flecks in the nasal discharge. The behavior of goats in the presence of adult bot flies is very excitatory and usually animals will snort with their noses towards the ground.

At this time there is only one effective product available for the treatment of nose bots in goats. Ivomec® (ivermectin) is registered as a 0.08 percent AI oral drench. Since it is labeled for sheep only, you should contact your local veterinarian for off-label prescribed usage and the correct dosage and withdrawal instructions for goats. Nose bots are usually a winter problem so treatment should be administered after the first hard frost, which kills the adult bot flies and assures no reinfestations.

Figure 3. These are the larval instars of the nose bot fly. The third instar is at the top of the photograph, followed clockwise by the first and second instars. *Credits: J.E. Lloyd, University of Wyoming*

Keds

Keds, more often called sheep ticks, are actually a wingless fly (Fig. 4). They spend their entire life cycle on sheep or goats, transferring between animals by contact. Sheep keds, *Melophagus ovinus*, are primarily a pest of sheep, but occasionally are found on goats. Adults are grayish-brown, six-legged, and 1/4 inch long with a broad, leathery, somewhat flattened, unsegmented, saclike abdomen covered with short spiny hairs. Sheep keds can live up to 6 months, during which time the female produces around 10-15 young at the rate of one every 8 days. Reproduction is continuous, though slow during the winter, producing several generations per year.

Unlike most insects, the female sheep ked gives birth to living maggots, which are nourished within her body until they are fully grown. The maggots are 1/4 inch long, whitish, oval, and without legs. The skin turns brown within a few hours after birth and forms a hard puparium (case) around the larva. These cases are often called eggs, nits, or keds. Adult keds emerge from the pupal cases in 2 to 5 weeks, depending on temperature. They crawl over the skin and feed by inserting their sharp mouthparts into capillaries and sucking blood, much like a mosquito. This results in considerable irritation, which causes the animal to rub, bite, and scratch. Another effect observed from animals infested with keds is the condition known as “cockle.” Hide buyers downgrade skins with “cockle” because it weakens the hide and discolors them.

Keds usually do not cause great damage if the animal is fed on a highly nutritious diet, but goats grazed throughout the year on pasture or range may acquire heavy burdens of keds during winter months and early spring. In addition, keds in large numbers can cause anemia, which can weaken the animal and make it more susceptible to other diseases.

Sprays, dips, and hand-dusting with insecticides are all effective methods for controlling sheep ked.

Figure 4. Illustration of an adult sheep ked. Credits: D. Rutz Cornell University

Mites

Goats can be infested by several species of mites, but the species more commonly found on goats are goat follicle mite (*Demodex caprae*), scabies mite (*Sarcoptes scabiei*), psoroptic ear mite (*Psoroptes cuniculi*), and chorioptic scab mite (*Chorioptes bovis*) (Fig. 5).

The goat follicle mite causes dermal papules and nodules and this resulting condition is known as demodectic mange in goats. These papules or nodules are caused by hair follicles or gland ducts becoming obstructed and producing these swellings, trapping the mites within these lesions. These continue to enlarge as the mites multiply, sometimes reaching several thousand mites per lesion. Cases of demodectic mange occur most commonly in young animals, pregnant does, and dairy goats. Papules usually appear on the face, neck, axillary region, or udder and these papules can enlarge to 4 cm in diameter as mites multiply. Nodules can rupture and exude the mites, resulting in transmission of the mite to other animals. Transmission of the goat follicle mite to newborn goats typically occurs within the first day following birth. Other possible means of transfer are licking and close contact during mingling or mating. Certain breeds of goat (e.g., Saanen) tend to be much more sensitive to demodectic mange than others.

The scabies mite burrows into the skin of its host, causing varying degrees of dermatitis, a condition known as sarcoptic mange. Although cases of sarcoptic mange in goats often resolve themselves without developing severe signs, heavily infested goats may exhibit crusty lesions and extensive hair loss around the muzzle, eyes, and ears; lesions on the inner thighs extending to the hocks, brisket, underside, and axillary region; dermal thickening and wrinkling on the scrotum and ears; and dry, scaly skin on all parts of the body, especially in areas of hair loss.

The psoroptic ear mite or ear mange mite causes lesions on or in the ear of the host animal. These lesions cause crust formation, foul odor discharges in the external ear canal, and behavioral responses such as scratching the ears, head shaking, loss of equilibrium, and spasmodic contractions of neck muscles. Psoroptic ear mite lives its entire life under the margins of scabs formed at infested sites. There the eggs are deposited and hatch in 4 days. The complete life cycle takes about 3 weeks. All stages of this nonburrowing mite pierce the outer skin layer. Transmission of this mite occurs between animals by direct contact. Prevalence rates as high as 90% have been reported in dairy goats, including both kids and adults, in the United States. Goats usually less than 1 year old generally exhibit higher infestation rates than do older animals. Signs of the psoroptic ear mite in kids are often observed as early as 3 weeks after birth, reflecting transfer of mites from mother to young. By 6 weeks of age most kids in infested goat herds are likely to harbor these mites. Chronic infestations have lead to anemia and weight loss in goats.

The chorioptic scab mite causes chorioptic mange in domestic animals, especially in cattle, sheep, goats, and horses. This mite occurs primarily on the legs and feet of its hosts, where all of the developmental

stages are likely to be found. Eggs are deposited singly at the rate of one egg per day and are attached with a sticky substance to the host skin. Adult females usually live for 2 weeks or more, producing about 14-20 eggs during this time. Eggs hatch in 4 days and are often clustered as multiple females lay their eggs in common sites. The immature stages last anywhere from 11 to 14 days and the entire life cycle is completed in 3 weeks. Infestations of chorioptic scab mite tend to be higher in goats than in sheep, with up to 80-90% of goats in individual herds being parasitized. The mites occur most commonly on the forefeet of goats, where the largest numbers of mites and lesions are usually associated with the accessory claws. However, they also can occur higher on the foot. Lesions are generally mild and seldom draw attention.

Treatment and control of mites should focus on all animals in a herd to achieve control. Delayed egg hatch requires retreatment at 10-12 days. To reduce the risk of introducing mites into herds, isolation of new animals should be practiced with at least a week to observe the animal for signs of mange.

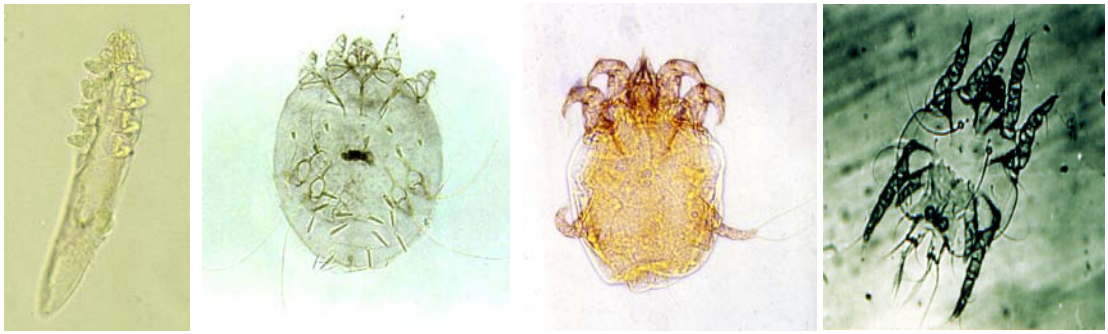

Figure 5. *left to right* Goat follicle mite, (*Demodex caprae*), scabies mite (*Sarcoptes scabiei*), psoroptic ear mite (*Psoroptes cuniculi*), and chorioptic scab mite (*Chorioptes bovis*). Credits: S.J. Upton, Kansas State University and Thomas Nolan, University of Pennsylvania.

Fleas

Adult fleas are small (1-8 mm), wingless insects that are narrow and are compressed on the sides with spines (combs) directed backwards. Most species move a great deal and remain on the host only part of the time to obtain a blood meal. The legs are well developed and are utilized to jump great distances (7 - 8 in.).

Fleas develop through a complete life cycle with 4 stages: egg, larva, pupa, and adult. Under ideal conditions, a generation can be completed in as little as 2 weeks. Mating takes place and eggs are laid on the host. Eggs then drop off the host to the ground or bedding material and hatch in 2 days but can delay hatching up to several weeks. Development of the larval and pupal stages occurs in the host's bedding material. Larvae are very small, worm-like, legless insects with chewing mouthparts. In several weeks they go through 3 larval stages, feeding on organic material. The pupal stage lasts approximately one week and then the newly emerged adult flea is ready to feed on blood within 24 hours.

There are two species that commonly infest goats: the cat flea (*Ctenocephalides felis*) and sticktight flea (*Echidnophaga gallinacea*) (Fig. 6). Female cat fleas can lay up to 25 eggs per day for a month, contributing to very high densities of fleas in a relatively short time. Cases of severe anemia associated with high numbers of cat flea bites have been reported in domestic animals. The sticktight flea attaches firmly to its host usually around the face and ears. This species remains attached to its host for as long as 2 to 3 weeks. Large populations of this flea may cause ulcers on the head and ears. Both of these flea species can easily spread to other animals so special considerations of monitoring herd dogs should be implemented if fleas become a problem in a goat herd.

Figure 6. Cat flea, *Ctenocephalides felis*, (left) and sticktight flea, *Echidnophaga gallinacea*, (right). Credits: S.J. Upton, Kansas State University and http://www.capcvet.org/copy/pics/fleas6.htm.

Ticks

Ticks harm their hosts by injuries caused by their bites that result in blood loss and transmission of disease pathogens. Ticks can be classified in three groups: one-host, two-host, and three-host ticks. Ticks commonly parasitizing goats in Oklahoma mainly belong to the three-host group. As the name implies three-host ticks infest three different hosts throughout their life cycle, which can make control difficult.

Research in Oklahoma identified three species of ticks parasitizing goats. The three tick species observed were: American Dog Tick (*Dermacentor variabilis*), Gulf Coast Tick (*Amblyomma maculatum*), and Lone Star Tick (*Amblyomma americanum*).

The adult American Dog Tick can be identified by their reddish-brown color with silver-white markings on the back and upper body regions (Fig. 7). The silver-white markings are on the scutum (u-shaped area behind the mouthparts) in females and on the male they extend over the whole back. Females increase in size dramatically when fully engorged (from ¼ to ½ inch), resembling a gray bean.

Figure 7: Female (left) and male (right) American Dog Tick.
Credit: R. Grantham; Oklahoma State University

The Gulf Coast Tick is most commonly found on goats with horns and more specifically at the base of the horns. Occasionally, some Gulf Coast Ticks are found in the ears of the animals. They are reddish brown with pale reticulations (Fig. 8) and very similar to but slightly smaller than American Dog Ticks. Gulf Coast Ticks have longer mouthparts than the American Dog Tick. The Gulf Coast tick is considered a presumed vector of *Ehrlichia ruminantium*, the rickettsial causative agent of heartwater, an African disease of ruminants that may enter the United States from the Caribbean.

Figure 8: Female (left) and male (right) Gulf Coast Tick.
Credit: R. Grantham; Oklahoma State University

Lone Star Ticks are more commonly found along the withers and neck areas of the goats. Occasionally, they can be found on the head and arm-pit regions. Adult females can be easily identified by the single lone spot on the back (Fig. 9). Adult males have non-connecting white markings along the posterior margin. This tick has much longer mouthparts when compared to the previously mentioned ticks. Research has shown that goats can serve as reservoirs of *Ehrlichia chaffeensis, which is the bacterial agent responsible for* human monocytic ehrlichiosis and the primary vector is the Lone Star Tick. Care should be taken when handling goats that are heavily infested with Lone Star Ticks.

Figure 9: Female (left) and male (right) Lone Star Tick.
Credit: R. Grantham; Oklahoma State University

All of the tick species found on the goats are three-host ticks which can complicate control since each life stage can parasitize different animals. A seasonal cycle of these ticks indicates that Gulf Coast Ticks begin to parasitize goats in April with the latest occurrence observed in June. The American Dog Tick and Lone Star Tick are observed on goats from May to August. Targeted insecticide applications should control all of these tick species, but re-application may be warranted 3 weeks later. Currently, there are very few insecticides registered for goats so extreme vigilance should be taken when selecting products to treat your goats.

Summary of Currently Available Insecticides Registered for Goats

Permethrin:

- Artoban 11% EC Insecticide – spray concentrate for flies, mites, ticks, lice, and keds.
- Catron IV – aerosol for control of flies, maggots, and ear ticks.
- GardStar 40% EC – spray concentrate for flies, ticks, and lice.

Zeta-pymethrin:

- Python Dust – dust insecticide for flies, lice, ticks, and keds.

Although many other brands and chemicals are effective against external parasites, they are not currently labeled for use in goats. Before you use such products, you should check with your local veterinarian for off-label usage instructions on dosages, withdrawal times, and special considerations for use on goats.

The use of trade names in this publication is solely for the purpose of providing specific information. OSU does not guarantee or warranty the products named, and references to them in this publication does not signify our approval to the exclusion of other products of suitable composition. All chemical should be used in accordance with directions on the manufacture's label. Use pesticides safely. Read and follow directions on the manufacture's label.

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

2009 Langston DHI Supervisor Test

(Must return by Jan. 31, 2009 if you want a certificate)

Where you previously certified by Langston to be a Supervisor? _____ _____
Yes No

Name: _____

Address: _____

City: _____ State:_____ Zip: _____

Telephone: _____

Who do you test for: _____

1. When a sample is spoiled or spilled, the year to date pounds of fat on the DMS 210 for that Doe will…
   ____increase ____decrease ____remain the same ____be zero

2. The $.08 charge on the invoice is for each sample submitted.
   ____True ____False

3. A Verification Test consists of ____ milkings?
   ____1 ____2 ____3 ____4

4. A new scale does not need the calibration checked.
   ____ True ____False

5. If the pill falls out of the vial, I should …
   ____pick it up and put back in vial.
   ____wash it off and put back in vial.
   ____ throw it in trash and get a new vial.

6. I can use a vial without a pill.
   ____True ____False

7. When I dry off all my Does, I do not need to send anything to Lab.
   ____True ____False

8. When a doe dries, it is not necessary to indicate it on the paperwork.
   ____True ____False

9. The best way to correct a problem is to …
   ____ Wait until the end of the year
   ____ Wait until another test to see if the problem was corrected.
   ____ Call as soon as you see a problem
   ____ Make a note of the error and highlight it.

10. The best way to label the vial is to …
    ____ Use a unique numbering system with a secret code.
    ____ Put the index number of the Doe on the vial.
    ____ Put the order in which the Does were milked (1, 2, 3, 4…ect.).
    ____ Put the Doe's name on the vial.

11. Explain the difference between a transfer Doe and a new Doe entering the herd.

12. Can Langston calibrate your scales?
    ____Yes ____No

13. Before sending the paperwork, I always ensure that I have put down fresh dates for Does that have freshened, dry dates for Does that have dried that have dried, sold dates for Does sold, and death dates for Does that have died since last test.
    ____True ____False

14. What is the best way to take a good milk sample?

15. To enter a Doe in the DHI program, You need :
    A. Registration Number
    B. Name
    C. Date Of Birth
    D. Fresh Date
    E. All The Above

16. If you have any question or comments, you may write it here.

Benefits of USDA Programs

Mr. Dwight Guy, Mr. Phil Estes, Ms. D'Ann Peterson
USDA

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Who We Are

Fact Sheet

September 2006

Natural Resources Conservation Service

Helping People Help the Land

With the mission of "Helping People Help the Land," the Natural Resources Conservation Service (NRCS) provides products and services that enable people to be good stewards of the Nation's soil, water, and related natural resources on non-Federal lands. With our help, people are better able to conserve, maintain, or improve their natural resources. As a result of our technical and financial assistance, land managers and communities take a comprehensive approach to the use and protection of natural resources in rural, suburban, urban, and developing areas.

A Partnership Approach

Since the Dust Bowl of the 1930's, NRCS has worked with conservation districts and others throughout the U.S. to help landowners, as well as Federal, State, Tribal, and local governments and community groups.

NRCS has six mission goals: high quality, productive soils; clean and abundant water; healthy plant and animal communities; clean air; an adequate energy supply; and working farms and ranchlands. To achieve these goals, the Agency implements these strategies:

- Cooperative conservation: seeking and promoting cooperative efforts to achieve conservation goals.
- Watershed approach: providing information and assistance to encourage and enable locally-led, watershed-scale conservation.
- Market-based approach: facilitating the growth of market-based opportunities that encourage the private sector to invest in conservation on private lands.

Conservation Assistance

Our locally-based NRCS staff works directly with farmers, ranchers, and others, to provide technical and financial conservation assistance. Our guiding principles are service, partnership, and technical excellence.

NRCS helps landowners develop conservation plans and provides advice on the design, layout, construction, management, operation, maintenance, and evaluation of the recommended, voluntary conservation practices. NRCS activities include farmland protection, upstream flood prevention, emergency watershed protection, urban conservation, and local community projects designed to improve social, economic, and environmental conditions.

NRCS conducts soil surveys, conservation needs assessments, and the National Resources Inventory to provide a basis for resource conservation planning activities and to provide an accurate assessment of the condition of the Nation's private lands.

As the leading source of technology as it applies to natural resource conservation on private lands, NRCS develops technical guides and other Web-based tools to help enhance natural resource conservation efforts.

For More Information

Please contact NRCS at your local USDA Service Center, listed in phone directories under U.S. Government, or visit our Web site at: http://www.nrcs.usda.gov.

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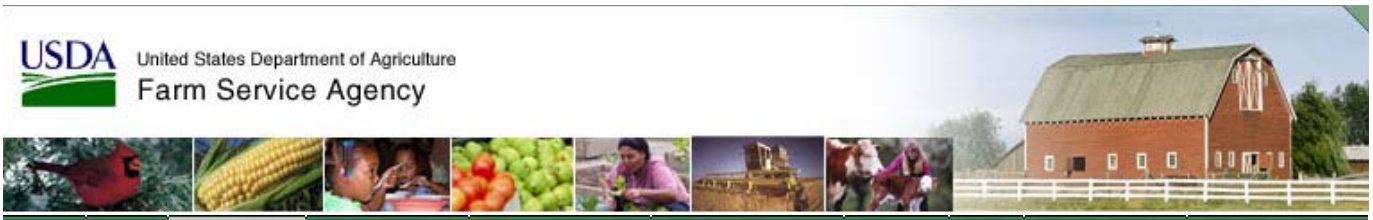

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About FSA

Office of the Administrator

The Farm Service Agency (FSA) administers and manages farm commodity, credit, conservation, disaster and loan programs as laid out by Congress through a network of federal, state and county offices.

These programs are designed to improve the economic stability of the agricultural industry and to help farmers adjust production to meet demand. Economically, the desired result of these programs is a steady price range for agricultural commodities for both farmers and consumers.

In the Eisenhower administration, the Congress split the functions of the Triple A committees, creating the state and county office system to take care of administrative functions and kept the farmer county committee to oversee implementation of federal programs in their county.

State and county offices directly administer FSA programs. These offices certify farmers for farm programs and pay out farm subsidies and disaster payments. Currently, there are 2,346 FSA county offices in the continental states. FSA also has offices in Hawaii, and a few American territories.

More than 8,000 farmer county committee members serve in FSA county offices nationwide. Committee members are the local authorities responsible for fairly and equitably resolving local issues while remaining dually and directly accountable to the Secretary of Agriculture and local producers though the elective process. They operate within official regulations designed to carry out Federal laws and provide a necessary and important voice in Federal decisions affecting their counties and communities.

Committee members make decisions affecting which FSA programs are implemented county-wide, the establishment of allotment and yields, commodity price support loans and payments, conservation programs, incentive, indemnity, and disaster payments for commodities, and other farm disaster assistance.

Structure & Organization

Provides contact information as well as a listing of the programs and offices that make up the Farm Service Agency.

FSA Biographies

Includes biographies of the Farm Service Agency leadership.

History & Mission

Provides a history of the agency and describes its vision and mission.

Budget & Performance

Includes information about the budget, the strategic plan, and efforts to ensure that activities are managed efficiently.

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- **Structure and Organization**
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Farm Loan Programs

Background

FSA makes direct and guaranteed farm ownership (FO) and operating loans (OL) to family-size farmers and ranchers who cannot obtain commercial credit from a bank, Farm Credit System institution, or other lender. FSA loans can be used to purchase land, livestock, equipment, feed, seed, and supplies. Our loans can also be used to construct buildings or make farm improvements. See our loan information chart which describes maximum loan amounts, rates, term, and use of proceeds.

Many FSA loan application forms are available on our website! We also encourage you to contact your local office or USDA Service Center to learn more about our programs and the information you will need for a complete application.

Our Customers

FSA loans are often provided to beginning farmers who cannot qualify for conventional loans because they have insufficient financial resources. FSA also helps established farmers who have suffered financial setbacks from natural disasters, or whose resources are too limited to maintain profitable farming operations.

Last Modified: 10/09/2007

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- **Funding**
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USDA Rural Development

Committed to the future of rural communities.

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Welcome to USDA Rural Development. Rural Development is committed to helping improve the economy and quality of life in all of rural America. Through our programs, we touch rural America in many ways.

Our financial programs support such **essential public facilities and services** as water and sewer systems, housing, health clinics, emergency service facilities and electric and telephone service. We promote **economic development** by supporting loans to businesses through banks and community-managed lending pools. We offer **technical assistance and information** to help agricultural and other cooperatives get started and improve the effectiveness of their member services. And we provide technical assistance to help communities undertake **community empowerment programs**.

We have an $86 billion dollar portfolio of loans and we will administer nearly $16 billion in program loans, loan guarantees, and grants through our programs.

Rural Development achieves its mission by helping rural individuals, communities and businesses obtain the financial and technical assistance needed to address their diverse and unique needs. Rural Development works to make sure that rural citizens can participate fully in the global economy.

