PROCEEDINGS OF THE 33rd ANNUAL

GOAT and HAIR SHEEP FIELD DAY

April 28, 2018

Agricultural Research and Extension Program
Langston University
Langston, Oklahoma 73050

WELCOME

We deeply appreciate your attendance at this 33rd Annual Goat Field Day of the E (Kika) de la Garza American Institute for Goat Research of Langston University. Recently, Langston University added a small research flock of Dorper, Katahdin, and St. Croix hair sheep and this year we will incorporate topics of interest to hair sheep producers. The Goat and Hair Sheep Field Day is one of the most important things we do each year. The primary purpose of Field Day is for education and extension in areas of greatest interest to stakeholders of the Institute. In addition to extension and education, Field Day provides an excellent opportunity for the staff of the Institute to meet other people who work with small ruminants. Such interaction helps make our program the most appropriate it can be for the people it serves. The proceedings of 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 for Goat and Hair Sheep Field Day is "Preventing Production Losses."

Here is the exciting program planned for today that has developed from your input.

The morning program consists of:

- **Where Have They Gone? Results from National Death Loss Studies** — *Mr. Matthew Branan*
- **Preventative Medicine 101** — *Dr. James Keen*
- **Diet and Parasite Control** — *Dr. David Pugh*

The afternoon workshops are:

- **Tools in the War on Parasites** — *Dr. David Pugh*
- **Common Diseases of Small Ruminants and Their Symptoms** — *Dr. James Keen*
- **Where Are They Going? A Look at Past and Future NAHMS Studies** — *Mr. Matthew Branan*
- **What Processors Want** — *Oklahoma meat processors*
- **Financial Statement Use and Analysis** — *Mr. Clark Williams*
- **Pack Goats** — *Mr. Dwite Sharp*
- **Tanning Goat Hides** — *Dr. Roger Merkel*
- **Basic Herd Health and Management** — *Dr. Lionel Dawson & Mr. Jerry Hayes*
- **The Art of Cheesemaking** — *Dr. Steve Zeng*
- **Nutrition for Health and Production** — *Dr. Steve Hart*
- **DHI Training** — *Ms. Eva Vasquez*
- **USDA Government Programs**
- **USDA/APHIS: Animal ID** — *Dr. Julie Aebi*
- **USDA/NRCS: Conservation Programs** — *Mr. Chris Best*
- **USDA/FSA: Farm Loans** — *Mr. Phil Estes*
- **USDA/NASS: Animal Inventories** — *Mr. Troy Marshall*
- **USDA/RD: Rural Development** — *Mr. Bryan Wiles*
- **USDA/WS: Wildlife Programs** — *Mr. Kevin Grant*
- **Fitting and Showing for Youth and Adults** — *Mr. Robbie Sanders*
- **Fun Tent** — *Ms. Shirlene Hurte*

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

Table of Contents

Where Have They Gone? Results from the NAHMS Goat and Sheep Death Loss Studies

Mr. Matthew Branan

Mathematical Statistician

USDA-APHIS-VS-National Animal Health Monitoring System, Fort Collins, CO

NAHMS website: http://www.aphis.usda.gov/nahms

Matthew.A.Branan@aphis.usda.gov

NAHMS introduction

Background

The National Animal Health Monitoring System (NAHMS) is a nonregulatory program that was created within the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Services (APHIS) with the task of collecting and disseminating scientifically accurate and statistically valid information on animal health and management within the United States. Since 1990, NAHMS has conducted nation-wide studies on many animal commodities, including goats, sheep, equine, catfish, beef cattle, dairy cattle, swine, and poultry on a rotating basis.

NAHMS studies are completely voluntary and are conducted with the aim of protecting producer identities through a number of means. NAHMS is committed to providing aggregate information and using avoidance disclosure methods to protect participant identities. Survey information is associated only with a numeric identification number, and blinding prevents linkage back to the participant.

Death Loss study outline

The death loss studies are conducted within three commodities: sheep, goats, and cattle to study death losses by specific cause, mitigation measures, and costs. The studies are a collaborative project among NAHMS, USDA-National Agricultural Statistics Service (NASS), and USDA-APHIS-Wildlife Services (WS). NASS implements annual January Cattle and their January Sheep and Goat surveys using their field enumeration force. The death loss questions are added only every five years. Funding has been provided in the years of 1995, 2000, 2005, 2010, and 2015 for sheep and goats (1992, 1996, 2001, 2006, 2011, and 2016 for cattle) to add the death loss questions to the annual commodity surveys, which focus on the January 1 inventories for the given year and the death losses incurred in the year prior. The surveys typically take approximately 30 minutes to complete. Approximately 26,000 producers in all 50 states were contacted to participate in the goat death loss questionnaire in January 2016. This was the first in-depth look at specific causes of goat deaths within each of the predator and nonpredator death loss categories.

Goat and Kid Death Loss, 2015

Inventory

Inventory estimates indicate there were approximately 2.6 million goats and kids on 150,000 operations in the U.S. in January, 2016. Approximately 80% of these goats were meat or other goats, 15% were dairy goats, and 5% were Angora goats. More than 60% of the operations have 1-9 goats, but more than 70% of the goats

reside on operations with 20-99 goats or 100 or more goats. Nearly 30% of goats in the U.S. reside in Texas, followed by California, Arizona, and Oklahoma, each accounting for 3-4% of the total U.S. goat inventory.

Overall death loss

There were approximately 505,000 goat and kid death losses reported in 2015. Of these, 180,000 (35%) were adult goat losses and 325,000 (65%) were kid losses, totaling a value of approximately $70 million (for the market value of the goat losses alone, not including loss of business, cost of disposal, or other expenses associated with death loss). This accounted for 10% of the goat inventory and nearly 20% of the 2015 kid crop.

Losses due to predators accounted for approximately 123,000 (25%) of the death losses while the other 382,000 (75%) losses were attributed to nonpredator causes regardless of age of the goat (adult, pre-weaned kid, post-weaned kid). Three times the number of pre-weaned kids died compared to post-weaned kids. For both nonpredator and predator losses, there were a large number of deaths with no specific cause attributed (120,000).

Nonpredator death loss

The three most common, specific nonpredator loss causes in adult goats were internal parasites (25% of nonpredator deaths), kidding problems (5.2%), and digestive problems such as bloat, scours, or acidosis (4.7%). For kids, these were internal parasites (22%), weather-related causes such as chilling, drowning, or lighting (16%), and kidding problems (7.9%). Larger operations (100 or more adult goats) tended to have higher rates of loss to respiratory problems (6-9%) compared to the smaller operations (1-4%). Also, goats in the Pacific region tended to have higher frequencies of deaths from respiratory disease-related causes (13%) compared with the other regions (1-6%). Goats in the Pacific and Northeast regions had fewer numbers of deaths attributed to internal parasites (11% or less) compared to goats in the West Central, Central, or Southeast regions (23-30%).

Predator death loss

Over 65% of the goat and kid deaths to predators were caused by coyotes and dogs. For adult goats, the top three specific predators were coyotes (32% of predator deaths), dogs (32%), and mountain lions, cougars, or pumas (4.2%). For kids, the top predators were coyotes (48%), dogs (17%), and bobcats or lynx (6.3%). Approximately 33,000 (52%) of preweaned kids were killed by coyotes while there were only 7,000 (36%) for postweaned kids. There were few kid deaths attributed to feral pigs or to eagles on smaller operations (0-1% and 0-2%, respectively) compared to the largest operations (2.3% and 7.8%, respectively).

Death loss mitigations

An expected 93% of goat producers employ at least one nonlethal method to control predator death losses. The most common, specific methods are fencing (45% of operations), guard dogs (33%), and night penning (24%). These methods did not vary much by region or State, but did vary by size of operation. The largest of operations tended to cull older goats to prevent death loss, perform more frequent checks in high predation areas and seasons, and remove carrion compared to the smallest of operations. Over 50% of operations practiced more than one nonlethal predator control method, where the most common combination methods included guard dogs combined with fencing or one of the two combined with "other nonlethal" methods.

Overall, 87% of operations practiced only nonlethal predator control methods, less than 1% practiced only lethal predator control methods, 7% practiced both, and close to 6% practiced no predator control methods. There were size differences in spending: larger operations outspent smaller operations 2 times on nonlethal methods and 5 times on lethal methods. Averaged across all operations, operations spent approximately $1,100 in a year on nonlethal predator control methods and $400 a year on lethal predator control methods, while only 2.3% of operations used the services of Federal or State government trappers to help control predators.

Sheep and Lamb Death Loss, 2015

About 23,000 operations were contacted to participate in the sheep death loss study in 2015.

Inventory

There is an estimated 5.3 million sheep and lambs on 95,000 operations in the U.S. in 2015. The number of sheep and lambs has steadily decreased since 1995 (almost 9.0 million). Mirroring this, the lamb crop (see caveat on this definition in the report) has decreased since 1994 (nearly 6,000) to its current value in 2014 (3,400). Numbers of operations decreased from 86,000 in 1995 to 68,000 in 2004 and has increased since 2004 to its current number (over 95,000). Small operations (1 to 99 breeding sheep) have increased in number and medium-sized operations (100 to 499 and 500 to 4,999 breeding sheep) have decreased in number, while the number of large operations (5,000 or more breeding sheep) has remained constant. Over a third of sheep and over 30% of the 2014 lamb crop were located in Texas, California, Utah, and Wyoming.

Overall death loss

In 2014, there were approximately 585,000 sheep and lamb death losses, at a cost of $102 million (for the market value of those animals only, not including other death loss-related expenses). Of those, 220,000 (38%) were losses of adult sheep and the other 365,000 (62%) were lamb losses. These values show a decline in the number of losses since 2009 (624,000), though the percent of the adult sheep inventory lost (6.5%) and lamb crop lost (10.6%) has remained the same since 2009 due to the decrease in overall inventory. Deaths due to nonpredator causes in adult sheep have accounted for approximately 72% ($32 million) of deaths and the other 28% ($12 million) is attributed to predator-related causes. For lambs, the split is weighted more towards predator-related causes. Over 40% of operations lost any sheep or lost any lambs to any cause during 2014 and this varied substantially among States. Undetermined causes of death accounted for a large portion of nonpredator and predator deaths (100,000).

Nonpredator death loss

Most commonly, sheep were lost to the specific nonpredator causes of old age (24% of nonpredator sheep deaths), lambing problems (12%), and internal parasites (8.6%). For lambs, these included weather (19% of nonpredator lamb deaths), lambing problems (12%), and internal parasites and respiratory problems (each accounting for 9.1%). The largest of operations tended to have fewer sheep die from internal parasites, tended to have more sheep and lambs stolen, and have fewer numbers of lambs die from weather-related causes than any of the small- or medium-sized operations. The smallest of operations tended to have greater rates of loss in sheep and lambs due to lambing problems.

Predator death loss

Adult sheep were most commonly lost to coyotes (54% of predator sheep deaths), dogs (21%), and mountain lions, cougars, and pumas (5.6%). Lambs shared the top three predators with adult sheep – coyotes (64% of predator lamb deaths), dogs (10%), and mountain lions, cougars, and pumas (4.5%). The largest operations tended to see more sheep deaths due to mountain lions, cougars, and pumas and more lamb deaths due to ravens and eagles than smaller operations. Predatory threats have not changed much since 1994.

Death loss mitigations

The percentage of operations using any nonlethal predator control methods has increased over 25% (32% in 2004 to 58% in 2014) over the previous 10 years. The methods seeing the greatest increases include using fencing (15% increase), guard dogs (15%), using a lamb shed (10%), and using night penning (9%). Nearly two-thirds of operations using any nonlethal predator control methods use more than one method. The top three combination methods include fencing combined with guard dogs, fencing combined with lamb sheds, and fencing combined with night penning.

Where can I find these results?

The NAHMS reports are published electronically on the NAHMS and hard copies are available upon request. NAHMS is currently piloting an interactive, electronic reporting tool (Tableau dashboards). This tool allows for interactive visualizations of report data and custom-filterable results.

The University of California Agriculture and Natural Resources (see http://anrcatalog.ucanr.edu) has produced a valuable resource looking at predator loss mitigation methods focused on California producers. This is valuable even outside of California as it gives relevant information for common predators even outside of that one State (coyotes, dogs, mountain lions). The American Sheep Industry Association has highlighted the importance of the sheep death loss reports produced by NAHMS to the industry and the producers it supports. The Wisconsin State Farmer produced a story highlighting results from the Cattle and Calves Death Loss, 2015 Report, focusing on the predators in Wisconsin. This report also gives links to useful tools provided by the Department of Natural Resources on predation reports. The article can be found at the following link: http://www.wisfarmer.com/story/news/state/2018/03/02/growing-predator-population-concerns-farmers-rural-citizens/388421002/.

Opportunity for feedback and participation

Each of the questionnaires typically take approximately an hour to complete. If you are of those few selected, we encourage you to participate. This not only improves the current study by supplying valuable (and confidential) information, but also, your participation ensures that producers similar to you are represented in the aggregated study results. This also lets us know that the study is valuable to our most valuable stakeholders: the producers.

We also fully invite any feedback on the questionnaire, how the questionnaire is delivered, the values in reports, the method of reporting, or any other factor of the survey that you think can be improved to provide the best picture of the State of livestock death loss in the United States. You can reach out to the contact information provided on the NAHMS website or

Address	National Animal Health Monitoring System (NAHMS)
	2150 Centre Ave, Building B, Mail Stop 2E7
	Fort Collins, CO 80526-8117
Phone number	1-866-907-8190

Where Are They Going? A Look at Past and Future NAHMS Goat Health National Studies

Mr. Matthew Branan

Mathematical Statistician

USDA-APHIS-VS-National Animal Health Monitoring System, Fort Collins, CO

NAHMS website: http://www.aphis.usda.gov/nahms

Matthew.A.Branan@aphis.usda.gov

NAHMS introduction

Background

The National Animal Health Monitoring System (NAHMS) is a nonregulatory program that was created in 1983 within the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Services (APHIS) with the task of collecting and delivering scientifically accurate and statistically valid information on animal health and management within the United States. Since 1989, NAHMS has conducted nation-wide studies on many animal commodities, including goats, sheep, equine, catfish, beef cattle, dairy cattle, swine, and poultry on a rotating basis.

NAHMS studies are completely voluntary and are conducted with the aim of describing national animal health and management while protecting producer identities through a number of means. NAHMS is committed to providing aggregate information that avoids protected information and using avoidance disclosure methods to protect participant identities. Survey information is associated only with a numeric identification number, and blinding prevents linkage back to the participant.

Study outline

The typical NAHMS national animal health and management study is a multi-phase, cross-sectional, observational study that collects information using a statistical sampling design. These are typically performed in collaboration with another statistical agency: the USDA-National Agricultural Statistics Service (NASS). NAHMS studies are the largest national animal health studies in the U.S. and their results can be generalized nationally, as the samples taken for the studies represent at least 70% of the operations and at least 70% of the animals in the commodity of interest.

The multi-phase study design includes Phase I, implemented by National Association of State Departments of Agriculture (NASDA) field enumerators, who administer the first questionnaire covering general inventory and management information. If the participant agrees to participate, they will be contacted by NAHMS field enumerators, who will administer the Phase II questionnaire. If the study has funding for a biologics testing component, those who complete the Phase II study will be offered complementary biological testing for specific disease agents. In the past, testing has included deworming and fecal egg count reduction testing, testing for anthelmintic resistance of internal parasites, BVD testing for beef calves, and testing for mycoplasma ovipneumoniae, salmonella, and enterococcus in sheep.

Comprehensive reports of aggregated survey results are compiled and released on the NAHMS website and mailing lists, along with information sheets for particular items of interest. This information can be used

by individual participants to gain insight into the current and possible future directions of the health of the industry, compare themselves to other producers at the national level, and biological testing results can help producers make informed disease decisions specific to their operation or farm.

NAHMS Goats 2009

Respondents

This was the first NAHMS study, providing an in-depth look at the goat industry. Over three-quarters of goat operations and 82.2% of goats in the U.S. were represented. Data were collected from 21 States, in three regions. Operations with fewer than 10 goats had the opportunity to complete a questionnaire over the phone while operations with 10 or more goats were visited in person. There were 2,484 respondents, which were evenly distributed among regions and size categories. Nearly half of respondents fell into the primary operation type category of raising meat goats, 14% fell into dairy, 4% in fiber, and 32% other.

Goat and operation inventory

There were over 2.6 million goats on approximately 150,000 in the U.S. in January, 2016. According to the NAHMS Goats 2009 Study results, nearly half (47%) of operations reported their primary use of goats was for meat, followed by pet/companion goats (25%), and milk goats (14%). Many of the pet/companion goats are housed on very small (fewer than 10 goats) operations, and most (70%) of the U.S. goats are estimated to be meat goats, 12% are estimated to be dairy goats, but only 3.4% are estimated to be pet/companion goats.

The goat industry appears to have a large number of operators who are new to the industry. Over a third of all operations were owned or managed by a producer with less than 6 years of experience, especially on the smaller operations. When asked about reasons for raising goats over one-third (36%) of operations reported that fun/hobby was "very important," this percentage being higher than 30% for all but the large (100 or more goats) operations (11%). On the other hand, only the large operations had a majority (58%) report that raising goats for a source of income was "very important." Nearly a third of operations reported that prescribed/target grazing, brush control, etc. was "very important," regardless of the size of the operation.

Breeding

The majority of operations (88%) with 10 or more goats bred any goats in the year prior to the study. Of the very small operations, only 36% had any kids born on the operation between July 1, 2008 and June 30, 2009. For those that did breed, less than one-fifth (19%) of operations used at least one of the listed reproductive practices, the most common being flushing (10% of all operations), followed by genetic selection for the ability to breed out of season (5.4%), ultrasounds (3.6%), and semen evaluations (3.3%). Large operations tended to report performing these practices than small or medium-sized operations.

Large operations tended to breed more does per buck (average of 20.4 does per buck of any type) compared to small (7.1 does per buck) or medium-sized (11.0 does per buck) operations. Close to half (48%) of operations had only one breeding season per year, followed by 35% having no defined breeding season, and 16% having two breeding seasons per year. Meat operations tended to breed more times per year than other types of operations. Almost 90% of bred does gave birth and only 2.5% had known abortions, with 95% of those kids born were born alive, and nearly 88% that survived past weaning or had not been weaned.

There are many disease risks to does and kids before, during, and after kidding, though there are prevention measures that can be taken. Before kidding, does kidding for the first time were separated from older does on 38% of operations. This practice can help prevent the first time does from being exposed to agents that could cause abortions or otherwise affect the health of the doe. At the time of kidding, providing a clean kidding area, by cleaning manure and waste bedding, between each kidding doe is another way to curb disease. Approximately one-quarter of operations performed this type of cleaning in the breeding season(s) prior to

the study. After kidding, preventing exposure to placentas and aborted fetuses can prevent many disease conditions. Approximately 59% of operations did not leave placentas or aborted fetuses in fields or kidding areas, with meat operations tending to clean these up less frequently. Less than half (43%) of operations fed kids medicated feed to help prevent coccidiosis. Coccidia are internal parasites that can take harbor in the small intestine and can result in scours, unthriftiness, weight loss, and even death.

Milking

There were approximately 16% of operations with 10 or more goats that milked does in the year prior to the study, with those operations milking approximately 65% of their does. This was more common in the Northeast (23% of operations, 73% of does on those operations) region. For those milking operations, three-fourths of operations fed the milk to kids on the operation and two-thirds kept the milk for home consumption. Large operations more frequently sold or traded milk products (57% of large operations that milked compared to 12-25% of very small to medium-sized operations). Smaller operations tended to sell or trade the milk for human, pet, or livestock consumption while larger operations tended to sell milk to be made into cheese or as milk for human consumption.

Culturing milk has many benefits, including identifying the most prevalent causes of clinical mastitis, helping to direct mastitis therapy, and screening purchased herds or milking strings for contagious mastitis pathogens. Bulk tank somatic cell count (BTSCC) refers to the number of white blood cells (leukocytes) and secretory cells per milliliter of raw milk and is used as a measure of milk quality and udder health. Increased BTSCCs are generally associated with increased intramammary infection and decreased milk production. Approximately 18% of operations performed individual goat milk culture or somatic cell counts and 10% performed pooled culture or somatic cell counts.

Veterinarian use

One-third of operations had consulted a veterinarian during the previous 12 months. Dairy operations and larger operations tended to consult veterinarians more often than meat operations. Other goat producers (33% of operations), veterinarians, nutritionists, or other paid consultants (30%), and the internet (27%) were rated as the most important sources of information for goat health.

Vaccination

Approximately half (49%) of all operations vaccinated any goats or kids the year prior to the study. Most commonly, operations vaccinated for enterotoxemia (90%) and tetanus (87%), which are widely recommended for goat vaccination. Only 15% or less of operations vaccinated for other diseases. For those operations that vaccinated for enterotoxemia, about 62% of operations gave boosters annually, 34% gave boosters 2-4 times per year. This is important because enterotoxemia vaccinations tend not to be effective for prolonged periods of time without boosters, and so frequent boosters are often recommended.

Internal parasites

Internal parasites are the most common causes of death of goats in the U.S., accounting for approximately 87,000 goat and kid deaths, or about 23% of all deaths to nonpredator causes, in 2015. Barber's pole worm is considered by some to be the most economically important parasite for goat producers. This parasite can cause anemia, bottle jaw, and even death in some cases. Prevention measures include the use of the FAMACHA© card, developed in South Africa, to determine if goats should be treated for barber's pole worms. The FAMACHA card allows the producer to selectively treat those goats that need treatment quickly and to help curb parasite resistance to deworming products. In 2009, approximately 92% of operations treated any goats or kids for worms in the three years prior, though only 14% of operations used the FAMACHA card to help manage internal parasites in goats and kids. Related to this, 11% of operations used a fecal egg count

reduction test to determine if parasites were resistant to dewormers, and this practice was more common in large operations (25%) compared to small operations (6.9%).

NAHMS Goats 2019

Needs assessment

The Goats 2019 Study marks the second time NAHMS has implemented a national study of the U.S. goat population. The needs assessment report is available at the following link: https://www.aphis.usda.gov/animal_health/nahms/goats/downloads/goat19/needs-assess.pdf. This was an effort to gather information from our stakeholders to focus the objectives, design, questions, and incentives offered to participants. The needs assessment survey was available from the NAHMS website and was sent out in email lists.

Management	**Disease**	**Greatest risk**	**Incentives**
Vaccines and pharmaceuticals	Internal parasites	Management costs	Parasite/resistance testing
Doe health and management	Caprine lymphadenitis	Disease	Individual animal testing
Infectious diseases	Caprine arthritis encephalitis	Access to veterinarians or pharmaceuticals	Feed/forage analysis
Antimicrobial use/ resistance	Mastitis		
Biosecurity/disease prevention	Lameness		

Over three-fourths (80%) of the 1,272 respondents were goat owners, 11% were veterinarians/nutritionists, and 8% were government or university employees. Of the goat owner respondents, nearly half (46%) had between 20 and 99 goats. About a third of the goat owners were categorized as meat production operations and a quarter of operations were primarily dairy operations and another quarter owned goats primarily for show or hobby. The needs assessment focused on the top priority management factors, disease interests, greatest risks to the industry, and top incentives for participation. The top three to five factors for each subject are presented above.

Biologics testing

All biologics testing planning is pending funding. The NAHMS Goats 2019 Study is hoping to include testing for E coli, salmonella, campylobacter, enterococcus, and cryptosporidium in fecal samples, and scrapie genetic resistance serotyping in hair samples. Also hoped for is pre-deworming fecal egg counts, deworming, and post-deworming fecal egg counts, along with fecal egg count testing results and anthelmintic resistance testing. Results of tests offered to participants will be securely mailed to participants so that NAHMS headquarters employees will not know the identities of the participants and NAHMS field enumerators will not know the results of the testing. This creates an information barrier that prevents individual testing results being connected to any single participant in the study.

Opportunities for feedback

For the NAHMS Goats 2019 Study, operations with 5 or more goats from the following 25 States will be selected: Alabama, Alaska, California, Colorado, Connecticut, Florida, Georgia, Indiana, Iowa, Kentucky,

Michigan, Minnesota, Missouri, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Vermont, Virginia, Washington, and Wisconsin.

Each of the questionnaires typically take approximately an hour to complete. If you are of those few selected, we encourage you to participate. This not only improves the current study by supplying valuable (and confidential) information, but also, your participation ensures that producers similar to you are represented in the aggregated study results. This also lets us know that the study is valuable to our most valuable stakeholders: the producers.

We welcome any feedback on the upcoming and future studies. You can reach out to the contact information provided on the NAHMS website or

Address	National Animal Health Monitoring System (NAHMS)
	2150 Centre Ave, Building B, Mail Stop 2E7
	Fort Collins, CO 80526-8117
Phone number	1-866-907-8190

Preventative Medicine 101

Dr. Jim Keen

University of Nebraska

Lincoln, NE

Introduction

In my experience, familiarity with and application of a few basic concepts provides a sound foundation for herd or flock health (preventive medicine). These practices minimize disease risk, maximize health, and optimize growth and reproduction. They also enhance benefits of raising small ruminants, including financial returns and personal satisfaction. Preventive medicine is really just risk management (insurance) by another name. Most herd or flock health (disease) is directly related to good (bad) husbandry. Thus, the good news is that you have a great deal of free agency and control over the overall health profile of your goat herd or sheep flock.