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Rural Development is within the U.S. Department of Agriculture and administers rural business, cooperative, housing, utilities and community development programs.

USDA

Pack Goats

Mr. Dwite and Mrs. Mary Sharp
Paradise Ranch

Introduction

Introduction to Dwite and Mary Sharp

Dwite and Mary Sharp have raised and trained pack goats for over ten years. They own and operate Paradise Ranch in the Flint Hills near the historical town of Council Grove, Kansas. Their family has lived in Morris County for eight generations. Although they grew up in southern California they have returned to the Flint Hills several times to live. The last time they moved to the Flint Hills was in 1997 when they moved from Charlotte, North Carolina; this time to stay.

In 2000 Dwite retired from auto racing where he had been a Design and Fabrication Engineer for over 30 years. Involved with NASCAR's Winston Cup Division he designed and built cars for Felix Sabotos, Rick Hendricks, Richard Childress and many others.

Mary had been in restaurant management for many years before returning to Kansas and after returning to the Flint Hills she opened her own café. After a year she called it quits and decided to stay home and raise pack goats. Since 1999 Mary has been the working force at Paradise Ranch tending to the chores on a daily basis.

In 2001 Dwite took a job with BNSF Railway in the engineering department, but his true passion now is the creatures of Paradise Ranch. There they raise pack goats, high end Boer goats, Mammoth Donkeys, guineas, and Doberman Pinschers.

Introduction to Goat Packing

Goat packing was first invented in 1972 out of necessity by John Mionczynski, a scientific researcher for the U.S. Forrest Service.

His job was to follow and stay close to a band of Rocky Mountain big horn sheep and to observe and record their food habits and behavior in the wild. The sheep had been fitted with radio collars.

John was on his own and at first he used horses to carry his equipment and supplies. The horses didn't work very well, they did a good job getting to base camp, but they couldn't get near the terrain where the sheep lived. There wasn't enough grass in that country to leave them picketed out for more than a day. He would have to come back once a day to move and water them. This was not going to work.

So the horses went and he started backpacking. Carrying a backpack in that terrain was dangerous enough but after weighing his pack it weighed over one hundred pounds.

He was at a high level of desperation, after a particularly difficult day in the mountains, he imagined a goat packed up like a horse. At first he laughed at the idea, but he was desperate. Several days later he returned home for a few days off. He had several goats, he liked goat milk. One was an eleven year old wether named Wethervane that he harnessed and used to haul water on a travois from a creek to a cabin. He knew Wethervane could haul a couple hundred pounds on a travois using an old upside down horse halter for a harness. He had no idea how he would react to carrying a load on his back. He started slowly using a saddle bag, adding a little weight at a time, leading him around. Wethervane acted as though he was carrying nothing. So John got some bigger bags and loaded them with his gear. He slung them over Wethervane's back, using a horse saddle pad for padding. It worked, this was becoming exciting. After a day of walking Wethervane around and increasing the weight, it became evident that with a few refinements he could prob-

ably take Wethervane back to the mountains with him. He made the first pack goat saddle out of some 1"x6" boards and cross bucks from a sawed up shovel handle. It became clear that with the saddle to help distribute the load more evenly, Wethervane could easily carry even more weight.

Back in the mountains Wethervane followed faithfully and silently. He was so quiet he let him stay at camp and even at the observation posts. Wethervane's true test came the day the sheep decided to migrate. Could he keep up? It started before daybreak. The radio signals were clear; they were on the move. Wild sheep can go thirty miles in one move and you have no idea where they will end up. John and Wethervane hiked for several days along escarpments and over mountains. Although Wethervane had a few new things to learn, he performed beautifully. John was ecstatic. You can teach and old goat new tricks!

Each day Wethervane worked and became stronger and could carry more weight. John could see Wethervane's muscles growing and firming up.

In time John was packing Wethervane, a doe named Jessie (a milk goat), and several kids as trainees.

John's greatest pleasure came from seeing how healthy, alert, and handsome a goat can look when it's being worked. Also how much like a wild animal it can act; testing the air for scents, twitching the ears, looking around ,curious about every new sound, scent, and movement. They were a different animal entirely from the sloth like, pot bellied barn potatoes.

Several years later Wethervane, the first pack goat, was killed by a hunter in the opening day of deer season.

John went on to run his own goat-centered outfitting/guide service, building and selling custom pack saddles, and raising pack goats. John Mionczynski is known as the father of goat packing.

Facts about Goats

1. Goats are quite picky about what they eat.
2. Goat's eyesight is seven times better than a human.
3. Goats can smell with their mouth (called the Flehman response), using an organ in the roof of their mouth called the Jacobsens organ. When they curl up their upper lip with their mouth slightly open, they are smelling.
4. Goats can be very social animals making them wonderful companions.
5. Goats will follow with out being led.
6. Goats are the most surefooted animal on the planet.
7. Goats are one of the most intelligent creatures on the planet.
8. Goats are thought to have been domesticated more than 10.000 years ago. 5,000 years before the horse and probably the first wild animal to be domesticated.
9. Goat's primary diet consists of weeds and brush.
10. Goats are browsers not grazers.
11. Goats can go 3 or 4 days without water. The only animal better is a camel.
12. While in the desert a large wether can carry enough water for you and itself to last a week.
13. Goats can adjust their metabolism as the need arises.
14. An exercising goat has up to 12% heat loss through their horns. (They are like radiators)
15. Generally there is no need to carry feed for goats on a pack trip.
16. Goats are herd animals and should be kept with at least one other goat.
17. Goats have the ability to regain all their natural instincts when taken into the wilderness.
18. Goats have the widest variety of food preferences.
19. When danger approaches pack goats will surround you and face the danger. They will not flee.
20. Horned goats are capable of killing predators, and will if forced to do so.

21. Wildlife has been known to follow and get extremely close to pack goats in the wild. This makes for great photo opportunities.
22. When given a large selection of plants in a pasture a goat is capable of eating the correct amount of the right plants to be at optimum health. A nutritionist can not compete with this ability.

Preparing the Facilities for Pack Goats

So as not to get the cart in front of the goat, we must get the facilities in order before bringing the goats home. Packgoats are no different than other goats as far as their needs.

Their needs are:

1. Goats need housing that will protect them from rain and wind, but is not so tight as to be unventilated. Goats are susceptible to respiratory problems, because they will urinate and defecate in their living quarters. Their housing should be well ventilated. A three sided structure will work just fine. Face the opening so the wind doesn't blow in. You can even build a wall in front of the opening 3'-4' out. Leave the eaves under the roof open so the air can circulate. Use your imagination. There is no set rule as to what the goathouse should look like, so lots of different buildings will work. If you have one goat that is aggressive you might want to have an escape door on each end. The size of the house will depend on the number of goats to be housed. A minimum of 15 square feet per goat is needed and more if you have horned goats.

2. Pens and Pastures; the goat house should have a pen or corral on the side or sides that are open, so you can contain the goats as needed. I recommend using 2"x4" woven wire or even 2"x4" horse panels. These two are five feet tall. My reasoning for this is to protect the goats inside the pens from predators. The 2"x4" openings will not allow the small kids to get their heads through the fence and be grabbed by something on the other side. This is a very common way for goats to be killed. We have had very bad luck using cattle panels and woven field wire (sometimes called hog wire) which have 6"x6" openings. Newborns have been known to crawl through these fences and as they get older and have horns they get their heads stuck in the fence and then they are at the mercy of what ever is on the outside. The wire with the 6"x6" opening is cheaper but don't take the chance! Spend the money at the beginning before you loose something precious to you! Also don't use welded wire. The welds will eventually break loose and your fence will come apart. We use T posts everywhere we use panels. With the woven wire you must have braced, hedge corner posts. The reason for this is because the wire must be stretched and if they are not cemented and braced the tension of the wire will pull the posts over. We use 4'-12' round tubular gates and cover the side the goats are on with 4' chain link. You could also use chain link gates. All the materials can be bought at a farm and ranch store. Remember to put the fence on the side of the post that will be pushed on most. For example, if you have cows on one side and goats on the other, then the fence should be on the side the cows are on. If you have nothing on the other side the fence should be on the goat side. Let the post support the fence not the wire that is holding the fence to the post. When putting the T posts in the ground do not forget to face the T post the correct way for the side the fence will be on.

Pasture fence can be a real challenge for keeping goats in. No other animal will point out your fence building short comings faster than a goat. It is said that if you build a 10' high solid wood wall all the way around the pasture and then go 3' inside that wall and build another one just like it. Now fill the 3' space between the walls full of cement. After it dries fill the pasture with water all the way to the top of the walls. If it holds water it might hold a goat!

My experience with goat fencing is vast. I've made every mistake I think I could have. I think I finally have it under control. Goats are brilliant escape artists and eating machines. These two attributes make them tough to fence. You might think you've beat them but you'll only know for sure when the eating looks better on the other side of the fence. That is why they will show you your deficiencies in fence building. I have had

way more Boer goats over the years than pack goats but it seems to be the trained pack goats that instigate the major break outs. These very large goats have escaped through the places I would not have believed if I had not seen it with my own eyes. They have shorted out electric fences and led one hundred goats into the neighbor's bean field. They have done this more than once.

If you have no pasture fencing at all and must start from scratch I recommend not using electric fences. If you have existing fences and can't afford to replace all of them electric fences are usually the cheapest option.

If you are putting up a completely new fence I would use goat and sheep woven wire. There are two kinds of this wire. The best is the one with 4"x4" openings. The other has 6"x12" openings. The 4"x4" wire will actually keep the goats heads on your side of the fence. The 6"x12" wire will allow the goats to put there heads through the fence but the opening is large enough to allow them to remove their heads easily. The 4'x4' wire is my first choice but because it has so much more wire, it is also more expensive. I use the 48" width. Both of these products are manufactured by Oklahoma Wire and Steel and come in 330' rolls.

I space the T post 10' to 15' apart and use cemented braced hedge posts on the corners. If the fence goes down into a low spot and then back up, you will probably need to cement a hedge post on both sides of the low areas to keep the tension of the fence from pulling the T post out of the ground (specially when it rains).

If you have an existing fence and you need to goat proof it you have several options. If it is barbed wire you can add more wires to the fence. Goats almost always go under the fence so adding wires to the bottom will help. Then stretch a wire (it can be the barbless wire) about 3" to 4" off the ground. Space it so they are closer together at the bottom and a little wider as they go up. If the wires are stretched tightly and spaced correctly, seven wires will work.

The next option is to install an electric fence on the inside of the existing fence. I've had a lot of experience with this. The first thing to do is select the fence charger. I highly recommend using a low impedance charger. Although the testers for electric fences test in volts, it is not the voltage that shocks. It is the amps that shock. A low impedance charger turns up the amperage (makes it hotter) as the fence is contacted by vegetation or wet grass. If you tested it with a tester it would show the voltage has dropped but, actually the fence is very hot. With the non low impedance fence charger the fence would have been colder. Low impedance chargers use joules to measure the power. I suggest at least 6 joules for goats. To get this you will need a charger that is rated for about 100 miles of fence. Battery operated fence chargers will not be hot enough. The lesser ones will work for a while and then the pack goats will figure it out and they will escape. I use a 100 mile low impedance Zareba fence charger. Orschlins and Tractor Supply sell them. My pastures are only about 25 acres total.

We attempted to place insulators on the same T posts that the existing barbed wire was on. This failed miserably. The pack goats went between the fence posts. They seemed to be able to tell when the fence surged. In between the surges they used their horns to push the hot wire over and hooked it on the barbwire. This shorts the fence out. They then kneel down and push their nose under the bottom wire of the barbed wire fence, which is about 6" off the ground, and they escaped. Once again there were one hundred goats in the bean field! All of this took about 30 seconds. I counter attacked! I bought ½" rebar and cut it into 4' lengths. I placed the rebar 20' to 25' apart and 1' inside the barbed wire fence. I then placed one 14 gage galvanized steel wire about 8" to 10" above the ground and another one 16" above the first. I stretched the wire as tight as a banjo string. I then released the goats from the corral. They slowly walked out of the corral and headed to the scene of the crime. Remembering the taste of the bean field, they broke into a full run. As they approached the new electric fence they skidded to a halt, looked up and down the new fence, and then turned and walked away. That was about six years ago and I haven't had a goat out since.

The bad part about electric fences is that they need constant attention. You must walk the fence to make sure that the insulators haven't broken and fallen off, or moved up or down the rebar. We have learned to use ceramic corner insulators. The plastic ones pull through and short out in time, killing the fence. Tree branches fall on the hot wires and push the fence to the ground stretching the wire. We have had our Anatolian Shepherd chase coyotes through the fence, damaging it. So if you can fence your goats with less maintenance you will make it easier on yourself.

Choosing Your Pack Goats

Not everyone who would like the benefits of a pack goat should actually own one. If your short on patience and aren't a big fan of Mother Nature, then goat packing will not be for you. To find out how you feel about pack goats you might want to rent one for a small outing and see how it goes.

If you decide you would like to own a pack goat you need to get at least two. Goats are herd animals and need at least one other goat in their life to be emotionally healthy.

You can buy an experienced pack goat from a breeder/ outfitter. If you do you will miss out on all the fun and experiences of seeing these wonderful creatures mature and blossom with your interaction.

The majority of our pack goats started bonding with us at birth or within the first week. A few of our pack goats were actually purchased and restructured into pack goats at a much older age. Four of them were actually two years old before becoming pack goats. I would not recommend this for the beginner. Two of these four were completely wild animals and quite dangerous. These two have turned out quite well but the amount of time required was immense. I would be willing to say that we will probably not do that again.

If you don't have a lot of experience caring for baby goats you may opt to purchase you pack goat pre-trained at about six months of age. This way he has a head start in the right direction (That is if you purchase him from a good pack goat breeder; they are not all equal). You can continue his training and learn together.

You need to learn about good pack goat conformation. This will be beneficial in selecting a goat with good potential. Don't think that all Dairy goat breeders know about good pack goat conformation, because this is not likely. They breed for milk production, utter attachment, etc. They do not breed for pack goat conformation. If you are going to spend all the time, effort, and money on a quality pack goat let a reputable pack goat breeder help you get started.

It is possible to get good pack goat kids from outside the pack goat industry but without the knowledge it's difficult to make an accurate choice.

We do sell pack goat kids, but only in advance. Meaning we discuss what you want and then we breed the kid, to be delivered a few days after birth or at six months. We take our responsibility seriously.

Training

Training is something that is best if it begins shortly after birth. It's best for the bonding with humans aspect if the human becomes mom right away. That is not to say a good pack goat can't be achieved later. Removing the kid immediately after birth has a negative impact on the mental well being of the doe. Also the kids seem to learn about eating hay, grain, and minerals better with their mother. Mom really does know best. The sooner the kids start eating hay, grain, etc., the better they will grow. When you remove the kids from the doe you become their mother; you have to teach them the most important thing in a goats life, EATING! Sometimes it can be a real struggle to get them to eat enough. We have had bottle babies that at three months were eating very little grain. We feared they would starve if we weaned them. You must spend a lot of time with the kids and teach them by placing the grain in their mouth over and over again. You must do this before giving them their bottle. This seems sometimes like they aren't going to figure it out and then

one day they finally get it. When you cut back the number of times a day they get a bottle they will think a little bit more about eating grain, hay, etc…

So why don't you just let the doe raise the kid? After all letting the doe raise the kid would be much easier. You would not have to get up in the middle of the night, get dressed, heat up the milk, go out in the cold, and feed the kids. When the doe does the work the kids tend to become wild goats and are not dependent on you. You want your pack goats to be completely dependent on you for food, water, and emotional support. Oh yes you have to become a goat!

You should spend a lot of time with the kids besides the feeding time. Go in to the pen, sit on a milk crate, talk to them, call them by name, pick them up, and hold them as long as you can. Soon they will be too large for this so do it while you can. For the first few weeks it is okay to let them jump on you. After a few weeks do not allow the goats to even put their front feet on the fence. Now start teaching them that it is not okay to jump on you, the gate, the fence, the car, or anything else. The word "down" should be taught at a young age.

Goats don't tolerate violence. Don't make the mistake of loosing your patience and yelling at or striking them. You will go from the top of the hill to the bottom, in their eyes. It could take weeks to regain their trust. Goats have a good memory and will get even. It may not be today or even tomorrow, but it will happen.

After a couple weeks you can put a small collar and leash on them. Let them get used to this slowly. Do not try to lead them until they are comfortable being tied (held by you). NEVER, NEVER, leave the collar on unless you are right there. Goats can strangle quickly. In time the goat and you will learn to deal with the safety issues of collars and horned goats.

1st Hour

1. Paradise Ranch Introduction
2. Introduction to Goat Packing
3. Facts about Goats
4. Pack Goat Facilities, Housing, Fencing, and Pens
5. Confirmation
6. Choosing your Pack Goat
7. Questions and Answers

2nd Hour

1. All Wether Marching Band Arrives
2. Introduction to the Goats
3. How to Tie Goats Out
4. Training
5. Goat Vaccinations
6. Parasite and Decox Control
7. Hoof Trimming

3rd Hour

1. Nutrition and Wavy Teeth
2. How to Pack a Goat
3.

This would not be possible without the members of the "All Wether Marching Band". (The Horn Section)

Alpine	Boer	LaMancha	Nubian	Nubor (Nubian/ Boer cross)	Oberhasli	Saanen	Sabor (Saanen/ Boer cross)	Toggenburg
Louis	Dynamite	Snow	Chief	Micah	Mud Pie	Rock Slide	Clark	Poncho
Geronimo	Brock	Axel	Jake	Rio	Satchel	Avalanche	Luke	Lefty
Cochese					Cargo	Glacier	Noah	
Forrest							Gabriel	

Books

"The Pack Goat"
by John Mionczynski
Published by Pruett Publishing Co., Boulder, Colorado

"Goat Medicine"
by Mary C. Smith & David M. Sherman
Published by Lea & Febiger

"Meat Goat Production Handbook"
Available from Langston University
www.luresext.edu/GOATS/mgph.html

"Practical Goat Packing"
by Carolyn Eddy for $17.95
"Diet for Wethers" by Carolyn Eddy for $14.95
Shipping for one or both for $3.50
Order from: Eagle Creek Pack Goats
PO BOX 755
Estacada, Oregon, 93023

"Field First Aid for Goats" $24.95
by Carolyn Eddy & Alice Beberness
"Packable Guide for First Aid for Goats" $16.95 by Carolyn Eddy & Alice Beberness
Order from: Alice Beberness
PO BOX 4
Alvadore, Oregon 97409
Check, money order, or pay pal ID # Carolyn@ goattracks.com

Magazine

"Goat Tracks Journal of the Working Goat"
558 Park Ave
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E-mail Shannon @ www.GoatTracksMagazine.com

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Tanning Goat Hides

Dr. Roger C. Merkel
Langston University

Introduction

Many people are interested in tanning goat or other hides such as deer. Learning the art of tanning hides can be very rewarding, through acquisition of new skills and the attractive products resulting from the endeavor. The equipment needed to tan hides can be purchased or much of it can be fashioned from items found around households or farms. Tanning chemicals are readily available from many suppliers and kits can be purchased for $25 – 35 that will tan one or two hides. While tanning is not difficult, it is a learning process and your skills will improve over time. Although home tanning may not match the quality of a professional tannery, good quality, long-lasting products can be made. However, if you do have a special hide, it is best to send it to a professional rather than attempting it yourself. This is particularly true if you are new to the art of tanning.

Tanned goat, deer, and elk hides.

Tanning Methods

Many of the tanning methods suitable for home tanning are used in the taxidermy industry to prepare deer capes and other hides for mounting. Tanning agents are available in powder, liquid, or cream form. The powdered forms, and some liquid forms, require mixing the chemical into a water and salt solution and immersing the prepared hide for a specified length of time. Most liquid and cream tanning agents are designed to be applied directly to the prepared hide using a paint brush or by hand wearing gloves. There are advantages and disadvantages to both paint-on and immersion systems.

Paint-on tans require fewer solutions to make and dispose. All areas of the skin must be covered with the paint-on tanning agent but care is needed around hide edges as the solution may stain the fur or hair. The amount to use may be difficult to gauge. Too heavy an application on thin skins may result in the tanning liquid being absorbed through the skin potentially discoloring hair and leaving it feeling greasy or oily. While the greasiness can sometimes be washed out with detergent or solvent, the stains remain. However, paint-on tans are easy to use, result in a well-tanned hide, and are preferred by many tanners and hobbyists. Examples of paint-on tans include: Liqua-Tan ., made by Knobloch's and available through many distributors; Kwiz-n-Eze by Rittel's; McKenzie Tan, available from McKenzie Taxidermy Supply; Tannit Solution, offered by Tandy Leather Co.; Bollman's Mammal Tanning Cream; and Trapper's Hide Tanning Formula. Other products are also available.

Immersion tanning methods negate problems with discolored or greasy hair sometimes encountered with paint-on tans. However, solutions must be mixed, pH monitored and spent solutions properly disposed. Through soaking, the tanning agent has access to both sides of the hide, although the hide should be stirred occasionally while in the tanning solution to ensure that there are no folds in the hide preventing adequate chemical penetration. Please note that the hair of deer is hollow and deer hides will float so stirring may need to be more frequent. If tanning is done correctly, weighting a deer hide to keep it submerged in the solution

[1] Mention of trade names, proprietary products, or vendors does not imply endorsement by Langston University or the E (Kika) de la Garza American Institute for Goat Research of the products or vendors named or criticism of similar products or vendors not mentioned.

is not necessary. Goat hides do not have this problem. There are many kinds of immersion tanning agents. Two examples are EZ-100 from Rittel's and Lutan F.