Concept #1 - Maximize biomimicry "Don't live by your own rules, but in harmony with nature" Epictetus, 1st century AD

As applied to preventive medicine, I define biomimicry as managing animals in the most "natural" way possible, i.e., in a way that goats and sheep have been evolutionarily adapted. In other words, the best preventive medicine for goats or sheep is to place them in an environment and manage them, as much as possible, in a manner to which these domestic ruminants were adapted since their domestication (in what is now Iran) about 10 thousand years ago. Looking at wild goats and sheep can also provide clues for problem prevention. Let a goat be a goat. Let a sheep be a sheep. A sheep is not a goat. Do not try to raise a fish out of water.

Biomimicry example - Goats are browsers, preferring, and well adapted to, feeding on leaves and soft shoots of woody plants such as shrubs, forbs and herbaceous dicots (non-grasses). In contrast, sheep are grazers, preferring, and well adapted to, feeding on grasses or other low vegetation, mostly monocots. Even though sheep and goats are bio-similar in many ways and closely related ruminants, they best utilize very dissimilar food sources. If one grass pastures sheep and goats together, and perhaps overgrazes the pasture, sheep will graze closer to the ground than can goats. Two problems may develop. First, goats are forced to eat grass. Second, goats must graze close to the ground, thereby ingesting many parasitic worm eggs or worm larvae, especially the blood sucking stomach worms (*Haemonchus* and *Ostertagia*). Theses worms cause severe blood loss, anemia, diarrhea and dehydration in a dose-dependent manner. Browsing goats are exposed and to low numbers of parasites. As grazers, sheep are much better evolutionarily adapted to stomach blood worms than goats, who may die from parasitic blood worms on short grass pastures. One cannot always manage a goat as a sheep or vice versa.

Concept #2 - The epi triad or epi triangle drives disease occurrence in individual animals.

The "epidemiologic triad" is the idea that individual animal health or disease risk results from the complex interaction (balance or imbalance) of three main factors:

1. *The host,* e.g., immune status, nutrition, age, gender, breed or genetics, physiology etc
2. *The disease agent* = that which is able to cause disease in a susceptible host. Agents can be biological (e.g., viruses, bacteria, worms), chemical (e.g., heat, toxins) or physical (e.g., excess or deficient nutrients)

3. *The environment* = the non-host, non-agent surrounding physical, climate, biologic, social and economic conditions and influences. Husbandry practices ("hu-management") are the major driver of good or bad preventive medicine in small ruminants, often from application (or not) of biomimicry.

In other words, many factors are involved in disease occurrence or non-occurrence. Health and disease occurrence are not random events. You can modify the risk of disease in your animals if you know the epi triad drivers. Since each animal's epi triad factors differ, animals in a herd are differentially impacted. Of the three epi triad components, the environment almost always has the greatest influence on good or poor goat/sheep well-being. Husbandry, especially feed, housing and sanitation, are often prime environmental drivers.

Epi triad example - With rare exceptions, most infectious agents co-evolved with their specific small ruminant hosts long before domestication thousands of years ago. Therefore, if an agent can survive under difficult free-range conditions of the wild sheep or goat, think of how much easier pathogen transmission (and high exposure dose) will occur in an intensively managed crowded pen environment. Coccidia (gut protozoan parasites) usually cause severe clinical disease (bloody diarrhea and death) only in young sheep and goats (poor kid or lamb immune status from receiving little colostrum) (the host) when crowded in a dry lot pen with heavy soil oocyst contamination (the environment) when exposed to a virulent strain of coccidian at high dose (the agent).

Concept #3 - The disease iceberg

The health status of animals in a flock or herd for any given disease problem can be classified in three ways:

1. Healthy = non-infected, non-diseased, unaffected
2. Clinical = signs of the disease can be detected during a normal clinical exam (the visible iceberg)
3. Subclinical = disease cannot be detected without special tests beyond human senses, e.g., antibody testing. These animals are sick or infected but visibly healthy (submerged portion of the iceberg)

For most livestock endemic (established, stable, local) and even epidemic diseases:

- Subclinical infections > clinically diseased
- Sick > dead among clinically affected
- Financial costs of subclinical disease > clinical disease. This is because clinically silent illnesses extract a physiologic cost from the host goat or sheep, which usually manifests as lowered production or poor reproduction. There is no free lunch!

As vulnerable prey species, goats and especially sheep, are stoic and will hide disease signs even when severely ill. This is the reason for the phrase "A sick sheep is a dead sheep". (Goats are typically much less pain tolerant than sheep). Therefore, absence of clinical disease expression may not represent absence of disease in an individual or a herd.

Concept #4 - Herd and flock bio-security

Many if not most contagious infectious diseases of goats and sheep first enter a herd or flock via the introduction of new animals. Good record keeping, quarantine and sometimes pre-purchase/pre-introduction testing (to detect subclinical infections) of new stock are prudent steps to prevent new infectious disease or even genetic problems. Slowly progressive insidious chronic diseases such as caprine arthritis encephalitis virus are very easy to introduce and extremely hard to eliminate. Keep a closed herd or flock as much as possible.

Concept #5 - "Management by needle"

Many people who raise goats, sheep and other livestock equate use of veterinary drugs and especially vaccines, with preventive medicine. Vaccines and drugs have certainly transformed veterinary medicine for

some non-infectious and several infectious diseases. However, principal reliance on drugs or vaccines for herd or flock health (the host component of the epi triad), while ignoring bio-mimicry and especially the goat or sheep environment, generally fails.

A second constraint on "management by needle" is the relative paucity of FDA-approved drugs and USDA-approved vaccines for sheep and especially goats. The high cost to pharmaceutical companies of vaccine and especially drug development and approval for "minor species" (domestic animals with small populations including sheep, goats, catfish, game birds, and honey bees among others) is a major financial roadblock to providing limited-demand animal drugs. Therefore, many veterinary drugs and some vaccines must be used "off label" (in a government non-approved manner) in sheep and goats. Another important issue in the use of veterinary medications in sheep and goats is overuse and subsequent drug resistance.

Management by needle example - Effective parasite control is a severe and growing problem in small ruminants. For example, widespread and often inappropriate use (and overuse) of ivermectin and related drugs resulted in development of drug resistance and clinical ineffectiveness. Use of the FAMACHA system is an excellent example of the subclinical disease iceberg for blood worm parasites in goats (Concept #3) and minimizing management by needle (Concept #5)

Concept #6 - Relationship

Establish a good relationship with a small ruminant veterinarian. Historically, relatively few vets are experts in sheep and goat health. However, this is changing for the better with the newer generation of veterinary practitioners. Utilizing the services of a veterinarian with small ruminant interest and expertise can be an important component and cost-effective investment in an effective goat or sheep preventive medicine program.

Veterinarians will have good knowledge of and experience with health problems in your area, e.g., dealing with endemic diseases, best available vaccines, wildlife vectors, antibiotics of choice and when to pursue or ignore a health issue.

Conclusions

"Superior doctors prevent the disease. Mediocre doctors treat the disease before evident. Inferior doctors treat the full blown disease." Huang Dee, Nai-Ching (1st Chinese Medical text, 2600 BC). Substitute "goat or sheep producer" or "vet" here in place of "doctor"

Most small ruminant diseases, both infectious and non-infectious, are endemic and clinically silent in most herd or flock members. Your goal is to keep a lid on them. You will see caseous lymphadenitis ("CL", local, endemic) long before you see foot and mouth disease (FMD, foreign, epidemic). Other useful preventive medicine concepts include:

- Biosecurity ≠ vaccination.
- Preventive medicine ≠ vaccination.
- Use time-tested practical approaches.
- Simpler is better and more sustainable over the years.
- Continue to educate yourself - learn from your vet, neighbors, Langston University, etc (www can be sketchy).
- Select stock that do well in your area. Most sheep and goat breeds were originally developed for and adapted to specific climates or geographic areas.
- A high enough infectious agent dose overwhelms the best sheep or goat immune system.
- Good sanitation is critical. "Civilization is the distance that man has placed between himself and his own excreta." Brian W Aldiss

Common Diseases of Small Ruminants and Their Signs

Dr. Jim Keen

University of Nebraska

Lincoln, NE

"When you hear hoof beats, think of horses not zebras". Theodore Woodward, 1940s

Disease is defined as failure of normal homeostatic processes at any level of biological organization, i.e., cell, organ, tissue, individual animal, herd or flock. The specific interactions of the epi-triad (host, agent, environment) determine whether homeostatic failure occurs in individual animals. This is why any given disease usually clinically affects only a proportion (often small) of animals at a given time.

Proper diagnosis is often key to effective disease control. Other times, a specific diagnosis is not needed, especially if the treatment will not change based on the diagnosis. Know that a diagnosis is simply an informed opinion based on available information. I describe four ways to classify goat and sheep diseases below.

Epi-triad model - diseases are separated into three categories

Infectious - agent driven

Genetic - host susceptibility driven e.g. scrapie in sheep and goats

Environmental - too much or too little of some non-infectious environmental constituent

DAMN-IT system

D =	degenerative, e.g., aging, osteoarthritis
A =	anomalous, e.g., auto-immune. What the heck is this?
M =	metabolic, e.g., hormonal
	mechanical, e.g., thermal
	mental, e.g., behavioral
N =	nutritional, e.g., under- or over-nutrition, nutrient deficiencies or excesses, toxic plants)
	neoplastic - benign or malignant
I =	inflammatory
	infectious, e.g., bacteria, protozoa
	non-infectious, e.g., injection of irritating drugs
	ischemic, e.g., vascular
	immune-mediated, e.g., hemolytic anemia
	inherited, e.g., cleft palate, undescended testes
	iatrogenic - caused by treatment, e.g., drug reactions, surgical complications
	idiopathic - cause unknown
T =	traumatic

trauma - external, e.g., fractures or internal, e.g., uroliths

toxic or toxins - endogenous or exogenous (chemicals, foods, plants, poisons)

Organ system affected and/or clinical signs (decreased productivity or overt illness)

There are eleven mammalian organ systems: integumentary (skin), muscular, skeletal, nervous, circulatory, lymphatic, respiratory, endocrine, urinary/excretory, reproductive and digestive.

Zoonotic - small ruminant infections that are transmissible to people, e.g., Q fever

In my presentation I will focus on common small ruminant diseases focusing on diagnosis and treatment using the organ system-clinical sign and zoonotic approaches

Diet and Parasite Control in Small Ruminants

Dr. D.G. Pugh
DVM MS MAG, Dipl ACT, ACVN, & ACVM
Director
Alabama Veterinary Diagnostic Laboratory System
890 Simms Road
Auburn, AL 36831-2209

Introduction

Internal parasitism of meat goats is the most significant health risk affecting production and can result in serious economic losses for producers. Financial losses are a result of decreases in growth, milk and fiber production, as well as increasing treatment and prophylaxis costs. Parasitic infections can also result in death and/or loss of function. Although a major concern in production animals, this can be quite devastating for pet animal owners.

Feeding practices, which increase stocking rates but also increase pasture contamination with nematode parasite eggs, magnify internal parasite infection in grazing goats. Care should be taken to minimize intake of infective nematode parasite larvae when feeding goats. Animals with limited nutrient intake or those offered diets deficient in one or more nutrients are more likely to suffer losses from internal parasitism than those fed a balanced diet.

Meat goats infected with internal nematode parasites quickly contaminate pastures through their manure. Others then become infected as they graze on the same pasture. Small ruminant or camelid production systems that use grazing without pasture rotation, particularly in areas of high rainfall and ground moisture, are more likely to have infected animals. Droughts, inclement weather or lack of adequate forage (or pasture) may result in increased animal concentration, which can also equate to an increase in parasitism. Feeding practices, which increase stocking rates but also increase pasture contamination with nematode parasite eggs, magnify internal parasite infection in grazing horses and other herbaceous animals. Care should be taken to minimize intake of infective nematode parasite larvae when feeding horses. Animals with limited nutrient intake or those offered diets deficient in one or more nutrients are more likely to suffer losses from internal parasitism than those fed a balanced diet.

Gastrointestinal tract (GIT) parasites appear to have a negative effect on protein and to a lesser extent, on energy metabolism, and increase requirements of these nutrients in goats. Increasing dietary protein (particularly proteins rich in sulfur containing amino acids) intake will aid in overcoming some of the clinical signs seen with parasitism. Protein quality appears to have a more significant affect than the quantity. Supplemental soybean meal and energy can improve resilience. Dietary supplementation appears is more effective when targeted (i.e., specific nutrients are deficient and the goat's requirements for those nutrients are greatest).

Given the complicated nature of parasite control and recent documentation of widespread resistance to deworming compounds in North America, meat goat producers take a multi-pronged approach to parasite control:

1. Employ husbandry and feeding practices that minimize parasite infection.
2. Use novel deworming practices that maximize endectocide efficacy and minimize parasite resistance.

Other management tools useful in controlling parasite associated diseases include:

1. Identify and remove animals from pasture that do not appear to be resistant to internal parasites. Culling these animals, while keeping and breeding meat goats that appear to perform better in the face of parasites, will enhance a herd's overall production on a farm where parasites are a major problem. This will rarely be used in pet animal herds.
2. Ensure proper nutrition to help meat goats naturally ward off internal parasites and recover from parasite-induced damage after deworming.
3. Providing good forages and meeting protein, energy, mineral and vitamin requirements are critical to maximizing flock or individual meat goat's production and reducing dependence on deworming agents.
4. Inclusion of higher quality and higher concentrations of protein in the diet (emphasis on legumes), including browse for foraging animals.
5. Insuring adequate macro and trace minerals (with emphasis on Ca, P, Zn, Cu, and Se).
6. Allowing access to condensed tannin containing forages all will aid in the reduction of internal parasite burdens.
7. Feeding to meet nutritional requirements for optimal growth/production.

These animals fed in such a manner as to improve health are usually more prone to have better resistance and resilience. Providing supplemental protein improves resistance & resilience, particularly with protected protein. Feeding forages with condensed tannins may help prevent parasitic disease.

Some dietary/herbal modifications of the diet include:

- Feeding goats sericea lespedeza hay or pelleting sericea lespedeza.
- Feeding birdsfoot trefoil and sainfoin for ~ 2 weeks appears to reduce the FEC.
- Feeding 600mg/kg bw of Orange oil emulsion can reduce the FEC by over 90%.
- Feeding *Albizia anthelmintica* bark has some effect by reducing the FEC by nearly 80% in some studies.
- *Lippia sioides* essential oil may also reduce the FEC by over 50% in some studies.
- Ethanolic extracts of *Iris hookeriana* rhizome may reduce the FEC by about 45%.
- Whereas feeding *Azadirachta indica* (neem) leaves does not affect FEC when studied.
- Feeding *Azadirachta indica* seed may reduce FEC by up to 40%.

Rotate pastures, allowing meat goat's access to tannin and/or protein rich forages (legumes); use proper pasture fertilization techniques, and administer dewormers to maximize herd production while minimizing the harmful effects of internal parasites.

Minimizing Resistance to Endectocides

Ensure adequate intake of all deworming products by weighing each animal; avoid administering an "average body weight" dose, and properly use administration equipment. Dosing or administering a dewormer based on average body weight will result in under dosing some goat's (ineffective control of parasites), while others are overdosed (increased costs, possible toxicity). Identify goat's that need deworming and only treat them to help diminish resistance to dewormers and slow the onset of dewormer-resistant parasite populations on farms.

Management tool that identify individual that need de-worming and those that have greater resistance (such as FAMACHA©), which identifies individual members of the flock that are anemic because of heavy

parasite burdens and would benefit from deworming. FAMACHA may also be effective in reducing the long-term use of de-wormers, increasing flock performance and lowering the incidence of parasite resistance to deworming agents. FAMACHA appears to be an effective tool for decision analysis of determining which goat needs to be effectively dewormed, and when it should be dewormed.

Feeding Protein

Whenever dietary protein is reduced to less than 6%, feed digestibility is reduced, which results in lowered feed intake. Requirements for maintenance for protein is approximately 8% of the diet. Feeding excess protein (>130% of requirements) has been shown to have some value in prevention and control of some GIT parasites. Inclusion of higher quality and higher concentrations of protein in the diet (emphasis on legumes), including browse for foraging goats may be useful in controlling parasitic diseases. Most moderate to good quality grass forages will be adequate in protein for maintenance, but may not supply sufficient quantities for other period of the life cycle (growth, lactation, growth, late gestation) or for sick or debilitated goats. Browse (leaves and twigs of trees and shrubs) generally contain higher levels of crude protein. Other sources of supplemental protein, when production demands result in higher requirements include:

1. grains - soybean meal, cottonseed meal, brewers grains.
2. legume forages – clover, alfalfa, peanut hay, kudzu, birdsfoot trefoil.

Legumes will have more protein than grasses, but as both are forages and ‘bulky’, the diet manager may need to include a grain source of protein in order to meet increased demands.

Financial Statements and Analysis

Mr. Clark Williams

Extension Specialist

Langston University

Department of Agriculture and Natural Resources

Importance of financial statements

The development of accurate financial statements is an important process for the farm/ranch manager. Financial statements not only help in meeting the documentation requirements for loan requests, but are also valuable management tools. Using financial statements, the manager can examine the financial health of the operation.

From the balance sheet, the financial position of the operation can be determined by examining the relationships between assets, liabilities, and owner's equity. The income statement indicates the performance of the operation by showing how much income was generated, how expenses were incurred, and how well debt payments were met. The cash flow statement indicates future cash surpluses and shortfalls that are necessary for planning.

Sources of financial information

The first step in completing financial statements is knowing were to find the financial information that is needed. Several possible sources of information are listed below. However, each individual manager may have a better idea of where to look for the appropriate information.

- Income tax returns
- Recordbooks or accounting systems
- Depreciation schedules
- Bank statements
- Financial lenders
- End of year inventories

The Balance Sheet

The balance sheet is a financial statement that provides information about the producer's assets (what is owned), liabilities (what is owed), and equity (net worth) and their relationships with each other at a specific point in time.

Assets are those items that are owned and provide a beneficial economic resource to the farm operator. They are normally classified as either current or non-current.

Current assets are composed of cash and items that can be converted into cash with little difficulty. They also include items that will turn into cash within the normal operating cycle of business, which is usually one year. Current assets are listing according to their liquidity (how easily they are converted to cash) with the most liquid, cash and checking, appearing first. The following is a description of several common categories that make up the current assets in the balance sheet.

Cash and checking – consists of a physical count of cash on hand and checking account balance assuming all checks written have cleared as of the date of the balance sheet.

Savings and time deposits – includes all savings accounts and certificates of deposit (CD's).

Investments and securities – includes stocks, bonds, and mutual funds.

Accounts receivable – refers to any money owed the farm operator from others.

Feed and supplies – includes feed, hay, grain, fertilizer, medicine, etc. that has been purchased but not used.

Livestock to be sold – includes livestock that will be sold in the next 12 months.

Growing crops – should equal the costs that have been spent on a crop that has not yet been harvested.

Non-current assets are things that are owned which have economic lives greater than one year. All depreciable assets are considered non-current. The following is a description of common non-current assets that are found on the balance sheet.

Breeding livestock – includes bulls, cows, and replacement heifers for cattle and the same equivalents for other species of livestock.

Machinery and equipment – includes tractors, trucks, farm implements, etc.

Buildings and improvements – includes buildings, drainage systems, fences, storage bins, etc.

Real Estate – includes all land that the producer is the titleholder of or land that the producer is making payments to acquire the title.

Liabilities represent everything that the farm operator owes whether in the form of cash, products, or services. Like assets, liabilities are categorized as being either current or non-current.

Current liabilities are those liabilities that will become due within one year and will be paid with a current asset or the creation of another current liability. The following is a description of common current liabilities that are found on the balance sheet.

Accounts/Notes payable – includes the amounts owed to creditors (banks, credit cards, and charge accounts) for goods or services provided but not paid for.

Current portion of non-real estate loans – includes the principal and interest due in the upcoming year on loans that are for longer than one year.

Current portion of real estate loans – same as for non-real estate loans.

Non-current liabilities are those liabilities that have a maturity greater than one year. Only the principal balance of non-current loans needs to be included because the accrued interest was included in the current

section. The main categories of non-current liabilities are the principal balance on non-real estate and real estate loans.

The owner's equity or net worth is calculated by taking total assets minus total liabilities. Equity represents the portion of the farm operator's ownership in the business. If assets increase more than liabilities, equity will increase in value. In a balance sheet, the assets must equal liabilities plus equity.

The Income Statement

The income statement (also called a profit and loss statement) is a summary of income and expenses for the fiscal year normally matching the tax year. It includes both cash and non-cash values and is used to help analyze the financial performance of the business. It is used as a means by which to measure profit for a business in a given year.

The income statement is divided into revenues and expenses. Farm revenues are derived from the normal operations of the business. Such items might include the sale of crops, feed, livestock, livestock products, and government payments. Farm expenses are also derived from the normal operations of the business. The cash operating expenses are broken down into a number of different categories. Most common expense categories correspond to the list of expenses on Schedule F of the IRS tax form.

Net farm income is what is left after subtracting total expenses from total revenue. It is the amount of income made from farm production for the year.

Cash Flow Statement

The cash flow statement is a recorded projection of the amount and timing of all cash inflows and outflows expected to occur throughout the planning period, usually one year. Inflows and outflows can be projected on a monthly or yearly basis. Breaking the cash flow statement into months will identify which months have cash surpluses and deficits and enable the manager to predict future operating loan needs.

Importance of Financial Analysis

Over time, agriculture has changed from subsistence production to modern, sometimes complex businesses utilizing land, labor, and capital with the expectation of making a profit. The need to measure financial position and performance increased when agricultural producers began to rely more on capital and less on labor and land.

Financial measures enable farm operators to analyze past performance versus present performance, present performance versus budgeted performance, and a multi-year performance trend. The user must identify which measures are most beneficial to their situations.

Ratio Analysis

Financial ratios are an excepted method to measure both financial position and financial performance. Financial ratios are simply the result of a comparison using two elements of financial data. It can be expressed as either a percent or as a comparison to one.

There are several reasons why ratio analysis is commonly used to analyze financial data. A few of these reasons are:

- Easy to calculate
- Easy to make comparisons with other business's
- Simple to interpret
- Understood by others outside of management

Ratio analysis also has some limitations. Unfortunately, a farm business does not exist in a perfect world where everything can be quantified precisely. Consequently, reliance upon financial measures as a sole determinant of financial position and performance is cautioned. Some common limitations of ratio analysis are:

- Ratios can warn you of a problem, but they can't specifically identify the problem.
- Ratios are only as good as the data source. Ratios derived from poor financial statements can be misleading.
- Ratios should not be a substitute for good judgement and common sense.

Financial Measures Categories

There are three broad categories of financial measures that will be discussed: Liquidity, Solvency, and Profitability. All measure either financial position or financial performance. For each category, there will be an explanation of what is being measured, a commonly used ratio, and an interpretation. All of the data needed for the ratios are found on either the balance sheet or the income statement.

Liquidity

Liquidity is a measure of the ability of a farm business to meet financial obligations as they come due in the ordinary course of business.

Current Ratio = Total current assets / Total current liabilities

This ratio indicates the extent to which current farm assets, if liquidated, would cover current farm liabilities. Higher calculated ratios are indicators of higher liquidity. A ratio of 1:1 is marginal. A ratio of 2:1 is considered good.

Solvency

Solvency is a measure of the amount of debt relative to the amount of owner's equity in the business. It provides an indication of the firm's ability to repay all financial obligations if all assets were sold. This measure is very important to lenders.

Debt/Equity Ratio = Total Liabilities / Net Worth

This ratio measures financial position and reflects the extent to which farm debt is being combined with farm equity. This ratio should be less than 1:1. Lower ratios represent increased solvency.

Profitability

Measures the extent to which a business generates a profit from the use of land, labor, capital, and management.

Return on Assets = Net Income / Total Assets

This ratio measures the rate of return on farm assets and is often used as an overall index of profitability. This ratio is normally expressed as a percent. Higher values indicate more profitability for the farming operation.

Analyzing Trends

Trend analysis is another simple and excepted way to measure financial performance. A trend indicates a direction or movement over time. To determine a trend, you make a comparison of the same measure over a period of time. In terms of financial analysis, this time period is two or more years.

Trends can be used to analyze ratios and data from past, present, and future financial statements. The following is a list of data that is commonly analyzed using trends:

- Total assets
- Total liabilities
- Net Worth
- Total Revenue
- Total Expenses
- Net Income
- Liquidity ratios
- Solvency ratios
- Profitability ratios
- Efficiency ratios

Online Resources

Langston University's American Institute for Goat Research provides both a Dairy and Meat Goat Producer Certification Course. Within these free courses are modules on Goat Herd Recordkeeping, Financial Management, Budgeting, and Business Planning. These modules can be accessed at the following link: http://certification.goats.langston.edu/

Cheesemaking

Dr. Steve Zeng

Langston University

Introduction

The goat industry is the fastest growing livestock sector in the U.S. According to USDA's National Agricultural Statistics Service, the U.S. goat population has increased 10 percent annually for the last two decades. In addition, since 1997 the number of dairy goat farms has increased by 45 percent. In January 2017, the National Agricultural Statistics Service of USDA (NASS; http://www.nass.usda.gov) reported a total of 344,000 registered dairy goats in the U.S. and estimated over 50 million pounds of goat milk produced annually. According to FAOSTAT data, goat milk production totals almost 12 million tons annually worldwide and more than half of the goat milk is used for cheese and other dairy products manufacture. Affection for goat milk and milk products such as cheeses has increased among American consumers in recent years. As evidenced by more than 300 goat cheese entries in the World Cheese Championship and the American Cheese Society Cheese Contest in recent years, artisanal cheesemaking (i.e., homestead, farmstead and small-scale commercial) has definitely become popular in the U.S. Workshops and training courses on goat cheeses are being provided to assist beginners to get started and experienced cheese makers to perfect their products, thus promoting the dairy goat industry as a whole viable agricultural sector.

Artisanal cheese making is an art coupled with a profound knowledge of science. Understanding the principles and basic controls of milk quality, microbiology, fermentation, safety, and dairy processing technology is imperative to make high quality and safe cheeses. In this one-day hands-on cheese workshop to be held in the pilot creamery at Langston University, we will share scientific theories, personal experiences and practical skills in small-scale manufacture of goat milk cheeses. We plan to demonstrate basic principles and practical skills of making hard cheeses using our own Grade "A" goat milk. Every attendee will participate in the cheese making process and learn basic cheesemaking steps using Cheddar cheese as a demonstration. Milk quality, lab testing, cheesemaking equipment, record keeping, and federal safety requirements will also be discussed. Handouts will be provided to include resources of ingredients, supplies and accessories for cheesemaking. Questions and answers will be facilitated for interactive demonstration and learning.

Following are manufacture procedures of a few common varieties of cheeses in small- scale production as a reference guide for beginners.

Goat Milk Soft Cheese

Step-by-Step Procedure

- Two gallon fresh goat milk
- Pasteurize at 145 ^{o}F for 30 minutes
- Cool down to 70 ^{o}F in tap water
- Add ¼ teaspoon of starter (MM100)*
- Add ¼ teaspoon of cheese rennet, which is diluted, with two tablespoons of tap water
- Mix well and cover the container (not too tight)
- Leave the container at room temperature (70 ^{o}F) for 12 to 16 hours (to form cheese curd)
- Dip the curd into cheese cloths or cheese bags and hang them up
- Drain for 2 hours
- Move the cheese in cloth to a cooler or a refrigerator and drain for 24 hours
- Take the cheese out of cheesecloth
- Add 1% (approximately one tablespoon) salt, Optional: Spice up with herbs to taste
- Mix well
- Pack in cups or vacuum pack in Food Saver

The shelf life of soft cheese in refrigeration is about three weeks.

Cheddar Cheese Make Procedure

(100 gallons of milk)

STEP	TIME	pH/TA	COMMENTS
Raw Milk	0 min	6.55 /0.15-0.16	Pasteurize, standardize, and temper the milk to 88-90 °F (32ºC).
Add Starter	60 min (DVS)		DVS cultures are used at one of the following rates: Original DVS – 50-60 g DVS and bulk starter cultures normally consist of *Lactococcus lactis subsp. cremoris* and *Lactococcus lactis subsp. lactis*.
Add calcium (optional)	1 h 15 min		Cal-Sol (calcium chloride) may be added at this time.
Add Color (optional)	1 h 15 min		If desired, Cheese Color (annatto) may be used at the rate of 1.0 to 1.5 oz. Dilute the coloring with cold water (do not use hard water) at a minimum ratio of 1:20.
Add Rennet (Coagulant)	1 h 20 min	6.49/0.16	Liquid rennet is used at the rate of 1 to 1-1/2 oz. According to the manufacturer's instruction. Dilute with water at 1:40 prior to addition.
Cutting	1 h 50 min to 2 h	6.51/0.10	Cut the curd with 3/8 to ½ inch knives.
Healing	2 h 5 min		Heal the curd for 5 min without stirring.
Heating	2 h 35 min		Cook the curd to 101-102º F. in 30 min. During the first 15 minutes, do not increase the temperature more than a total of 5-6º F.
Cooking	3 h 5 min		Cook the curds at this temperature for another 30 min
Draining	3 h 20 min	6.12/0.24	Drain the whey from the vat or pump the curd and whey to the drain table.
Cheddaring	5 h 20 min	5.35/0.50	Cut the matted curd into slabs and turn the slab every 15 min for 2 h.
Milling	5 h 30 min		Mill the slabs into 1 in. cubes
Salting	5 h 45 min		Salt the curd using a minimum of two applications for a total of 2.0-2.5 lb.
Hooping	6 h		Hoop the salted curds into Cheddar cheese molds.
Initial Pressing	8 h		Press the cheese initially at 30 – 35 psi for 2 h.
Final Pressing	20 h		Increase the pressure to 60-70 psi and press overnight.
Vacuum-packing			Vacuum-pack the cheese blocks in proper films
Alternatively, Air-drying for wax-coating	2 – 3 days		Place the cheese blocks in an aging room at 55 °F with 70% humidity for 2 – 3 d for easy waxing.
Ripening	3 – 6 months		Ripen the cheese in a cheese ripening room at 50 - 55 °F with 70 - 80% humidity for at least 3 months.
Sales-packing	3 – 9 months		Cut the cheese blocks into retail sizes, wax-coat and/or vacuum-pack with shrinking films.

Manufacturing Procedure of Colby Cheese

(10 gallons of milk)

When manufacturing Colby cheese, it is a good idea to use at least five gallons of goat milk per batch in order to have enough curd for pressing later on. Our experience shows that a finished Colby cheese to milk ratio of 0.8-0.9 lb per gallon can be expected. This ratio depends on the fat and protein content of goat milk and will vary between breeds. The following manufacturing procedure is recommended for a batch of 10 gallons.

1. Goat milk to be used for cheesemaking should be fresh (preferably less than two days old), clean (strained) and sanitary (total bacteria count <100,000/ml). Most importantly, the milk should be antibiotic-free. Antibiotic residues in milk will not only present a health risk to the consumer but also inactivate the cheese culture (starter bacteria), resulting in slow or no fermentation at all.

2. The milk for Colby cheese manufacturing should be pasteurized although it is legal to use raw milk provided that the cheese is aged/ripened for at least two months (60 days). Pasteurizing a batch of milk is commonly carried out at 145^{o}F for 30 min. This kills all the pathogens and almost all the organisms present in the milk. Alternatively, a high temperature and short time (HTST) technique (i.e., 161^{o}F for 15 sec) can be used and this is commonly practiced in large scale commercial productions.

3. After pasteurization, the milk is cooled down to 88-90^{o}F. When the desired temperature is reached, add 3 g (approximately one teaspoon) of Direct Vat Inoculant (DVI) starter (e.g., MAO11). This freeze-dried powdered starter is packaged in a pouch and can be stored in a freezer for up to two years. If desired, a liquid mesophilic starter culture can be used according to manufacturing instructions. The culture bacteria break down lactose in milk and produce lactic acid.

4. Mix the starter thoroughly into milk by stirring vigorously. Let the milk set undisturbed for one hour while keeping the temperature at 88-90^{o}F. This process activates the culture bacteria and is known as milk ripening.

5. Measure 10 ml (approximately two teaspoons) of liquid cheese rennet into a cup and dilute it with one cup of tap water. Rennet is a protease that coagulates milk into curds. Important: start stirring the milk first before adding the diluted rennet into the milk. Keep stirring until a uniform mixture is achieved (usually within 30 sec). Caution: excessive stirring will disturb the initial curd formation and thus should be avoided. Then, leave the milk to set for 45 to 60 min to form curd while keeping the temperature at 88-90^{o}F.

6. When a clean-break curd develops, cut the curd into ½ inch cubes with a curd knife. Leave the curd undisturbed for 5 min, allowing the newly cut surfaces of the curd cubes to form a thin film. This will help keep the cubes intact during the next few steps.

7. While gently agitating, heat the curd slowly to 102^{o}F in next 30 min. As a rule of thumb, increase the temperature by 2 ^{o}F every 5 min. Heating the cubes too quickly will seal their surfaces and cause the whey to be retained in the curd, resulting in a high moisture cheese. Caution: temperatures higher than 104^{o}F will injure or even kill the culture bacteria.

8. Cook the curd for another 30 min at the same temperature with steady agitation to remove the whey from the curd. Before draining, stop stirring for a few min to set the curd on the bottom of the vat or pot. Drain the whey to the curd level and immediately add tap water to cool the temperature down to

80°F. Stir the curd for 15-20 min more. The whole process is called washing curd. It helps develop a unique flavor and a characteristic body and texture. However, a prolonged washing at this temperature will cook more whey out and result in a lower moisture cheese.

9. Drain the whey completely and pour the curd into a perforated colander lined with cheese cloth to drain further for 20 min.
10. Pour out the curd in the vat or a pan and break the curd into particles. Add 3% (curd weight) salt (non-iodized salt preferred). Mix the salt thoroughly with the cheese curd. Put the salted curd into a cheese mold lined with cheese cloth and press at 30 pounds per square inch (PSI) for the first hour and then increase the pressure to 60 PSI and press it overnight (14-16 hours).
11. Take the cheese block out of the press. Remove the cheese block from the mold and the cheesecloth. Place the cheese in a well-ventilated cooler or a refrigerator and let its surface air-dry for one to two days.
12. Cut the cheese into desirable wheels, wedges or blocks and wax them with a food-grade cheese wax (red or yellow) by dipping three times. The temperature of wax should be around 140 °F before waxing. Alternatively, vacuum-pack the cheese after a certain period of ripening.
13. Ripen (age) the cheese in a cooler or refrigerator (45-50°F) with a moderate humidity (80-90%) for two to three months before consumption.

Approximately 8-9 pounds of Colby cheese (before waxing) can be expected from 10 gallons of goat milk. The finished Colby cheese should have a mild pleasant flavor and a soft smooth body and texture.

Feta Cheese Make Procedure (10 gallons milk)

Feta cheese is a heavily salted (up to 7%) variety of cheese originally made in Greece with sheep or goat's milk or the mixture of sheep and goat's milk. Today in the U.S. and many other countries, cow's milk is commonly used for Feta cheese manufacture. The characteristic crumbliness of Feta cheese makes it ideal for varieties of salads.

Milk	High quality whole milk is used.
Heat treatment	Pasteurize at 63 °C (145°F) for 30 min and then cool to 30-32°C (88-90°F) or at 72°C (162°F) for 15 sec.
Culture	5 g (1 teaspoon) of freeze-dried DVS mesophilic culture or following the manufacturer's instruction.
Lipase	Optional for a stronger flavor. Add 0.5 g (1/8 teaspoon).
Pre-ripening	Pre-ripen the milk for 1 h.
Rennet	Add 10 g (2 teaspoons) of liquid rennet after dilution (1:40).
Cutting	When a clean curd is developed after 45 min to 1 h, the curd is cut into ½ to 5/8 inch cubes.
Healing	The curd should be allowed to heal for 5 min.
Stirring	Stir the curd gently for 15 min to expel excessive whey.
Dipping	Dip the curd into a perforated colander lined with cheese cloth or Feta cheese molds.
Draining	Drain the curd for at least 4 h.
Brining	Slice the curd into desirable sizes (blocks) and place the slices in a saturated brine solution (20-23% salt, or use 2# salt in one gallon of water) at a temperature of 10°C (50°F) or lower. The time in brine depends on the size of cheese and the salt percentage wanted in the final cheese (4 hours to 2 days).

(Feta cheese can also be flavored with different herbs or soaked in olive oil)

Tanning Goatskins

Dr. Roger C. Merkel

Langston University

Introduction

Many people are interested in tanning goat or other skins such as deer. Learning the art of tanning skins can be very rewarding, through acquisition of new skills and the attractive products resulting from the endeavor. The supplies needed to tan skins 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 that will tan one or two skins. The art of tanning skins is a learning process that requires effort and labor to produce a soft, attractive product and your skills will improve through practice. 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 skin, it is best to send it to a professional rather than attempting to tan it yourself. This is particularly true if you are new to the art of tanning.

Hand-tanned goat, deer, and elk hides.

This chapter deals with tanning skins leaving the hair on. The techniques discussed are intended for those persons wishing to try tanning a skin for hobbyist use. Skinning and preparing hides for taxidermy are not covered. Consult a taxidermist should you wish to have an animal skinned and the skin or cape tanned and mounted.

Tanning Methods

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

Paint-on tans are easy to use, result in a well-tanned skin, and are preferred by many tanners and hobbyists. Paint-on tans require fewer solutions to prepare and dispose than do immersion systems. All areas of the skin must be covered with the paint-on tanning agent but care is needed around skin edges as the solution may be oily and could stain the fur or hair requiring later cleaning. The amount of paint-on tan 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 the hair and leaving it feeling somewhat greasy or oily. Solvents and detergents can be used to clean the hair, but care is needed. Examples of paint-on tans sold by various distributors include[1]: Liqua-Tan™, Rittel's Kwiz-n-Eze, McKenzie Tan, Rinehart Tanning Cream, Curatan®, and Trapper's Hide Tanning Formula™. Other products are also available.

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

Immersion tanning methods require making solutions, monitoring pH, and safely disposing spent solutions. Through soaking, the tanning agent has access to both sides of the skin, although the skin should be stirred occasionally while in the tanning solution to ensure even and adequate chemical penetration. Please note that the hair of deer is hollow and deerskins will float so stirring may need to be more frequent. If tanning is done correctly, weighting a deerskin to keep it submerged in the solution is not necessary. Goatskins do not have this problem. There are many kinds of immersion tanning agents. Examples are EZ-Tan (EZ-100), Kwik-Tan, and Lutan® FN.

For initial attempts at tanning, it is beneficial to purchase a kit complete with tanning chemicals, instructions, and a list of the needed supplies. Some kits come with instructional videos. Many distributors sell kits using either the immersion or paint-on tanning methods. Examples of some kits include EZ 2000 Hide Treatment that includes EZ-100 powder, Saftee Acid, and tanning oil; Liqua-Tan™ Tanning Kit with Liqua-Tan™, acid, and tanning oil; and McKenzie Tan Tanning Kit with McKenzie Tan and acid. Kits using other chemicals, e.g., Para Tan, Curatan®, Krowtann 2000, Kwik-Tan, Lutan® FN, etc., are available or one can purchase tanning chemicals individually. Finally, while not covered in this article, chemicals and kits are available for tanning birds, fish, and reptiles.

Basic Tanning Steps

Whatever method is chosen to use in tanning a skin - immersion or paint-on, kit or purchase of separate chemicals - many of the basic steps are the same: skinning the animal, preserving the skin, fleshing the skin, 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 skins 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 chapter to address all of the tanning procedures and variations available. Rather, only some pertinent information on each of the basic steps will be given. More detailed information can be found in the sources listed at the end of this chapter or websites listed for some of the companies that sell tanning chemicals. Finally, the information presented is designed for the hobbyist tanner and, as such, no use of tanning machinery is required.

Skinning

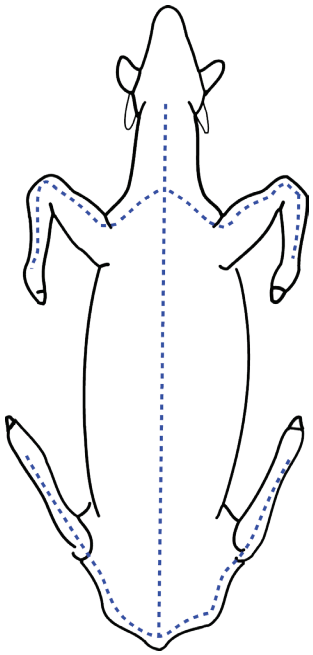
Most people wanting to tan a skin will also use the carcass for meat and will take the animal to a meat locker or abattoir for processing. Inform the facility that you wish to tan the skin and that extra care should be taken when skinning. Make arrangements to pick up the skin as soon as it is removed from the carcass.

If you wish to skin an animal, be sure the carcass is fresh as decay begins immediately upon death. Bacteria become active breaking down tissue, damaging the skin, 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. Diseases such as tuberculosis, rabies, tetanus, and anthrax can be transmitted to humans through contact with infected animals. Animals that are ill, acting strangely, or found dead from an unknown cause should be buried or disposed and not skinned, even when wearing gloves.

For people who hunt or raise deer and elk and wish to tan their skins, 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/), 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. Abscesses contain greenish, cheesy pus that should be trapped on paper towels and burned or buried. Take care when skinning goats as abscesses not apparent on the live animal can be found under the skin. Wear gloves when skinning any animal and throughout the tanning process. Avoid using skins of goats having an abscess. In addition to disease concerns, the skin at the abscess site is thin and weak and can tear during the tanning process.



Proper placement of initial cuts.
Illustration by K. Williams.

Well-shaped skin after skinning.

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 the 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 skin.

It is easier to skin a hanging rather than lying carcass as the skin can be pulled downwards and "fisted" away from the body by using your gloved fist to push between the skin and carcass. This lessens 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 and causing holes that mar the skin and must be sewn later. Skins can also be removed using mechanical means. No matter how the skin is removed, a large amount of fat or meat should not be left on the skin as this material can impede salt penetration when preserving and must be removed during the

tanning process. Any obvious blood spots or dirt should be washed off. A good job in skinning will make the initial tanning steps easier.

Preserving

If the skin will not be tanned immediately, it must be preserved. The goal of preservation is to stop the decay begun by bacteria immediately upon death. Never leave fresh skins 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 skin as quickly as possible by laying it open. If available, place ice on the flesh side. While plastic garbage bags may be useful in handling a wet, bloody skin do not leave skins 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 skin and creates an unfavorable environment 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 readily than large grain products.

To salt a skin, lay it flat, flesh side up, on a plastic tarp or piece of wood. Pour a generous amount of salt on the skin, approximately one pound salt per pound skin, and rub it in thoroughly covering every portion. Fold the skin flesh to flesh down the midline, roll, and place on a slanted board to drain. The following day check the condition of the salt, adding new salt if needed. If the salt is dirty or bloody, 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 skin flat to dry. Drying may take several days or longer depending upon the weather. Skins should not be dried in direct sunlight or where temperatures are very high. Dried skins can be stored in a dry place until tanning. However, salted skins should be tanned within a reasonable time frame as salt-tolerant bacteria can grow on salted skins and do damage.

To salt, rub a generous amount of salt into the skin, covering every portion. Then fold the skin down the midline, roll, and place on a slanted board to drain.

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

To begin the tanning process, the preserved skin must be rehydrated in preparation for fleshing. Frozen skins should be soaked in water to thaw. Salt and a bactericide can be added to prevent bacterial growth. Submerge salted skins in a brine solution of 1 to 2 pounds salt for each gallon of water needed to completely

cover the skin. Use plastic barrels and wooden or plastic poles, such as old broom or shovel handles, for all tanning procedures. Skins should be soaked until they are like a wet dishrag. Relaxing agents are available that can assist in preparing the skin for fleshing and tanning.

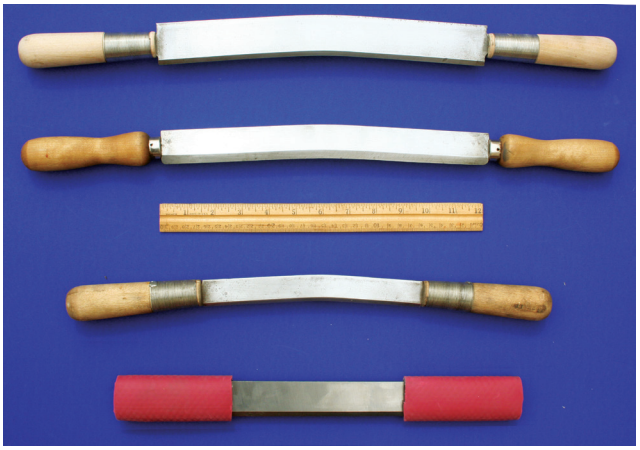
Dirty skins can be washed of obvious blood, manure, and other dirt after thawing. A more thorough washing is done after fleshing. If slaughtering one of your own animals, you can minimize dirt by care prior to slaughter and during the slaughter process. Angora skins can be a problem if excessively dirty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

Fleshing

To flesh a skin means to scrape all fat, meat, and membrane from the skin in preparation for the actual tanning process. This can be done before the skin is salted to allow easier salt penetration. Fleshing is most easily done by using a fleshing beam and fleshing knife. A fleshing beam is a structure over which the skin is draped for scraping and can be made from wood, logs, or PVC pipe. Wooden fleshing beams are commonly made from a 2″ × 6″ or 2″ × 8″ board 5 or 6 feet long. Hardwood is recommended. 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. Unused or scrap PVC pipe 4 to 8 inches in diameter works well and is very sturdy.

A PVC pipe 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 skin. The knife edge of the blade should be dull as the goal is to push and scrape off all fat, meat, and membrane, leaving only the skin. A blade that is too sharp can cut the skin exposing hair roots leading to subsequent hair loss. Fleshing knives can be purchased from many taxidermy supply stores at a reasonable cost. Most fleshing knives have a single beveled edge, others are double beveled. Even a square-



Different styles and sizes of fleshing knives (above).

To flesh a hide, drape it over the fleshing beam with the tail nearest you. Lean into the beam to hold skin and scrape off all meat, fat, and membrane.

edged piece of metal can be used to flesh. Mill planer blades can be fashioned into fleshing knives and these types of knives are available on the internet.

To flesh a skin, pull the skin from the rehydration bath and drape it, flesh side up, over the pointed end of the fleshing beam with the neck farthest from you. Lean into the beam with your midsection to hold the skin in place while you are scraping. Push the fleshing knife down the skin scraping off unwanted material. To make fleshing easier and lessen the chance of cutting the skin, flesh with the lay of the hair. Begin by fleshing the legs towards the tail and midline, then from the rear pushing towards the neck. Wear gloves while fleshing. This protects your hands and is essential if abscesses are suspected.

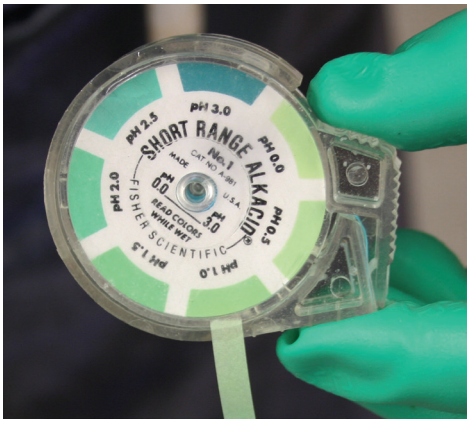
Fleshing takes practice and, initially, can be time consuming but must be done properly, removing even the thin membrane held tightly onto the skin. The thin membrane on the flesh is shiny and feels slippery; after removal the skin will look duller and lose the slippery feeling. Keep the skin wet when fleshing. If it becomes too dry, soak in water before proceeding.

After fleshing, plunge the skin up and down in water mixed with a small amount of dish detergent to remove remaining dirt, blood, and some of the grease on the skin. Then rinse thoroughly to remove all soap. There are commercial products to remove blood and other stains, if desired. Once the skin is fleshed, it should be salted to draw out fluids and substances not wanted in the tanning process. This salting occurs even if the skin was salted originally for preservation. For frozen skins, fleshing occurs upon thawing and is then followed by salting.

Fleshing machines, found in taxidermy supply catalogs, are available for fleshing and shaving skins. The cost is usually prohibitive for the hobbyist tanner. Even with machines, some professionals still do initial fleshing with a traditional fleshing knife and beam. Fleshing machines do have distinct advantages in shaving skins. Shaved skins are thinner, use less tanning chemicals due to reduced weight, and result in a softer finished product. This is especially true for skins from large animals such as elk that have thick skins. Whilst shaving can be tried by using a very sharp knife, it is difficult to achieve a consistent thickness and avoid cutting through the skin. Generally, goatskins can be tanned and softened adequately without shaving.

Pickling and neutralizing

Pickling 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 use an acid pickle, though it may be included in the tanning process itself and not a separate step. Some paint-on tans, such as Liqua-Tan™, can be applied directly to the fleshed skin without the skin undergoing a pickle.



Use pH paper to check pickle pH.

Pickling solutions are mixtures of water, salt, and acid made in a plastic barrel. There are a number of acids and formulations used in pickling and the tanning recipe followed will have specific instructions. Enough pickle solution should be made to completely submerge the skin without overcrowding if several skins are pickled together. At a minimum, make 2 quarts of pickling solution for every pound of wet, drained skin. The pH must be carefully monitored and protective gloves, eyewear, and apron must be worn when using acids. Monitoring pH can be done using simple pH paper and adjustments made using the recommended acid or an alkaline substance such as sodium bicarbonate (baking soda). Acids should be added slowly to the pickle, pouring them along the side of the container so as to run gently into the solution. Use a wooden stick and mix slowly. For example, kits using EZ-100

recommend 0.5 fluid ounces Saftee Acid (included in the kit) and 1 pound salt per gallon water resulting in a pickle solution of approximately pH 1.0.