For initial attempts at tanning, it is beneficial to purchase a kit complete with tanning chemicals, instructions, and a list of the needed equipment. Rittel's manufacturers many types of kits available from various distributors including EZTAN Kit using EZ-100, Trapline Tanning Kit and Rancher's Tanning Kit that both utilize Rittel's Kwik-Tan, and Dehairing and Leather Tanning Kit. Kits using other chemicals, e.g., Liqua-Tan, Para Tan, Krowtann 2000, Lutan F, etc., are also available or one can also purchase tanning chemicals individually. Authentic Taxidermy Supply Company sells a product called "One Hour Tan" that requires hides to soak for only one hour in the tanning solution. Finally, while not covered in this article, chemicals and kits are available for tanning birds and reptiles.

Basic Tanning Steps

Whatever method is chosen to use in tanning a hide - immersion or paint-on, kit, or purchase of separate chemicals - many of the basic steps are the same: skinning the animal; preserving the hide; fleshing the hide; pickling and neutralizing; the actual tanning process; oiling; drying and softening; and finishing. As with any craft there are many variations on the main themes and different texts will provide different tanning recipes, order of steps, chemicals to use and tips on how to successfully follow their method. It is a good idea to read through several methods and speak with someone knowledgeable on tanning hides before selecting a particular one. As each method or tanning recipe is slightly different, it is best to follow the instructions and learn the basics. One can then experiment in the future.

It is not the goal of this paper to present all of the tanning variations available. Rather, some pertinent information on each of the basic steps will be given. More detailed information can be found in the texts listed at the end of this paper or one of the other information sources previously mentioned. Further, the information presented is designed for the hobbyist tanner and, as such, no use of tanning machinery is required.

Skinning

Most people who want to tan a hide will also use the carcass for meat and will take the animal to a meat locker or abattoir where it will be expertly skinned. If you wish to skin an animal for its hide, be sure the carcass is fresh as putrefaction and decay begin immediately upon death. Bacteria become active breaking down tissue, damaging the hide, and causing hair slippage. Also, ligaments under the skin can shrink as the carcass cools making skinning more difficult. If you do your own butchering ensuring that a carcass is fresh is no problem; however, if an animal is found dead caution is warranted. In addition to possible problems with skinning and hair loss you may be in danger of contracting a disease. Some animal diseases, such as rabies, tetanus, and anthrax, can be transmitted to humans through contact with infected animals. If an animal is seen to be ill, acting strangely, or found dead for an unknown cause it should be buried or disposed of and not skinned, even wearing gloves (Hobson,1977).

For people who hunt or raise deer and elk and wish to tan their hides, Chronic Wasting Disease (CWD) is of concern. CWD is a transmissible spongiform encephalopathy (TSE) of which bovine spongiform encephalopathy, BSE or Mad Cow disease, is the most well-known. Scrapie in sheep and goats is also a TSE. There is currently no evidence that CWD can be transmitted to humans but wearing gloves when skinning and butchering deer has been recommended. Hunters are advised not to consume meat from suspect animals. As the disease agent is found in central nervous tissue, the practice of brain tanning has been discouraged in some areas. Information on CWD can be found at the USDA Animal Plant Health Inspection Service CWD website, http://www.aphis.usda.gov/animal_health/animal_diseases/cwd/ the Chronic Wasting Disease Alliance Website, http://www.cwd-info.org/; and state wildlife departments and websites.

Finally, caseous lymphadenitis or abscesses is a common disease of goats that can be transmitted to humans. Care must be used when skinning goats as some abscesses not apparent on the live animal will be found when skinning. Abscesses contain greenish, cheesy pus that should be trapped on paper towels and burned or buried. Use gloves when skinning goats suspected of having abscesses. Try to avoid using skins of goats having an abscess.

Many people who hunt or butcher at home have experience skinning and have their own favorite tools and methods. Skinning can be done with the carcass hanging or lying. Initial cuts should be made down the midline of the belly from the anus to neck and from the legs inwards. Cuts on the legs should be done on the side where the hock and knee bend, the rearmost portion of the hind leg and the foremost portion of the front leg. This will result in a more rectangular shaped hide. It is easier to skin a hanging carcass as the skin can be pulled downwards and "fisted" away from the body, thereby lessening the need to use a skinning knife. A skinning knife should be very sharp and used sparingly to decrease the chance of cutting the skin which mars the hide. Hides can also be removed using mechanical means. No matter how the hide is removed, large amounts of fat or meat should not be taken with the skin as this material will have to be removed later and can impede salt penetration when preserving. Any obvious blood spots or dirt should be washed off. A good job in skinning will make tanning easier.

Preserving

If the hide is not to be tanned immediately it must be preserved. The goal of preservation is to stop the putrefaction and decay begun by bacteria immediately upon death. Never leave fresh hides rolled up or stacked. The heat remaining in them will encourage bacterial growth and increase the possibility of hair slippage. If skinning takes place in a different location than preservation, try to cool the hide as quickly as possible by laying it open. While plastic garbage bags may be useful in handling a wet, bloody hide, do not leave hides in a closed bag. This traps the heat allowing decay to start. Begin your preservation technique as quickly as possible.

The main methods of preservation are salting and freezing. Salt removes moisture from the hide and creates an unfavorable climate for bacterial growth. Use only non-iodized salt such as table or pickling and curing salt. Rock salt should never be used as it has impurities. A fine grain salt is preferred and penetrates the skin more easily than large grain products.

Salting a hide.

Salted hides draining on a slanted board.

To salt a skin, lay it flat and pour a generous amount of salt, between one-half to one pound salt per pound hide, down the middle and rub in thoroughly covering every portion. Fold the hide flesh to flesh, roll it up and place on a slanting board to drain. The following day shake off the wet salt and resalt with new salt. After the second day, continue in the tanning process or, if tanning will take place at a later date, resalt and lay the hide flat to dry. Drying may take several days or longer depending upon the weather. Hides should not be dried in direct sunlight or where temperatures are very high. Dried skins can be stored in a dry place until tanning.

When preserving by freezing, the goal is to reduce hide temperature quickly. Immediately after skinning lay the hide flat in a freezer. When it begins to stiffen, fold it flesh to flesh, roll and place inside a plastic bag. A frozen hide can last for months or even years with no damage to the hide. However, it is best to tan the hide within a reasonable time frame.

To begin the tanning process, the preserved skin must be rehydrated in preparation for fleshing. Frozen hides should be soaked in water to thaw. Soak salted hides in a brine solution of one to two pounds salt for each gallon of water needed to completely cover the hide. Hides should be soaked until they are like a wet dishrag. Relaxing agents are available that can assist in preparing the hide for fleshing and tanning.

Dirty hides need to be washed of obvious blood, manure and other dirt after thawing. A more thorough washing is done after fleshing. If slaughtering one of your own animals, you can minimize hide dirt by care prior to slaughter and during the slaughter process. Angora hides can be a problem if excessively dirty and have hay or grass matted in the mohair.

Fleshing

To flesh a hide means to scrape all fat, meat and membranes from the skin in preparation for the actual tanning process. This can be done before the hide is salted to allow easier salt penetration. Fleshing is most easily accomplished through the use of a fleshing beam and a fleshing knife. A fleshing beam is a piece of wood over which the hide is draped for scraping. A common type of fleshing beam can be fashioned out of a 2”× 6” or 2” × 8” board five or six feet long. One end should be cut to a blunt point and all edges rounded and smoothed. Legs are attached near the pointed end so that the fleshing beam slants upward from the ground to waist level. While this is the most common type of beam, others can be fashioned from rounded logs or large PVC pipes.

Fleshing beam.

A fleshing knife is a blade with a handle on both ends allowing even pressure to be exerted as the blade is pushed down the hide. Blades should be dull as the goal is to push and scrape all fat, meat, and membranes off the hide, leaving only the skin. A blade that is too sharp can cut the hide exposing hair roots leading to subsequent hair loss. Fleshing knives are available from many taxidermy supply stores at a reasonable cost. Alternatively, a dull draw knife or butcher knife driven into a block of wood for a second handle can be used. Churchill (1983) describes methods to make fleshing knives and other knives from used industrial hacksaw blades. Mill planer blades from logging mills can also be fashioned into fleshing knives and these types of knives are available on the Internet.

Fleshing knife.

To flesh a hide, pull the hide from the rehydration bath and drape it over the pointed end of the

fleshing beam. Push the fleshing knife down the hide scraping off unwanted material. To make fleshing easier and lessen the chance of cutting the hide, flesh with the lay of the hair. The legs should be fleshed towards the belly and the hide from the tail pushing towards the neck (Rittel, 1994b). Fleshing takes practice and initially can be time consuming but must be done properly, removing even the thin membrane held tightly onto the skin. The hide should be like a wet dishrag when fleshing. If it becomes too dry, soak in water before proceeding. After fleshing, plunge the hide up and down in soapy water using laundry or dish detergent to remove remaining dirt and blood and rinse thoroughly to remove all soap. There are commercial products to remove blood and other stains, if desired.

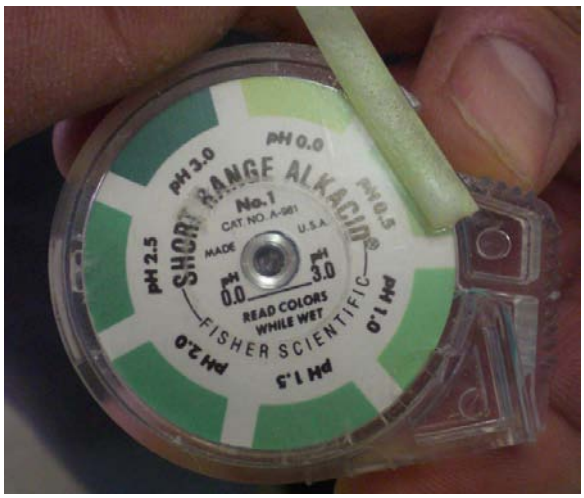
Flesh down the hide; scraping off unwanted tissue.

Electric fleshing machines, found in taxidermy supply catalogs, are available for fleshing and shaving hides. The cost is usually prohibitive for the hobbyist tanner as the least expensive handheld models cost approximately $200 and bench models cost over $600. Even with machines, many professionals still do initial fleshing with a traditional fleshing knife and beam. Fleshing machines do have distinct advantages in shaving hides. Shaved hides are thinner, use less tanning chemicals due to reduced weight and result in a softer finished product. This is especially true for hides from thick-skinned species. While shaving can be accomplished using a very sharp knife, it is very difficult to produce a consistent thickness and to avoid cutting through the hide. Generally, goat hides can be tanned and softened without shaving.

Pickling and neutralizing

Pickling, as described by Rittel (1993), is the use of an acid solution to acidify and temporarily preserve a skin while physically and chemically preparing it for tanning. Most tanning recipes will call for an acid pickle, though it may be included in the tanning process itself and not a separate step. Some paint-on tans, such as Tannit solution and Liqua-Tan, are applied directly to the fleshed hide without the skin undergoing a pickle.

Pickling solutions are mixtures of water, salt, and acid made in a plastic barrel. Enough solution should be made to completely submerge the hide while not resulting in over-crowding if several hides are done together. If in doubt about proper quantity, Rittel (1993) suggests making two quarts of pickling solution for every pound of wet, drained hide. The pH must be carefully checked and proper precautions, i.e., use of eye protection, a protective apron, and rubber gloves, should be followed when using acids. Monitoring pH can be done using simple pH paper and adjustments made using acids or alkaline substances such as sodium bicarbonate. Acids should be added slowly to the pickle, pouring them along the side of the container so as to run gently into the



Monitor pH of pickling solutions.

solution. Use a wooden stick and mix slowly, but well. There are a number of acids and formulas used in pickling and the tanning recipe followed will have specific instructions. For example, the EZ-100 tanning kit recommends 0.5 fluid ounces Saftee Acid (included in the kit) and 1 pound salt per gallon water.

Skins are usually left in the pickling solution and stirred occasionally for a minimum of three days after which time they must be neutralized. Neutralizing raises the pH of the skin through the use of a solution containing an alkaline substance such as sodium acetate, sodium formate, sodium bicarbonate, or other similar compound. Neutralization is generally brief, 15 to 20 minutes, after which the skins should be rinsed with clean water, drained, and put into the tanning solution (Rittel, 1993). Again, the tanning recipe or kit should have complete instructions on the neutralization method. After draining and prior to tanning, any holes in the hide should be sewn. This will prevent further ripping the hide during softening.

Dispose of pickling and neutralizing solutions properly. Acid pickles should be raised to a pH of 6.5 to 7.0 before dumping. Rittel (1993) states that sulfates are considered hazardous materials and if an acid is used in which sulfates are formed local health authorities should be contacted concerning proper disposal. Do not dump or dispose of solutions where they can contaminate streams or ground water. If no other disposal means is available, neutralized solutions should be dumped in a driveway or other area where vegetation does not grow. Chemical and salt water solutions should never be put into septic systems as these can kill the microflora needed to break down waste. Contact local authorities about proper disposal methods.

Tanning

To describe the varying tanning recipes and methods is beyond the scope of this paper and those can be found in various texts, taxidermy supply, or tanning chemical dealer catalogs and in the instructions included with tanning kits or chemicals. The main tanning process may be as simple as one of the paint-on tans mentioned earlier or more complex entailing the application of chemicals in a tanning soak or bath. If making a tanning solution, the pH needs to be monitored and the solution neutralized prior to safe disposal. Hides should be stirred with the blunt end of an old wooden broom or shovel handle while in the solution to ensure proper tanning. Remove hides after the specified time length and drain and rinse prior to oiling. Do not overtan as this can result in a stiffer hide.

Powdered tanning agents are mixed into a salt:water solution at the recommended rates. The skin is drained and weighed after neutralizing and draining. That weight is used to calculate the amount of tanning agent needed. As an example, Rittel's EZ-100 instructions state that for every pound wet, drained hide use 4 ounces salt, 0.5 ounces EZ-100, and 2 quarts lukewarm water. The solution pH should be 4.0 and skins tan in 16 to 20 hours. Alternatively, one could mix enough solution to completely submerge the hide, though this is wasteful of chemicals.

Paint-on tans that call for pickling and neutralizing also require draining before tanning. Others, such as Liqua-Tan that do not require pickling, call for the hide to be washed and drained or wrapped in a towel to remove excess moisture prior to application. The hide is laid flat on plastic tarp and the tanning agent applied. After several hours, the excess is worked into the skin. Oiling may or may not be included in the instructions. Some paint-on tans state that oils are included in the tanning solution; others suggest

Apply paint-on tans carefully using gloves

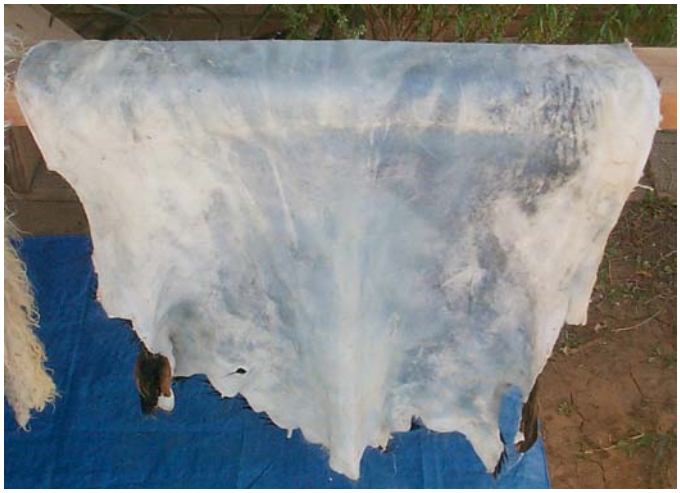
use of a separate oil for optimum softness. As an example, Knobloch's recommends applying Liqua-Soft tanning oil the day following application of Liqua-Tan if the tanned hide will be used for a flat skin or rug.

Oiling

Oiling is done to increase the softness of the finished product and many oils are available in the marketplace. If a tanning kit is purchased, the recommended oil will be included. To oil the hide, lay it flat with the flesh side up. One part oil is mixed with one to two parts hot water and liberally applied to the skin. The hide is folded in half skin to skin and again hair to hair. The folded hide should then be allowed to "sweat," or absorb oil, for approximately 4 to 6 hours. After that time, the hide is hung to begin drying.

Drying and softening

Drying methods range from simple hanging or laying flat to tacking on wood or tying in a frame. Artificial heat should not be used as it dries the skin too fast making softening difficult. Check the hide as it dries to determine when softening should begin. If the hide is stretched and pulled when too wet it can become misshapen. If one waits too long, the hide stiffens and is difficult to soften. As the hide dries, it will become white and less pliable. The thinner edges will dry more quickly than the thicker center line and edges are usually worked first. If a hide starts to become too dry, fold it around damp towels and place overnight in a plastic bag. Plastic bags can be used with partially softened hides to slow down the pace of drying.



The white drier areas mean this skin is ready to soften.

Softening involves stretching and bending the hide to break up fibers in the skin. The time and effort spent on this step directly determines the suppleness of your final product. Common methods include staking or cabling. Staking involves use of a staking beam, boards cut and fashioned in the shape of a braced, inverted T with the upright end rounded to a blunt edge. The flesh side of the damp hide is pulled down over the blunt edge to stretch and break up skin fibers. Cabling is a more effective method than staking and involves stretching and pulling the hide around a cable. Regular rope can be used but aircraft cable (wire rope) clamped around a pole works very well and results in an extremely soft hide. Often, both methods are used on the same hide, staking to begin breaking up very stiff areas followed by cabling to finish softening and give a soft, supple hide.

Commercial tanneries use equipment for softening such as large, rotating drums that tumble the hide, generally with sawdust, as it dries. In addition to softening the hide, a solvent may be added to the sawdust to help clean hair or fur. Some texts recommend using an old laundry dryer with the holes plugged for tumbling hides. Whereas this will help clean the hair, it will not help significantly in softening the hide. To do this requires a tumbler with at least a six foot drop along with 100 pounds of hardwood sawdust (P. Helms, McKenzie Taxidermy Supply, personal communication).

Finishing

After the hide is softened, the hair should be cleaned and brushed and rough or uneven edges trimmed. Most goat hides will only need combing or brushing. Should deeper cleaning be necessary it can be done by simply rubbing sawdust or corn cob grit into the hair. Rittel (1994a) recommends that local sawdust not be used as it may contain pitch and be unevenly grained. Taxidermy or tanning chemical supply houses sell

Staking beam.

Cabling a goat hide.

sawdust and solvents to be used in cleaning. Hobson (1977) explains how to use cleaning substances such as cornmeal, oatmeal, bran, chalk and plaster of Paris.

Once the hair is clean and brushed, the skin side can be sanded or rasped. This helps to remove rough spots and further soften the hide. Some staking methods can make the hide appear brown and dirty and sanding or rasping will make it look cleaner and more professional. Cabled hides generally will not need rasping or sanding. Hide edges are usually uneven and may be stiffer than inner portions and trimming these results in a more attractive product. Use a box cutter or similar knife and cut from the flesh side making sure not to cut off the hair.

Trimming edges using a razor knife.

Optional steps

When reading about tanning, additional steps such as dehairing and degreasing will be found. Dehairing is accomplished by soaking the hide in a hydrated lime or caustic lye solution after which the hair is scraped off. The hide is then tanned for leather using the same or similar methods as those described. Leather making tanning kits are available. Degreasing is done on hides with large amounts of fat in the skin, such as raccoon, bear, and the like. For hair-on tanning, it is unlikely that goat hides would need degreasing.

Where to Find Further Information

The instructions that come with any tanning chemical will provide good detail and instruction on hide preparation and chemical usage. However, for those interested in further information on hide tanning, an internet search will provide many articles, forums and websites on tanning methods and procedures. Companies selling tanning chemicals provide product information on their websites, some of which have “How to” sections that provide excellent information on hide handling and newer tanning methods. A local taxidermist or sporting goods store is another potential source of information and supplies. Books on home tanning and

leathercraft are available but most were written between twenty and thirty years ago and do not contain information on newer tanning methods. One recent book, "The Ultimate Guide to Skinning and Tanning" by Monte Burch, 2002, does contain information on new techniques and chemicals.

When searching for tanning information on the Internet one will come across the art of "brain tanning." This is the traditional method used by Native Americans and other cultures of using animal brains to make buckskin. This can certainly be done with goat hides. In addition to websites dedicated to "brain tanning," several good texts have been written on the subject.

References

Churchill, J.E. 1983. The Complete Book of Tanning Skins and Furs. Stackpole Books, Harrisburg, PA. 197 pp.

Hobson, P. 1977. Tan Your Hide! Storey Communications, Inc., Pownal, VT. 135 pp.

Rittel, B. 1994a. Syntans as a tanning agent. Breakthrough 38:26-31.

Rittel, B. 1994b. When fleshing or shaving- the only way is the right way. Breakthrough 36:22-24.

Rittel, B. 1993. The basic principles of pickling and neutralizing. Breakthrough 33:48-52.

Partial List of Supplies Needed to Tan Hides

- Skinning knife if needed
- Sharpening stone
- Non-iodized salt, not rock salt
- Fleshing knife
- Fleshing beam
- Plastic garbage can or barrel (metal containers should never be used)
- Wooden pole or paddle to stir tanning solutions
- Tanning kit or chemicals
- Rubber gloves, protective apron, and eye protection for handling chemicals and solutions
- pH paper, if pH of solutions must be checked
- Cable, staking beam or other softening device
- Comb or brush for hair
- Scale to weigh hides and chemicals
- Source of hot water to mix solutions

List of Some Available Books on Tanning and Taxidermy

Deerskins into Buckskins: How to Tan with Brains, Soap or Eggs. 2004. 2nd Ed. Matt Richards. Backcountry Publishing, Cave Junction, OR. 240 pp.

The Ultimate Guide to Skinning and Tanning: A Complete Guide to Working with Pelts, Fur, and Leather. 2002. Monte Burch. The Lyons Press. Guilford, CT. 240 pp.

Buckskin: The Ancient of Art of Braintanning (Originally titled "Wet-Scrape Braintanned Buckskin"). 2001. Steve Edholm, Tamara Wilder and Jim Riggs. Paleotechnics, Boonville, CA. 307 pp.

How to Tan Skins the Indian Way. 1991. Evard H. Gibby. Eagle's View Publishing, Liberty, UT. 28 pp.

Outdoor Life Complete Home Taxidermy. 1987. Tim Kelly. Outdoor Life Books, Danbury, CT. 271 pp.

Home Tanning & Leathercraft Simplified. 1984. Kathy Kellogg. Williamson Publishing Co., Charlotte, VT. 192 pp.

The Complete Book of Tanning Skins and Furs. 1983. James E. Churchill. Stackpole Books, Harrisburg, PA. 197 pp.

The Complete Book of Taxidermy. 1979. Nadine H. Roberts. TAB Books, Blue Ridge, Summit PA. 351 pp.

Tan Your Hide! 1977. Phyllis Hobson. Storey Communications, Inc., Pownal, VT. 135 pp.

Home Book of Taxidermy and Tanning. 1969. Gerald J. Grantz. Stackpole Books, Harrisburg, PA. 160 pp.

Where to Find Tanning Supplies and Chemicals

The following is a partial list of companies and dealers that sell tanning supplies and chemicals. Other companies, dealers, or distributors can be found on the Internet at http://taxidermy.net or through using any Internet search engine. Local taxidermists and tanneries can also be a source of information and(or) supplies.

Adirondack Outdoor Company
P.O. Box 86
Elizabethtown, NY 12932
Phone: 518-873-6806
http://www.adirondackoutdoor.com/tanning.htm

Jonas Supply Company
1850 Dogwood St.
Louisville, CO 80027
Phone: 800-525-6397
http://www.jonas-supply.com

Knobloch's
1850 Dogwood St.
Louisville, CO 80027
Phone: 303-666-9045
http://www.knoblochs.com/

McKenzie Taxidermy Supply
P.O. Box 480
Granite Quarry, NC 28072
Phone: 800-279-7985
http://www.mckenziesp.com/

Rittel's Tanning Supplies
51 Summer Street
Taunton, MA 02780
Phone: 508-822-3821
Fax: 508-828-3921
http://rittelsupplies.net/

Tandy Leather Co. (Locations throughout the U.S.)
1339 SW 59th Street
Oklahoma City, OK 73119
Phone: 877-428-5754
http://www.tandyleatherfactory.com/

Van Dyke Supply Co. Inc.
Phone: 800-737-3355
http://www.vandykestaxidermy.com/

WASCO
1306 West Spring Street
P.O. Box 967
Monroe, GA 30655
Phone: 800-334-8012
http://www.taxidermy.com/

Goats from a Professional Buyer's Viewpoint

Mr. Mike and Ms. Katie Pershbacher

Introduction

The goat market has been shaped by influx of immigrants. They are the ones who buy goat meat and therefore create demand for certain types of goat meat. Misconception that goats are little beef cattle and that we should market goats like we do cattle. Many ethnics buy their meat at local ethnic butcher markets where they slaughter animals. This is because they want their meat very fresh, like day of slaughter and they also want their mean in a variety of ways, head on, head off, skin on, skin off, kidneys in, etc. They do not like fat on their goat meat. Fat goats may lose much of their fat while being transported to the Northeast US. Most important criteria for a meat goat is weight. The market wants a goat weighing between 45 and 65 pounds. Heavier weights get lower prices.

When to sell

NO

June 1 to October 1 is the yearly low for the goat market because the market is flooded with goat without a great increase in demand.

YES

1. Muslim/Other Holidays

Holiday Calendar for Marketing Sheep and Goats.

Holidays	**2009**	**2010**	**2011**
Eid ul Adha (Festival of Sacrifice)	November 28	November 17	November 7
Islamic New Year	---------	December 8	---------
Passover/Pesach	April 9-16	March 30-April 6	April 19-26
Mawlid al Nabi (Birth of the Prophet)	March 9	February 26	March 20
Ramadan (Begins Month of Fasting)	August 22	August 11	September 24
Eid al Fitr (Ramadan Ends)	September 21	September 10	August 31

2. Week before Christmas because sales close down for two weeks.

Where to sell?

Study different auctions to determine where you get the best price.

Competition from frozen meat shipped over from Australia. Frozen goat meat turns black and is not preferred by ethnics although cheap $2.29/lb. U.S. meat is bright red, but only has a 7 day refrigerated life and costs $3.99/lb.

What to sell?

Favorite breed of meat goat is a half pigmy and other half anything. Also Kiko crossbreds are good. Higher yielding from 40-50 lbs.

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

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**

Extension Overview

Terry A. Gipson
Goat Extension Leader

The year 2008 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 a quarterly newsletter. 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, the eighth annual meat buck performance test and various goat workshops on artificial insemination and on internal parasite control.

Goat Field Day

Our annual Goat Field Day was held on Saturday, April 26, 2008. This year's theme was Innovative and Traditional Goat Marketing. Our featured speakers were Ms. Ellie Winslow who spoke on Nine Steps to Attract More Customers, and Mr. James Jones, who spoke on Feed Market Situation and Outlook. Ms. Ellie Winslow is an author and motivational speaker. Ms. Winslow's company, Beyond The Sidewalk Marketing, is dedicated to helping rural entrepreneurs form strategies that can make businesses more profitable and fun. Ms. Winslow's formal education is in English and Biology. However, she has raised many types of livestock and companion animals, including almost 35 years of dairy goats. Ms. Winslow has written two books (Making Money With Goats and Marketing Farm Products). She has also edited an anthology of stories that celebrate country living (Stories From Beyond the Sidewalk). She is a native of California who has lived in most of the Western & Mid Western States. She is currently located in Ontario, Oregon. Mr. James Jones known as "JJ" is the Area Agricultural Economics Specialist for the Southeast District of the Oklahoma Cooperative Extension Service housed in the Pontotoc County Extension office in Ada, OK. JJ was raised on a small cattle and hog farm in southwest Oklahoma. JJ went to Oklahoma State University where he received a Bachelor of Science degree in Animal Science and a Master of Science degree in Agricultural Economics. After graduation he started his career working for the University of Tennessee Agricultural Extension Service as an Area Farm Management Specialist. After ten years working in Tennessee, JJ returned to Oklahoma to work for OSU. JJ is responsible for the planning, implementing and support of the agricultural economics programs for the nineteen county Southeast district. JJ now lives in Roff, OK with his wife and three kids. They operate a small 35 doe Boer goat operation. Ms. Winslow offered a full-afternoon Living Beyond the Sidewalk Short Course entitled Growing Your Rural Business: Attitudes, Marketing Secrets and Methods. Ms. Winslow's afternoon session received some of the highest evaluations scores and most positive comments of any of the afternoon sessions. Due to health issues, Ms. Sheila Stevenson was not able to supervise the full day activities for youth ages 5-12 in the Fun Tent. Ms. Cheryl Glover and Ms. Shirlene Hurte assumed leadership for the Fun Tent. Some of the activities included baby goat activities, pony rides; pot your own plant, movies, and many others. Youth and interested adults participated in a full-day clipping, fitting, and showing workshop conducted by Ms. Kay Garrett of the Oklahoma Meat Goat Association and a Vo-Ag teacher in Prague, OK. Participants had the opportunity to have hands-on practice of clipping, fitting, and showing a goat. The Oklahoma Goat Producers Association sponsored three contests (Poster, Speech and PowerPoint) during the 2008 Langston University Goat Field Day. There were two age divisions for each contest. Junior division is 12 and under and senior division is 13 to 18. Cash prizes were awarded for 1st, 2nd, and 3rd place for each division and contest. The theme for the poster contest was "What Goats

Mean to Me". Speech and PowerPoint contestants could have presented their speech on any aspect of the goat industry. The Friday before the Goat Field Day, Dr. Steve Zeng conducted a full-day cheesemaking workshop. There were 23 attendees and Dr. Zeng demonstrated the fabrication of several varieties of goat cheeses. Participants also enjoyed hands-on cheesemaking activities.

In the afternoon session, participants broke into small-group workshops. There were a total of thirteen workshops; however, participants had time enough to attend three. The afternoon workshops included:

- Growing Your Rural Business: Attitudes, Marketing Secrets and Methods with Ms. Ellie Winslow (this was a full afternoon workshop).
- Livestock Marketing with Mr. James Jones
- Basic Goat Husbandry - hoof trimming, injection sites, farm management calendar, disbudding, etc. with Mr. Jerry Hayes.
- Basic Herd Health - herd health program including vaccinations and other approved drugs with Dr. Lionel Dawson.
- 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.
- Introduction to Goat Barbecue - overview of how to prepare goat barbecue with Ms. Gladys Young.
- Internal Parasite Control - sustainable internal parasite control program 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.
- Oklahoma Department of Agriculture Services - overview of ODA services for Oklahoma farmers and ranchers with Mr. Justin Whitmore, Mr. Justin Harvey, and Ms. Chris Kirby.
- Body Condition Score as a Management Tool - overview/hands-on of conducting body condition scoring for management use in goat production with Mr. Glenn Detweiler.
- Fitting and Showing for Youth and Adults - tips and pointers on fitting and show ring etiquette with Ms. Kay Garrett (this was a full day workshop).

Attendance at the Goat Field Day continues to remain high. This year 328 people pre-registered, 86 by mail, 23 by phone, and 219 by the web site. Of the 328 pre-registered individuals, 263 actually attended the Goat Field Day. In addition, 93 people registered on-site. A total of 356 participants attended the Goat Field Day. The breakdown of pre-registered participants by state of residence was:

State	Pre-registered by mail	Pre-registered by Phone	Pre-registered by web
AR			1
IL			2
KS	9	1	13
KY	1		
MD			1
MO			1
NM			4
OK	70	22	180
PA	1		
TX	5		17
Total	86	23	219

Goat DHI Laboratory

The Langston Goat Dairy Herd Improvement (DHI) Program is housed at the dairy farm, west of campus, 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. We have 111 producer herds in these 29 states enrolled in the Langston Goat Dairy DHI Program. In 2008, the DHI laboratory processed ~16,000 samples as compared to 9418 samples 2007. 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. 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 2008. Interest in the newsletter has grown and we currently have over 3400 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 2008, AI workshops were held in September at the Langston University campus and in October at the county fairgrounds in Antlers.

Meat Goat Production Handbook

The Meat Goat Production Handbook, which is a companion to the Web-based Training and Certification Program, both of which were funded through an USDA/FSIS grant. The 400-plus page Meat Goat Production Handbook is an answer to the paucity of information, especially on the aspect of quality assurance, which will be a key production element as the meat goat industry grows and evolves. A quality assurance program ensures the production of a safe, healthy product that satisfies consumers and increases profit for the production industry. Conventional topics such as herd health, nutrition, herd management, and many others are covered comprehensively, yet remain clear and easy-to-read. Additional topics generally not covered in conventional handbooks are also included, topics such as disaster preparedness, legal issues, and organic meat goat production. Even though Langston University has taken the lead in this 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.

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 inappropri-

ate 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.

Internet Website

http://www2.luresext.edu

The Agricultural Research and Cooperative Extension program of Langston University recently unveiled a new and improved Internet web site. The Internet address (URL) of the new web site is 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.

Rehabilitation of Under-Utilized Forest Land by Goats for Economic Benefits

In 2008, Langston University collaborated with the Oklahoma State University Forest Resources Center located in Idabel, OK to demonstrate that goats can be used to remove woody vegetation and underbrush so that forest land can be constructively and sustainably maintained. Moreover, meat goat production itself is profitable and an enterprise appropriate for smallholders. Besides this, goats can improve soil fertility by release of nutrients sequestered in woody plants. Nonetheless, although use of goats for vegetation management is gaining in popularity, it still is not widely prevalent; in part because of incomplete knowledge and probably more importantly a lack of familiarity with the method. Control of invasive species in forest and rangelands is costly for landowners. Recently, goats have been used as a biological means to control invasive and/or undesirable plant species on rangelands. However, their effectiveness in a forested environment is unknown. Twenty-five mature wether goats were fitted with a GPS collar and released upon the 9-acres study.

Long-Term Retention of Electronic Boluses

With the aim of assessing the influence of breed on electronic bolus retention, 295 goats from 4 breeds were identified with 3 bolus types containing 32 mm HDX transponders. Ruminal pH was used as an indicator to evaluate feeding conditions. Bolus features were: B1 (75 g, 68.2 × 21.0 mm, n = 100), B2 (82 g, 69.1 × 21.2 mm, n = 100) and B3 (20 g, 56.4 × 11.2 mm, n = 95). Distribution of boluses by breed and bolus type (B1, B2, B3) was: Alpine (25, 24, 25), Boer-cross (26, 24, 23), Angora (25, 26, 24) and Spanish (25, 25, 23). Goats were also identified with a standard flag-button plastic ear tag (4.6 g, 51 × 41 mm). Boluses were administered with a balling gun adapted to each bolus type. Time required for bolus administration was recorded as well as any incident observed. An ISO handheld reader was used to read the boluses. Retention rate (read/applied × 100) of boluses and ear tags was recorded at d 1, 7, 30, 60 and 120. Ruminal pH was measured with a portable pH meter, in random samples of 5 goats from each breed and feeding conditions, after bolus administration and at wk 1, 2, 3 and 4. Ruminal fluid was obtained at 2 h after feeding by using an oro-ruminal probe. Time required for bolus administration varied according to bolus type (B1, 24 ± 2 s; B2, 27 ± 2 s; B3, 14 ± 2 s; $P < 0.05$) and goat breed (Alpine, 34 ± 3 s; Boer-cross, 16 ± 1 s; Angora, 17 ± 2 s; Spanish, 19 ± 2 s; $P < 0.05$). No health or behavior disturbances were observed. Ruminal pH differed according to breed and feeding conditions (lactating Alpine, 6.50 ± 0.07; yearling Alpine, 6.73 ± 0.08; Boer-cross, 6.62 ± 0.04; Angora, 6.34 ± 0.06; Spanish, 6.32 ± 0.08; $P < 0.001$) but showed no influence on bolus retention. Only 1 goat regurgitated a B3 bolus when inverted on an operating table during laparoscopy surgery. At 120 d, bolus retention was greater than ear tag retention (99.7 vs. 97.6%; $P = 0.07$). In conclusion, medium-term bolus retention was not affected by breed and feeding conditions, and remained over the ICAR requirements for official livestock identification (>98%). Long-term bolus and ear tag retention is under study.

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 700 producers have enrolled for certification and 93 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.”

Breed Association	Number of Members Certified
Alberta Goat Breeder's Association	1
American Boer Goat Association	37
American Kiko Goat Association	7
American Meat Goat Association	15
International Boer Goat Association	1
International Kiko Goat Association	3
United States Boer Goat Association	13
None	35

The table above shows the association affiliations for the 93 certified producers. Please note that certified producers may be a member of more than one association.

Meat Buck Performance Test

Meat goat production represents the most rapidly growing animal industry in the US today, and is becoming a mainstream livestock enterprise. To further genetic progress through the identification of superior sires in the industry, Langston University and the Oklahoma Meat Goat Association established a meat goat performance test in 1997.

Entry

The twelfth annual meat buck performance test started May 3, 2008 with 35 bucks enrolled from 8 different breeders. Geographical distribution is given in the table below.

State	Bucks
KS	4
MO	3
NE	3
OK	3
TX	22
Total	**35**

Bucks were given a physical examination by Dr. Lionel Dawson, dewormed with Cydectin (moxidectin), deloused with Atroban De-Lice, given a preemptive injection of Nuflor for upper respiratory infections, and those bucks that needed booster or initial vaccinations for enterotoxemia and caseous lymphandinitis. Four weeks after check-in, all bucks were given a booster vaccination for enterotoxemia and caseous lymphandinitis.

Average age in days and entry weight are detailed in the table below.

Data	Total
Average of Entry Weight (lbs)	45.4
Average of Entry Age (days)	92

Adjustment Period

The Feed Intake Recording Equipment (FIRE) system was used for all animals. The FIRE system is a completely automated electronic feeding system, which was developed for swine but we have adapted it to goats. Animals wear an electronic eartag, which is read by an antenna in the feeder. The FIRE system automatically records body weight and feed intake. All bucks underwent an adjustment period of two weeks immediately after check-in. During the adjustment period, bucks were acclimated to the test ration and to the FIRE system.

The area immediately around FIRE feeders and waterers is concrete, however, the large majority of the inside pen is earth and is covered by pine shavings. Pine shavings were periodically added as needed to maintain fresh bedding. Bucks had free access to water provided by float-valve raised waterers. Whenever the weather was permitting, the bucks had access to the outside pens as well as the inside pens.

This year we were fortunate to hire a second year veterinary student from Oklahoma State University, Ms. Madeline Deatherage. Madeline has done a wonderful job with the bucks.

Ration

Nutritionists at Langston University formulated the following ration. In 1999, the amount of salt and ammonium chloride was doubled due to problems with urinary calculi the previous year. Except for the increase in salt and ammonium chloride, the ration was unchanged from that which was used in the first two meat buck performance tests. The ration was fed free-choice during the adjustment period and during the 12-week test.

Ingredient	**Percentage (as fed)**
Cottonseed hulls	29.07%
Alfalfa meal	19.98%
Cottonseed meal	15.99%
Ground corn	15.99%
Wheat midds	9.99%
Pellet Partner (binder)	5.00%
Ammonium chloride	1.00%
Yeast	1.00%
Calcium Carbonate	0.95%
Salt	0.50%
Trace mineral salt	0.50%
Vitamin A	0.02%
Rumensin	0.01%
TOTAL	**100.00%**

The crude protein content of the ration is 16% with 2.5% fat, 20.4% fiber and 60.6% TDN. Calcium phosphorus and sodium levels are .74%, .37% and 1.07%, respectively. Zinc concentration is 33.04 ppm, copper is 17.15 ppm and selenium is .21 ppm. In 2003, competitive bids were sought for the buck-test feed and Bluebonnet Feeds of Ardmore, OK was awarded the contract to supply feed for the buck performance test for 2003, 2004, 2005, 2006, 2007, and 2008.

ABGA Approved Performance Test

In early 2000, the Oklahoma performance test was designated by the American Boer Goat Association Board of Directors as an ABGA Approved Performance Test. Qualified fullblood or purebred Boer bucks will be eligible to earn points towards entry into the "Ennobled Herd Book". Candidate bucks must pass a pre-performance test inspection conducted by one (1) or more ABGA approved breeders. Ten (10) points will be awarded a Boer buck who shows an average daily weight gain (ADG) in the top five percent (5%) of the animals on test. Five (5) points will be awarded a Boer buck who shows an average daily weight gain (ADG) in the next fifteen percent (15%) of the animals on test. All bucks must gain at least three-tenths (.3) pounds per day to be awarded any points.

International Boer Goat Association, Inc. Sanctioned Test

In 2003, the Oklahoma buck performance test was sanctioned by the International Boer Goat Association, Inc.

Gain

The official performance test started on May 21 after the adjustment period was finished. Weights at the beginning of the test averaged 51 lbs with a range of 32 to 84 lbs. Weights at the end of the test averaged 97 lbs with a range of 65 to 139 lbs. **Weight gain for the test averaged 47 lbs with a range of 29 to 63 lbs**.

Average Daily Gain (ADG)

For the test, the bucks gained on averaged 0.55 lbs/day with a range of 0.35 lbs/day to 0.75 lbs/day.

Feed Efficiency (Feed Conversion Ratio)

For the test, the bucks consumed an average of 296 lbs of feed with a range of 180 to 449 lbs.

For the test, the bucks averaged a feed efficiency of 6.48 (feed efficiency is defined as the number of lbs. of feed needed for one lbs. of gain), with a range of 3.75 to 10.56.

Muscling

The average loin eye area as determined by ultrasonography was 1.79 square inches with a range of 1.05 to 2.48 square inches and the average left rear leg circumference was 14.1 inches with a range of 11.0 to 17.0 inches.

Index

For 2008, the index was calculated using the following parameters:

- 30% on efficiency (units of feed per units of gain)
- 30% on average daily gain
- 20% on area of longissimus muscle (loin) at the first lumbar site as measured by real time ultrasound adjusted by the goat's metabolic body weight:

$$\frac{\text{area of longissimus muscle (loin)}}{BW^{0.75}}$$

- 20% circumference around the widest part of the hind left leg as measured with a tailor's tape adjusted by the goat's metabolic body weight:

$$\frac{\text{circumference of hind left leg}}{BW^{0.75}}$$

The adjustment to metabolic body weight gives lighter weight goats a fair comparison of muscling to heavier goats.

The deviation from the average of the parameters measured from the goats in the performance test was used in the index calculation. Thus, the average index score for bucks on-test was 100%. Bucks that are above average have indices above 100% and those below average have index scores below 100%.

Congratulations

The Oklahoma Meat Goat Association and the Agricultural Research and Extension Program at Langston University congratulate:

- Ms. Jessica Stephens of Elm Creek, NE
  for having the Top-Indexing buck
  in the 2008 Oklahoma Meat Buck Performance Test

Also, deserving congratulations are:

- Mr. Sam Stephens of Elm Creek, NE
  for having the #1 Fastest-Gaining buck
- Ms. Jessica Stephens of Elm Creek, NE
  for having the #2 Fastest-Gaining buck
- Mr. Orlin Scrivener of Cabool, MO
  for having the #3 Fastest-Gaining buck
- Mr. Sam Stephens of Elm Creek, NE
  for having the #4 (tie) Fastest-Gaining buck
- Mr. Martin Peters of Barksdale, TX
  for having the #4 (tie) Fastest-Gaining buck
- Mr. Marvin Shurley of Sonora, TX
  for having the Most-Feed-Efficient buck
- Mr. Marvin Shurley of Sonora, TX
  for having the Most-Heavily-Muscled buck

Acknowledgments

The Buck Test supervisor wishes to acknowledge Dr. Lionel Dawson of Oklahoma State University for his contributions as the admitting and on-call veterinarian, Ms. Madeline Deatherage for her management and oversight of the day-to-day activities, Mr. Jerry Hayes and Mr. Erick Loetz of Langston University for aid and supervision, Mr. Les Hutchens and his associates at Reproductive Enterprises, Inc. for conducting the ultrasound measurements for the loin eye area, and Bluebonnet Feeds of Ardmore, OK for custom mixing the feed.