Skins should remain in the pickle solution for a minimum of 3 days, stirred occasionally. Skins can be temporarily stored in a pickle for up to 2 weeks with pH monitored and adjusted if needed.

After being in the pickle, skins must be neutralized. Neutralizing raises the pH of the skin through soaking in a solution containing an alkaline substance such as sodium acetate, sodium formate, sodium bicarbonate, or other similar compound. A commonly used neutralizing solution is one ounce sodium bicarbonate per gallon water, making enough to submerge the skin. If a scale is not available, use one heaping tablespoon of baking soda per gallon water as a neutralizing solution. The tanning recipe or kit should have complete instructions on the neutralization method.

Neutralization is generally brief, 20 to 30 minutes, after which the skins should be rinsed with clean water, drained, and tanned. After draining, and prior to tanning, close any holes in the skin by sewing with nylon thread; dental floss can be used. This will prevent further ripping of the skin during softening.

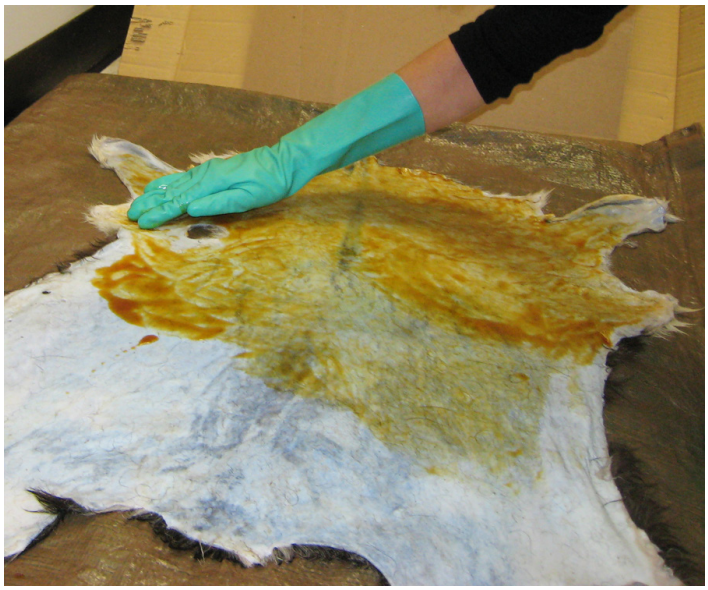
Dispose of pickling and neutralizing solutions properly. Acid pickles should be raised to a pH of 7.0 before dumping. Do not dump or dispose of solutions where they can contaminate streams or ground water. Dispose via drains leading to sewage treatment plants, not storm water runoff drains. If in a rural area and 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

There are many tanning recipes and methods found in various books, taxidermy supply, or tanning chemical dealer catalogs and websites, 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 a more complex immersion tan entailing the application of chemicals in a tanning soak or bath. To illustrate these tanning processes, examples are given of a paint-on tan and an immersion tan.

Paint-on tan

Some paint-on tans, such as Liqua-Tan™ and Rinehart Tanning Cream, do not require the use of an acid pickle. McKenzie Tan recommends using a pickle solution and acid pickles can be used with other paint-on products. In either case, prior to tanning the skin is soaked in a rehydrating (if salted only) or neutralizing (if pickled) solution, rinsed, and drained. Remove excess moisture to get the skin in a damp state. This is commonly done by rolling the skin in a towel. After the excess moisture is removed, lay the skin flat on a plastic tarp or piece of wood and apply the tanning solution. Using a gloved hand or paint brush, apply an even coat of the tanning solution on the skin, covering every portion while taking care around edges and holes. It is best to warm the tanning solution slightly prior to applying.



Apply paint-on tans carefully using gloves.

After several hours, or overnight, work the excess solution into the skin. Some paint-on tans recommend

rinsing the skin in cool water after tanning. Softening oil is then applied. Some paint-on tans state that oils are included in the tanning solution. Others recommend using a companion oil to the tan, such as applying Liqua-Soft™ softening oil the day following application of Liqua-Tan™ if the tanned skin will be used for a flat skin or rug or pairing McKenzie Leather Oil with McKenzie Tan. Stains and greasiness left on the hair after rinsing can be removed during drying and softening by washing the area with a grease-cutting dish detergent or by using odorless mineral spirits poured on a rag and rubbed on the hair.

Immersion tan

Different powder and liquid tans are available that require application using an immersion or tanning bath. The following example describes using EZ-100 synthetic tanning powder. Just prior to tanning, the skin should be removed from the acid pickle and placed in the neutralizing solution. After neutralizing, the skin should be drained for up to 45 minutes and then weighed. The EZ-100 instructions state that for every pound of wet, drained skin use 4 ounces salt, 0.5 ounces EZ-100, and 2 quarts lukewarm water. Dissolve the EZ-100 powder in a small amount of hot water and bring to volume to make a lukewarm solution. After mixing with the salt, check the solution pH. An EZ-100 tanning solution must have a pH of 4.0. If the pH is too high, lower it using small amounts of Saftee Acid. If the pH is too low, raise it using an alkaline substance such as sodium bicarbonate (baking soda). Immerse the skin into the tanning solution and recheck the pH after 30 minutes. Adjust to pH 4.0 if needed. Skins should be stirred occasionally while in the tanning solution to ensure proper penetration of the tanning agent. Skins will tan in 16 to 20 hours after which they should be removed, rinsed, and drained for 20 minutes prior to oiling. Do not leave skins in the tan longer than recommended.

Oiling

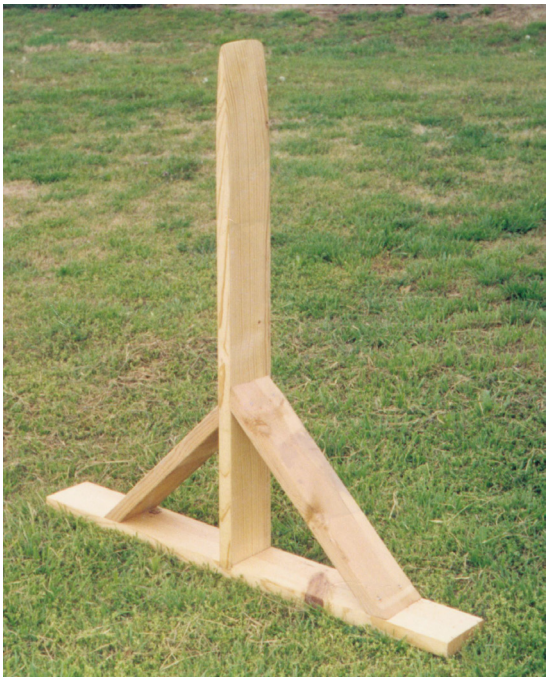
Oiling is done to increase the softness of the finished product and many oils are available in the marketplace. If a tanning kit is purchased, the recommended oil will be included. Some oils, such as Liqua-Soft™, are ready to use from the bottle. Others require mixing one part oil to two parts hot water before use. To oil the skin, lay it flat with the flesh side up. Liberally apply the oil being careful around the edges of the skin. Fold the skin flesh to flesh and allow it to absorb oil for 4 to 6 hours or even overnight. Then, hang the skin to begin drying.

Drying and softening

Drying methods range from simple hanging to tacking on wood or tying in a frame. Allow skins to air dry, using a heat source dries the skin too fast making softening difficult. Check the skin as it dries to determine when softening should begin. If the skin is stretched and pulled when too wet it can become misshapen. If one waits too long, the skin stiffens and is difficult to soften. As the skin 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 the skin is drying too fast or time constraints prohibit you from working on the skin, place the skin in a plastic bag for several hours or overnight to slow down the drying process. You can also wrap the skin around damp towels and place it in a plastic bag overnight to partially rehydrate the skin. Continue working the skin as it dries.

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



A staking beam looks like an inverted "T" with the top sanded to a blunt point (left). To soften the skin, pull it back and forth over the point of the beam (right).

Softening involves stretching and bending the skin to break up fibers in the skin. The time and effort spent on this step directly determines the suppleness of your final product. Initially, roll the skin in your hands to make the skin more flexible. As the skin dries and becomes stiffer, the skin can be staked and cabled. 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. Pull the flesh side of the skin back and forth over the blunt edge to stretch and break up skin fibers.

Cabling is a more effective softening method than staking and involves stretching and pulling the skin around a cable. Regular rope can be used but aircraft cable (wire rope) clamped around a pole works very well. Often, both methods are used on the same skin, staking to begin breaking up very stiff areas followed by cabling to create a soft, supple skin.

Cabling a goatskin using wire cable.

Finishing

After the skin is softened, the hair should be cleaned and brushed. Most goatskins will only need combing or brushing. If the hair feels greasy, one can use dish detergent or even shampoo to wash the hair. When using this method, do not get the skin too wet as it may need to be staked or cabled again as it dries to maintain softness. The tanning agent is chemically bound in the skin and will not wash out. Some texts explain how to clean the hair using sawdust or corn cob grit dampened with a solvent or cleaning agent. Taxidermy or tanning

chemical supply houses sell sawdust and solvents to be used for cleaning. Locally obtained sawdust may contain pitch and be unevenly grained, rendering it not as useful.

Once the hair is clean and brushed, the skin side can be sanded or rasped to remove rough spots and further soften the skin. Staking may make the skin appear brown and dirty and sanding or rasping will make it look cleaner. Cabled skins generally will not need rasping or sanding.

Skin edges are usually uneven and 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 the hair so as to leave a fringe covering the skin's edge.

Finish the skin by trimming rough edges.

Optional steps

Some tanning recipes include a degreasing step or recommend degreasing certain types of skins, usually carnivores. Degreasing is removing fat in the skin using a detergent or solvent degreasing agent. One example of a detergent degreaser is Kemal-4™. Dish soap, such as Dawn®, acts as a degreaser when washing skins and works well with thin goatskins. Solvent degreasers may be more efficient at extracting fats from the skin, examples being Kemsol and Super Solvent. Degreasers can also be added to the pickle solution, as with McKenzie Relaxer/Degreaser. For most hair-on tanning of goatskins, washing with dish soap is sufficient. If a goatskin has a lot of fat, degreasing may help in the tanning process.

Making Leather

Many people wish to make leather from skins. Some of the tanning chemicals used for hair-on tanning can be used for leather, but some type of coloring agent is needed to give the leather specific colors. This could be a dye or a vegetable tanning agent, such as quebracho, sumac, or wattle, among others. Kits using chromium are available to make leather. However, chromium is a heavy metal requiring special disposal. Great care is needed when using chromium-based kits and local authorities should be consulted on proper disposal of tanning solutions. To make leather, skins are salted and fleshed, then unhaired. The kit used will contain unhairing chemicals and explain the steps to follow to remove the hair. The tanning procedure may be different than for hair-on tanning but the oiling and softening steps are similar.

Where to Find Additional Information

The instructions included with any tanning chemical will provide detailed instructions on skin preparation and chemical usage. However, for persons interested in obtaining further information on skin 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 and videos on skin 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 leather craft are available but most were written many 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 some newer 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 of using animal brains to make buckskin as done by Native Americans and other cultures. This can certainly be done with goatskins. In addition to websites dedicated to "brain tanning," several good texts have been written on the subject.

Partial List of Supplies Needed to Tan Skins

- Skinning knife
- Sharpening stone
- Non-iodized salt, not rock salt
- Fleshing knife
- Fleshing beam
- Plastic barrel (metal containers should never be used)
- Wooden pole or paddle to stir tanning solutions
- Tanning kit or chemicals
- Protective gloves, apron, and eyewear 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 skins and chemicals
- Source of hot water to mix solutions

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 using any internet search engine. Information and forums on tanning are at http://taxidermy.net and other websites. Local taxidermists and tanneries are a good source of information and(or) supplies.

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

Dan Rinehart Taxidermy Arts Supply
83 Artisan Drive
Edgerton, WI 53534
Phone: 866-296-2782
http://www.taxidermyarts.com

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

Resources

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.

List of Some Available Books on Tanning and Taxidermy (check your local library)

Burch, M. 2002. The Ultimate Guide to Skinning and Tanning: A Complete Guide to Working with Pelts, Fur, and Leather. The Lyons Press. Guilford, CT. 240 pp. ISBN 1-58574-670-3.

Churchill, J.E. 1983. The Complete Book of Tanning Skins and Furs. Stackpole Books, Harrisburg, PA. 197 pp. ISBN 0-8117-1719-4.

Edholm, S., T. Wilder and J. Riggs. 2001. Buckskin: The Ancient of Art of Braintanning (Originally titled "Wet-Scrape Braintanned Buckskin"). Paleotechnics, Boonville, CA. 307 pp. ISBN 0-9654965-4-6.

Gibby, E.H. 1991. How to Tan Skins the Indian Way. Eagle's View Publishing, Liberty, UT. 28 pp. ISBN 0-943604-33-8.

Grantz, G.J. 1985. Home Book of Taxidermy and Tanning. Stackpole Books, Harrisburg, PA. 160 pp. ISBN: 0-8117-2259-7.

Hobson, P 1977. Tan Your Hide! Storey Communications, Inc., Pownal, VT. 135 pp. ISBN 0-88266-101-9.

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

Kellogg, K. 1984. Home Tanning & Leathercraft Simplified. Williamson Publishing Co., Charlotte, VT. 192 pp. ISBN 0-9135890-4-7.

Richards, M. 2004. Deerskins into Buckskins: How to Tan with Brains, Soap or Eggs. 2nd Ed. Backcountry Publishing, Cave Junction, OR. 240 pp. ISBN 0-9658672-4-2.

Riggs, J. 2003. Blue Mountain Buckskin. 2nd Ed. Backcountry Publishing, Cave Junction, OR. 140 pp. ISBN 0-0-9658674-1-8.

Roberts, N.H. 1979. The Complete Book of Taxidermy. TAB Books, Blue Ridge, Summit PA. 351 pp. ISBN 0-8306-9754-4.

Pack Goats

Mr. Dwite and Mrs. Mary Sharp

Paradise Ranch Packgoat Research & Development

Introduction to Dwite and Mary Sharp

Dwite and Mary Sharp have raised and trained pack goats for over 20 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 probably 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 John 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 you are 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.

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"
owned and published by Larry Robinson
13 Norwood Place
Boise, ID 83716-3283

To become a member of the "North American Pack Goat Association"
Log on to www.napga.org

Goat Herd Health and Management

Dr. Lionel Dawson and Mr. Jerry Hayes
Oklahoma State University and Langston University

Introduction

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

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

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

Ageing Goats

Number and arrangement of teeth

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

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

Telling the age of goats

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

As kids age, the deciduous incisors are replaced by permanent incisors, again from the center pair outward. The middle pair of deciduous incisors will be replaced sometime around 12 months. The second,

third, and fourth pairs are replaced at roughly yearly intervals at 1.5 to 2 years, 2.5 to 3 years, and 3.5 to 4 years of age. Thus, a goat with 1 pair of permanent incisors is roughly 1 year of age, 2 pair of permanent incisors is 2 years of age, and so on. At four years of age when all permanent teeth are in place, the animal may be referred to as having a "full mouth."

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

Animal Identification

The proper identification of animals is essential. Proper identification enables the producer to keep compre- hensive records for milk production, reproduction, health problems, and management practices. The efficient maintenance of this information requires a permanent identification system. Several systems of identification may be used. The system selected will depend upon the size of the herd, the environmental conditions, the primary purpose for identifying individual animals, and regulations of federal government and breed-governing bodies. There are two basic types of identification: permanent and non-permanent. Permanent identification includes tattooing, ear notches or microchips. Non-permanent identification includes paint, chalk and tags.

Tattooing

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

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

Ear tags

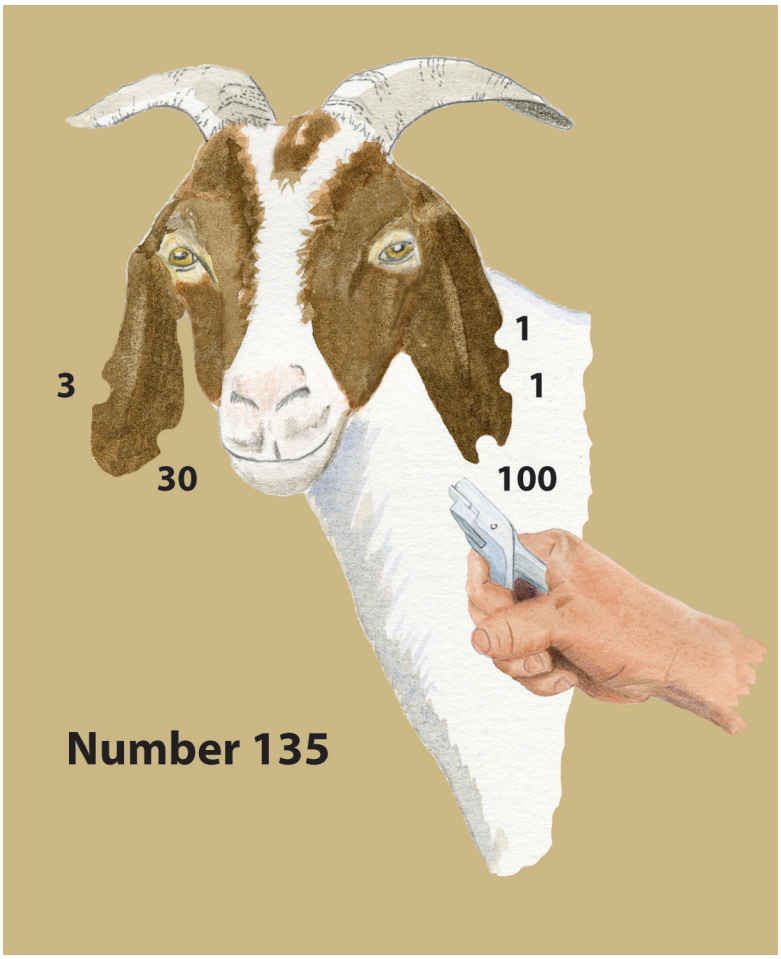
Ear tags are an easy way to identify each goat in the herd. Unlike tattoos, they can be read without actually having to catch the goat. Unfortunately, unlike tattoos, they can break or be ripped out of the goat's ear. Some producers use two ear tags because of this problem. Goats that are shipped are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

Microchip

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

Ear notching

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



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

Hoof Trimming

Hoof trimming goats is a simple task that can be easily learned. The goal of hoof trimming is to allow your goat to walk normally. The lack of trimming, or improper trimming, can lead to foot and leg problems. The amount of time between trimmings depends on many factors, such as type of terrain, the goat's age, level of activity, nutritional level, and genetics. In environmental areas where natural wearing does not occur, producers need to trim hooves on a regular basis. Goats raised in relative confinement and on small acreages may require more frequent trimmings than goats raised in vast pastures. Generally, foot trimming should be done as needed. Each hoof of the goat has two toes. The wall of each toe tends to overgrow and must be trimmed. The heels of the hoof and the dewclaws (especially on an older goat) may also develop extra tissue that needs to be trimmed. Most producers use foot shears or hoof trimmers. Other tools used may include a hoof knife with sharp edges, a pocketknife or a rasp. Pocketknives or a hoof knife can be dangerous to use

for both operator and animal as goats may jump. Some people like to use hoof nippers to cut off the tip of the hoof or file it down with rasps.

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

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.

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

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.

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 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.

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. Underburning 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 "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.

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 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.

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

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

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.

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

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.

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.

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.

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.

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** (0.1% 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.*

Goat Nutrition

Dr. Steve Hart
Langston University

Introduction

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

The ruminant stomach

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

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

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

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

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

Nutrients

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

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

Water

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

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

Carbohydrates

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

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

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

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

Fats

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

Protein

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

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

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

Vitamins

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

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

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

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

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

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

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

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

Minerals

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

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

Macrominerals

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

Calcium (Ca) 0.3 - 0.8%

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

Phosphorus (P) 0.25 - 0.4%

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

Sodium (Na) 0.2%

Potassium (K) 0.8 - 2.0%

Chloride (Cl) 0.2%

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

Sulfur (S) 0.2 - 0.32%

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

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

Magnesium (Mg) 0.18 - 0.4%

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

Micro or trace elements

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

Iron (Fe) 35 - 500 ppm

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

Copper (Cu) 10 - 50 ppm

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

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

Cobalt (Co) 0.11 - 25 ppm

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

Zinc (Zn) 40 - 500 ppm

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

Manganese (Mn) 40 - 1000 ppm

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

Selenium (Se) 0.1 - 20 ppm

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

Molybdenum (Mo) 0.1 - 5 ppm

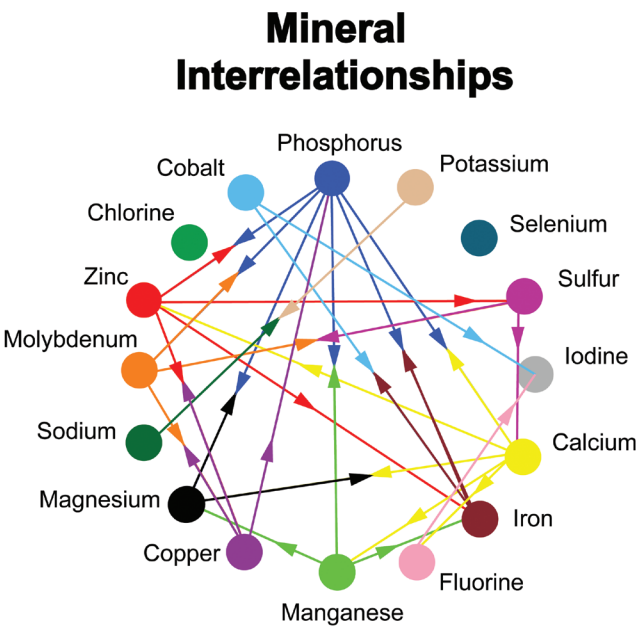
Molybdenum deficiencies are very rare. Toxicity occurs above 3 ppm due to reduced copper absorption, resulting in a copper deficiency. The copper level must be six times the molybdenum level to overcome this effect. High dietary levels of molybdenum are usually related to soil content. Molybdenum (as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

Iodine (I) 0.5 - 50 ppm

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

Mineral nutrition considerations

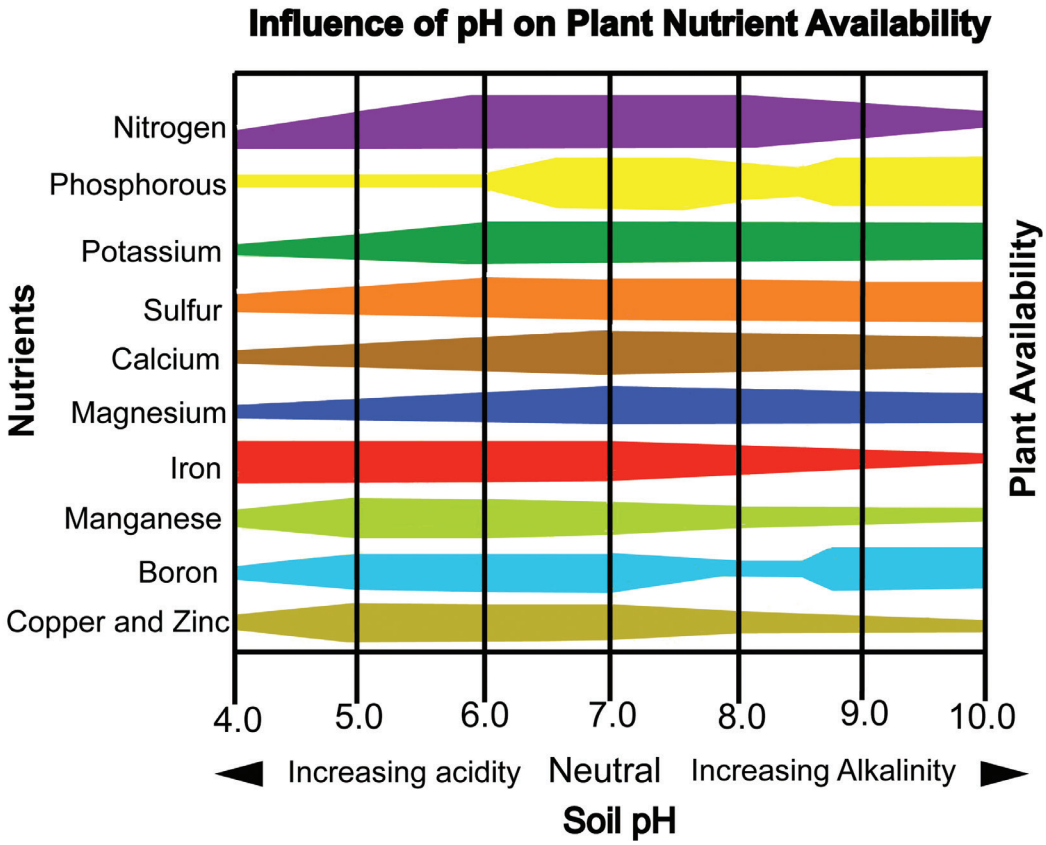
Plants are a major source of minerals for the goat, requiring all minerals that goats require except iodine. However, plant requirements for minerals, such as cobalt and selenium, may be much lower than the level required for animals. Some soils are inherently deficient in some minerals such as iodine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



Drawing by K. Williams.