2008 World Cheese Championship Contest

Dr. Steve Zeng, Associate Professor/Dairy Product Specialist, was invited as an Official Judge to the 2008 World Cheese Championship in Madison, WI during March 9-14, 2008. It was his first time to be invited in this world prestigious cheese event and he was the only professor from 1890 Land Grant University ever participated. During the world championship, 1941 cheese entries were judged. In all, 79 classes of cheese varieties were presented. Among them were more than two hundred goat and sheep milk cheeses. As a judge, Dr. Zeng was able to taste and judge many varieties of cheeses from all over the world (actually 21 nations). He was totally impressed how good the overall quality of all the cheeses was. He was further assured that goat milk cheese is not only getting popular as a specialty cheese but also it is becoming a favorite cheese to American consumers, especially in the northern states, the east and west coasts. This cheese contest enhanced his knowledge in cheese judging as career development and more importantly gave a chance for him to represent the E. (Kika) de la Garza American Institute for Goat Research and Langston University at a national/international stage. In the end, professors and industry leaders in this championship got better understanding and knowledge about our goat research and extension programs at Langston University.

Goat Cheese Making Workshop in Republic, MO

Dr. Steve Zeng, our Dairy Product Specialist, was invited to conduct a goat cheesemaking workshop in Republic, MO April 4-5, 2008. The workshop was co-sponsored by the Southwest Missouri Dairy Goat Association and the E. (Kika) de la Garza American Dairy Goat Association. Twenty goat producers attended the event. Obviously there is a lot interest in goat cheese making in the southwestern part of Missouri and Langston University is taking an active role in helping disseminate technical information to the producers. A variety of cheeses were fabricated during this hands-on workshop. Soft cheeses (Chevrè and cream cheese), a semi-hard cheese (Mozzarella) and a hard cheese (Colby) were demonstrated from milk pasteurization, fermentation, coagulation, cooking, to cheese aging. There were a plenty of questions and discussions during the event. Participants not only learnt basic principles and practical techniques, but also had some cheeses to take home for continuous ripening and tasting. The participants now know more about our goat programs in research and extension and some producers are exploring opportunities for commercial goat cheese operations.

Cheese Demo Live in the Oklahoma State Fair

Dr. Steve Zeng, Associate Professor/Dairy Product Specialist, was invited to conduct a Cheese Demo Live in the Oklahoma State Fair on September 17, 2008. This Cheese Demo Live was a first ever in the history of the fair and rightfully fitted in as a creative event in the Creative Arts and Handcrafts Building. Dr. Zeng demonstrated the basic cheese making principles, skills and techniques to diversified audiences. He used Nubian goat milk from Foremost Registered Goats in Edmond and made several batches of Colby cheese, our very own American type, LIVE! A huge turnout was present and was certainly much greater than anticipated. During the show, cow cheeses (seven varieties from Christian's Cheese in Kingfisher) and goat cheeses (several varieties from Pure Prairie Creamery in Ada and from the Langston University Pilot Creamery) were samples by hundreds of show-attendees and fair-spectators. In the end, all the fresh cheese made in the show were tasted and evaluated. This show raised the public's awareness of cheese in general and goat milk cheese in particular. For many it was their first time to see and actually taste goat cheeses. It was truly a showcase of made-in-Oklahoma cheeses. This Cheese Demo Live was a big success and it is being planned for another one in 2009. More cheese makers are expected to participate in future events.

International Overview

Roger Merkel
International Program Leader

Objectives

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 hosts visiting scientists from over 20 foreign countries to conduct research. 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. 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. As recognition of the impact that the Institute has had on international development, five Langston University scientists, Drs. Terry Gipson, Arthur Goetsch, Roger Merkel, Tilahun Sahlu, and Steve Zeng, were jointly awarded the 2006 George Carver Agricultural Excellence Award of USAID for their efforts and positive impact on international agriculture.

International Research

While most international projects conducted by the Institute have aspects of research, training, and extension, some are more research oriented. Many of these types of grants are typified by a number of projects with countries in the Middle East.

Egypt, Israel, Jordan, Al-Quds University in the West Bank (Palestinian Authority)

The grant "Multinational Approaches to Enhance Goat Production in the Middle East" supported by the Middle East Regional Cooperation program of USAID, officially began in October, 2000. The program promotes collaborative research, training, and extension activities among Langston University, the Desert Research Center of Egypt, the Volcani Center in Israel, Al-Quds University in East Jerusalem working in the West Bank, and the Jordan University of Science and Technology. The project ended in the fall of 2008. The Executive Summary of the Final Report for the project is given below.

The project was aimed to develop goat farming in the region, keeping in mind an often heard saying that goats are the "poor man's cows." Despite differences in starting points among the participating institutions, the research project enabled for the first time the precise addressing of problems associated with goat production in the various areas of the Middle East. In the Middle East, goat production has long been considered somewhat backward, practiced by undeveloped people coming from marginal income sectors. Therefore, little attention and investment have been given to goat farmers. It was expected that such a project will result in exposing the goat herders to new technological advantages, which in turn will increase the safety of consuming goat milk and products regardless of location.

The project was conducted to address various constraints limiting goat production and contributions of goats to economic and food securities in the Middle East. A number of problems were addressed in the project. One of the most important issues is the lack of transfer of existent knowledge to goat producers,

such as pertaining to animal health care, milk hygiene, cheesemaking, the importance of prevention of and treatment for subclinical mastitis, use of available byproducts as feedstuffs, etc. Prior to this project, most prevalent production systems and greatest constraints to goat production in the Middle East were not thoroughly understood. A problem addressed by each Middle East collaborator was little knowledge of the composition of goat milk and its impact on cheese yield and quality. A problem focused upon by the Israeli team was the prevalence of subclinical mastitis in goats, its effects on milk and cheese yield and quality, and means of prevention and treatment. Goats have not previously received great research or technology transfer attention in Middle Eastern countries. Hence, this project has heightened awareness of the importance of goats to economic and food securities in the region. This project, focusing on goats, fit well with this other previous work. This project was innovative in a mixture of complementary research and technology activities undertaken at four locations in the region. Activities and findings of specific collaborators influenced activities at other sites. Some activities were common to each cooperating MidEast institution, whereas others were focused upon specific constraints most important to particular collaborators. The primary means of Arab-Israeli cooperation on the project was in information sharing that occurred at five operational meetings held in 2001, 2003, 2005, 2006, and 2008. There were also project meetings held at various conferences and a milk and milk product technology training session. Moreover, there was special collaboration between The Volcani Center and Al-Quds University for training in milk research methodologies to be employed at Al-Quds University.

Other research grants with Middle Eastern Institutions

The Institute has been involved in a number of additional grants having research collaboration with institutions in the Middle East. The first of these entails collaboration with the Newe Ya'ar Research Center of the Agricultural Research Organization in Israel on a grant entitled "Energy Expenditure for Activity in Free-Ranging Ruminants: A Nutritional Frontier." There are three other grants that continue the collaborative research relationship between the Institute and the Desert Research Center of Egypt. The first project, "Effects of Acclimatization on Energy Requirements of Goats," was completed in June of 2008. Other projects, entitled "The Grazing Activity Energy Cost of Goats" and "Effects of Nutritional Plane on the Maintenance Energy Requirement of Goats" are currently underway. Each of these research grants deal with important aspects of energy expenditure by goats.

Jordan, China, Mexico, Rwanda, Ivory Coast

Another grant involving a Middle Eastern institute also includes institutions in three other regions of the world. The grant "International Collaboration in Goat Research and Production Web-based Support Aids" partners the American Institute for Goat Research with Jordan University of Science and Technology, Northwest Science-Technology University in China, National University of Rwanda, Centre National Recherche Agronomique in Cote d'Ivoire, and University of Chapingo in Mexico. This grant expands usage of the interactive, web-based nutrient calculator for goats and the goat production simulation program developed by Institute scientists through translation into Arabic, Chinese, French, and Spanish. Having the web-based nutrient calculator in these languages will increase the number of producers and scientists who will be able to utilize the unique features of the calculator and enhance its usefulness.

Training and Program Support

International Collaboration in Goat Research and Production in China

In June/July 2007, Drs. Marvin Burns, Dean of School of Agriculture and Applied Sciences, Tilahun Sahlu, Director of the America Institute for Goat Research, and Steve Zeng, Associate Professor/Dairy Product Specialist traveled to several Chinese agricultural universities to conduct or establish collaborative activities in goat research and production. At the China Agricultural University, the team assisted graduate students with

experimental design and conduct, English manuscript preparation, conducted a cheese processing workshop, and a dairy and cheese judging and sensory evaluation seminar. Dr. Zeng demonstrated cheese judging skills and practical techniques to professors and students. Participants evaluated ten cheese varieties from the US and ten local varieties. Discussions were held with faculty and students from the College of Food Science & Nutrition Engineering and the Key Laboratory of Functional Dairy Foods at China Agricultural University. Based on mutual interests in dairy foods, Langston University and China Agricultural University signed a Memorandum of Understanding for research and academic collaboration. Specific items of interest include but are not limited to milk quality, processing technology, analytical technique, sensory evaluation, cheese development, cheese standards, and functional dairy foods.

The Langston team then visited Northwest A&F University in Yangling, Shaanxi province, a long-time collaborator in goat research. The team toured dairy goat farms of the government-financed system and farmers' cooperative. They also discussed future research collaboration with university officials, faculty and students. Dr. Zeng gave a seminar on Dairy Herd Improvement (DHI) Laboratory Operation using the Langston DHI lab as a model to demonstrate the basics and principles of the DHI system. Both the Chinese collaborators and Langston delegation agreed that a DHI-type system will soon become a reality in China.

The final university visited was Zhejiang University, one of the top universities in China. Dr. Zeng presented a seminar on Dairy and Cheese Judging and Sensory Evaluation seminar and demonstrated cheese judging skills and practical techniques. In addition, a seminar on how to prepare English manuscripts for publication in Science-Citation-Index (SCI) journals was conducted collectively by the Langston team for graduate students. Assistance was also provided to several Ph.D. candidates in preparation and revision of scientific manuscripts for publication in SCI cited journals.

Cheese Celebration-2007 in Italy

Dr. Steve Zeng, Associate Professor/Dairy Product Specialist, was invited to attend the bi-annual Cheese Celebration-2007 in Turin, Italy in September, 2007. This cheese conference was sponsored by the International Slow Food Organization, specifically promoting small scale, farmstead and artisanal cheese making in the world. Goat and sheep cheese makers from around the world presented their cheeses to an estimated audience of fifty thousand visitors. Dr. Zeng was one of few delegates from the U.S. Dr. Zeng gave overviews of the research and extension programs of the American Institute for Goat Research in several small settings. As a taste panel member, Dr. Zeng had the opportunities to taste thousands of artisanal cheeses of cow, goat, sheep, buffalo and yak milk. This experience provided Dr. Zeng with an opportunity to taste and experience the vast variety of unique and traditional cheeses from around the world. Goat and sheep cheeses were more highly regarded as a delicacy than cow cheese. Dr. Zeng also had the opportunity to tour farmstead cheese makers and observe the function of cooperatives to promote the dairy goat industry as a whole. Many of the practices observed could be applied to the U.S. dairy goat industry.

Agricultural Development

Ethiopian Sheep and Goat Productivity Improvement Program

In 2005 the American Institute for Goat Research of Langston University and Prairie View A&M University, Prairie View, TX were awarded a $5.5 million grant from the USAID Mission in Ethiopia for a project entitled "Ethiopia Sheep and Goat Productivity Improvement Program." This 5-year program entails collaboration with the Ministry of Agriculture and Rural Development of the Government of Ethiopia. The overall goal of the program is to conduct research and extension activities in the areas of production and marketing that will result in a sustainable increase in small ruminant productivity in Ethiopia to improve food and economic securities. The project works in six regions of Ethiopia (Tigray, Amhara, Oromia, Southern

States, Afar, and Somali), and addresses a number of factors including human and institutional capacity building, research and technology transfer, and introduction of improved animal genetics.

Activities in the area of research and technology transfer have focused on on-farm research and demonstration of technologies such as ammoniation of crop residues via urea and making molasses/urea blocks. Development agents are taught these techniques and participate with project staff in conducting demonstrations with village participants. Applied on-farm research on animal supplementation and improved feeding strategies, such as creep feeding and use of locally available byproduct feedstuffs, is also conducted. More detailed research on certain aspects of the Ethiopia small ruminant meat industry, such as reasons for and methods to reduce darkening of carcasses of Highland sheep, is important in assisting the growing sheep and goat meat export market.

In 2007, Boer goats and Dorper sheep were imported from South Africa into Ethiopia, the first ever importation of these animals into the country. These animals will form the backbone of a crossbreeding program designed to utilize the fast growth rate and larger carcass of these animals with the native adaptability and toughness of local breeds. The resulting crossbreds will be able to supply the export market with the desired frame size and carcass characteristics.

The training component of the project aims to enhance the knowledge and ability of village development agents to assist farmers in raising small ruminants via direct training in small ruminant productivity. Village development agents receive training in sheep and goat production and management. In support of this program, the Sheep and Goat Production Handbook for Ethiopia was published in 2008. This text, written by Ethiopian scientists, is the first of its kind in Ethiopia and has over 400 pages of information that can be used by development agents. The depth of information in the book also allows its use as a classroom text by university faculty. In addition, technical bulletins of certain aspects of sheep and goat production have been produced and distributed to development agents and institutions throughout the country. The technical bulletins are designed to contain material that a development agent could use directly in training village farmers. These bulletins are very popular and are now being translated into several different regional languages of Ethiopia to broaden their use. In order to combat the problem of external parasites downgrading the quality of Ethiopian sheep and goat skins for the important leather industry, the project is training villagers to be providers of dipping and spraying services to control these pests. As with the applied research and crossbreeding component, the training component aims to enhance the ability of Ethiopian institutions and personnel to effect sustainable, positive change in small ruminant production.

Finally, ESGPIP and AIGR staff have established a project website, www.ESGPIP.org, that contains the technical bulletins, handbook and other materials and reports produced by the ESGPIP.

The End Result

The American Institute for Goat Research is proud of its international activities and the impact they have on strengthening human and institutional capacity of foreign institutions, providing important and relevant research results on local issues of importance, and in the assistance provided to small farmers, and particularly women, in enhancing family nutrition and income generation. These are unique activities that support the mission and goals of the Institute.

Recent International Grants

Years	2006-2007
Title	Sustainable Interventions to Increase Child Education in Ethiopia: Models for Poverty Reduction and Overcoming Child Labor Constraints
Collaborators	Langston University; Hawassa University, Hawassa, Ethiopia
Funding source	United Negro College Fund Special Programs
Funding amount	$25,000

Years	2005-2010
Title	Ethiopia Sheep and Goat Productivity Improvement Program
Collaborators	Langston University; Prairie View A & M University, Ministry of Agriculture and Rural Development of the Government of Ethiopia
Funding source	USAID Ethiopia
Funding amount	$5,500,000

Years	2005-2009
Title	International Collaboration in Goat Research and Production Web-Based Decision Support Aids
Collaborators	Langston University; Jordan University of Science and Technology; Northwest Science-Technology University, China; National University of Rwanda; Centre National de Recherche Agronomique in Cote d'Ivoire; University of Chapingo in Mexico
Funding source	USDA International Science and Education Competitive Grants Program
Funding amount	$99,959

Years	2005-2009
Title	Energy Expenditure for Activity in Free-Ranging Ruminants: A Nutritional Frontier
Collaborators	Langston University; Newe Ya'ar Research Center of the Agricultural Research Organization, Israel
Funding source	United States – Israel Binational Agricultural Research and Development Fund
Funding amount	$310,000

Years	2005–2008
Title	Effects of Acclimatization on Energy Requirements of Goats
Collaborators	Langston University; Desert Research Center, Egypt
Funding source	U.S. – Egypt Joint Science and Technology Fund
Funding amount	$58,500

Years	2007–2009
Title	The Grazing Activity Energy Cost of Goats
Collaborators	Langston University; Desert Research Center, Egypt
Funding source	U.S. – Egypt Joint Science and Technology Fund
Funding amount	$60,000

Years	2008–2010
Title	Effects of Nutritional Plane on the Maintenance Energy Requirement of Goats
Collaborators	Langston University; Desert Research Center, Egypt
Funding source	U.S. – Egypt Joint Science and Technology Fund
Funding amount	$60,000

Years	2000 – 2008
Title	Multinational Approaches to Enhance Goat Production in the Middle East
Collaborators	Langston University; Desert Research Center, Cairo, Egypt; Volcani Center, Bet Dagan, Israel; Al-Quds University in East Jerusalem working in the West Bank; Jordan University of Science and Technology, Irbid, Jordan
Funding source	USAID/Middle East Regional Cooperation Program
Funding amount	$1,199,725

Research Overview

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 2007, abstracts for 2008, and summaries of scientific articles that were published in 2007 or currently are "in press" to appear in 2008 journals.

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

Research Projects

Current Research Projects (2007-2008)

Title:	Enhanced Goat Production and Products in the South-Central U.S.
Type:	CSREES project
Project Number:	OKLX-SAHLU
Period:	2006-2011
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:	Characterization of the Energy Requirement for Activity by Grazing Ruminants
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2005-38814-16352
Period:	2005-2010
Investigators:	T. Sahlu[1], R. Puchala[1], A. L. Goetsch[1], T. A. Gipson[1], K. E. Turner[2], and B. Kouakou3
Institutions:	[1]Langston University, [2]Applachian Farming Systems Research Center, and [3]Fort Valley State University
Objectives:	Develop and evaluate a system to predict the grazing activity energy cost for ruminants by determining effects of animal and dietary conditions on energy expenditure, metabolizable energy intake, the grazing activity energy cost, grazing and walking times, and horizontal and vertical distances traveled.

Title:	The Ability of Goats to Withstand Harsh Nutritional Environments
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2005-38814-16353
Period:	2005-2010
Investigators:	A. L. Goetsch[1], R. Puchala[1], T. Sahlu[1], and H. C. Freetly[2]
Institutions:	[1]Langston University and [2]Meat Animal Research Center
Objectives:	Determine if there are differences between goats and sheep and between meat goat species of the US in the ability to utilize diets with limited supplies of nitrogen and energy and to characterize the physiological bases of any such differences.

Title:	International Collaboration in Goat Research and Production Web-Based Decision Support Aids
Type:	USDA International Science and Education Competitive Grants Program
Project Number:	2005-51160-02281
Period:	2005-2009
Investigators:	A. L. Goetsch and T. A. Gipson
Institution:	Langston University
Goal:	Facilitate future collaborative research between the American Institute for Goat Research (AIGR) and institutions in Arabic-, Chinese-, French-, and Spanish-speaking countries, as well as to gain knowledge of goat research and production practices in other areas of the world.
Objectives:	Translate and adapt two web-based goat production and research decision-support tools developed at the AIGR (goat nutrient requirements and feed intake; goat production system simulation model) for use and future collaborative research in the Middle East, China, France and other French-speaking countries, and Central and South America.

Title:	Energy Expenditure for Activity in Free-Ranging Ruminants: A Nutritional Frontier
Type:	United States - Israel Binational Agricultural Research and Development Fund
Project Number:	US-3694-05 R
Period:	2005-2009
Investigators:	A. L. Goetsch[1], Y. Aharoni[2], A. Brosh[2], R. Puchala[1], T. A. Gipson[1], Z. Henkin[3], and E. Ungar[4]
Institutions:	[1]Langston University, [2]Newe Ya'ar Research Center, Agricultural Research Organization, [3]MIGAL-Galilee Technology Center, and [4]Agronomy and Natural Resources, Agricultural Research Organization
Objectives:	Develop and evaluate a system(s) to predict the grazing activity energy cost of ruminants by determining effects of stocking rate (influencing available forage mass and forage quality) and animal production state and season (affecting energy demand) on energy expenditure, metabolizable energy intake, energy expended in grazing activity, grazing and walking times, horizontal and vertical distances traveled, and diet quality with grazing females of two breeds of cattle and goats.

Title:	Effects of Acclimatization on Energy Requirements of Goats
Type:	United States - Egypt Joint Science and Technology Fund Program
Project Number:	BIO9-017
Period:	2005-2008
Investigators:	A. L. Goetsch[1] and H. El Shaer[2]
Institutions:	[1]Langston University and [2]Desert Research Center
Objective:	Develop a means of adjusting the maintenance energy requirement of goats for acclimatization.

Title:	Decreased Methane Emission by Ruminants Consuming Condensed Tannins
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2004-38814-02606
Period:	2004-2008
Investigators:	R. Puchala[1], A. L. Goetsch[1], C. R. Krehbiel[2], and V. H. Varel[3]
Institutions:	[1]Langston University, [2]Oklahoma State University, and [3]USDA ARS Meat Animal Research Center
Objectives:	· Determine effects of consuming different condensed tannin sources on the ruminal microflora and methane emission, digestibility, nitrogen and energy balance, and energy expenditure by goats.
	· Determine effects of consuming diets with different levels of a forage containing condensed tannins on the ruminal microflora and methane emission, digestibility, nitrogen and energy balance, and energy expenditure by goats
	· Determine effects of different frequencies of consumption of a forage containing condensed tannins on the ruminal microflora and methane emission, digestibility, nitrogen and energy balance, and energy expenditure by goats.