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

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



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

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

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

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

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

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

Choosing a mineral supplement

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

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

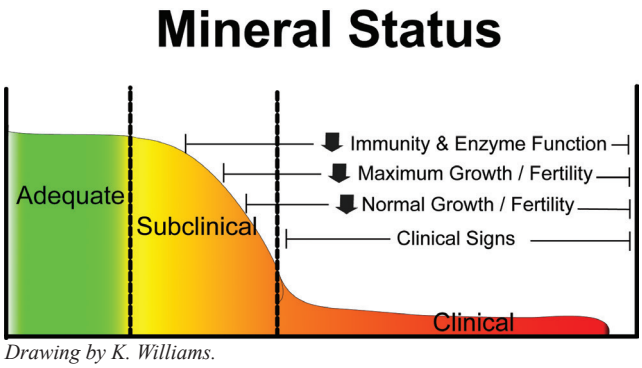
Current approximate wholesale costs for supplying 100% of mineral needs of a 150 lb goat for various minerals in 1 year are as follows:

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

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

Diagnosing mineral deficiencies or toxicities

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



Drawing by K. Williams.

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

Take home lessons on mineral nutrition

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

Body Condition Scoring

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

Body condition scoring is a system of assigning a numerical score based on physical characteristics indicative of fatness. These include the amount of muscle and fat covering the spine in the loin area and ribs and fat

pad at the sternum. Body condition scores range from 1 (very thin) to 5 (obese) in one-half score increments. Langston University has information on the American Institute for Goat Research website describing Body Condition Scoring of Goats (see http://goats.langston.edu/Body_Condition_Scoring) and Examples of Body Condition Scores in Goats (see http://goats.langston.edu/body-condition-scoring-example).

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

Using the Langston Interactive Nutrient Calculator

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

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

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

Getting started

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

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

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

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

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

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

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

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

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

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

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

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

Providing needed nutrients

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

There may be periods when nutrient requirements cannot be met, resulting in loss of body weight. This is acceptable at certain times in the production cycle if body condition is sufficient for the animal to draw upon body reserves and maintain the desired production level. An example would be weight loss during early lactation because sufficient nutrients cannot be consumed. However if the doe is in poor body condition, is a growing yearling, or has severe weight loss during this time, milk production will be depressed. During a drought, it may be acceptable for open or early pregnant animals that are not lactating to lose weight. During late pregnancy, inadequate nutrition can have adverse effects on pregnancy outcome and subsequent lactation. We can estimate what the projected bodyweight losses would be by reducing the bodyweight gains in question five and then calculating nutrient requirements until the energy and protein requirements match

intake of those nutrients. Severe undernutrition can cause abortion, reduced livability of the kid(s), reduced milk production and adversely affect maternal behavior.

Feeding Different Classes of Goats

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

Feeding bucks

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

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

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

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

The mineral supplement bag label predicts intake of 0.5 to 1 lb/month/hundred lbs of body weight. At that rate, the 200 lb buck will consume 2 lbs/month or 0.067 lbs/day (2 lbs ÷ 30 days), roughly 1 ounce. Some supplements estimate an intake such as 1 to 1.5 oz/day, but this can vary with the size of the goat. Enter 0.07 lbs for the mineral. Therefore, in this example it can be assumed that forage dry matter intake is 3.55 lbs. The value of 3.55 is entered into the "Amount, as-fed" column for range forage. Clicking in the "Amount, lbs DM" column will calculate the amount of DM and nutrients provided (Running total) compared with the Requirements. The amount of as-fed native range grass provided should be increased until the forage

dry matter provided equals the 3.55 lbs previously calculated. This is done by trial and error method until a correct answer is found. In this case, the correct amount is 3.95 lbs of as-fed native range, which will provide 3.55 lbs of dry matter. Therefore, the estimated daily ration for this buck is 3.95 lbs of native range grass hay, or an equivalent amount of pasture, on a dry matter basis plus 0.07 lbs of mineral per day.

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

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

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

Feeding replacement bucks and does

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

Does will generally gain sufficient weight if an adequate amount of a moderate quality forage is available. If doelings are not gaining adequate weight (as measured by a scale or through the heartgirth conversion program), they could be supplemented with whole shelled corn at 0.5 to 1% of body weight per day (¼ to ½ lb of corn per head per day for 50 lb doeling). Feeding excessive grain to does causes an overly fat condition. Fat may be deposited in the udder, leading to reduced formation of milk secretory tissue. The doe is also more likely to have pregnancy toxemia and birthing problems. If sufficient good quality pasture is not available, growing doelings will need good quality hay and a supplement such as whole shelled corn, sweet feed, or range cubes or pellets at 0.5 to 1.0% of body weight.

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

Feeding does throughout their life cycle

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

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

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

Flushing meat goats

Some people advocate "flushing" of meat goats prior to breeding. Flushing refers to the practice of providing extra nutrition to does approximately 2 weeks prior to breeding and for a variable portion of the breeding

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

Winter feeding of does

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

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

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

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

To continue formulating the ration, select the 16% molasses lick and winter bermudagrass, then click on "Input these Feed Ingredients to the Ration." Enter 0.25 lbs for the 16% molasses lick under the "Amount, as-fed" column and guess at 1.5 lbs of winter bermudagrass. Through trial and error a total of 2.0 lbs bermudagrass is selected to fulfill intake requirement. The table shows that this diet provides 0.91 lbs of TDN (76%

of requirement), 0.12 lbs CP (86% of requirement), 4.74 grams of calcium, and 1.52 grams of phosphorus (deficient). The diet is quite deficient in energy. To provide additional energy, add whole shelled corn. The diet is then reformulated to contain 0.6 lbs whole shelled corn, 1.4 lbs winter bermudagrass, and 0.25 lbs of lick molasses. This provides 1.15 lbs TDN (97% of the energy requirement) and meets the CP needs. Phosphorus is slightly deficient (13%), but if the bermudagrass is better than average the requirement can be satisfied. Mineral supplements vary in their phosphorus levels as phosphorus is an expensive ingredient. If a mineral supplement with a high phosphorus level is selected for feeding, the requirement would be met but likely at a high monetary cost.

Feeding does in late gestation

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

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

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

Feeding the lactating doe

The lactating doe has very high nutrient requirements. Calculate the requirements for a 4 year old 110 lb Boer cross doe nursing twins in week 4 of lactation. When lactating is selected under question #2 on LINC, a form drops down. Select litter size (twins), week of lactation (4), and age at kidding (4). The program then predicts production of 4.5 lbs of milk per day with 3.6% fat and 3.3% crude protein. Nutrient requirements are 2.65 lbs of TDN, 0.41 lbs of protein, 7.61 g of calcium, and 5.33 grams of phosphorus, with 4.14 lbs of dry matter intake predicted (based on default dietary TDN and CP concentrations). During lactation, the doe can consume nearly enough nutrients if an abundant supply of high quality pasture is available, such as in spring or early summer. If "Range, early summer" is selected and fed at 4.7 lbs, the diet meets protein and calcium requirements, and 90% of energy requirement. However, phosphorus is deficient (3.76 vs. 5.33) and needs to be supplemented. However, does will likely lose some bodyweight due to the high demands of peak lactation (weeks 3 to 8 of lactation) and an inability to consume an adequate quantity of feed. Kidding should take place when there is an adequate supply of high quality pasture. If there is not adequate pasture,

supplemental feed will be required. Inadequate nutrition will decrease body condition, reduce milk production, reduce kid weaning weight, and increase kid mortality.

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

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

Creep feeding

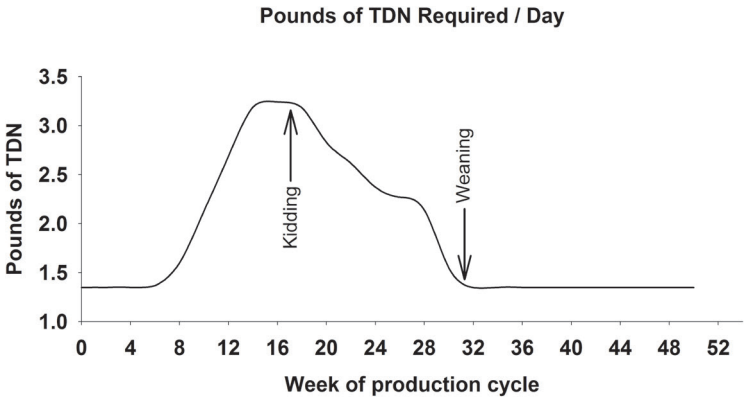
Creep feeding is a method of providing feed for the kids only. This is accomplished by fencing around a feeder and using a creep gate that has holes about 5 inch wide by 1 ft high. These holes are small enough so that kids can enter the feeder, but adults are excluded because they are too big to go through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

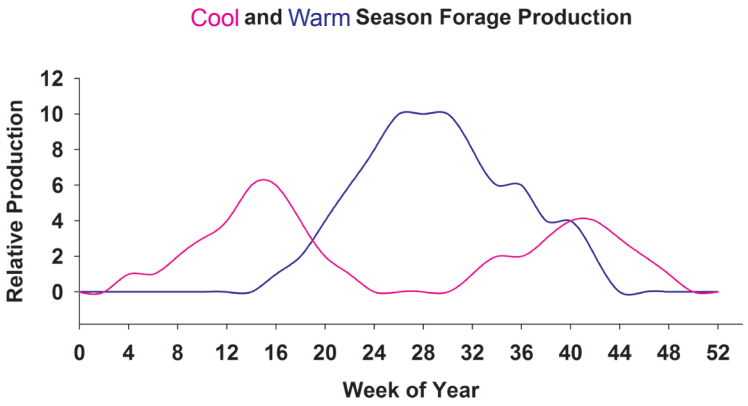
An alternative to grain-based creep feeds that is used in the beef cattle industry is to creep graze calves, using a creep gate that allows calves access to ungrazed high quality pasture. This may have application for goats using high quality pastures (crabgrass or sudangrass that is planted for the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

Effect of Kidding Season on Nutrient Requirements

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

Kidding should be planned for a time when pasture is rapidly growing. This period corresponds to late spring for pastures comprised of warm season forages such as bermudagrass or native range, browse, and forbs, but could be either fall or early spring for cool season grasses such as ryegrass, wheat, orchardgrass, and fescue. Cool season grasses usually produce less forage per acre than warm season forages, but generally are higher in energy and protein. The accompanying figure shows the relative production of cool and warm season forages for central Oklahoma. Consult a local pasture extension specialist or livestock extension specialist for local forage growth patterns. Rapidly growing pasture is high in protein and energy. A major consideration in determining the date to kid is level of forage production at that time. However, there are other





considerations in selecting kidding date, such as parasites and market opportunities. Some markets provide a substantial price premium from kidding at a specific time of the year, such as producing prospect show wethers or registered animals. However, it may take a considerable market premium to cover the cost of purchased feed, so general reliance on pastures and forages is best.

Artificial Raising of Kids

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

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

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

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

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

Considerations in Ration Formulation

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

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

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

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

Feeding Systems

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

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

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

Nutritional Disorders

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

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

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

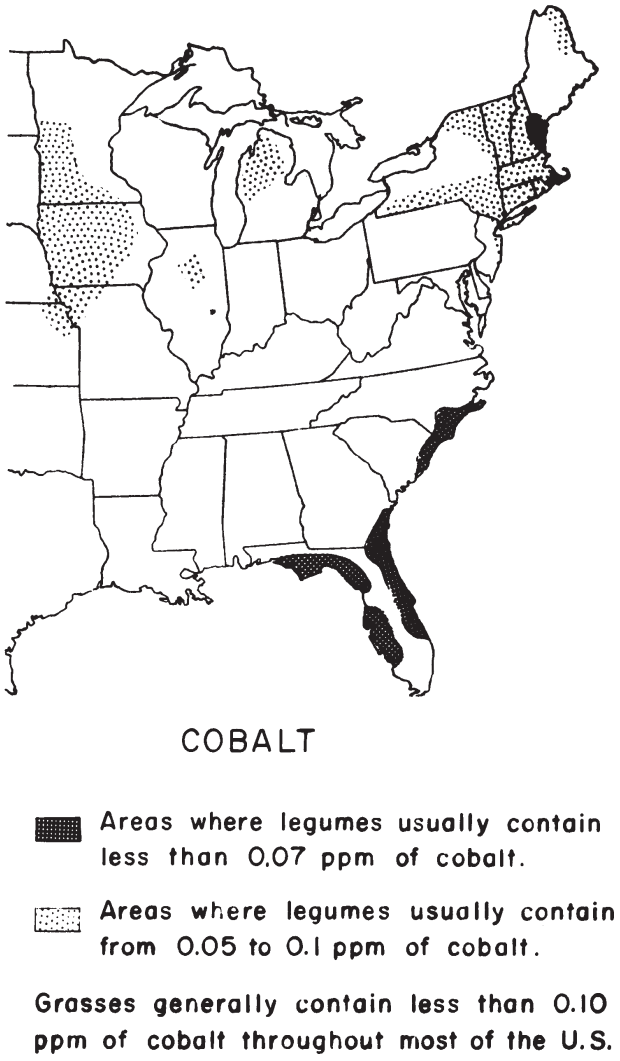
Enterotoxemia is caused by bacteria in the intestine that grow rapidly and produce an endotoxin in response to high levels of starch (grain) in the diet. Animals are in extreme pain from the effect of the endotoxin and often die quickly. Vaccination will help prevent this disease.

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

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

Soil-Related Nutritional Problem Areas for Grazing Animals

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



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

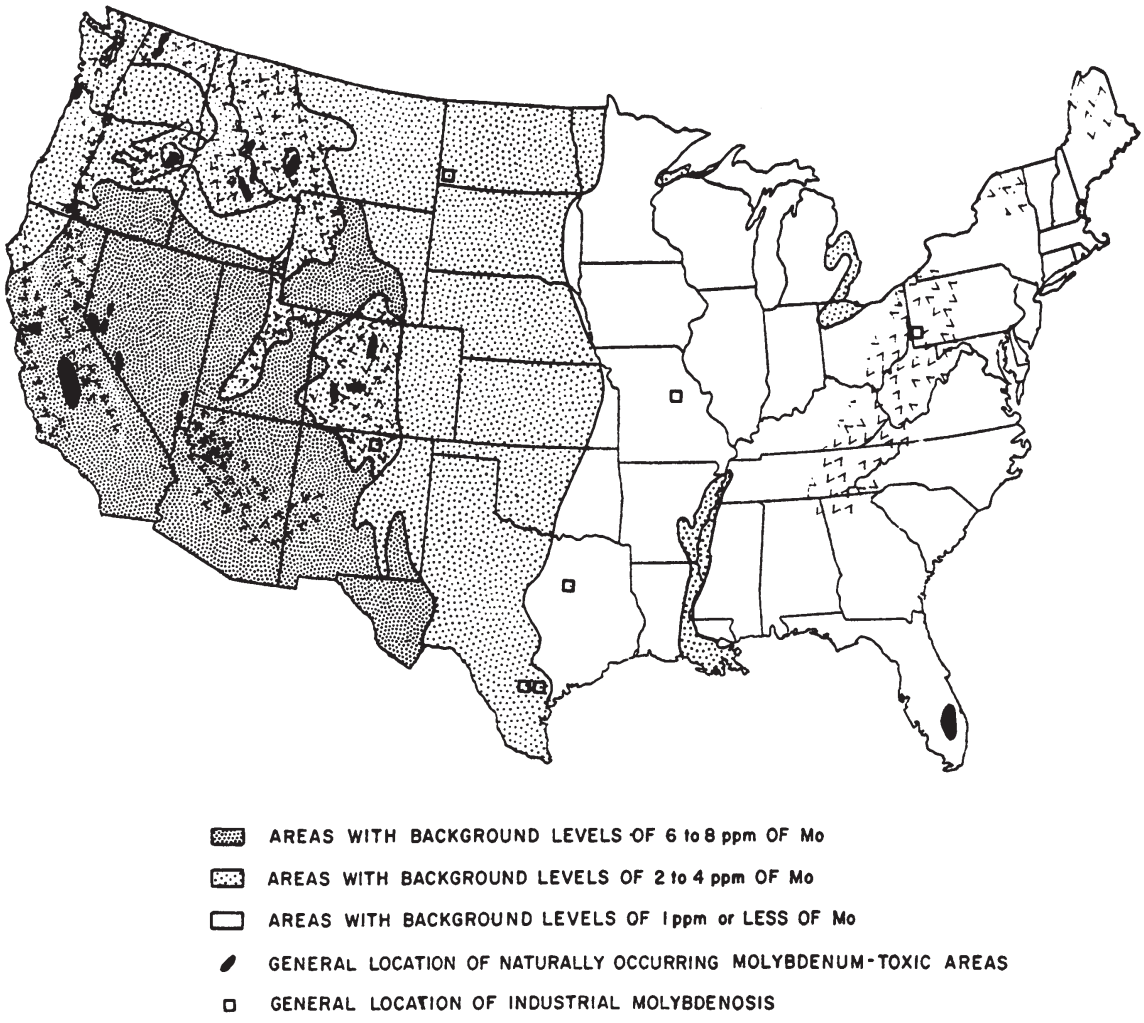


Figure 6. Generalized regional pattern of molybdenum concentration in legumes of the United States (ppm = 1 $\mu g/ g^{-1}$). From Kubota, 1977, by courtesy Marcel Dekker, Inc.

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

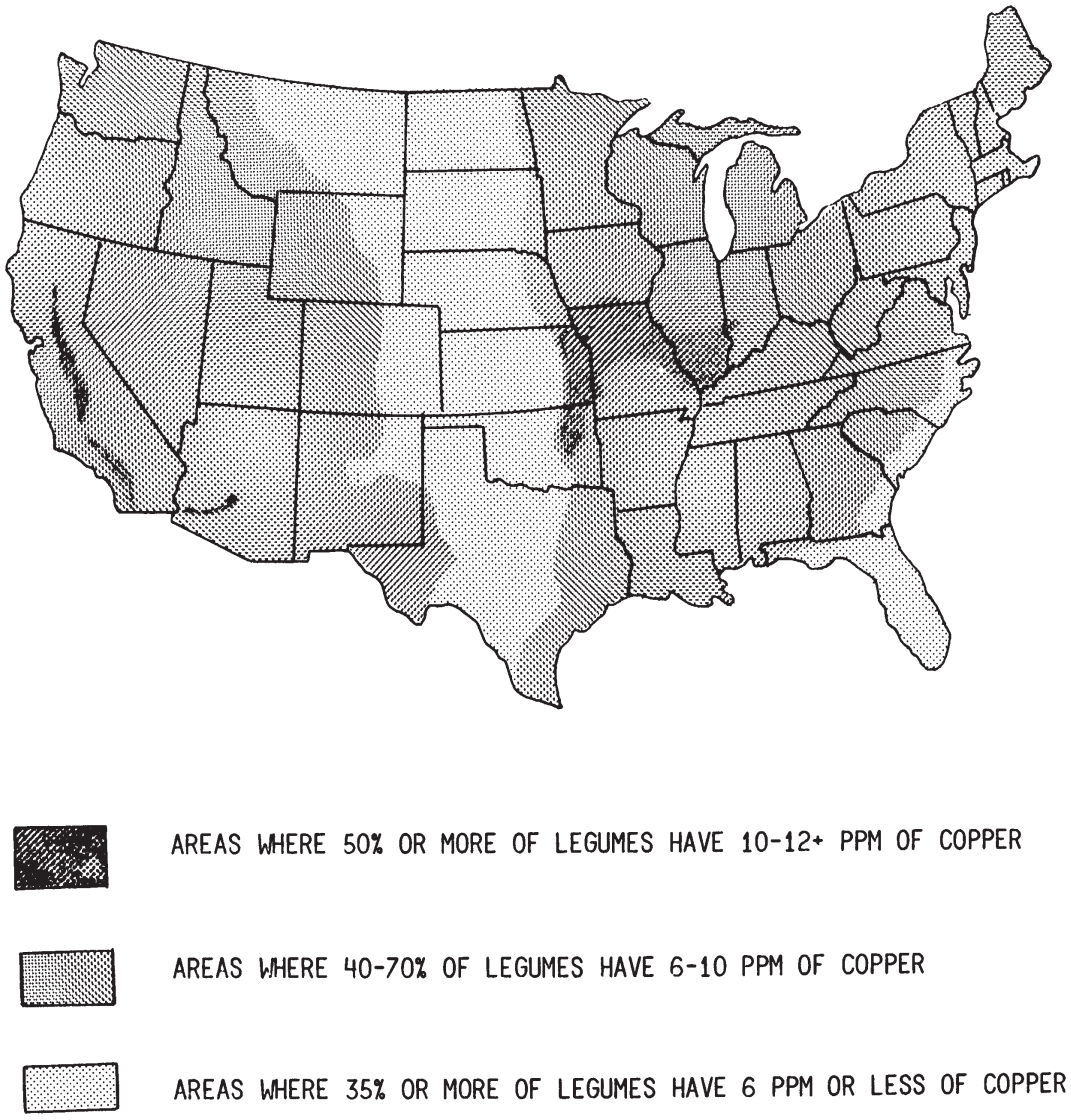


Figure 7. Generalized distribution of copper concentration in legumes of the United States (ppm = 1 μg/ g^{-1}). From Kubota, 1983a, by permission Amer. Society of Agronomy.

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

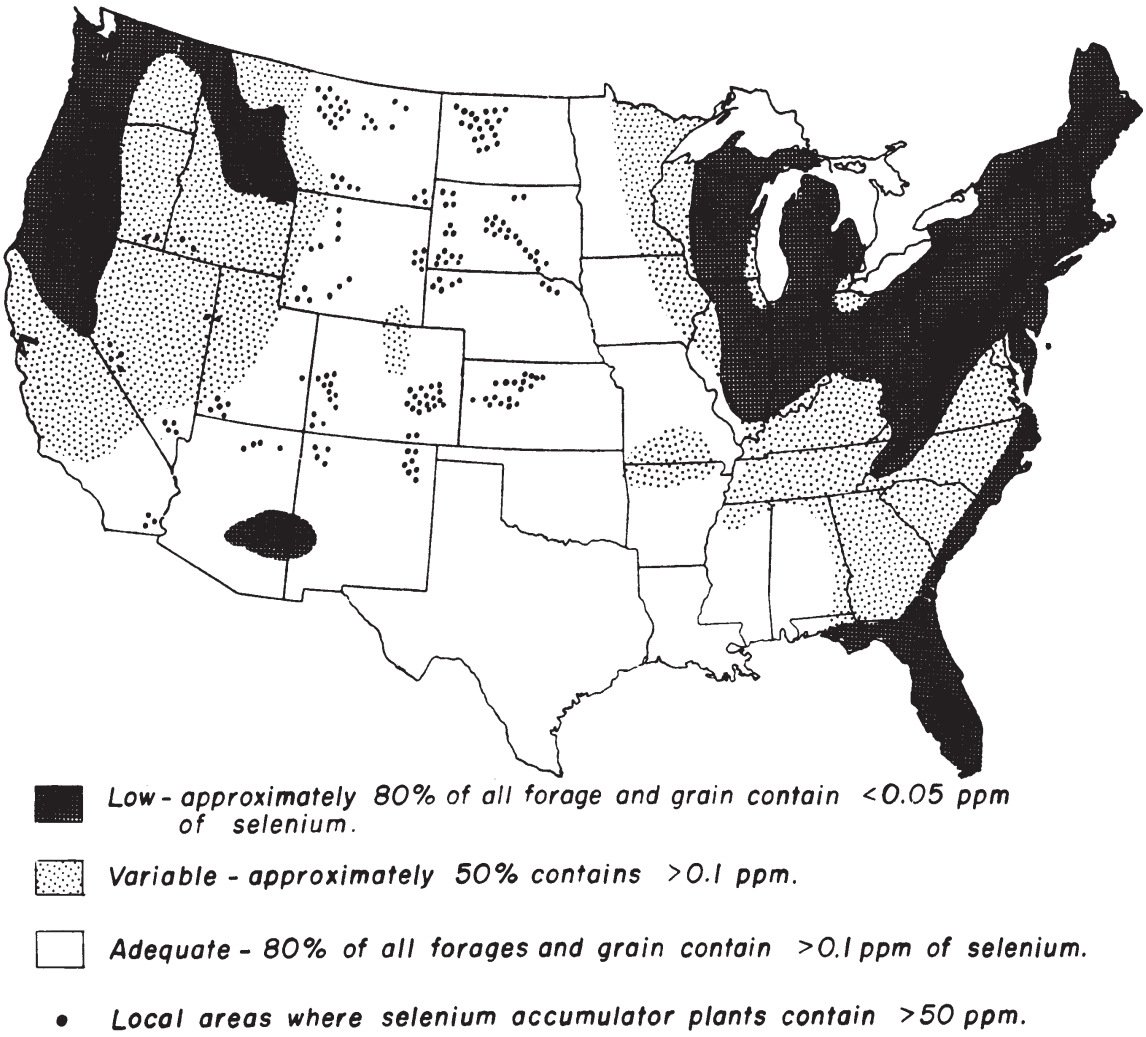


Figure 8. Geographical distribution of low-, variable-, and adequate-Se areas in the United States (ppm = 1 μg/g). From Kubota and Allaway, 1972, by permission Soil Science Society of America.

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.

DHI Training

Ms. Eva Vasquez
Langston University

In 1996, the Langston DHI program launched under the umbrella of the Texas DHIA. That partnership was not mutually beneficial and Langston Goat Dairy DHI elected to operate independently. In addition, the dairy records processing software that had been initially acquired from Texas DHIA had reached well beyond it capabilities and could not be modernized. Thus, Langston Goat Dairy DHI has partnered with Dairy Records Management System (DRMS) of Raleigh, NC to conduct the record processing. 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.

NATIONAL DAIRY HERD IMPROVEMENT PROGRAM
UNIFORM OPERATING PROCEDURES

Effective June 1, 2014

CODE OF ETHICS

PURPOSE

This *Code of Ethics* provides guidelines for appropriate conduct in the production, collection, and distribution of DHI information for all individuals and organizations involved with these data.

UNETHICAL PRACTICES

A. Impairing the reliability of DHI data.
B. Not cooperating or interfering in the use of the *Uniform Data Collection Procedures* to record DHI data.
C. Intentionally providing inaccurate data or withholding necessary data resulting in misrepresentation of DHI information.
D. Engaging in management practices with the intent of misrepresenting the performance of individual animals and/or the herd. Among these practices, but not limited to, are the movement of animals between herds, influencing the relative performance of herd mates, and/or the selective use of management techniques in an effort to bias DHI data. Management practices on test day should be representative of normal practices used on other days.
E. Permitting the collection of supervised data by a technician with a direct financial or family interest in the herd being tested without notification to and consultation with the field service auditor.
F. Any practice defined as fraudulent or unethical by the Board of Directors of National DHIA.

REMEDY

Any person, corporation, or other entity violating this *Code of Ethics* may be subject to action by an injured party.

UNIFORM DATA COLLECTION PROCEDURES

PURPOSE

The purpose of these procedures is to provide the framework for a uniform, accurate system that will enhance data reliability.

The uniform records and data thus provided are used for:

- Making farm management decisions
- Genetic evaluation of cows and sires
- Educational programs and research
- The promotion and sale of animals

AUTHORITY

These *Uniform Data Collection Procedures* have been developed and adopted under the direction of National DHIA.

A Cooperative Agreement exists between the United States Department of Agriculture (USDA), Agricultural Research Service (ARS) and the Council on Dairy Cattle Breeding (CDCB) to ensure the flow of DHI data for industry purposes including genetic evaluation programs.

RESPONSIBILITY

DHI service providers, DHI personnel, and dairy herd owners, as well as persons in their employ, are individually and collectively responsible for adherence to these *Uniform Data Collection Procedures*.

These basic and minimum standards are to be uniformly followed throughout the DHI program. They serve to ensure that DHI data will provide the accuracy, uniformity, and integrity essential to all segments of the dairy industry.

All DHI service providers - field service providers, laboratories, meter centers, and dairy records processing centers (DRPC) - must maintain certification by Quality Certification Services to verify compliance with these *Uniform Operating Procedures* and the guidelines for their specific service area.

To participate in the DHI program a dairy producer must agree in writing (membership or service agreement as applicable) to conform to these *Uniform Data Collection Procedures* and *Code of Ethics*.

DEFINITIONS

DAIRY COW is defined as any cow from which milk production is intended for use or sale for human consumption, or which is kept for raising replacement dairy heifers and is an integral part of the dairy herd.

DAIRY HERD is defined according to the following principles that are generally appropriate for herds enrolled in the DHI program:

- All cows of one breed, housed or managed under a single management system, regardless of individual cow ownership
- Farms with two or more distinct breeds may calculate and report either a composite herd average or a separate herd average for each breed

In general, herd codes should be assigned in accordance with the principles stated above. However, it is recognized that legitimate exceptions may exist that warrant assignment of separate herd codes. For example:

- A herd owner may operate separate units under separate management systems, with no movement of cows between these management units.
- If two groups of cows are housed together but with different ownership, management goals, and with no movement of cows from one ownership group to the other; one owner may wish to participate in the DHI program and the other owner may not.
- Farms with two or more distinct breeds may enroll one breed in the DHI program and not the other(s).

DHI Field Service Providers shall only assign herd codes from state/county lists allocated by National DHIA in order to prevent duplication among providers. In so far as possible, herds should be assigned herd codes designating the state/county location where the herd resides.

TEST is defined to be the entire process of information collection at the farm, and may include some or all of the following: weighing of milk during the milking process, electronic collection of milk weights, collection of milk samples, and collection of other data. Since the actual testing of milk samples does not occur at the farm, this procedure should be labeled as the laboratory test.

TEST DAY is defined as the 24-hour period during which data is recorded and milk sampled. Herds recording daily milk yield on the dairy are permitted to use longer intervals (most commonly 5, 7, or 10 days) to estimate 24-hour test-day production if accurately labeled.

DHI TECHNICIAN This and equivalent terms such as supervisor, tester, independent service provider, etc. defines persons approved by the DHI Field Service Provider responsible for data collection that meets the standards described in the Uniform Operating Procedures.

DHI SAMPLE TAKER – This and equivalent terms such as assistants, technicians, helpers, etc. defines persons supervised by and responsible to the DHI Technician, and ultimately to the DHI Field Service Provider, that assist in data collections on farms. DHI Sample Takers should be trained by the DHI Field Service Provider in a

fashion equivalent to the DHI Technician for the job functions they perform such as recording milk weight information and collection of a proper sample.

DHI SERVICE PROVIDERS are quality certified organizations that provide one or more services, including:

- **FIELD SERVICE PROVIDER** is defined as an organization that collects data and/or samples on dairy farms and arranges delivery of DHI reports to the dairy producer.
- **LABORATORY** is defined as a facility that analyzes components and performs animal health diagnostic screening.
- **DAIRY RECORDS PROCESSING CENTER (DRPC)** is defined as an organization that provides electronic processing of DHI data using approved procedures and rules for calculations.
- **METER CENTER** is defined as the entity that repairs and checks calibration of recording devices that weigh and/or sample milk.

DATA COLLECTION PROCEDURES

1. COLLECTION OF MILK WEIGHTS AND SAMPLES

The yield of individual cows is to be measured at the time of milking with a minimum of interference to the normal routine. Milk samples must be representative of all milk taken from the cow during the measured milking. All recording and sampling devices must be used strictly according to the manufacturer's instructions at all times.

Data for each test day for each herd must be labeled using the following categories to identify the degree of supervision used in data recording:

A. **SUPERVISED TEST:** All test day production data and cow identification has been recorded by the DHI technician who is expected to collect data as accurately as possible and to use approved procedures when taking milk samples. The DHI technician may employ assistants to perform these tasks when the facilities or milking processes do not permit a single DHI technician to observe identification, milk weights, and sample collection as they occur. (*Supervision Code 1*)

B. **UNSUPERVISED TEST:** Test day production data and/or cow identification has been recorded by someone other than the DHI technician. (*Supervision Code 2*)

C. **PARTIALLY SUPERVISED TEST:** The DHI technician collected production data and/or cow identification information for at least one milking on test day and someone else collected production information and cow identification for other milking(s) on test day. The DHI technician certifies that the test day information is believed to be correct and accurate. (*Supervision Code 3*)

D. **AUTOMATIC MILKING SYSTEM TEST:** Test day production data and/or cow identification has been recorded by an automatic/robotic milking system. Milk has been sampled using an automatic sampling device approved to provide representative samples when used with the automatic milking system. (*Supervision Code 4*)

E. **SUPERVISED ELECTRONIC TEST:** The DHI technician performed a supervised test using the electronic recording of production data and cow identification together with appropriate verification that equipment for cow identification, weighing milk, and obtaining milk samples is in proper operating condition and is accurate. (*Supervision Code 5*)

F. **UNSUPERVISED ELECTRONIC TEST:** Test day production and cow identification has been collected using electronic recording and is submitted for processing without verification by a DHI technician. (*Supervision Code 6*)

G. **PARTIALLY SUPERVISED ELECTRONIC TEST:** The DHI technician performed a Supervised Electronic Test, but cow identification was manually entered by farm employees. (*Supervision Code 7*)

2. STANDARD EQUIPMENT

A. **DHI FIELD SERVICE PROVIDER OWNED EQUIPMENT**

All equipment that is owned, leased, or used by DHI Field Service Providers, including independent service providers receiving their certification from the DHI Field Service Provider, and used for collection of DHI milk weights and/or samples:

- Recording devices, including associated samplers and integrated software programs, must be of a model and type approved by International Committee for Animal Recording (ICAR) and accepted by National DHIA for use in DHI programs.
- Recording devices must be in proper working condition when in use.
- Recording devices must be checked for accuracy at least once a year using an approved method. New and returned-to-service recording devices must be checked for accuracy before being used in the DHI program.
- Portable meters must have a durable label/tag affixed to each device stating the date accuracy was last checked and the meter center that performed the inspection.
- Fixed (in-place) electronic meters/devices must have a record of accuracy verification on file at the dairy and in the office of the DHI Field Service Provider. Checks of device performance and accuracy produced by the milking system software and/or by DHI software may be used to verify the accuracy of these devices as an alternative to device calibration.
- Recording devices (portable and fixed) that are out of tolerance must be removed from DHI service and be repaired and checked for accuracy before returning to DHI service.

B. **PRODUCER OWNED EQUIPMENT**

The accuracy of all producer owned recording devices and samplers used in the collection of milk weights and/or samples is the joint responsibility of the DHI Field Service Provider and the dairy producer. It is required that DHI dairy producers owning their own equipment follow the same guidelines for verifying meter accuracy as DHI Field Service Providers. The DHI Field Service Provider is responsible for appropriately labeling records from herds using equipment that is not in compliance with the guidelines for DHI owned equipment.

3. RECORDING PROGRAMS

The DHI program offers a variety of supervised and unsupervised test plans to meet the management needs of the individual dairy producers. A list of the type of test codes and plan descriptions is available from the National DHIA office and www.dhia.org. The off-farm use of data from these programs will be determined by the users of the data.

4. METHODS FOR CALCULATING LACTATION RECORDS:

Lactation totals and lactation-to-date totals must be calculated using an ICAR-approved method.

A. The *Test Interval Method (TIM)* is currently used to calculate DHI lactation and lactation-to-date totals. The test interval (number of days from the previous test day through the current test day) is divided into two equal portions. Production credits for the first half of the test interval are calculated from the previous test day information, and those for the second half of the test interval are calculated from the current test day information. The totals for the two portions of the test interval are added to obtain the interval totals. Production totals from the first day of the lactation until the first test day are based on the first test day information; and production totals for the interval from the last test day until the record is terminated are based on the last test day information. In either case, an approved regression factor shall be used to accurately estimate actual milk production for the current test day. The next test interval begins on the following day. DRPC are permitted to adjust credits for the test interval based upon average lactation curve effects; provided such adjustments more nearly reflect daily production and have been approved by National DHIA.

B. The *Best Prediction Method* is used for prediction of lactation totals from completed test days as a correlated response. *Best Prediction* produces more accurate genetic evaluations and may be used for DHI record calculations.

5. COWS TO BE TESTED

A. All dairy cows in the herd with the same herd code, which have ever calved, will be enrolled in DHI. Dairy cows may be removed from DHI only when they leave the herd permanently. Dairy cows used as embryo recipients are to be included.

B. Cows classified as *Dry Donor Dams* may be permanently assigned to a separate *Dry Donor String* in the herd or to a separate *Dry Donor Herd*. No data on the *Dry Donor Dam* will be included in herd average or management information. *Dry Donor Dams* that later calve will be returned to the milking herd and a 365-day dry period with zero production

data will be applied against the herd average in the current test interval. For *Dry Donor Dams* that were out of the milking herd for less than 365 days, the dry period will be the actual number of days the *Dry Donor Dam* was out of the herd with zero production data applied for that period.

6. IDENTIFICATION

A. All cows must be identified with a permanent number for genetic evaluation. Permanent identification consists of an official USDA Animal Identification Number (AIN) ear tag, National Uniform Eartagging System (NUES) tag, or breed association registration number. If the ear tag is not in the ear, the number must be cross-referenced to a picture, sketch, or a brand or tattoo that is unique within that herd.

B. For a supervised test, the DHI technician must be able to visibly identify the cow quickly and accurately during the milking process. All visible identification must be in place on the cow prior to the beginning of the milking and be visible from several feet or accurately scanned and displayed by an electronic identification reader. Visible identification must be cross-referenced to permanent identification if the data are to be used in genetic evaluations.

7. MILK SHIPPED MEASUREMENTS

Milk shipped weights shall be recorded (data for shipments immediately prior to date of test) indicating the number of milkings (or days) included in each shipment. If the milk shipped weights do not contain a complete day's production, the DHI technician shall report the best estimate of each day's milk shipped. If milk shipped weights are not available, the fact that they cannot be obtained and the reasons why should be reported in writing to the DHI Field Service Provider. Milk shipped weights for appropriate days may be used as verification of the accuracy of production credits of the herd.

8. COWS IN MILK

All cows in milk, when possible, should have milk weighed and/or sampled on the test day. Data will be used for record calculation for cows that are four or more days (morning of the fifth day for AM/PM records), counting the day of calving as the first day. The record begins on the calving date.

9. DRY COWS

The dry date is the first calendar day the cow is not milked. Cows coded dry on test day will have their production credits projected forward from the previous test day, using the previous test day production data and approved National DHIA estimation procedures.

10. COWS LEAVING THE HERD

The calendar day the cow leaves the herd counts as the last day in the herd, with production being credited for that day.

11. COWS ENTERING THE HERD

Any lactating cow entering the herd will start receiving production credits in the new herd on the calendar day following the last day of credits in the former herd.

12. COWS THAT ARE SICK, INJURED, IN ESTRUS OR ABNORMAL

Actual production should be recorded on test day for all cows that are sick, injured, in-estrus, or otherwise abnormal, and subsequently be coded with a Condition Affecting the Record (CAR). The milk weight will be adjusted by the DRPC for cows so coded if the percentage decrease in total daily pounds of milk from the previous test day exceeds the percentage obtained with the following formula:

Percent = 27.4 plus 0.4 x days in the previous test interval.

(As an example, for a 28-day test interval: Percent = 27.4 + (0.4 x 28) = 38.6%, and the test day weight will be adjusted if the decrease is more than 38.6%)

This procedure does not apply to milk weights routinely adjusted at the beginning or end of lactation. If the first test day is coded abnormal the succeeding test day will be used to calculate the record.

13. COWS ABORTING OR CALVING PREMATURELY

A cow beginning her lactation 30 or more days prior to the expected due date, whether in milk or dry, will be coded as starting the subsequent lactation with an abortion. When a breeding date is available, a cow beginning her lactation less than 30 days prior to the expected due date will be considered a normal calving.

If a cow aborts the pregnancy while in milk and has carried a calf less than 152 days, her current record will continue without interruption. If a breeding date is not available, and the cow aborts the pregnancy while in milk for less than 200 days, her current record will continue without interruption. Except for the specific situations above, the current record will end and a new lactation will begin.

14. COWS CALVING WITHOUT GOING DRY

If a cow calves without a dry period, the record will end on the day immediately preceding the calving and the new lactation will begin on the day of calving.

15. PREPARTUM MILK

Prepartum milk will not be counted as part of the lactation and it will not be included in the lifetime production record.

16. COWS MILKED MORE THAN TWICE PER DAY

Herds or cows normally milked more than twice per day will follow the same milking routine on test day.

Lactation records obtained by milking cows more than twice per day for all or part of the lactation will be labeled according to National DHIA procedures.

Herd averages, where some or all of the cows are milked more than two times a day, will be so labeled. The number of times the herd is milked daily will be rounded to the nearest whole number.

17. MISSING MILK WEIGHTS AND/OR SAMPLES

When complete milk weights or samples are not obtained on test day or are lost, the missing data will be estimated by the DRPC for the test period spanned using procedures outlined below. All estimated or missing data will be appropriately labeled. Only actual data will be sent for use in genetic evaluations. Reasons for lost or missed milk weights and/or samples will be recorded by the DHI technician. All adjustments to production credits will be made by the DRPC with routine programming. Exceptional cases should be referred to the DHI Field Service Provider.

A. First Test Day Weights or Samples Missed

- Missing milk weights and component percentages shall be calculated in the succeeding test interval by appropriate factors and procedures approved by National DHIA. Records having first test day more than 90 days after calving are not used in genetic evaluations.
- If the milk sample is missing or cannot be tested by a quality certified laboratory, the percentage of each component for the succeeding test day will be used.

B. Cows Missed For One or More Intervals During the Lactation After the First Interval

- Missing milk weights and component percentages shall be calculated based on the previous milk weights and component percentages using appropriate factors approved by National DHIA.
- The milk weights and component percentages may be held open and later computed as described in the *Test Interval Method*.
- If the sample is missing or cannot be tested by a quality certified laboratory, component data will be estimated according to National DHIA procedures.
- For herds weighed more than once daily and one milk weight is missed, AM/PM factors may be applied to the remaining weight(s) and component analysis to calculate test day yield. This yield shall be considered an actual yield.

C. New Cows Entering The Herd

- A cow purchased in milk with transfer credits will have production credits computed through the sale date in the previous (seller's) herd. The cow's production credits will start the next day in the current (purchaser's) herd, using test day data from the succeeding test. The *Test Interval Method* is required in making these computations. Dry cows will accumulate days on test in the previous (seller's) herd through the sale date and will start on test in the current (purchaser's) herd the next day.
- A cow entering the herd while in milk without previous production credits may have her record computed back to the calving date for management purposes. If the cow has no known calving date as of the first test date, the cow will receive credits for the current test interval only. The DRPC may extend the record back to the fresh date for management purposes only. Only actual data will be used in genetic evaluations.

18. STANDARD CALCULATIONS

A. Days Carried Calf = current sample date - effective breeding date +1
B. Days Open = effective breeding date - previous calving date
C. Gestation Days = resulting calving date - effective breeding date
D. Days Dry = next calving date - dry date
E. Calving Interval = next calving date - current calving date
F. Days in Milk
= dry date - previous calving date, or
= left herd date - previous calving date + 1, or
= current test date - previous calving date + 1
G. Assumptions
- The day of calving is an open day, a day in milk, and not a dry day.
- The day of breeding is a day carried calf.

H. Calculation of Ages of Cows (Truncation Method)

From the year, month, and day of the calving date, subtract the year, month, and day of the birth date. If the days are positive, discard. If the days are negative, add -1 to months. Then, if months are positive, use years and months as age of the cow. If months are negative, add 12 months, and add -1 to years. Use the resulting years and months as the age of the cow.

I. Adjusting Records to 24 Hours

When milk that is weighed is from an interval other than 24 hours, the recorded weight shall be adjusted to a 24-hour interval using approved AM/PM factors or the following procedure approved by National DHIA when AM/PM factors are not appropriate:

Divide 24 by the interval (measured in hours), then multiply by the total milk recorded during the interval.

Examples:
- For a 25-hour interval, (24/25) x 65 lbs. = 62.4 lbs. test day weight
- For a 20-hour interval, (24/20) x 65 lbs. = 78 lbs. test day weight
- For a 168 hour (7-day) interval (24/168) x 525 lbs.= 75 lbs. test day weight

J. Adjusting Milk Weights to a Verifiable Source

Acceptable adjustment procedures are as follows:
- If the DHI Field Service Provider has verifiable source for both milk shipped and milk not shipped, the test day milk weights are adjusted at the herd level to sum of both milk shipped and milk not shipped.
- If the DHI Field Service Provider has verifiable source for milk shipped but cannot account for milk not shipped, the test day milk weights are adjusted at the herd level to 102.8% of the milk shipped weights.
- In the absence of both milk shipped and milk not shipped, the DHI Field Service Provider shall not adjust the test day milk weights. The normal application of both the 24-hour adjustment and AM/PM adjustment factors by the DRPC shall apply.
- Test day milk weights adjusted at the dairy should not be further adjusted by the DRPC or other entity. The DRPC may recalculate a test day milk weight using the raw milk data if changes in the parameters used in the calculation of the adjusted test milk weight warrant such recalculation.

19. VERIFICATION TESTING

DHI Field Service Providers will conduct verification tests to verify the performance of cows and herds at the request of either a dairy producer member or allied industry representative. DHI verification tests will be performed based on pre-existing terms agreed to among the DHI Field Service Provider, the allied industry representative, and the herd owner. Verification test may be based on situational terms agreed to among all parties. DHI verification tests requested by the dairy producer will include the entire herd.

Acceptable verification procedures are as follows:
- A different DHI technician conducts a duplicate test immediately following the regular test.
- A different DHI technician tests the herd for one milking, in addition to the regular testing schedule.
- A different DHI technician tests the herd using the normal and routine testing schedule (i.e. no additional milkings).

All verification test results will be used in computing credits except under extraordinary circumstances, in which case the DHI Field Service Provider will determine which test(s) will be used.

20. RETESTING AT THE DAIRY PRODUCER'S REQUEST

If a dairy producer is not satisfied with the regular testing of the herd, a retest may be requested. Such a request shall be made within 15 days of the original test day and be directed to the DHI Field Service Provider. The member is responsible for the cost of the retest unless otherwise determined by the DHI Field Service Provider.

Retest results will be used in place of the test day data for which dissatisfaction has been registered when an obvious discrepancy exists. Both tests may be used if no discrepancy exists in the judgment of the DHI Field Service Provider.

21. PRODUCTION REPORTS

DHI lactation records of 305 days or less will be computed as required by National DHIA policies. All DHI records used in genetic evaluations must be processed at a quality certified DRPC. Electronic herd summary reports and cow lactation records will carry record standards variables to describe the conditions under which the records were collected.

22. YEARLY AVERAGES

Herd and Field Service Provider yearly averages will be computed on a cow-year basis. These will be summarized and transmitted as required by National DHIA policies. A herd must have DHI production credits for 365 days before a DHI herd average is published.

23. TRANSFER OF HERD DATA

Herds choosing to transfer service and herd data to a different DHI Field Service Provider are required to sign an intent-to-transfer form provided by the new DHI Field Service Provider.

A. The current DHI Field Service Provider must approve the transfer of the herd data within 15 days of receipt of the intent-to-transfer form provided the herd is in good financial standing.
B. The current DRPC subsequently transfers the herd data using current Standard Transfer Formats (STF).
C. Any cost associated with the transfer is the responsibility of the herd owner requesting the transfer.

24. TRANSFER OF INDIVIDUAL COW DATA

Transfer of individual cow data to new owners shall be accomplished within 10 days of notification from the buyer containing the herd and cow ID of the cow being transferred. This is best accomplished by STF exchange between the DRPC(s) servicing the buyer and seller or by sending a copy of the individual cow page.

25. AUTOMATIC MILKING SYSTEM (ROBOTIC) PROCEDURES

A. Test day milk weights will be obtained as 24-hour yield obtained from the automatic (robotic) milking system software. The average 24-hour milk yield reported should represent a minimum of three consecutive days and not to exceed ten consecutive days. There will be no application of AM/PM factors on milk yields.
B. Milk samples shall be obtained using National DHIA accepted sampling devices for one of the milkings during the test day. There will be no application of AM/PM factors on milk component results.
C. Data obtained from automatic (robotic) milking system software may not be used in genetic evaluations unless the system meets National DHIA/Quality Certification Services standards for on-farm, in-line analyzers.

26. DATA COLLECTION RATING

This index reflects the accuracy of the estimated lactation total. The Data Collection Rating is based on the number of test days, degree of test day supervision, and completeness of data collected on each test day.

Herd Data For Next Test

Date of Test			Technician	Net Per CWT		%	Fat Differential		%	Pro Differential	
Month	Day	Year	Number	$	Cents	Fat	Cents	10ths	Pro	Cents	10ths

Bulk Tank Weights	# Milkings	Total Lbs	SCC	MUN	
Pickup 1					Entire Herd Milked 3X
Pickup 2					_____
Pickup 3					

Milking	Start Time	End Time	Sampled	Weighed	Previous Test		
					Samp.	Wgh	Start Time
1st Milking (Prior for AM/PM)	: AM PM	: AM PM	Y N	Y N			
2nd Milking (Weigh for AM/PM)	: AM PM	: AM PM	Y N	Y N			
3rd Milking (3X Herd)	: AM PM	: AM PM	Y N	Y N			

HERD CODE ____-____-_____

TRANSFER DOES

DOE				CODE	COMPLETE THIS SECTION IF COW TRANFERS FROM ANOTHER HERD ON TEST			
					OLD HERD CODE			
INDEX NO.	REGISTRATION OR EARTAG NO.	BR	BARN NAME		STATE	COUNTY	HERD NO.	INDEX NO.
				T				
				T				
				T				
				T				

BREED CODES FOR NEW AND TRANSFER DOES

A - ALPINE	**E - EXPERIMENTAL**	**S - SAANEN**
B - OBERHASLI	**L - LA MANCHA**	**T - TOGGENBURG**
C - SABLE	**N - NUBIAN**	**M - MIXED**
D - NIGERIAN DWARF	**P - PYGMY**	

A-RECORD AN "A" IF ADDING 1ST LACTATION DOE WITH DRPC COMPUTER REF. NUMB.
C-RECORD A "C" IF CORRECTING EXISTING DOE.