Title:	Evaluation and Modeling Extended Lactations in Dairy Goats
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2003-38814-02579
Period:	2004-2008
Investigators:	T. A. Gipson[1], A. Capuco[2], T. Sahlu[1], L. J. Dawson[3], and S. Ellis[4]
Institutions:	[1]Langston University, [2]USDA ARS Gene Evaluation and Mapping Laboratory, [3]Oklahoma State University, and [4]Clemson University Research Center
Objectives:	· Compare extended versus standard lactations with reference to milk, fat, and protein yield, reproduction and health issues, nitrogen and energy balance, and energy expenditure by goats.
	· Mathematically model the lactation curve for extended lactations in dairy goats, with particular emphasis on the effect of extended lactations has upon the shape and scale of the lactation curve
	· Examine the physiological changes in the mammary gland over the course of an extended lactation.

Title:	Quality, Safety, and Shelf-Life of Dairy Goat Products in the U.S. Market
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2003-38814-02587
Period:	2004-2008
Investigators:	S. S. Zeng[1], M. Perdue[2], and S. E. Gilliland[3]
Institutions:	[1]Langston University, [2]USDA ARS Environmental Microbial Safety Laboratory, and [3]Oklahoma State University
Objectives:	· Establish a comprehensive database of dairy goat product safety, quality and shelf-life on the store shelves.
	· Identify the unique values such as CLA of dairy goat products.
	· Develop and implement biological, biochemical and/or physical interventions to control undesirable microbes.
	· Enhance the marketability and profitability of goat milk and dairy products by improving product microbiological and sensory quality, and by prolonging shelf-life of finished products
	· Assist store managers and personnel handling goat milk and dairy products by providing information and techniques to maximize product quality and shelf-life

Title:	Nutrient Requirements of Goats: Composition of Tissue Gain and Loss
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2003-38814-13923
Period:	2003-2008
Investigators:	T. Sahlu[1], A. L. Goetsch[1], C. L. Ferrell[2], and C. R. Krehbiel[3]
Institutions:	[1]Langston University, [2]USDA ARS Meat Animal Research Center, and [3]Oklahoma State University
Objective:	· Determine the composition of tissue gain by growing Boer crossbred and Spanish meat goats consuming different quality diets from weaning to 1 year of age
	· Determine the composition of tissue loss and gain by mature meat goats
	· Determine the composition of tissue loss and gain by lactating dairy goats.
	· Develop equations to predict body composition of growing and mature meat goats and lactating dairy goats based on shrunk body weight and urea space

Title:	The Grazing Activity Energy Cost of Goats
Type:	United States - Egypt Joint Science and Technology Fund Program
Project Number:	BIO11-001-005
Period:	2007-2009
Investigators:	A. L. Goetsch[1], R. Puchala[1], T. A. Gipson[1], H. El Shaer[2], and A. Helal[2]
Institutions:	[1]Langston University and [2]Desert Research Center
Objective:	· Determine the magnitude of the grazing activity energy cost of goats under different common production settings in an arid region of Egypt and in the south-central U.S.
	· Develop simple means of predicting the grazing activity energy cost of goats based on factors relatively easily estimable by farmers

Title:	Impact of Sub-Clinical Mastitis on Production and Quality of Goat Milk and Cheese
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2007-38814-18474
Period:	2007-2010
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
Objective:	· Assess prevalence of subclinical mastitis in dairy goats during a year-round lactation in Oklahoma
	· Quantify and qualify losses in milk yield and cheese production associated with subclinical mastitis test the impact of major types of CNS bacteria
	· 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
	· Study the mechanism by which CNS affects caseinolysis and in turn the coagulation properties
	· Investigate changes in PL and SCC of milk caused by subclinical mastitis and their effects on milk coagulation, and cheese yield and texture

Title:	Effects of Nutritional Plane on the Maintenance Energy Requirement of Goats
Type:	United States - Egypt Joint Science and Technology Fund Program
Project Number:	BIO12-001-016
Period:	2008-2010
Investigators:	R. Puchala[1], A. L. Goetsch[1], T. A. Gipson[1], A. R. Askar[2], and A. Helal[2]
Institutions:	[1]Langston University and [2]Desert Research Center
Objective:	· Determine how nutrient restriction impacts energy expenditure (EE) and the maintenance energy requirement (ME_m) with common goat genotypes of Egypt and Oklahoma
	· Determine how adequate nutrient intake following nutrient restriction affects EE and MEm with common goat genotypes of Egypt and Oklahoma
	· Use data from specific objectives 1 and 2 to develop a method of predicting the impact of low nutritional planes on ME_m

Title:	Boer Goat Selection for Residual Feed Intake
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2008-38814-02661
Period:	2008-2011
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:	· 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.
	· 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 Research Capacity Building
Project Number:	2008-38814-02520
Period:	2008-2011
Investigators:	R. C. Merkel[1] and C. K. Liu[2]
Institutions:	[1]Langston University and [2]USDA ARS Eastern Regional Research Center
Objective:	· Establish a pilot tannery and capability for goat leather research at the LU campus
	· Determine the effects of goat breed, diet and age upon skin chemical composition and the mechanical properties of resulting leather
	· Evaluate environmentally friendly tanning methods on U.S. goat skins

Experiments in 2008/2009

Title:	Effects of length of pasture access on the grazing activity energy cost in Boer does during different stages of production
Experiment Number:	ITL-08-01
Project Number:	BIO11-001-005
Investigators:	I. Tovar-Luna, A. L. Goetsch., R. Puchala, T, Gipson, G. Detweiler, L. J. Dawson, K. Tesfai, T. Sahlu
Objectives:	1) Determine effects of 'night-locking' or length of pasture access on MEa of Boer goats in different stages of production (i.e., pregnant, lactating, dry, breeding periods) during a 1-year period.
	2) Develop a simple means of predicting MEa of goats based on factors relatively easily estimable by goat producers.
Title:	Prevalence of subclinical mastitis in dairy goats
Experiment Number:	LW-08-03
Project Number:	2007-38814-18474
Investigators:	L. Wang, S. Zeng, L. Spicer, D. Bannerman, B. Bah, and E. Vasquez
Objectives:	Assess prevalence of subclinical mastitis and its effect on milk yield in Alpine and Nubian goats during an entire lactation.

Title:	Development of a method to screen for cell mediated immune response to *Coxiella burnetii* in goats
Experiment Number:	LD-08-04
Project Number:	OSU Vet School, OKLX-SAHLU
Investigators:	L. J. Dawson, J. Ritchey, and E. Shaw
Objectives:	1) Identify goats which have previously been exposed to C. Burnetii and express a cell-mediated immune response to C. Burnetii antigen which is detectable by digital palpation
	2) Determine whether an in vitro assay can be use dto screen goats for previous exposure to C. Burnetii by measuring specific inducible T-cell response to C. Burnetii antigen

Title:	Evaluate intra-operative and post-operative complications with three different methods of castration in goats
Experiment Number:	LD-08-05
Project Number:	OKLX-SAHLU
Investigators:	K. Simpson, C. Baumwart, L. J. Dawson, T. A. Gipson, J. Shumacher, T. Lehenbauer, A. L. Goetsch, and J. Hayes
Objectives:	Evaluate intra-operative and post-operative complications with three different methods of castration. The three methods include castration with a Henderson tool, emasculation, and banding. Evaluation of the patients after surgery will include pack cell volume, total protein, feed intake daily, weekly weight gain and feed efficiency.
Title:	Effects of gender and age on the maintenance energy requirement of Boer goats
Experiment Number:	ITL-08-06
Project Number:	OKLX-SAHLU
Investigators:	I. Tovar-Luna, A. L. Goetsch, R. Puchala, K. Tesfai, and T. Sahlu
Objectives:	1) Determine effects of gender and age of Boer goats on a) fasting heat production, b) maintenance energy requirement, c) efficiency of metabolizable energy utilization for maintenance, and d) efficiency of energy utilization for growth
	2) Determine the relationship between heart rate and heat production measured in growing Boer goats with ad libitum consumption and when fed near maintenance and fasted

Title:	Development of a model to evaluate methods of modifying cattle barb wire fence for goat containment
Experiment Number:	AG-08-07
Project Number:	OKLX-SAHLU
Investigators:	A. L. Goetsch, G. D. Detweiler, J. Hayes, T. A. Gipson, L. J. Dawson, and T. Sahlu
Objectives:	Develop and evaluate an accurate and repeatable method of evaluating methods of modifying cattle barb wire fence for goat containment
Title:	Use of mimosa as a protein bank for lactating meat goats
Experiment Number:	AG-08-08
Project Number:	OKLX-SAHLU
Investigators:	A. L. Goetsch, G. D. Detweiler, Z. Wang, and T. Sahlu
Objectives:	Determine effects of once or twice weekly ‘protein bank’ grazing of pastures with mimosa trees on performance of meat goat does and suckling twin kids

Title:	Alternative dewormers for goats
Experiment Number:	SH-08-09
Project Number:	LU-4-19336
Investigators:	S. P. Hart and Z. Wang
Objectives:	1) Investigate the efficacy of two levels of copper sulfate in deworming goats
	2) Investigate the anthelmintic potential of Artimesia ludovisciana
	3) Investigate the efficacy of black pepper and walnut hull extract on deworming goats
Title:	Accuracy and precision of fixes and calculated distances of GPS animal collars
Experiment Number:	TG-09-01
Project Number:	2005-38814-16352
Investigators:	T. A. Gipson, I. Tovar-Luna, A. L. Goetsch, and G. D. Detweiler
Objectives:	1) Evaluate the accuracy and precision of post-differentially corrected and uncorrected stationary GPS collar fixes
	2) Examine the effect of post-differential correction versus raw fix data on distance traveled on mobile GPS collars

Title:	Investigation of CNS bacteria related to subclinical mastitis: changes in goat milk composition, casein fractions, and the plasmin system
Experiment Number:	LW-09-02
Project Number:	2007-38814-18474
Investigators:	L. Wang, S. Zeng, R. Shangguan, L. Spicer, and D. Bannerman
Objectives:	Test the impact of major types of CNS bacterial species causing intramammary infection (*Staphyloccus epidermidis*) on the inflammatory response in milk and blood, and to investigate changes in the plasmin system and somatic cell count of milk caused by subclinical mastitis, in order to study the mechanism by which CNS affects caseinolysis
Title:	Investigation of CNS bacteria related to subclinical mastitis: changes in cheese yield, quality, and microstructure
Experiment Number:	LW-09-03
Project Number:	2007-38814-18474
Investigators:	L. Wang, S. Zeng, R. Shangguan, L. Spicer, and D. Bannerman
Objectives:	Assess effects of subclinical mastitis in dairy goats on milk production, composition, and caseinolysis, milk coagulation properties, and curd yield and microstructure profiles

Title:	Effects of CNS bacteria induced subclinical mastitis on the gene profile of dairy goats and casein fractions and the plasmin system of goat milk
Experiment Number:	RS-09-04
Project Number:	2007-38814-18474
Investigators:	R. Shangguan, L. Wang, S. Zeng, L. J. Spicer, and C. DeWitt
Objectives:	Investigate the effect of subclinical mastitis caused by major types of CNS bacteria species (S. Epidermidis, S. Simulans, S. Caprae, and S. Chromogenes) on the plasmin system, casein fractions, the mechanism by which CNS affects caseinolysis, and gene profiles in Alpine and Nubian dairy goats

Title:	Effects of goat breed on energy expenditure during and after a low nutritional plane
Experiment Number:	AH-09-06
Project Number:	BIO12-001-016
Investigators:	A. Helal, R. Puchala, G. D. Detweiler, T. A. Gipson, T. Sahlu, and A. L. Goetsch
Objectives:	1) Determine how nutrient restriction impacts energy expenditure (EE) and the maintenance energy requirement MEm) with common goat breeds of the USA
	2) Determine how adequate nutrient intake following nutrient restriction affects EE and MEm with common goat breeds of the USA
	3) Use data from specific objectives 1 and 2 to develop a method of predicting the impact of low nutritional planes on MEm

Title:	Selection for Residual Feed Intake in young Boer bucks - Phase I
Experiment Number:	WH-09-06
Project Number:	2008-38814-02661
Investigators:	W. Hu, T. A. Gipson, R. Puchala, T. Sahlu, and A. L. Goetsch
Objectives:	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

Abstracts

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Body composition of growing meat and lactating dairy goats

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Growing 3/4 Boer x 1/4 Spanish (B) and Spanish (S) wethers were used to determine influences of diet and breed and multiparous Alpine does were used to determine how stage of lactation and dietary forage level affect body composition. Growing goats were fed 50% concentrate pelleted diet (C) or one based on grass hay (H) free-choice. Six wethers of each breed were harvested at 0 wk and six of each diet-breed combination were harvested at 14 and 28 wk. Empty body concentration of protein was 18.3, 17.5, 18.3, and 19.7% (SE = 0.29) and of fat was 24.0, 23.4, 10.8, and 10.3% for B:C, S:C, B:H, and S:H, respectively (SE = 0.59). Energy in accreted tissue was 17.0, 18.7, 16.3, and 6.4 MJ/kg for C:wk 1-14, C:wk 15-28, H:wk 1-14, and H:wk 15-28, respectively (SE = 1.39). Initial measures with lactating goats were on six does a few days after kidding (0 mo). Eighteen does were fed a 40% forage diet (40F) and 18 received a diet with 60% forage (60F) for 2, 4, or 6 mo of lactation. Fat in the carcass (13.8, 13.1, 16.5, 11.2, 11.5, and 14.4%), noncarcass tissues (18.6, 24.2, 33.3, 14.3, 16.5, and 24.5%), and empty body (16.5, 18.7, 25.2, 12.9, 14.1, and 19.5% for 40F-2 mo, 40F-4 mo, 40F-6 mo, 60F-2 mo, 60F-4 mo, and 60F-6 mo, respectively) was affected by stage of lactation and diet ($P < 0.06$). Based on daily change in tissue mass (-141, 56, and 90 g/d; SE = 21.4) and energy (-2.31, 1.11, and 2.90 MJ/d for 1-2, 3-4, and 5-6 mo, respectively; SE = 0.66), energy concentration in tissue mobilized or accreted was 16, 20, and 32 MJ/kg at 1-2, 3-4, and 5-6 mo, respectively. In conclusion, other than with a prolonged limited nutritional plane, an average energy concentration in accreted tissue of growing meat goats is 17.3 MJ/kg. The concentration of energy in tissue mobilized or accreted by dairy goats may vary with stage of lactation.

Sensory quality and microstructure of Colby-like cheese made of goat milk and Soymilk

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In the present study, the sensory quality and microstructure of Colby-like cheese made of goat milk and soymilk were investigated. Nine batches of Colby-like cheese were made from milk with three different ratios of Nubian goat milk to soymilk, i.e., 100% goat milk (A), 90% goat milk and 10% soymilk (B), and 85% goat milk and 15% soymilk (C). Aged cheese samples (day 60) were analyzed for scores of flavor, body and texture, overall sensory and microstructure. Results showed that cheese C had a significantly lower flavor score than cheese A ($P < 0.05$). Cheese B and C showed significantly lower scores of body & texture

and overall sensory than cheese A ($P < 0.05$), whereas there were no significant differences between B and C. The confocal laser scanning micrographs indicated that cheese A exhibited intact protein matrix with fat entrapped, while cheese C displayed a more serum phase with poor protein matrix. The results indicated that soymilk protein had a poorer coagulating capacity than casein during cheese manufacture and thus affected the flavor and body and texture scores and the microstructure of aged Colby-like cheeses.

Somatic cell count in milk of goats enrolled in Dairy Herd Improvement Program in 2007

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The effects of breed, parity, stage of lactation (month), herd size, and regions/states on somatic cell count (SCC) and production of milk from dairy goats enrolled in the Dairy Herd Improvement (DHI) program in the United States in 2007 were investigated to monitor the current status of SCC and to help goat producers improve their herd management and receive premiums for high quality goat milk. Statistical analysis of composite DHI data (n = 29,000) indicated that SCC and production of goat milk were affected by many non-infectious factors. Significant variations ($P < 0.05$) in SCC were found among breeds, with Toggenburg and Nubian being the highest, and Pygmy and Nigerian Dwarf being the lowest. The mean SCC of milk from Toggenburg and Nubian goats were near the current regulatory limit of 1.0×10^6/ml for Grade "A" goat milk. As parities increased, SCC in milk increased steadily ($P < 0.05$). Significant differences ($P < 0.05$) in both SCC and milk production were discovered among regions. Large herds of goats tended to have higher milk production and SCC than the small herds ($P < 0.05$). The above findings suggest that consideration be given to culling goats with high somatic cell score (SCS) in their 5th lactation as SCS is expected to increase as they age that year-round breeding and lactation programs be practiced, if dairy goat producers in the United States are to meet the Grade "A" goat milk requirements. All factors that contributed to variations in SCC and production of goat milk should be taken into consideration when establishing price incentive systems for goat milk.

Comparison of raw versus post-differentially corrected GPS collar fixes in free-ranging goats

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Even though selective availability of GPS signals was discontinued on May 1, 2000, there remains some debate as to whether GPS fixes need to be post-differentially corrected. The objective of this study was to determine the effect of post-differential correction on fixes of GPS collars worn by free-ranging goats. Twenty-one wether goats (46 ± 4.7 kg) were fitted with GPS collars that recorded a fix every 5 min and released into a novel environment (35°53'40"N, 94°45'21"W) of 4.6 ha. Collars were downloaded after 1 wk and 41,744 raw (R) GPS fixes were post-differentially corrected (C). For fix status, C decreased 3-D fixes and increased 2-D fixes and No-fix compared with raw fixes (R: 95,8, 4.0, and 0.2%; C: 69.1, 28.4, and 2.5%

for 3-D, 2-D, and No-fix status, respectively; χ^2 = 10,270, P < 0.01). A higher percentage of C fixes were located within the boundary of the study compared with R (89.7 vs. 86.3%, P < 0.01). The correcting distance between R and C fixes was greater in daylight hours than at night (23.4 vs. 16.9 m; P < 0.01). With distance calculations restricted to fixes within the boundary, the minimum (straight-line) distance traveled between consecutive fixes was greater for R than for C (29.5 vs. 27.6 m, P < 0.01). Therefore, the calculation of daily total minimum distance traveled per goat was greater for R than for C (4.16 vs. 3.82 km, P < 0.01). Inter-goat distance was greater for R than for C (19.9 vs. 15.4 m, P < 0.01). Analysis using R vs. C fixes may affect conclusions because more C than R fixes were within study area boundary, corrections were greater during daylight hours when animals were most active, and intra/inter-animal distance calculations were greater for R than for C. These differences may be especially important for researchers studying spatial distribution of grazing animals or calculating distance traveled such as in energy expenditure experiments.

Comparison of copper sulfate and copper oxide wire particles as an anthelmintic for goats

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Gastrointestinal nematodes are the leading cause of morbidity and mortality in small ruminants, especially those raised in warm humid environments. The overuse of anthelmintics has resulted in anthelmintic resistance of gastrointestinal nematodes to most of the available anthelmintics. Copper sulfate has been used as an anthelmintic early in the previous century and more recently has been shown efficacious in sheep. Copper oxide wire capsules have been recently shown to be effective as an anthelmintic in both sheep and goats. The objective of this study was to compare copper sulfate at two dose levels as an anthelmintic to copper oxide wire particles. This study was conducted with Angora does that were 2 years of age or older. Fecal samples were taken for three consecutive days before treatments were administered and goats stratified by fecal egg count (FEC) and randomly assigned to treatments, 10 goats per treatment. Goats were fasted overnight prior to treatment administration. Four treatments were administered: N, negative control administered a water drench; C, 4 g of copper oxide wire particles administered in a gelatin capsule; L, low dose of copper sulfate (16.5 mg/kg BW); H, high dose of copper sulfate (33 mg/kg BW). Copper sulfate treatments were administered as a 1.5% drench. Fecal samples were taken at 7, 8 and 9 d post- treatment and fecal egg count reduction (FECR) calculated. Fecal egg counts were conducted by the McMaster procedure. Data were analyzed by the SAS NPAR1WAY procedure for non-parametric tests. Mean FEC for the group before treatment was 5,350 eggs/g (range 200-29,900). FEC was not significantly reduced by N (FECR = 44%; P > 0.10). FEC was significantly reduced (P < 0.05) by L (FECR = 83%), C (FECR = 77%), and H (FECR = 67%). Copper sulfate drench at both dose levels was equally effective to copper oxide wire capsules in reducing fecal egg counts of Angora goats.

Garlic as an anthelmentic for goats

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A previous experiment (J. Anim. Sci. 86 (E-Suppl. 2):292) showed that feeding garlic to Spanish goat wethers infected with *Haemonchus contortus* reduced fecal egg count (FEC). The present experiment was conducted to determine the anthelmintic effect of garlic in mature does. Twelve Spanish does (7 yr of age; 39 ± 2.2 kg BW) naturally infected with *H. contortus* were allocated to two treatments (six per treatment) and housed individually for 28 d. Does were fed diets (ME = 8.7 MJ/kg and CP = 10% DM) of coarsely ground grass hay (73%) and concentrate (primarily corn and soybean meal) at a level of intake for BW maintenance without or with 2% garlic powder hand-mixed with concentrate. Fecal samples were collected on d 0, 2, 4, 8, 11, 15, 18, 21, and 24 and blood was collected on d 0, 14, and 28; d-0 values were used as covariates. Statistical analysis of FEC entailed log transformation. Initial FEC averaged 6,167/g (SEM = 2,319; range = 600 to 13,050) for Control and 13,800/g (SEM = 5,301; range = 2,050 to 38,650) for Garlic. Average daily gain during the experiment was greater ($P < 0.02$) for Garlic vs. Control (-42 vs. 74 g). Average FEC was decreased ($P < 0.02$) by garlic supplementation (6,395 vs. 1,290/g), although there was a trend for an interaction between treatment and day ($P < 0.06$). Effects of garlic on FEC on d 2 and 4 were nonsignificant ($P > 0.43$), whereas differences occurred on d 8 (5,819 vs. 912/g; $P < 0.03$), 11 (7,368 vs. 605/g; $P < 0.01$), 15 (6,114 vs. 658/g; $P < 0.01$), 18 (5,783 vs. 745/g; $P < 0.02$), 21 (8,571 vs. 1,777/g; $P < 0.07$), and 24 (9,362 vs. 1,720/g; $P < 0.05$). Serum concentrations of IgA, IgM, and IgG and the number of blood eosinophils were not influenced by feeding garlic ($P > 0.10$). However, the number of white blood cells tended ($P < 0.08$) to be greater for Garlic than for Control (11,153 vs. 8,783/μL). In conclusion, garlic appears to possess anthelmintic activity against *H. contortus* via cell mediated immunity, which requires a feeding period of at least 4 d for expression.