NEW DOES ENTERING THE HERD OR IDENTITY CORRECTION

DOE				DATE OF BIRTH			SIRE		DAM			KID'S SIRE IDENTITY		CODE	DRPC COMPUTER REFERENCE NUMBER
INDEX NO.	REGISTRATION OR EARTAG NO.	BR	BARN NAME	MONTH	DAY	YEAR	UNIFORM AI CODE NUMBER REGISTRATION OR EARTAG	BR	REGISTRATION OR EARTAG NO.	BR	BARN NAME	SIRE CODE EARTAG OR OTHER NUMBER	BR		

SUPERVISOR'S BARN SHEET

DHI-201

Supervisor's Signature

Herd Code _____ - _____ - _____

Test Date: Mo | Day | Yr

Type Test		Sched. Day		Assoc.		Supv.		Cows In Herd		Cow Months		Total Fees	

String	Old Status: Code / Brd	Old Status: Date / Reg/Tag Number	Old Status: Last Milk	Cow Index	Milk Weights: Milking 1st	2nd	3rd	Feed Prg or Conc. Fed 2	CAR	Conc. Fed 1	Sample No.	Batch	Barn Name	New Status: Code	New Status: Date Changed Mo	Day	New Repro Status: No. Br.	Repro Code	Bred or Heat Date Mo	Day	Calf Identity or Service Sire: Calf: Tattoo, Tag, or Other / Sire: Reg No. or Bull Code	Sex	Disp	Calf Number	Body Wt.	Birth Diff.	Old Repro Status: No. Br.	Repro Code	Due Date / Bred or Heat Date	Error Code

Status Codes
2. Calved
3. Dry
5. Left Herd
6. First Lact
7. Entered Herd
8. Aborted
9. Induced Lact

Condition Affecting Record (CAR)		
1. Sold Feet/Legs	6. Died	A. Abnormal
2. Sold Dairy	7. Sold Mastitis	H. In Heat on Test Day
3. Sold Low Prod.	8. Sold Disease	E. Milk Weight Missed
4. Sold Repro.	9. Sold Udder	I. Injected on Test Day
5. Sold Injury/Other	X. Sold Reason Not Rprtd.	F. Sample Missed

Repro. Codes
1-9 No. Breedings
C. DNB (Do Not Breed)
H. In Heat
K. Checked OK to Breed
N. Open
P. Diagnosed Pregnant

Birth Difficulty
1. No Problem
2. Slight Problem
3. Needed Assistance
4. Considerable Force
5. Extreme Difficulty

Disposition Codes	
B. Died, Birth	4. Died, Other
E. Died, 1st 24 Hrs	5. Sold, Dairy
1. Died, Scours	7. Sold, Other
2. Died, Respiratory	T. Embryo Transplant
3. Died, Disease	

Condition Codes From Previous Test	
1. Bred Date Removed	6. Cow ID Missing
2. Calving Date Missing	7. Reported Sire of Cow Invalid
3. Dry Date Missing - Estimated	8. Calving Dates Less Than 200 Days Apart
4. Milk Weights Missing - Estimated	9. New Cow ID Invalid
5. Milk Weights Abnormal	

Calf Sex
F. Female
M. Male
7. Unknown

Date_____ 2018 Langston DHI Supervisor Test
Must return by Mar. 1, 2018 if you want a certificate

Were you previously certified by Langston to be supervisor Yes No
Tester Number

Name:_____

Address:_____

City:_____State:_____ Zip:_____

Telephone: _____

Who do you test for:_____E-mail: _____

1. A transfer doe is....
   A: A doe from another herd on test, that is entering your herd.
   B: A doe in your herd that has just freshened.
   C: A doe coming into your herd who has not been on test before.
   D: None of the above.

2. A verification test consist of how many milkings?
   A: 1
   B: 2
   C: 3
   D: 1 AM & 1PM

3. If I have a milk weight entered for a doe, and she has a #3 in the second column (at top) on the barn sheet (DMS 201) there is no problem.

   True False

4. Before sending the paperwork, I always ensure that I have put down fresh dates for does that have freshened and dry dates for does that have since the last test.

   True False

5. If I have not put down a milk weight for a doe who has a #2 or #6 in the second column on the barn sheet (DMS 20 I) there is no problem.

   True False

6. What is the difference between the Service Affiliate Fee (.08) and the Milk Analysis Fee (1.15)? (and not 1.07).

7. My neighbor has bought some goats from me, but she is not interested in testing them. Therefore she can still test my goats.

   True False

8. In order for my tests to be valid, my scales have to be checked for calibration .. .

   A: Three months

   B: Six months

   C: Eight months

   D: One year

9. When I find a mistake (Eva never makes mistakes. ;)) I should...
    A: Wait until the end of the year
    B: Wait until another test to see if the problem was corrected.
    C: Call or email as soon as you see a problem
    D: Make a note of the error and highlight it.

10. Doe pages are automatically sent to the owners when the doe dries or leaves the herd.

    True False

11. Milk samples must be refrigerated before shipping....
    A: So they don't spoil
    B: Because they will cool and not spill easily
    C: So the butter fat will be on top
    D: None of the above

12. If the pill falls out of the vial, I should.....
    A: Pick it up and put it back in the vial
    B: Wash it off and put it back in the vial
    C: Throw it in the trash and get a new vial
    D: None of the above.

13. The best way to label the vial is to. . .
    A: Put the does name on the vial.
    B: Put the order in which the does were milked on the vial , (l ,2,3,4..ect.).
    C: Put the index number tor the doe on the vial.
    D: Use a unique numbering system with a secret code.

IF YOU HAVE ANY QUESTIONS, PLEASE ASK THEM HERE:

Langston DHIA
Invoice

Herd Code # _____

Herd Owner _____

Verification Test YES NO

Service Affiliate Fee
DMS 201 _____x $.08 _____

Herd Processing Fee 01 – 20 does = $6.00 _____
21 – 40 does = $7.00
41 – 60 does = $8.00
61 – 80 does = $9.00
81 – 100 does = $10.00

Milk Analysis Fee
Total Samples _____ x $1.15 _____

Accounting Fee ……..$2.00

No Cash. Check or Money Order Only Please

Total _____

HERD OWNERS:
YOU MUST RETURN THIS SHEET BEFORE YOUR HERD WILL BE PROCESSED!
THIS SHEET MUST BE FILLED OUT BY THE HERDOWNER!

Number of Does dried this month _____

Number of Does freshened this month _____

Does Dried:

INDEX # DRY DATE

Does Freshened:

INDEX # FRESH DATE

(COPY THIS SHEET IF MORE SPACE IS NEEDED)

Langston University Goat DHIA
Agriculture Research & Cooperative Extension

E.L. Holloway Agriculture Research, Extension, and Education Center
Langston University
PO Box 1730
Langston, OK 73050
405-466-6207
dhi@langston.edu

Acknowledgement of Membership Agreement
in the Langston University Goat DHIA

As the owner of dairy goats and being interested in making my herd more efficient and more profitable through the use of herd management records as provided to members of this association, I hereby apply for membership of the above organization and desire DHIA-like testing services.

Should my membership be accepted, I agree:

1. To comply with all rules, regulations, administrative procedures and policies now in effect or established by the association during my continued membership, and I acknowledge receipt of a copy of existing rules, regulations, and policy manual which I have read and understand;
2. To comply with the National Dairy herd Improvement Program Uniform Operating Procedures as approved by the Council on Dairy Cattle Breeding and requests from Dairy Records Management Systems, and to be responsible equally with the supervisor in seeing that all rules and regulations are complied with in obtaining production records for my herd;
3. To cooperate with the supervisor if a supervisor is used in the testing plan which I am enrolled in and to provide him/her access to whatever information I control or have so as to enable him/her to keep complete records for my herd, specifically including but not limited to freshening and dry dates, purchase and sales dates, identification of all animals and plant delivery weights on milk sold.

_____ _____
Date Signature of Applicant

Applicant name:

Name: _____

Address: _____

City State Zip: _____

Phone: _____ Email: _____

Agreement accepted this _____day of _____ 20__ as a member, the applicant is entitled to all rights, benefits and privileges of this organization.

_____
Langston University Goat DHIA Representative

CURRENT PROGRAM SUMMARY

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

- **EXTENSION OVERVIEW**
- **RESEARCH OVERVIEW**
- **INTERNATIONAL OVERVIEW**

[This page intentionally left blank.]

Extension Overview

Dr. Terry A. Gipson
Goat Extension Leader

The year 2017 was a busy year for the Langston Goat Extension program. The goat extension specialists have answered innumerable producer requests for goat production and product information via the telephone, letters and e-mail, have given numerous presentations at several state, regional, national and international goat conferences for potential, novice and veteran goat producers, and have produced quarterly newsletters. They have also been busy with several major extension activities. These activities include the annual Goat Field Day, Langston Goat Dairy Herd Improvement (DHI) Program, grazing demonstrations, and various goat workshops on artificial insemination, tanning hides, and on internal parasite control.

Goat Field Day

Our annual Goat Field Day was held on Saturday, April 29, 2017 at the Langston University Goat Farm with registration beginning at 8:00 a.m. Last year's theme was Selection: from Eyeball to Genomics. Last year, our featured speakers were Dr. Ken Andries, Dr. Brian Sayre, and Ms. Lisa Shepard. Dr. Ken Andries was raised on a livestock and crop farm in Louisiana. He did his graduate work at Louisiana and Kansas State Universities majoring in animal genetics. Dr. Andries has worked in extension since graduation from Kansas State University in 1996. He is currently an Animal Science Specialist and Assistant Professor at Kentucky State University where he is responsible for the small ruminant extension programming, goat production research, and teaching undergraduate classes. He is a member of the national eXtension Goat Community of Practice, the American Goat Federation, goat representative on the National Sheep Improvement Program board, and has conducted many workshops and programs on goat production since starting at KSU. His extension programs have focused on improved production, health, and genetics for a more sustainable goat industry. He started the Kentucky Goat Herd Improvement Program (KyGHIP), and the program is gaining acceptance by producers around the country as a way to improve animal performance. Dr. Brian Sayre is a Professor in the Department of Biology at Virginia State University. Dr. Sayre's research program revolves around utilizing a systems genetics and genomics approach to identify candidate genes associated with production characteristics or diseases. Recent research is to identify genes in sheep and goats associated with resistance to internal parasite infections and humans for diabetes and obesity. Additionally, Dr. Sayre is a founding member of the International Goat Genome Consortium (IGGC), African Goat Improvement Network (AGIN) and ADAPTmap project. His research program has been involved in the development of the goat radiation hybrid (RH) panel, Illumina Goat 60K SNP panel and multiple sequencing projects for creation of a high quality reference genome sequence for the goat. Partnering with international collaborators for application of these tools to a goat, current applications include the ADAPTmap project to associate genotypes with GPS and environmental data, development of low-density SNP panels for selection in goat improvement projects in Africa, and partnering with the US goat industry for development of genomic selection tools. Dr. Sayre is a member of a national Critical Thinking Fellows Institute to promote implementation of critical thinking skills into the classroom. The research is focused on the development and identification of the non-cognitive aspects of student learning for improved outcomes in biology courses. Ms. Lisa Shepard currently works for the American Dairy Goat Association as the Performance Programs Manager. This involves efforts with the DHI Production Testing, Linear Appraisal, Sire Development, DNA Typing, Artificial Insemination, and Type programs. Prior to this, she was employed in the laboratory genetics field for 30 years with her work evolving into the areas of quality assurance and regulatory affairs. Ms. Shepard is also a representative to the California Dairy Goat Advisory committee, on the Board of New Mexico's caprine DHIA, and on the local

water commission. Lisa and her husband raise a small seedstock herd of Saanens in northern New Mexico. They keep it small so that they can enjoy their other interests in traveling and hiking.

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

- Dairy Goat Production Evaluations with Ms. Lisa Shepard.
- Dairy Goat Type Evaluations with Ms. Lisa Shepard.
- Combining Information for a Selection Index with Ms. Lisa Shepard.
- Getting Started Collecting and Using Data in Meat Goats with Dr. Ken Andries.
- Using Performance Ratios and EBVs for Selection in Meat Goats with Dr. Ken Andries.
- Value of Performance in your Herd: A Look at the Cost and Returns of Using Data in Selection with Dr. Ken Andries.
- Applied Animal Genomics with Dr. Brian Sayre.
- Basic Herd Health and Management with Dr. Lionel Dawson and Mr. Jerry Hayes.
- The Art of Cheesemaking with Dr. Steve Zeng.
- Internal Parasite Control with Dr. Barry Whitworth.
- Nutrition for Health and Production with Dr. Steve Hart.
- DHI Training with Ms. Eva Vasquez.
- USDA/APHIS: Animal ID with Dr. Michael Pruitt and USDA/WS: Wildlife programs with Mr. Kevin Grant.
- USDA/NRCS: Conservation programs with Ms. D'Ann Peterson and USDA/FSA: Farm loans with Mr. Phil Estes
- USDA/NASS: Animal inventories with Mr. Wil Hundl and Perry Livestock: Livestock auctions and marketing with Mr. Travis Perrin
- Fitting and Showing for Youth and Adults with Ms. Janet and Messrs. Robbie and Coleman Sanders.

The Goat Field Day for Kids provides the opportunity for kids to explore and enjoy "old-fashioned fun activities" while their parent(s) participate in the Goat Field Day Program. With all of today's technological gizmos from the iPod to high-end smart phones and handheld games, most kids are no longer exposed to the old-fashioned games and activities that shaped the imaginations and innate creativity of their parents and grandparents. The Goat Field Day for Kids Program is intended to challenge and enhance cognitive and social skills. The development of intellectual and socialization practices have been determined as prerequisites for helping children to learn more complex concepts, thereby enhancing their personal capabilities.

Cheese Manufacturing Workshop

Our ever-popular goat milk cheesemaking workshop was scheduled on Friday April 28, 2017 (the day before our annual goat field day on April 29). Dr. Steve Zeng, Dairy Product Specialist at Langston University, was the host/instructor for this workshop. He has instructed cheese workshops in many states as well as internationally. He has also judged cheeses for the World, the United States, the American Cheese Society and the American Dairy Goat Association cheese championships/contests in the last decade. He shared his rich background, personal experience and masterful skills in small-scale cheese manufacture, particularly goat milk cheeses. He demonstrated basic principles and practical skills of making hard cheeses using our own Grade "A" goat milk. Milk quality, cheesemaking facility and federal safety requirements were also discussed. This one-day hands-on workshop was held in the pilot creamery at Langston University.

Goat DHI Laboratory

This past year was a year of change for the Langston Goat Dairy Herd Improvement (DHI) Program as it became independent and expanded its record processing capabilities. In 1996, the Langston DHI program

launched under the umbrella of the Texas DHIA. That partnership was not mutually beneficial and Langston Goat Dairy DHI elected to operate independently. In addition, the dairy records processing software that had been initially acquired from Texas DHIA had reached well beyond it capabilities and could not be modernized. Thus, Langston Goat Dairy DHI has partnered with Dairy Records Management System (DRMS) of Raleigh, NC to conduct the record processing. 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 have 157 producer herds in 34 states enrolled in the Langston Goat Dairy DHI Program. In 2017, the DHI laboratory processed more than 12,000 samples. Langston University continues to serve the very small-scale dairy goat producer. The average herds size on test with Langston University is 10 animals. This is significantly smaller than the herd size average for the five other processing centers. For those interested in becoming a Langston goat DHI tester, training is available either in a formal classroom setting or through a 35-minute video tape (see additional information in the YouTube section). Every tester is required to attend the DHI training session or view the tape and take a test. Upon completion of the DHI training, the milk tester can start performing monthly herd tests.

Goat Newsletter

To date, the Goat Extension program published four issues of the 8-page Goat Newsletter in 2017. Interest in the newsletter has grown and we currently have over 1,600 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 2017, an AI workshops was held in October at the Langston University campus. Eleven participants were trained.

Production Handbooks

The first edition Meat Goat Production Handbook has been sold-out and the revised second edition is available. The Meat Goat Production Handbook was partially funded by USDA/FSIS/OPHS project #FSIS-C-10-2005. An illustrated and scaled-down version of the Meat Goat Production Handbook is available. Our collaborating project institutions/organizations include Kentucky State University and the University at Puerto Rico at Mayagüez. Partial funding to develop the Meat Goat Production Basics was from USDA/NIFA grant #2010-38821-21581 (OKLX-GIPSON10). The University of Puerto Rico – Mayagüez has translated the Meat Goat Production Basics book into Spanish for the Producción de Cabros para Carne Conceptos Básicos.

The Dairy Goat Production Handbook has 475 pages of information on all aspects of dairy goat production and could be considered as a companion book to the Institute's Meat Goat Production Handbook, 2nd Edition. Partial funding to develop the Dairy Goat Production Handbook was from USDA/NIFA grant #2011-38821-30952 (OKLXMERKEL11). In addition to the full handbook, the Institute has also created the Dairy Goat Production Basics, a condensed, easy-to-read version of selected chapters from the full handbook similar to what was done to create the Meat Goat Production Basics. Partial funding to develop the Dairy Goat Production Basics was from USDA/NIFA grant #2011-38821-30952 (OKLXMERKEL11). To better serve the Institute's Spanish speaking clientele, the Dairy Goat Production Basics book has been translated into Spanish and the Producción de Cabras Lecheras Conceptos Básicos is available. The Institute worked with scientists of the University of Puerto Rico – Mayagüez (UPRM) in the editing and review process. Partial funding to develop the Producción de Cabras Lecheras Conceptos Básicos was from USDA/NIFA grant #2011-38821-30952 (OKLXMERKEL11).

Order forms for these production handbooks can be found later in the proceedings.

Controlling Internal Parasites Workshop

Internal parasites (Barberpole worm, *Haemonchus contortus*) is the leading cause of death in goats in the Southern US, accounting for as many deaths as the total of the next three leading causes of death in goats. Several factors contribute to the high mortality caused by internal parasites.

Goats which originated in dry areas where there was no internal parasite challenge have been brought to the humid South where there is great parasite challenge. Only a few animals have good genetic resistance against internal parasites. In addition, goats are forced to graze rather than browse which provides greater opportunity to consume infective larvae and especially so when animals overgraze. Producers are not familiar with monitoring animals for signs of parasitism and do not understand how animals get infected. In addition internal parasites have developed a high level of resistance to dewormers from the overuse of dewormers in goats. To address these concerns, Langston developed a parasite workshop to educate producers about internal parasites. It includes 3 hours of lecture on biology of the parasite, pasture management to avoid worms and monitoring parasite infection using the FAMACHA chart which assesses the degree of anemia. This is a cooperative effort with OSU Extension Veterinarian who addresses dewormer resistance and correct use of dewormers. Producers get hands-on instruction in use of the FAMACHA card, taking fecal samples and running fecal egg counts.

YouTube Channel

Created in 2005, YouTube is a video-sharing website on which users can upload, view and share videos. YouTube now has over 120 million videos, including movie clips, TV clips, and music videos, as well as amateur content such as video blogging and short original videos. The Goat Program at Langston University

has created its own YouTube channel (https://www.youtube.com/user/taglu01) The following are the YouTube videos that are available and you can quickly access them on a mobile device by using the QR (2D barcode) to the right. Additional videos will be added to the channel in the future

Artificial Insemination (AI) in Goats (length 8:47)

This video describes the steps involved in artificial insemination in goats.

AI Kit (length 6:28)

This video describes the equipment needed for artificial insemination in goats.

Basic Hoof Care (length 10:48)

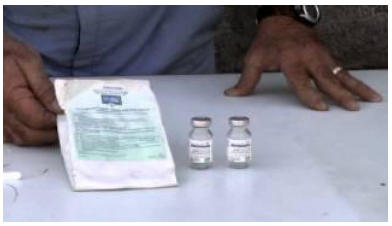
This video explains basic hoof care for goats.

Body Condition Scores in Goats (length 2:11)

This video describes how to evaluate body condition score in goats.

Buck Effect (length 1:53)

This video describes the buck effect and its use in estrus synchronization.

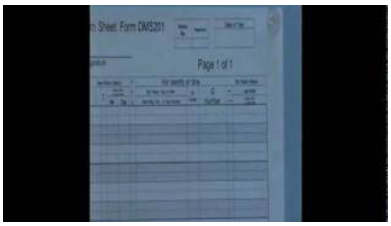


Estrous Synchronization in Goats (length 5:08)

This video explains estrous synchronization for artificial insemination in goats.

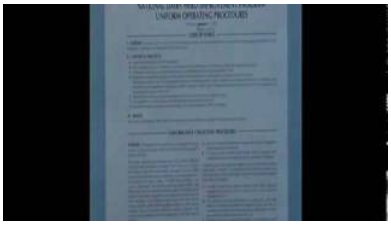
Langston DHI Tester Training - Part 1 (length 9:24)

This video describes how to conduct proper DHIA testing procedures for milk sampling.



Langston DHI Tester Training - Part 2 (length 9:48)

This video describes how to conduct proper DHIA testing procedures for milk sampling.



Langston DHI Tester Training - Part 3 (length 9:19)

This video describes how to conduct proper DHIA testing procedures for milk sampling.

Langston DHI Tester Training - Part 4 (length 8:28)

This video describes how to conduct proper DHIA testing procedures for milk sampling.

Semen Tank (length 6:39)

This video explains semen tank handling and semen storage for artificial insemination in goats.

Signs of Does (female goats) in Estrus (length 0:35)

This video shows an example of signs of estrus (flagging) in goats.

Nutrient Requirements of Goats

Under a research project which developed equations for energy and protein requirements for goats, as well as prediction of feed intake, an extension sub-project developed a website calculation system for "Nutrient Requirements of Goats" (http://www2.luresext.edu/goats/research/nutreqgoats.html). Most calculators were based on studies of the project reported in a Special Issue of the journal Small Ruminant Research. For

calculators with score inputs (i.e., grazing and body conditions), pictures are available to aid in determining most appropriate entries. Realistic examples are given, as well as discussion of appropriate and inappropriate usage. However, for the experienced user there is an option to hide text and examples and to view only inputs and outputs.

In 2005, a calculator for calcium and phosphorus requirements was added to the existing calculators for metabolizable energy, metabolizable protein, and feed intake for suckling, growing, mature, lactating, gestating, and Angora goats. Also in 2005, the interface of the calculators was unified into a single calculator with the English measurement system used. This will encourage the use of the calculators by American producers. The least-cost ration balancer was modified so that it incorporates the least-cost feed percentage into the diet. Also, calculators are equipped with printable version commands to obtain inputs and outputs in hard copy format. In 2007, the calculators were continued to be updated.

Langston University's popular web-based nutrient calculator is now available for free on the iPad. To install this version, simply go the App Store and search for "Goat Nutrient Calculator". Once installed on your iPad, you will be able to calculate the nutrient requirements for any goat in any age, breed or stage of production, as well as, calcium and phosphorus requirements.

The original web-based nutrient calculators were developed under a research project and were only accessible via the website (http://www2.luresext.edu/goats/research/nutreqgoats.html or http://goats.langston.edu/Nutrient-Calculators). This iPad version is the first stand alone version of the calculators available.

The web-based version has a feed library and a least-cost ration balancer so that rations can be formulated to meet nutrient requirements. Currently, the iPad version does not have these attributes but it is planned to update this version with those capabilities with the next release.

For these calculators to be of value, they must be readily accessible and reasonably simple. It is hoped that this iPad version will enjoy widespread usage and enhance feeding practices for goats.

Tanning Goat Hides

People express interest in tanning skins for a variety of reasons. Some sheep and goat producers wish to tan skins of animals they raise. Other people are hunters who wish to tan deerskins. Reasons for this interest include: wanting to use as much of the animal as possible, disliking the waste of an animal's skin; ownership of an exceptionally pretty goat that they wish to tan after harvest for home use; learn new skills; wish to use tanning skills on other mammals such as deer; wishing to learn "old-time" skills, and some producers see a source of potential income through tanning goat skins and selling handicrafts. Some attendees already tan skins but want to expand their knowledge. All of these producers wish to learn to tan skins. There is no other tanning skins course in the nearby area. Langston University instituted a tanning goat skins course that teaches tanning skills to persons wishing to tan skins as a hobby. The workshop uses readily available chemicals and all processes are done by hand. Thus, it is a low cost process that producers can try at home. The hands-on nature of the course whereby participants work with actual skins in most of the tanning steps ensures skill transfer. This format allows students to work with and learn from each other and receive practical knowledge of the tanning process that will help them when trying tanning skins at home. In 2017, one tanning goatskins workshop was held at Langston University in April.

Internet Website

http://goats.langston.edu (new) or http://www2.luresext.edu (old)

In 2014, Langston University unveiled a new web presence with new branding design. In 2015, the Office of Public Relations informed the Institute that our website must meet branding requirements and we took steps to comply with branding requirements. This was done by purchasing a new server and engaging a Drupal

consultant. Capabilities of the new web site include a document library with the complete proceedings of the annual Goat Field Day 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.