Behavior x nutrition: goats

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Factors influencing feeding behaviors of goats include grazing management practices, type of vegetation and season, breed and stage of production, group size, and properties of diets fed in confinement. Considerable information has been gathered from methods such as visual observation during daylight. However, there are now tools available to characterize feeding behavior of goats while grazing and in confinement throughout 24-h periods. Global positioning system collars with motion/position sensors can be used to assess horizontal and vertical distances traveled, up/down position of the head, and movement within pasture/rangeland areas. A commercially available leg activity monitor allows estimation of the number of steps and time spent standing, lying, and moving rapidly without grazing. However, these measurements do not directly determine grazing. Therefore, prediction equations based on visual observation must be developed. Classification tree analysis is a robust method in developing these equations because the decision tree can be pruned or expanded to provide the best fit. Another equipment system is based on patterns of jaw movement to determine time spent eating, ruminating, and idle, although in some instances differentiation between eating and ruminating is subjective. In addition to use of n-alkanes as internal markers to estimate digestibility, their profile can provide an indication of botanical composition of the selected diet. Automated feeding systems for confined goats permit determinations such as number of feeder visits and meals, eating time, and rate and pattern of feed intake. Heart rate measured while goats are in normal production settings can be used

to predict total energy expenditure through multiplication by energy expenditure per heart beat of individual animals. To partition the activity energy cost, an estimate of ME intake or measures of change in body energy status and milk energy yield are needed to determine other sources of heat to be subtracted from total energy expenditure. These methods create opportunity to gain a fuller understanding of factors influencing feeding behaviors of goats and their relationships with levels and efficiencies of production.

Efficiency of energy utilization by lactating Alpine goats

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Thirty-six lactating Alpine does (50.5 ± 1.2 kg BW) were used to determine the effect of stage of lactation on energy utilization. Twelve does were assigned for measurement periods in early, mid-, and late lactation (28-35, 91-98, and 189 to 196 d of lactation). For six does of each group, after measures with ad libitum consumption of a 60% concentrate diet, feed intake was restricted to the ME requirement for maintenance (ME_m) for 8 d followed by a 4-d fasting period. For the other six does, fasting immediately followed ad libitum consumption. Heat production or energy expenditure (EE) was measured using a head-box calorimetry system the last 2 d with ad libitum intake, near maintenance intake, and fasting. Ad libitum intake of ME was affected ($P < 0.05$) by stage of lactation (22.2, 24.0, and 18.4 MJ/d), and was similar when fed near ME_m (9.8, 10.4, and 10.8 MJ/d) in early, mid-, and late lactation, respectively. Recovered energy in milk did not differ in early and mid-lactation and was lower ($P < 0.05$) in late lactation (8.77, 7.84, and 5.40 MJ/d respectively; SE = 0.418). Efficiency of ME utilization for maintenance (k_m) based on ME intake and EE by does fed near maintenance and when fasting was similar ($P > 0.05$) among stages of lactation (0.780, 0.813, and 0.803 in early, mid-, and late, respectively; SE = 0.0459). However, ME_m (based on fasting after ad libitum intake divided by k_m) was similar ($P > 0.05$) in early and mid-lactation and lowest ($P > 0.05$) in late lactation (494, 472, and 412 kJ/kg $BW^{0.75}$; SE = 23.7, respectively). Efficiency of use eof dietary ME for lactation (k_{l-d}) was not influenced ($P > 0.05$) by stage of lactation (0.615, 0.574, and 0.569 in early, mid-, and late lactation, respectively; SE = 0.0191). Although k_m and k_{l-d} by lactating goats were similar among stages of lactation, the ME_m requirement appears lower in late lactation than at early times.

Methane emission by goats consuming condensed tannin-containing forage at different frequencies.

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Twenty-four yearling Boer x Spanish wethers (33.5 ± 0.36 kg BW) were used in a 32-d experiment to assess effects of frequency of feeding fresh condensed tannin (CT)-containing sericea lespedeza (SL; *Lespedeza cuneata*) on ruminal methane (CH_4) emission. Fresh SL (15.3% CT) was fed free-choice every day (1SL), other day (2SL), fourth day (4SL), and eighth day (8SL), with ad libitum consumption of fresh alfalfa (0.2% CT) on other days. Measures occurred on the last 8 d of the experiment. Ruminal fluid for microbial assays was collected 1 d after SL feeding and at the end of the longest interval (short and long interval samples, respectively). Average daily DMI (0.94, 0.96, 1.01, and 0.95 kg, respectively; SEM = 0.057) was similar among treatments, and average daily heat production was less ($P < 0.05$) for 1SL and 2SL vs. 4 SL and 8SL (444, 452, 531, and 530 kJ/kg $BW^{0.75}$). Average daily CH_4 emission differed among all treatments ($P < 0.05$; 9.7, 11.6, 15.5, and 18.3 g/d, respectively), but emission on days when SL was fed did not differ (9.7, 10.2, 10.7, and 10.7 g/d for 1SL, 2SL, 4SL, and 8SL, respectively; SEM = 0.64). The number of protozoa in the short interval sample was similar among treatments (5.2, 5.3, 5.7, and 6.5 x 10^5/mL; SEM = 0.98), whereas the number in the long interval sample was 6.5, 10.4, 18.4, and 20.5 x 10^5/mL for 1SL, 2SL, 4SL, and 8SL, respectively; SEM = 1.84). In vitro CH_4 emission (3-wk incubation for methanogens) was similar among treatments for the short interval sample (18.2, 18.2, 19.7, and 20.0 ml; SE = 1.45) but less ($P < 0.05$) for 1SL and 2SL vs. 4SL and 8SL in the long interval sample (20.5, 20.3, 26.3, and 29.5 ml, respectively). In conclusion, greatest effects of CT of SL occurred with daily feeding, although there were carryover effects with 2SL. The influence of SL CT on CH_4 emission was immediate with no or minimal time for adaptation, and the effect appeared attributable to activity of methanogenic bacteria and protozoa.

Effects of small ruminant species and origin in Ethiopia (Highland vs. Lowland areas) and lengths of rest and feeding on harvest measures

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Yearling goats (G) and sheep (S) from Highland (H) and Lowland (L) areas of Ethiopia were used to determine effects of species and origin and lengths of rest and feeding on harvest measures, particularly carcass surface lightness. The H goat used was Arsi-Bale, and the L goat was Somali. The fat-tail indigenous H sheep is thought to be an Arsi-Bale genotype, and the fat-rump indigenous L sheep genotype was the Black Head Ogaden. There were two experiments (each a 2 x 2 x 3 factorial), one with rest for 0, 1, and 2 d before slaughter (R0, R2, and R3, respectively) and the second with feeding 0, 2, and 4 wk (0 wk = 2 d rest; 0F, 2F, and 4F, respectively). There were 10 animals per treatment. In the rest experiment, pH of the *longissimus dorsi* muscle 1 d post-slaughter (PS) was 5.91, 6.29, 5.82, and 5.98 (SEM = 0.039) for G-H, G-L, S-H, and S-L, respectively. The instrumental color measure L* (indicating lightness) for the hind leg surface 3 d PS was lower ($P < 0.05$) for H than for L (34.8, 36.3, 37.4, and 38.9 for G-H, G-L, S-H, and S-L, respectively; SEM = 0.45). Surface L* on d 3 was increased ($P < 0.05$) by 1 and 2 d of rest compared with 0 d for goats regardless of origin, but was not affected for sheep (33.2, 36.3, 37.2, 38.5, 37.8, and 38.2 for G-R0, G-R1,

G-R2, S-R0, S-R1, and S-R2, respectively; SEM = 0.56). *Longissimus* muscle pH on d 1 PS was 5.93, 5.97, 5.85, and 5.74 for G-H, G-L, S-H, and S-L, respectively (SEM = 0.036). Surface L* on d 3 was lower ($P < 0.05$) for H vs. L (36.5, 39.0, 36.2, and 39.8 for G-H, G-L, S-H, and S-L, respectively; SEM = 0.46). Feeding 4 wk increased ($P < 0.05$) surface L* on d 3 regardless of species and origin (37.7, 36.8, and 39.2 for F0, F2, and F4, respectively; SEM = 0.40). In summary, goat and sheep carcasses from Highland areas of Ethiopia may darken more quickly compared with Lowland areas, and 1 or 2 d of rest before slaughter can increase lightness of the surface of goat carcasses.

Summaries of Recent Journal Articles
(2008 and In Press)

Methane emission by goats consuming different sources of condensed tannins
Animut, G., R. Puchala, A. K. Patra, T. Sahlu, V. H. Varel, J. Wells, and A. L. Goetsch
Animal Feed Science and Technology 144:228-241. 2008

Twenty-four yearling Boer × Spanish wethers (7/8 Boer; initial body weight (BW) of 37.5 ± 0.91 kg) were used to assess effects of different condensed tannin (CT) sources on methane (CH_4) emission. Diets were Kobe lespedeza (*Lespedeza striata*; K), K plus quebracho providing CT at 50 g/kg dry matter (DM) intake (KQ), Sericea lespedeza (*Lespedeza cuneata*; S), and a 1:1 mixture of K and S (KS). Forages harvested daily were fed at 1.3 times the maintenance metabolizable energy requirement. The experiment was 51 days divided into two phases. In phase A forage diets were fed alone, and in phase B, 25 g/day of polyethylene glycol (PEG) was given mixed with 50 g/day of ground maize grain. Adaptation periods were 28 and 7 days in phases A and B, respectively. After adaptation there were 8 days for feces and urine collections, with gas exchange measured on the last 2 days. Ruminal fluid was collected at the end of the experiment via stomach tube for microbiology assays. The N concentration was 22.8 and 23.6 g/kg DM, in vitro true DM digestibility was 0.698 and 0.648, and the level of CT was 140 and 151 g/kg DM for S and K, respectively. DM intake was similar among treatments in both phases (phase A: 720, 611, 745, and 719 g/day (SE = 59.0); phase B: 832, 822, 867, and 880 g/day (SE = 55.3) for K, KQ, S, and KS, respectively). N digestibility was affected by treatment in phase A ($P < 0.05$) but not in phase B (phase A: 0.514, 0.492, 0.280, and 0.413 (SE = 0.0376); phase B: 0.683, 0.650, 0.638, and 0.662 (SE = 0.0203) for K, KQ, S, and KS, respectively). Gross energy digestibility was similar among treatments in phase A (0.475, 0.407, 0.393, and 0.411 (SE = 0.0353)) but differed among treatments in phase B (0.449, 0.373, 0.353, and 0.409 for K, KQ, S, and KS, respectively (SE = 0.0221)) CH_4 emission was 9.6, 6.8, 10.6, and 8.9 l/day (SE = 1.44) in phase A and 19.0, 16.6, 21.8, 19.2 l/day (SE = 1.51) in phase B for K, KQ, S, and KS, respectively (SE =1.25). When data of both phases were pooled, supplementation with PEG in phase B markedly increased ($P < 0.05$) CH_4 emission (9.0 versus 19.1 l/day). In accordance, there was a substantial difference ($P < 0.05$) between phases in in vitro CH_4 emission by ruminal fluid incubated for 3 weeks in a methanogenic medium and with other conditions promoting activity by methanogens (11.5 and 22.9 ml in phases A and B, respectively). Counts of total bacteria and protozoa were similar among treatments in both phases, but values were greater ($P < 0.05$) in phase B versus phase A. In summary, CT from different sources had a disparate influence on N digestion, but similar effects on ruminal microbial CH_4 emission by goats, possibly by altering activity of ruminal methanogenic bacteria though change in actions of other bacteria and/or protozoa may also be involved.

Methane emission by goats consuming diets with different levels of condensed tannins from lespedeza
Animut, G., R. Puchala, A. K. Patra, T. Sahlu, V. H. Varel, J. Wells, and A. L. Goetsch
Animal Feed Science and Technology 144:212-227. 2008

Twenty-four yearling Boer × Spanish wethers (7/8 Boer; initial body weight (BW) of 34.1 ± 1.02 kg) were used to determine effects on methane (CH_4) emission of dietary levels of a condensed tannin (CT)-containing forage, Kobe lespedeza (*Lespedeza striata*; K), and a forage very low in CT, sorghum-sudangrass (*Sorghum bicolor;* G). Treatments were dietary K levels (dry matter (DM) basis) of 1.00, 0.67, 0.33, and 0 (100K, 67K,

33K, and 0K, respectively). Forages were harvested daily and fed at approximately 1.3 times maintenance metabolizable energy requirement. The experiment lasted 21 days, with most measures on the last 8 days. The CT concentration was 0.3 and 151 g/kg DM in G and K, respectively. DM intake was similar among treatments (i.e., 682, 675, 654, and 648 g/day; SE = 30.0) and gross energy (GE) digestibility increased linearly ($P < 0.05$) with decreasing K (0.472, 0.522, 0.606, and 0.666 for 100K, 67K, 33K, and 0K, respectively). CH_4 emission changed quadratically ($P < 0.05$) with decreasing K (10.9, 13.8, 17.6, and 26.2 l/day; 32, 42, 57, and 88 kJ/MJ GE; 69, 81, 94, and 133 kJ/MJ digestible energy for 100K, 67K, 33K, and 0K, respectively). In vitro CH_4 emission by incubation of ruminal fluid for 3 weeks with a medium for methanogenic bacteria and other conditions promoting activity by methanogens also was affected quadratically ($P < 0.05$) by K level (7.0, 8.1, 9.2, and 16.1 ml for 100K, 67K, 33K, and 0K, respectively). The total bacterial count of ruminal samples was similar among K levels, but the number of total protozoa increased linearly ($P < 0.05$) as K declined (8.3, 11.8, 15.6, and 27.1 x 10^5/ml for 100K, 67K, 33K, and 0K, respectively). The CT-containing forage K decreased CH_4 emission by goats regardless of its feeding level, although the effect per unit of K increased with decreasing K. Forage type (i.e., legume versus grass) may have contributed to the effect of K on CH_4 emission, but most of the change appeared attributable to CT, which appeared to directly impact activity of methanogenic bacteria, although alterations of protozoal activity could have been involved. These findings suggest that relatively low dietary levels of CT could be employed to lessen CH_4 emission without a marked detrimental effect on other conditions such as total tract protein digestion.

On-farm performance of Arsi-Bale goats receiving different concentrate supplements

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Livestock Research for Rural Development Volume 20, Article #201.
www.lrrd.org/lrrd20/12/guru20201.htm

An experiment was conducted to compare effects of supplements based on different byproduct feedstuffs on on-farm performance of yearling Arsi-Bale goats in the Adami Tulu district of Ethiopia. The study was conducted during the main growing season (wet season) at the time when most grazing land is cultivated. A farmer research group (FRG) was formed in each of three villages. Each FRG consisted of nine farm households, with eight contributing three animals and one providing six. A barn with three pens was constructed at one farm in each village. One or two animals from each farm were allocated to three supplementation treatments. Animals received supplements and resided at night in the barn pens. Supplements, offered at 2.5% of body weight, consisted of 50% wheat bran, 1% salt, and 49% noug cake (N), formaldehyde-treated noug cake (F-N), or linseed meal (L). Initial body weight was 14.5 (SE = 0.18 kg). Average daily gain was greater for L than for N ($P < 0.05$) and F-N ($P < 0.08$) (100, 113, and 134 g/day for N, F-N, and L, respectively; SE = 6.6). The difference between the increase in estimated animal value due to supplementation and supplement cost was 51.87, 61.1, and 79.75 Ethiopian birr per animal for N, F-N, and L, respectively. In conclusion, based on average daily gain and the greater concentration of metabolizable energy in linseed meal vs. noug cake, energy appeared relatively more limiting to performance than protein. Supplementation of goats with available byproduct feedstuffs offers a means of achieving marketable body weight and profit with suboptimal grazing conditions.

Tethering meat goats grazing forage of high nutritive value and low to moderate mass

Patra, A. K., R. Puchala, G. Detweiler, L. J. Dawson, T. Sahlu, and A. L. Goetsch
Asian-Australian Journal of Animal Science 21:1252-1261. 2008

Twenty-four yearling Boer x Spanish goats were used in a crossover design experiment to determine effects of tethering on forage selection, intake and digestibility, grazing behavior and energy expenditure (EE) with forage high in nutritive value and low to moderate in mass. Objectives were to determine if tethered goats could be used as a model for study of unrestrained animals and to characterize tethering as a production practice. Four 0.72-ha pastures of wheat (*Triticum aestivum*) and berseem clover (*Trifolium alexandrium*) were grazed in December and January. Each pasture hosted six animals, three with free movement and three attached to a 4.11-m tether for access to a circular area of 53.1 m^2. Tethering areas were moved each day. One animal of each treatment and pasture was used to determine forage selection, fecal output or grazing behavior and EE; therefore, there were eight observations per treatment. Mass of forage DM before grazing in Tethered areas averaged 1,280 and 1,130 kg/ha in periods 1 and 2, respectively. The CP concentration in ingesta was greater ($P < 0.05$) 239 and 209 g/kg; SE = 8.0) and the NDF level was lower ($P < 0.05$) for Free vs. Tethered animals (503 and 538 g/kg; SE = 12.0); in vitro true DM digestion was similar between treatments (0.808 and 0.807 for Free and Tethered, respectively; SE = 0.0096). Intakes of DM (1,013 and 968 g/d; SE = 78.6), NDF (511 and 521 g/d; SE = 39.9) and ME (10.9 and 10.7 MJ/d; SE = 0.90) were similar between treatments, but CP intake was greater ($P < 0.05$) for Free vs. Tethered animals (241 and 203 g/d; SE = 17.2). There were small treatment differences in in vivo apparent digestibility of OM (($P < 0.05$) 0.780 and 0.814; SE = 0.0049), CP (($P < 0.05$) 0.800 and 0.817; SE = 0.0067) and NDF (($p<0.09$) 0.777 and 0.760 for Free and Tethered, respectively; SE = 0.0078). There were no treatment effects on time spent ruminating or grazing (346 and 347 min/d for Free and Tethered, respectively; SE = 42.5), but EE was considerably greater ($p<0.05$) for Free vs. Tethered animals (571 and 489 kJ/kg $BW^{0.75}$; SE = 8.9). In conclusion, with forage of high nutritive value and low to moderate in mass, tethering can offer a production advantage over free grazing of less energy used for activity despite similar grazing time. With forage removal considerably less than that available for grazing, effects of tethering on chemical composition of selected forage were small and less than needed to markedly affect digestion. Tethering may offer a means of studying some aspects of grazing by ruminants, but would not seem suitable for energy metabolism.

Effects of tethering on forage selection, intake, and digestibility, grazing behavior, and energy expenditure by Boer x Spanish goats grazing high quality forage

Patra, A. K., R. Puchala, G. Detweiler, L. J. Dawson, T. Sahlu, and A. L. Goetsch
Journal of Animal Science 86:1245-1253. 2008

Twenty-four yearling Boer x Spanish goats were used in a crossover experiment to determine effects of tethering on herbage selection, intake, and digestibility, grazing behavior, and energy expenditure (EE) with high quality herbage. Four 0.72-ha paddocks of wheat (*Triticum aestivum*) and berseem clover (*Trifolium alexandrium*) were grazed in the spring. Each paddock hosted 6 animals, 3 with free movement and 3 attached to a 3-m tether for access to an area of 28.3 m^2 that was moved daily. One animal of each treatment and paddock was used to determine herbage selection, fecal output, or grazing behavior and EE. Herbage DM mass in tethered areas before grazing averaged 2,649 and 2,981 kg/ha in Periods 1 and 2, respectively. The CP concentration in ingesta was greater ($P < 0.05$; 23.1 and 20.3 ± 0.82%) for free vs tethered animals, although in vitro true DM digestion (75.7 and 76.5 ± 1.20%) did not differ ($P > 0.05$) between treatments.

Intake of ME based on in vitro true DM digestion and fecal output was greater ($P < 0.05$) for free vs tethered animals (12.7 and 10.4 ± 0.89 MJ/d). No treatment effects were observed ($P > 0.05$) on time spent ruminating or grazing (405 and 366 ± 42.5 min/d, respectively), although mean EE was greater ($P < 0.05$) for free vs tethered animals (633 and 512 ± 27.4 kJ/kg $BW^{0.75}$ for free and tethered, respectively), with differences ($P < 0.05$) between treatments at each hour of the day. Tethering animals may be acceptable to model ones with free movement for some measures such as ingesta composition but appears inappropriate for others, such as energy metabolism.

Effects of acclimatization on energy expenditure by meat goats

Patra, A. K., R. Puchala, G. Animut, T. A. Gipson, T. Sahlu, and A. L. Goetsch

Small Ruminant Research 81:42-54. 2009

Eight Spanish and eight Boer yearling doelings were used to assess relationships between energy expenditure (EE) and ambient temperature (Ta), relative humidity (RH), and temperature-humidity index (THI). Four doelings of each genotype were housed in two 5.6 x 3.1 m pens of an enclosed facility with a concrete floor without cooling and with heat provided only to prevent damage to waterers and water lines from freezing. EE was determined over 2 day periods 13 times during a 1 yr period based on EE:heart rate (HR) of each doeling. Climate variables were averaged over 2, 4, 6, and 8 wk preceding EE measurement. Doelings were fed to meet the maintenance energy requirement (ME_m). Average mean, low, and high values during the 2 wk preceding EE determination were 19.9, 7.9, and 31.8°C for Ta and 53.6, 36.1, and 62.5% for RH, respectively. Neither Ta nor THI were correlated with or had significant effects in regressions to predict the difference between EE at particular measurement times and the 1 yr mean (EEdiff). Conversely, RH was correlated ($P < 0.01$) with EEdiff. When the 13 HR measurement times were assigned to cool and warm seasonal periods, EEdiff was affected ($P < 0.01$) by a genotype x period interaction. Nonetheless, the effect of RH in models including genotype, period, and genotype x period was significant for 2, 4, 6, and 8 wk ($P < 0.01$). The R^2 of linear regressions of EEdiff against RH was slightly greater for 2 and 4 vs. 6 and 8 wk (0.11, 0.10, 0.08, and 0.07, respectively); regression coefficients for 2 and 4 wk were 1.265 and 1.163 kJ/kg $BW^{0.75}$ per 1% RH, respectively. With RH of 50%, regression coefficient of 1.214 kJ/kg $BW^{0.75}$ per 1% RH, and ME_m of 390 kJ/kg $BW^{0.75}$, predicted ME_m is 372 and 408 kJ/kg $BW^{0.75}$ at 35 and 65% RH, respectively. In conclusion, without extremes eliciting cold or heat stresses, RH appears to have a slight effect on ME_m of meat goats by acclimatization in both cool and warm periods of the year.

The relationship between heart rate and energy expenditure in growing crossbred Boer and Spanish wethers

Puchala, R., I. Tovar-Luna, T. Sahlu, H. C. Freetly, and A. L. Goetsch

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Eight Boer (75%) x Spanish (BS) and 8 Spanish (S) wethers (155 ± 8 d of age and 19.2 ± 2.3 kg BW, initial) were used in a replicated crossover design with a 2 x 2 factorial arrangement of treatments to determine effects of genotype, diet quality, and time of the day on energy expenditure (EE), heart rate (HR), and EE: HR with ad libitum, near maintenance, and fasting levels of feed intake. Diets were 65% concentrate and coarsely ground alfalfa hay. Energy expenditure ranked ($P < 0.05$) ad libitum > maintenance > fasting (500, 390, and 270 kJ/kg $BW^{0.75}$). Heart rate did not differ between genotypes when fasting and with maintenance

intake, but was greater ($P < 0.05$) for S vs BS when intake was ad libitum (BS: 55, 71, and 92; S: 52, 72, and 100 beats/min for fasting, maintenance, and ad libitum, respectively (SE = 2.0)). There was an interaction in EE:HR ($P < 0.05$) between level of feed intake and genotype (BS: 5.31, 5.59, and 5.00; S: 5.07, 5.57, and 5. 22 kJ/kg $BW^{0.75}$:beats/min for ad libitum, maintenance, and fasting, respectively (SE = 0.13)), without an effect of diet. The effect of time on EE, HR, and EE:HR differed among levels of intake ($P < 0.05$). General patterns of change in EE and HR as time of day advanced did not differ, but increases near meals followed by decreases were of slightly greater magnitude for maintenance vs ad libitum intake. The ratio of EE:HR was greater for the maintenance level of feed intake than for ad libitum intake at most times. These results indicate similar potential for use of HR to predict EE of different genotypes of growing meat goats and that establishing EE:HR with different diets or levels of intake may not be crucial. Magnitudes of difference among hours suggest that when EE:HR is used to predict EE of confined goats from full-day measurement of HR, EE:HR should be determined over an extended period of time, such as 24 h.

Impact of animal science research on U.S. goat production and predictions for the future
Sahlu, T., L. J. Dawson, T. A. Gipson, S. P. Hart, R. C. Merkel, R. Puchala, Z. Wang, S. Zeng, and A. L. Goetsch
Journal of Animal Science 87:400-418. 2009

Goat research in the U.S. has increased but at a rate less than that in production. Research on goat meat includes nutritional quality, packaging, color, sensory characteristics, and preharvest management. Goat skins have value for leather, yet quality of goat leather has not been extensively studied. Research in the production, quality, antibiotic residues, and sensory characteristics of goat milk and its products has aided development of the U.S. dairy goat industry. Limited progress has been made in genetic improvement of milk or meat production. There is need to explore applications of genomics and proteomics and improve consistency in texture and functionality of goat cheeses. New goat meat and milk products are needed to increase demand and meet the diverse tastes of the American public. Despite research progress in control of mohair and cashmere growth, erratic prices and sale of raw materials have contributed to further declines in U.S. production. Innovative and cooperative ventures are needed for profit sharing up to the consumer level. Internal parasites pose the greatest challenge to goat production in humid areas largely because of anthelmintic resistance. Study of alternative controls is required, including immunity enhancement via nutrition, vaccination, pasture management such as co-grazing with cattle, and genetic resistance. Similarly, the importance of health management is increasing related in part to a lack of effective vaccines for many diseases. Nutrition research should address requirements for vitamins and minerals, efficiencies of protein utilization, adjusting energy requirements for nutritional plane, acclimatization, and grazing conditions, feed intake prediction, and management practices for rapid-growth production systems. Moreover, efficient technology transfer methods are needed to disseminate current knowledge and that gained in future research.

Co-grazing of sheep and goats: benefits and constraints
G. Animut and A. L. Goetsch
Small Ruminant Research 77:127-145. 2008

Co-grazing of sheep and goats has been practiced throughout history and is commonplace around the world. However, its benefits may not be fully appreciated and means to maximize them have not been extensively

studied. Advantages of co-grazing of sheep and goats are derived primarily from differences in preferences for particular plant species and parts, abilities or willingness to consume forages that are not highly preferred and would have greater adverse effects on the other species, and physical capabilities to gain access to specific types of vegetation. Hence, the degree to which total stocking rate or carrying capacity is greater for co- vs. mono-species grazing increases with increasing vegetation diversity and, concomitantly, decreasing dietary overlap. Perhaps the most important management decision pertaining to co-grazing is appropriate stocking rates. A simple 'baseline' or 'starting point' method of estimating co-grazing stocking rates is: (number with mono-species grazing x (100 - % overlap) / 100) + (number with mono-species grazing x (% overlap x 0.5 / 100)). The equation is applied to both sheep and goats, with values added to determine the total stocking rate. Botanical composition and available forage mass are important determinants of numbers of both sheep and goats with mono-species grazing, and factors affecting nutrient requirements such as body weight and production state, preference for or willingness to consume forages present, and desired length of grazing will have impact as well. Previous experience with the particular grazing and animal conditions will aid in projecting mono-species stocking rates. Estimates of dietary overlap when co-grazing should be based on the most accurate method available, which in many instances may be prior experience or visual observation at different times of the day and in various seasons. However, the equation noted above has limitations. It assumes that intake of forages potentially consumed by each animal species is equal, which obviously is not always true. Furthermore, interactions between stocking rates when the two species graze together vs. alone are not considered. Nonetheless, because of its simplicity, the method may have value in field settings, and illustrates the importance of browse plant species in many grazing systems and why management practices are frequently employed to maintain or increase their prevalence and vegetation diversity.

Effects of small ruminant species and origin in Ethiopia (Highland vs Lowland areas) and lengths of rest and feeding on harvest measures

Abebe, G., G. Kannan, and A. L. Goetsch

African Journal of Agricultural Science (In press). 2009

Yearling goats (G) and sheep (S) from Highland (H) and Lowland (L) areas of Ethiopia were used to determine effects of species and origin and lengths of rest and feeding on harvest measures, particularly carcass surface lightness. The H goat used was Arsi-Bale , and the L goat was Somali. The fat-tail indigenous H sheep is thought to be an Arsi-Bale genotype, and the fat-rump indigenous L sheep genotype was the Black Head Ogaden. There were two experiments (each a 2 x 2 x 3 factorial), one with rest for 0, 1, and 2 d before slaughter (R0, R1, and R2, respectively) and the second with feeding 0, 2, and 4 wk (0 wk=2 d rest; 0F, 2F, and 4F, respectively). There were 10 animals per treatment. In the rest experiment, the instrumental color measure L* (indicating lightness) for the hind leg surface 3 d PS was lower ($P<0.05$) for H than for L (34.8, 36.3, 37.4, and 38.9 for G-H, G-L, S-H, and S-L, respectively). Surface L* on d 3 was increased ($P<0.05$) by 1 and 2 d of rest compared with 0 d for goats regardless of origin, but was not affected for sheep (33.2, 36.3, 37.2, 38.5, 37.8, and 38.2 for G-R0, G-R1, G-R2, S-R0, S-R1, and S-R2, respectively). In the feeding experiment, surface L* on d 3 was lower ($P<0.05$) for H vs L (36.5, 39.0, 36.2, and 39.8 for G-H, G-L, S-H, and S-L, respectively). Feeding 4 wk increased ($P<0.05$) surface L* on d 3 regardless of species and origin (37.7, 36.8, and 39.2 for F0, F2, and F4, respectively). In summary, goat and sheep carcasses from Highland areas of Ethiopia may darken more quickly compared with Lowland areas, and 1 or 2 d of rest before slaughter can increase lightness of the surface of goat carcasses.

Effects of breed and diet on growth and body composition of crossbred Boer and Spanish wether goats

Ngwa, A. T., L. J. Dawson, R. Puchala, G. D. Detweiler, R. C. Merkel, Z. Wang, K. Tesfai, T. Sahlu, C. L. Ferrell, and A. L. Goetsch

Journal of Animal Science (In press). 2009

Sixty growing 3/4 Boer x 1/4 Spanish (BS) and Spanish (SP) wethers were used to determine influences of diet and breed on growth and body composition. A 50% concentrate pelleted diet (CON) and one based on grass hay (HAY) were fed free-choice. Six wethers of each breed were harvested at 0 wk (total of 12) and 6 of each diet-breed combination were harvested at 14 and 28 wk (24 per time). Initial BW of fed wethers was 21.6 and 18.8 kg for BS and SP, respectively (SEM = 0.67). Average daily gain during the entire experiment was influenced by an interaction ($P < 0.05$) between breed and diet (199, 142, 44, and 50 g for BS:CON, SP:CON, BS:HAY, and SP:HAY, respectively). Carcass mass was greater ($P < 0.05$) for CON vs. HAY (56.2, 56.2, 53.2, and 54.0% empty BW for BS:CON, SP:CON, BS:HAY, and SP:HAY, respectively). Mass of the liver (2.11, 1.92, 2.00, and 1.98% empty BW; SEM = 0.048) and gastrointestinal tract (5.50, 4.83, 8.43, and 8.36% empty BW for BS:CON, SP:CON, BS:HAY, and SP:HAY, respectively; SEM = 0.158) tended ($P < 0.07$) to be influenced by an interaction between breed and diet. Mass of internal fat (12.2, 12.1, 3.4, and 3.4% empty BW for BS:CON, SP:CON, BS:HAY, and SP:HAY, respectively; SEM = 0.28) differed ($P < 0.05$) between diets. Energy in the carcass (320, 236, 87, and 79 MJ), noncarcass tissues (318, 237, 77, and 72 MJ), and empty body (638, 472, 164, and 150 MJ) ranked ($P < 0.05$) BS:CON > SP:CON > BS:HAY and SP:HAY. Empty body concentration of protein was 18.3, 17.5, 18.3, and 19.7% (SEM = 0.29) and of fat was 24.0, 23.4, 10.8, and 10.3% for BS:CON, SP:CON, BS:HAY, and SP:HAY, respectively (SEM = 0.59). Energy concentration in accreted tissue was 17.0, 18.7, 16.3, and 6.4 MJ/kg for CON:wk 1-14, CON:wk 15-28, HAY:wk 1-14, and HAY:wk 15-28, respectively (SEM = 1.39). In conclusion, relatively high growth potential of growing Boer goats with a moderate to high nutritional plane does not entail a penalty in realized growth when the nutritional plane is low. Body composition of growing Boer and Spanish goats is fairly similar regardless of growth rate. For growing meat goats other than with a prolonged limited nutritional plane, an average energy concentration in accreted tissue is 17.3 MJ/kg.

Effects of stage of lactation and dietary concentrate level on body composition of Alpine dairy goats

Ngwa, A. T., L. J. Dawson, R. Puchala, G. D. Detweiler, R. C. Merkel, Z. Wang, K. Tesfai, T. Sahlu, C. L. Ferrell, and A. L. Goetsch

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Multiparous Alpine does (42) were used to determine how stage of lactation and dietary forage level affect body composition. Initial measures were made with six does a few days after kidding (0 mo). Before parturition does were fed a 50% concentrate diet free-choice. Eighteen does were fed a 40% forage diet (40F) and 18 received a diet with 60% forage (60F) for approximately 2, 4, or 6 mo of lactation. The 60F diet had 20% more dehydrated alfalfa pellets than the 40F diet, with higher levels of corn and soybean meal and inclusion of supplemental fat in the 40F diet. Intake of dry matter was greater for 60F vs. 40F, average daily gain tended to be affected by an interaction between diet and month (0, 24, 121, -61, 46, and 73 g), and 4% fat-corrected milk was less in mo 5-6 than earlier. Internal fat mass was greatest among times at 6 mo and greater for 40F vs. 60F. Mass of the gastrointestinal tract was less for 40F than for 60F and decreased with increasing time in lactation. Concentrations of fat in the carcass (13.8, 13.1, 16.5, 11.2, 11.5, and 14.4%),

noncarcass tissues (18.6, 24.2, 33.3, 14.3, 16.5, and 24.5%), and empty body (16.5, 18.7, 25.2, 12.9, 14.1, and 19.5% for 40F:2 mo, 40F:4 mo, 40F:6 mo, 60F:2 mo, 60F:4 mo, and 60F:6 mo, respectively) were affected by stage of lactation and diet. Based on daily change in tissue mass and energy, energy concentration in tissue mobilized or accreted was 16, 20, and 32 MJ/kg in 1-2, 3-4, and 5-6 mo of lactation, respectively. In conclusion, based on tissue mass more energy was expended by the GIT with 60F vs. 40F. Considerable internal fat is mobilized in early lactation particularly with diets moderate to high in forage, with more rapid and a greater magnitude of repletion by does consuming diets lower in forage. The concentration of energy in tissue mobilized or accreted may vary with stage of lactation.

Goat nutrition and feeding

Goetsch, A. L. and R. C. Merkel

In: R. O. Kellems, and D. C. Church (Editors) Livestock Feeds and Feeding. Prentice Hall, Upper Saddle River, NJ. 2009 (Book Chapter; In Press)

Goats have been selected for different purposes, such as milk production, mohair or cashmere fiber yield, and average daily gain or meat production, resulting in different physiological conditions that affect nutrient requirements and most appropriate feeding methods. Nutrient requirements and dietary management practices are also unique for indigenous or local genotypes of goats that may not have been intensively selected by many for a particular type of production, but that have adapted to survive under specific and often harsh environmental conditions. Goats differ from other domesticated ruminant livestock species, namely beef and dairy cattle and sheep, in numerous ways; however, most notable are unique feeding behaviors. Goats generally consume a wider variety of plants when available, especially browse and foliage of woody plant species. Moreover, because of factors including mobile lips and precise tongue actions, goats exert considerable selection in the particular plant fragments and feed particles consumed. Another difference between goats vs cattle and sheep is the ingestion of relatively greater levels of many plants containing 'anti-nutritional factors' such as tannins that can influence nutrient absorption and utilization. In addition to effects of selection on nutrient requirements and desired feeding management practices, previous plane of nutrition has impact. This can be assessed by body condition score as practiced with other ruminant species. Knowledge of body condition score and other factors influencing nutrient requirements, such as breed, gender, desired levels of production including pregnancy status, and grazing and environmental conditions, are necessary to assess specific needs for energy, protein, minerals, and vitamins. Then dietary means of meeting these requirements can be devised. For animals in confinement this might be considered a bit easier than for grazing goats, since all nutrients are provided by feedstuffs offered. Although, many times in confinement forage is fed free-choice as the basal diet, similar to forage consumed when grazing. In both cases nutrients provided by the basal diet must be projected in order to formulate a supplement to satisfy any nutrient deficits at the lowest cost. Total mixed rations are frequently used as well, particularly for dairy goats, in which case least-cost formulation procedures considering different available forage and concentrate feedstuffs will yield greatest profitability.

Effects of milk fat depression induced by a dietary supplement containing *Trans*-10, *Cis*-12 conjugated linoleic acid on properties of semi-hard goat cheese

Chen, S. X., M. Rovai, A. L. Lock, D. E. Bauman, T. A. Gipson, F. Z. Ren, and S. S. Zeng
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Dietary supplements of conjugated linoleic acid (CLA) containing *trans*-10, *cis*-12 CLA reduce milk fat synthesis in lactating goats. This study investigated effects of milk fat depression induced by dietary CLA supplements on the properties of semi-hard goat cheese. Thirty Alpine does were randomly assigned to three groups and fed diets with lipid-encapsulated CLA that provided *trans*-10, *cis*-12 CLA at 0 (control), 3 (CLA-1) or 6 g/d (CLA-2). The experiment was a 3x3 Latin square design. Periods were 2 wk in length, each separated by 2-wk periods without CLA supplements. Bulk milk was collected on d 3 and 13 of each of three periods for cheese manufacture. The largest decrease (23.2%) in milk fat content induced by the high dosage (6 g/d per doe) of *trans*-10, *cis*-12 CLA supplementation at d 13 of treatment resulted in the decreases of cheese yield and moisture by 10.2 and 10.0%, respectively. Although CLA supplementation increased the hardness, springiness and chewiness and decreased the cohesiveness and adhesiveness of cheeses, no obvious defects were detected and no significant differences were found in sensory scores among cheeses**.** In conclusion, milk fat depression induced by a dietary CLA supplement containing *trans*-10, *cis*-12 CLA resulted in changes of fat-to-protein ratio in cheese milk and consequently affected properties of semi-hard goat cheese.

Current status of composition and somatic cell count in milk of goats enrolled in Dairy Herd Improvement Program in the United States

Zeng, S. S.[1], Zhang, L.[1,2], G.R. Wiggans[3], J. Clay[4], R. LaCroix[5], J.Z. Wang[1], and T. Gipson[1]
In: New Research on Livestock Science and Dairy Farming. Nova Science Publishers, Inc. Hauppauge, NY (In press).

The effects of breed, parity, stage of lactation (month), herd size, and regions/states on fat and protein content, somatic cell count (SCC) and production of milk from dairy goats enrolled in the Dairy Herd Improvement (DHI) program in the United States (U.S.) in 2007 were investigated to monitor the current status of composition and SCC and to help goat producers improve their herd management and receive premiums for high quality goat milk. Statistical analysis of composite DHI data indicated that composition, SCC and production of goat milk were affected by many non-infectious factors. Marked variations ($P < 0.05$) in fat and protein content and milk production were found among goat breeds, particularly among those non-registered goats. In the first five parities, milk fat and protein content was relatively constant, however, a sharp decline ($P < 0.05$) was observed in parity 6. As parities increased, SCC in milk increased steadily ($P < 0.05$). Significant differences ($P < 0.05$) in all variables were discovered among regions. Large herds of goats tended to have lower milk fat and protein content but higher milk production and SCC than the small herds ($P < 0.05$). The above findings suggest that it be economically imperative to consider culling goats after their fifth lactation and that year-round breeding and lactation programs be practiced, if dairy goat producers in the U.S. are to meet the Grade "A" goat milk requirements. All factors that contributed to variations in fat, protein, SCC and production of goat milk should be taken into consideration when establishing price incentive systems for goat milk.

Visiting Scholars (2008/2009)

Dr. Asefa Asmare
Native of Ethiopia
Research Project: The Ability of Goats to Withstand Harsh Nutritional Environments (USDA 2005-38814-16353)
Experiments: AA-06-08, AA-07-05

Dr. Adnan Beker
Native of Ethiopia
Research Project: Energy Expenditure for Activity in Free-Ranging Ruminants: A Nutritional Frontier (US-3694-05 R)
Experiments: AB-06-06, AB-06-16

Dr. Ahmed Askar
Native of Egypt
Research Project: Characterization of the Energy Requirement for Activity by Grazing Ruminants (USDA 2005-38814-16352)
Experiments: AAR-06-07, AAR-07-03

Dr. Ignacio Tovar-Luna
Native of Mexico
Research Project: The Grazing Activity Energy Cost of Goats (BIO11-001-005)
Experiments: AA-07-02, ITL-08-01

Dr. Lynn Wang
Native of China
Research Project: Impact of Sub-Clinical Mastitis on Production and Quality of Goat Milk and Cheese (USDA 2007-38814-18474)
Experiments: LW-08-03, LW-09-02, LW-09-02

Mr. Li Zhang
Native of China
Training Focus: Cheese Manufacturing and Dairy Herd Improvement (DHI) Laboratory Operation

Ms. Rulan Shangguan
Native of China
Research Project: Impact of Sub-Clinical Mastitis on Production and Quality of Goat Milk and Cheese (USDA 2007-38814-18474)
Experiment: RS-09-04

Dr. Wenping Hu
Native of China
Research Project: Boer Goat Selection for Residual Feed Intake
Experiment: WH-09-06

Dr. Yoko Tsukahara
Native of Japan
Training Focus: Goat Research and Production and the Importance of Goats in Development Projects

Dr. Ahmed Helal
Native of Egypt
Research Project: Effects of nutritional plane on the maintenance energy requirement of goats
Experiment: AH-09-05

Notes