Tracking code for Google Analytics was added to the new Drupal server. Overall in 2017, there were 68,674 visits (up 42% from 2016); however, the Drupal server was only functional for 11 months in 2017. Visitors spent an average 1 minutes and 44 seconds, which is down slightly from 2016 (2 minutes, 00 seconds). The United States accounted for 62% of all users. The top 25 countries (users) are listed in Table 1.

Country	Users	New Users	Sessions	Bounce Rate	Pages / Session	Avg. Session Duration (sec)
United States	13855	13838	17070	69.24%	2.34	110.73
India	1590	1585	1827	78.49%	1.56	67.41
Nigeria	1339	1334	1604	73.32%	1.63	81.02
Ethiopia	1297	1277	1631	79.77%	1.46	111.37
China	1082	1081	1094	96.98%	1.17	11.55
Philippines	986	984	1085	74.65%	1.64	105.16
Kenya	534	530	640	77.34%	1.48	68.94
Canada	479	476	579	71.33%	2.27	99.83
South Africa	452	452	495	77.58%	1.61	83.14
United Kingdom	414	400	460	79.35%	1.64	52.17

Every state in the union visited the web site with Texas accounting for the most visits on both the old and new servers. Top ten states are listed in Table 2.

Region	Users	New Users	Sessions	Bounce Rate	Pages / Session	Avg. Session Duration (sec)
Texas	2142	2072	2612	70.02%	2.15	85.87
Oklahoma	1256	1200	2240	40.76%	3.95	268.56
California	1041	1028	1165	83.09%	1.64	56.21
New York	579	569	635	81.10%	1.99	75.22
North Carolina	561	545	631	73.53%	2.57	130.55
Missouri	485	476	570	70.88%	1.89	89.32
Florida	480	475	545	73.58%	2.09	104.72
Georgia	428	421	484	73.14%	2.19	93.22
Tennessee	412	404	445	78.43%	2.11	75.72
Illinois	384	375	439	73.58%	2.25	107.89

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 was unveiled in late 2005.

In 2017, the online course was expanded to include dairy goat production and moved to a Moodle platform (http://certification.goats.langston.edu). The web-based training and certification program for dairy goat producers was developed with funding from USDA/NIFA project #OKLXMERKEL11 entitled "Extension Education Delivery Tools for Dairy Goat Producers: a Web-based Certification Program and E-book" and with technical support from eXtension i-Three Issue Corps. The web-based training and certification program for meat goat producers was developed with funding from USDA/FSIS/OPHS project #FSIS-C-10-2004 entitled "Development of a Web-based Training and Certification Program for Meat Goat Producers" and with technical support from eXtension i-Three Issue Corps.

Country	State	Dairy QP Number	Meat QP Number
USA	Alabama	2	6
	Arkansas	1	13
	Arizona	1	2
	California	1	7
	Colorado	1	3
	Connecticut	0	1
	Florida	0	25
	Georgia	2	18
	Iowa	0	5
	Idaho	1	1
	Illinois	1	5
	Indiana	0	8
	Kansas	1	11
	Kentucky	0	14
	Louisiana	0	3
	Massachusetts	0	2
	Maryland	1	4

Country	State	Dairy QP Number	Meat QP Number
	Maine	1	0
	Michigan	5	11
	Minnesota	0	4
	Missouri	4	14
	Mississippi	1	3
	Montana	0	2
	North Carolina	0	18
	Nebraska	0	4
	New Hampshire	0	1
	New Jersey	1	2
	New Mexico	1	0
	Nevada	0	3
	New York	0	9
	Ohio	4	12
	Oklahoma	3	35
	Oregon	3	9
	Pennsylvania	1	11
	South Carolina	1	6
	South Dakota	0	2
	Tennessee	2	13
	Texas	3	41
	Utah	0	2
	Virginia	2	13
	Vermont	0	1
	Washington	0	5
	Wisconsin	1	5
	West Virginia	1	6
	Wyoming	1	5
Canada	Alberta	0	2
	British Columbia	0	4
	Manitoba	0	3
	Nova Scotia	0	1
	Ontario	0	3
Other Country	Botswana	0	1
	England	0	2
	India	0	1
	Malaysia	0	4
	Mexico	0	2

Country	State	Dairy QP Number	Meat QP Number
	Pakistan	0	1
	Russian Federation	1	0
	Saudi Arabia	0	1
	South Africa	0	1
	Suriname	0	1
	Zimbabwe	1	2
Total		***49***	***394***

Current Extension Projects

Title: Enhancing Cityscapes and Landscapes: Partnerships between Langston University and Tribal and Municipal Governments
Type: USDA Renewable Resources Extension Act Program
Project Number: OKLURREA2016
Period: 2016-2021
Investigators: T.A. Gipson, S. Hart, R. Merkel, T. Sahlu
Institution: Langston University
Objective: 1) Establish partnerships between Langston University and tribal and municipal governments, and will establish demonstration sites using goats for biological control with Langston University providing technical assistance.

Title: Empowering Community-Based Organizations in Rural Oklahoma to Increase Knowledge Base, Enterprise Productivity, and Economic Sustainability
Type: 1890 Universities Foundation
Project Number: Langston
Period: 2018
Investigators: T.A. Gipson, R. Merkel, M. Anderson, C. Williams, D. Guy
Institution: Langston University
Objective: 1) Reestablish and build new partnerships with Community-Based Organizations (CBOs) serving limited resource, veteran and beginning farmers; establish baseline parameters for small ruminant and/or vegetable production systems;
2) Provide technical assistance to support production and management of lucrative and sustainable small ruminant enterprises as well as for intensive vegetable production systems for CBOs serving limited resource producers;
3) Provide a series of training workshops to inform CBOs of USDA Rural Development and other programs that will help to enhance enterprise profitability and sustainability.

Research Overview

Dr. Arthur Goetsch
Goat Research Leader

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

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

To provide an idea about our research program since the last Field Day, listed below are research projects and experiments we have been involved with in 2017 and 2018, some of the abstracts that will be presented at meetings in 2018, and summaries of scientific articles that were published in 2017 or that have been accepted for publication but are not yet in print.

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

2017 and Current Research Projects

Title:	Management Practices for Production of Goats in the South-Central U.S.
Type:	USDA NIFA Evans Allen
Project Number:	OKLXSAHLU2017
Period:	2012-2017
Investigators:	T. Sahlu, A. L. Goetsch, R. Puchala, R. C. Merkel, T. A. Gipson, S. P. Hart, S. Zeng, Z. Wang, L. J. Dawson, and E. Loetz
Institution:	Langston University
Objective:	Study goat management practices and product technologies to increase the level and efficiency of goat productivity for increased profitability from goat production and lower costs to consumers of goat products.

Title:	Management Practices for Production of Goats in the South-central U.S.
Type:	USDA NIFA Evans-Allen
Project Number:	OKLUSAHLU2017
Period:	2017-2022
Investigators:	T. Sahlu, A. L. Goetsch, R. Puchala, R. C. Merkel, T. A. Gipson, S. P. Hart, S. Zeng, Z. Wang, E. Loetz, and L. J. Dawson
Institution:	Langston University
Objective:	Study goat management practices and product technologies to increase the level and efficiency of goat productivity for increased profitability from goat production and lower costs to consumers of goat products.

Title:	Genomics of Resilience in Sheep to Climatic Stressors
Type:	USDA 1890 Institution Capacity Building – Research and Teaching
Project Number:	OKLXGOETSCH13
Period:	2013-2018
Investigators:	A. L. Goetsch[1], T. A. Gipson[1], R. Mateescu[2], S. Zeng[1], R. Puchala[1], M. Rolf[3], T. Sahlu[1], P. Oltenacu[2], and B. K. Wilson[4]
Institutions:	[1]Langston University, [2]University of Florida, [3]Kansas State University, and [4]Oklahoma State University
Objectives:	1) Gain a better understanding of the genetic basis of adaptation in sheep to change in climate 2) Through a landscape genomics phase, document that some allele frequencies of otherwise genetically similar populations vary as a function of environmental climatic conditions 3) Evaluate traits expected to be important for resilience to climatic stressors under identical conditions with sheep of four breeds randomly selected from four different locations with varied environmental conditions 4) In a genome-wide association phase, ascertain if these resilience traits are genetically based and heritable 5) Compare and rank genomic breeding values for these resilience traits of oldest sheep of each location and bred to elucidate how different environmental climatic conditions affect the importance of these traits to fitness 6) Investigate change in the mean value of each resilience trait along environmental gradients, possibly consistent with climatic variation

Title:	Comparison of Biological Control of Red Cedar with Goats to Conventional Methods of Control
Type:	USDA 1890 Institution Capacity Building – Research and Extension
Project Number:	OKLXHART14
Period:	2014-2018
Investigators:	S. P. Hart[1], T. A. Gipson[1], R. C. Merkel[1], J. Pennington[2], C. Clifford-Rathert[2], and C. Williams[1]
Institutions:	[1]Langston University, and [2]Lincoln University

Objectives:	1) Learn more about factors affecting red cedar consumption by goats so that they can be more effectively for control red cedar 2) Compare the degree of control and cost of use of goats versus alternative methods of clipping, burning, and herbicide
Title:	Enhancing Wellbeing and Productivity of Dairy Goats Using Smart Technology
Type:	USDA 1890 Institution Capacity Building - Research
Project Number:	OKLXGIPSON14
Period:	2014-2018
Investigators:	T. A. Gipson[1], S. P. Hart[1], R. Puchala[1], E. Loetz[1], L. J. Dawson[2], and B. Ardrey[2]
Institutions:	[1]Langston University, and [2]Smartsock
Objectives:	1) Validate the appropriate use of a rumen bolus for real-time monitoring of rumination and ruminal temperature 2) Model rumination time and rumen movement using the rumen bolus 3) Examine temperature and rumination time in relation to estrus using the rumen bolus 4) Examine temperature and rumination time in relation to mastitis using the rumen bolus
Title:	Sustainable Control of Greenhouse Gas Emission by Ruminant Livestock
Type:	USDA 1890 Institution Capacity Building - Research
Project Number:	OKLXGOETSCH14
Period:	2014-2018
Investigators:	A. L. Goetsch[1], R. Puchala[1], T. Sahlu[1], M. Flythe[2], and G. E. Aiken[2]
Institutions:	[1]Langston University, and [2]USDA ARS Forage-Animal Production Research Unit
Objective:	Characterize long-term effects of lespedeza condensed tannins in combination with other substances potentially reducing ruminal methane emission by sheep and goats
Title:	Combating Anthelmintic Resistant Parasitic Nematodes in the Small Ruminant Industry
Type:	USDA 1890 Institution Capacity Building - Research
Accession Number:	1012072
Proposal Number:	2016-06596
Period:	2017-2020
Investigators:	Z. Wang[1], J. Zhao[2], A. L. Goetsch[1], S. P. Hart[1], T. Sahlu[1], and W. C. Davis[3]
Institutions:	[1]Langston University, [2]AZ Nature Art LLC, and [3]Washington State University
Objective:	Develop alternative approaches to diminish use of chemical anthelmintics that parasites of small ruminants have developed resistance to
Title:	A Respiration Calorimetry System for Study of Energy Use and Methane Emission by Small Ruminants in Production Settings
Type:	USDA AFRI Foundational Equipment Grant
Accession Number:	1014848
Project Number:	OKLUGOETSCH2018
Period:	2018
Investigators:	A. L. Goetsch, R. Puchala, T. A. Gipson, and T. Sahlu
Institution:	Langston University
Objectives:	Long-term goal: Use an indirect open-circuit calorimetry system with groups of small ruminants in free-moving settings to enhance efficiency of use of nutrients and energy, decrease ruminal emission of the greenhouse gas methane, and develop optimal grazing management strategies. Objectives: Acquire and set up the system and conduct research to determine optimal experimentation conditions, namely appropriate numbers and times of daily measurements and numbers of individual animal observations.

2017/2018 Experiments

Title:	Validation of rumination time in goats using rumination halters fitted with accelerometers
Project Number:	OKLUTGIPSON2014
Experiment Number:	SL-17-01
Investigators:	S. LeShure, T. A. Gipson, R. Puchala, A. L. Goetsch, and T. Sahlu
Objective:	To model rumination time using accelerometer fitted nosebands and video observation in goats.

Title:	Evaluation of resilience of hair sheep breeds from different regions of the USA to restricted availability of drinking water - trial 3 and animal set 4
Project Number:	OKLXGOETSCH2013
Experiment Number:	AH-17-02
Investigators:	A. Hussein, A. L. Goetsch, R. Puchala, T. A. Gipson, D. Tadesse, and T. Sahlu
Objectives:	Evaluate resilience to limited drinking water availability of three hair sheep breeds (Dorper, Katahdin, and St. Croix), four ecotypes from different eco-climate domains of the USA (Upper Midwest, Central Texas, Southeast, Pacific Northwest), and individual animals

Title:	Evaluation of resilience of hair sheep breeds from different regions of the USA to limited feed intake – trial 2 and animal set 1
Project Number:	OKLXGOETSCH2013
Experiment Number:	DT-17-03
Investigators:	D. Tadesse, A. Hussein, R. Puchala, T. A. Gipson, Z. Walng, T. Sahlu, L. J. Dawson, and A. L. Goetsch
Objectives:	Evaluate resilience to limited feed intake of three hair sheep breeds (Dorper, Katahdin, and St. Croix), four ecotypes from different eco-climate domains of the USA (Upper Midwest, Central Texas, Southeast, Pacific Northwest), and individual animals

Title:	Effect of season on reproductive behavior, semen quality, sperm structure, and resilience to freezing of goat semen collected by different procedures
Project Number:	OKLXSAHLU2012
Experiment Number:	EL-17-07
Investigators:	E. Loetz, L. J. Dawson, M. Rojas, and A. Haile
Objectives:	Evaluate the response of male goats of five breeds (Alpine, Boer, Spanish, Angora, and Tennessee Stiff Leg) to seasonal changes throughout the year at five times in regards to reproductive behavior, semen quality, sperm structure, and resilience of goat semen collected by two methods to freezing

Title:	Investigation of the effects of *Staphylococcus epidermidis* induced mastitis on temperature and rumination time in goats using rumination halters
Project Number:	OKLUTGIPSON2014
Experiment Number:	SL-17-08
Investigators:	S. LeShure, T. A. Gipson, S. Hart, R. Merkel, and L. Dawson
Objective:	Examine temperature and rumination time in relation to *S. epidermidis* induced mastitis in dairy goats using accelerometer-fitted rumination halters

Title:	Evaluation of resilience of hair sheep breeds from different regions of the USA to high heat load – trial 4 and animal set 2
Project Number:	OKLUGOETSCH2013
Experiment Number:	DT-17-09
Investigators:	D. Tadesse, R. Puchala, T. A. Gipson, L. J. Dawson, Z. Wang, T. Sahlu, and A. L. Goetsch
Objectives:	Evaluate resilience to high heat load index of three hair sheep breeds (Dorper, Katahdin, and St. Croix), four ecotypes from different eco-climate domains of the USA (Upper Midwest, Central Texas, Southeast, Pacific Northwest), and individual animals

Title:	Effects of water restriction and provision of a 50% concentrate pelletized diet on metabolizability and energy utilization by hair sheep
Project Number:	OKLUGOETSCH2013
Experiment Number:	AH-17-10
Investigators:	A. Hussein, D. Tadesse, R. Puchala, I. Portugal, A. Hussein, and A. L. Goetsch
Objectives:	Determine effects of 50% water restriction and provision of a 50% concentrate pelleted diet fed at 160% of the maintenance requirement on metabolizability and energy utilization by hair sheep

Title:	Evaluation of resilience of hair sheep breeds from different regions of the USA to limited feed intake – trial 3 and animal set 3
Project Number:	OKLUGOETSCH2013
Experiment Number:	DT-17-11
Investigators:	D. Tadesse, A. Hussein, R. Puchala, T. A. Gipson, Z. Wang, T. Sahlu, L. J. Dawson, and A. L. Goetsch
Objectives:	Evaluate resilience to limited feed intake of three hair sheep breeds (Dorper, Katahdin, and St. Croix), four ecotypes from different eco-climate domains of the USA (Upper Midwest, Central Texas, Southeast, Pacific Northwest), and individual animals

Title:	Evaluation of resilience of hair sheep breeds from different regions of the USA to restricted availability of drinking water - trial 4 and animal set 2
Project Number:	OKLUGOETSCH2013
Experiment Number:	AH-17-12
Investigators:	A. Hussein, A. L. Goetsch, R. Puchala, T. A. Gipson, D. Tadesse, and T. Sahlu
Objectives:	Evaluate resilience to limited drinking water availability of three hair sheep breeds (Dorper, Katahdin, and St. Croix), four ecotypes from different eco-climate domains of the USA (Upper Midwest, Central Texas, Southeast, Pacific Northwest), and individual animals

Title:	Resiliency of Alpine, Angora, Boer, Spanish, and Tennessee Stiff Leg embryos when retrieved during anestrous and cryopreserved by vitrification
Project Number:	OKLXSAHLU2012
Experiment Number:	EL-17-13
Investigators:	E. Loetz, Y. Tilahun, L. Dawson, A. Haile, and M. Rojas
Objectives:	Evaluate the stability of a group of putative steadily expressed ‘house-keeping’ genes for the unattached 7-day goat embryo before and after cryopreservation

Title:	Effects of lespedeza condensed tannins, monensin, soybean oil, and coconut oil alone and in combinations on ruminal methane emission, feed intake, feeding behavior, digestion, energy metabolism, and growth performance by growing Alpine doelings
Project Number:	OKLUAGOETSCH2014
Experiment Number:	LR-17-14
Investigators:	L. Ribeiro, R. Puchala, I. Portugal, T. A. Gipson, T. Sahlu, and A. L. Goetsch
Objectives:	Determine if there is adaptation in sheep to the inhibition of ruminal methane production by naturally occurring condensed tannins in lespedeza forage when fed for a prolong period of time and if such effects vary with dietary level of lespedeza as well as effects of monensin, soybean oil, and coconut oil

Title:	Evaluation of resilience of hair sheep breeds from different regions of the USA to limited feed intake – trial 4 and animal set 4
Project Number:	OKLUGOETSCH2013
Experiment Number:	DT-17-15
Investigators:	D. Tadesse, A. Hussein, R. Puchala, T. A. Gipson, Z. Wang, T. Sahlu, L. J. Dawson, and A. L. Goetsch
Objectives:	Evaluate resilience to limited feed intake of three hair sheep breeds (Dorper, Katahdin, and St. Croix), four ecotypes from different eco-climate domains of the USA (Upper Midwest, Central Texas, Southeast, Pacific Northwest), and individual animals

Title:	Ruminating and lying behavior of dairy goats in confinement or grazing
Project Number:	OKLUTGIPSON2014
Experiment Number:	LR-17-16
Investigators:	L. Ribeiro, S. Ishii, T. Gipson, R. Merkel, and S. LeShure
Objective:	Examine rumination time and lying behavior simultaneously by using two tri-axial accelerometers, one fitted into an elastic, nose-band halter and the other attached to the hind leg, in confinement and grazing environments

Title:	Characterization of protective immunity to Haemonchus contortus in goats
Project Number:	OKLUSAHLU2017
Experiment Number:	ZW-17-17
Investigators:	Z. Wang, H. Liu, Q. Yang, Y. Tilahun, R. Merkel, W. Davis, L. Dawson, S. Hart, A. Goetsch, and T. Sahlu
Objectives:	Manipulate the immunity of goats and observe the outcome of immunity to infection of H. contortus

Title:	Effect of estrus on rumination in dairy goats
Project Number:	OKLUTGIPSON2014
Experiment Number:	MR-17-18
Investigators:	M. Rojas, L. Ribeiro, E. Loetz, L. Dawson, R. Merkel and T. Gipson
Objective:	Examine the effect of estrus on rumination time

Title:	Pregnancy rate and embryo viability for timed vaginal insemination of estrus/ovulation synchronized Spanish goats using pooled-fresh semen with different motile sperm concentration, insemination volume, and semen extender during the breeding season
Project Number:	OKLUSAHLU2017
Experiment Number:	EL-17-20
Investigators:	E. Loetz, L. J. Dawson, M. Rojas, and A. Haile
Objectives:	Evaluate if motile sperm concentration of the insemination dose (300 and 500 million/mL), insemination dose volume (1 or 2 mL), and the use of two different semen extenders (milk and egg-based) influence pregnancy rate and(or) embryo viability

Title:	Effect of storage length and conditions for raw goat skins on subsequent leather strength and quality
Project Number:	OKLUSAHLU2017
Experiment Number:	RM-17-21
Investigators:	R. C. Merkel, T. A. Gipson, and Z. Wang
Objectives:	Compare two methods of skin preservation, traditional salt packs vs. packing in a plastic drum, each of which will be evaluated with skins stored for three lengths of time

Title:	Effects of restricted periods of diet access on feed intake, behavior, and performance of lactating Alpine goats consuming diets differing in forage and fiber levels
Project Number:	OKLUSAHLU2017
Experiment Number:	LR-18-01
Investigators:	L. P. S. Ribeiro, R. Puchala, T. A. Gipson, T. Sahlu, I. Portugal, A. Manley, E. Loetz, L. J. Dawson, and A. L. Goetsch
Objectives:	Determine effects two restricted feed access treatments and dietary forage and fiber levels on feed intake, behavior, and performance of Alpine goats in early, mid-, and late lactation on feed intake, digestion, ingestive behavior, milk yield and composition, and efficiency of feed and energy utilization.

Title:	Interactions of drinking water salinity and dietary protein level in growing meat goats
Project Number:	OKLUSAHLU2017 and Fulbright Fellowship
Experiment Number:	AK-18-02
Investigators:	A. Keli, R. Puchala, T. A. Gipson, and A. L. Goetsch
Objectives:	Determine effects of drinking water varying in concentration of total dissolved salts and protein supplementation of a moderate quality basal forage on intake, digestion, efficiency of energy utilization, and performance of growing meat goats

Abstracts

2018 Meeting of the Southern Section of the American Society of Animal Science in Fort Worth, Texas and National Meeting of the American Society of Animal Science in Vancouver, British Columbia, Canada. (The American Society of Animal Science has copyright ownership and the Journal of Animal Science is the source of this information.)

Effects of Level of Brackish Water and Salinity on Feed Intake, Digestion, Heat Energy, Ruminal Fluid Characteristics, and Blood Constituent Levels in Growing Boer Goat Wethers and Mature Boer Goat and Katahdin Sheep Wethers

H. Yirga[1,2], R. Puchala,[1] Y. Tsukahara[1], K. Tesfai[1], T. Sahlu[1], U. L. Mengistu[2], and A. L. Goetsch[1]

[1]American Institute for Goat Research, Langston University, Langston, Oklahoma
[2]Department of Animal and Range Sciences, Haramaya University, Dire Dawa, Ethiopia

Effects of the level of a brackish water source (BRW; 5,600 mg/L total dissolve salts; TDS) and higher levels of TDS through the addition of NaCl on feed intake, digestion, and heat energy in growing Boer goat wethers (GRO-G) and mature Boer (MAT-G) and Katahdin sheep wethers (MAT-S) were determined. Five GRO-G (22±2.5 kg; 0.76±0.121 yr of age), MAT-G (52±5.0 kg), and MAT-S (66±4.2 kg) were assigned to three simultaneous 5×5 Latin squares with 3-wk periods. Treatments within squares were ad libitum intake of fresh water (0-BRW), 50% fresh water and 50% BRW (50-BRW), 100% BRW (100-BRW), 100-BRW plus 3,450 mg/L NaCl (Low-SLW), and 100-BRW plus 6,900 mg/L NaCl (Mod-SLW). Total water intake was not influenced by TDS level with GRO-G or MAT-S but increased linearly with increasing TDS (P=0.004) for MAT-G (952, 1,087, 1,284, 1,192, and 1,372 g/d for 0-BRW, 50-BRW, 100-BRW, Low-SLW, and Mod-SLW, respectively; SEM=147.7). Intake of OM was not influenced by water treatment with GRO-G but changed quadratically as TDS increased (P=0.049) with MAT-G (744, 749, 785, 732, and 703; SEM=76.3) and linearly (P=0.065) with MAT-S (870, 867, 835, 788, and 694 g/d for 0-BRW, 50-BRW, 100-BRW, Low-SLW, and Mod-SLW, respectively; SEM=80.0). Total tract OM digestion in MAT-G and MAT-S was not influenced by water TDS level but decreased linearly (P=0.004) and changed quadratically (P=0.054) in GRO-G (59.3, 55.5, 47.8, 47.0, and 49.5% for 0-BRW, 50-BRW, 100-BRW, Low-SLW, and Mod-SLW, respectively; SEM=4.67). Intake of ME decreased linearly with increasing TDS for MAT-G (P=0.014; 458, 458, 441, 449, and 381; SEM=34.2) and MAT-S (P=0.045; 384, 361, 328, 317, and 289; SEM=33.2) and increased linearly and changed quadratically (P≤0.031) for GRO-G (519, 402, 321, 319, and 363 kJ/kg $BW^{0.75}$ for 0-BRW, 50-BRW, 100-BRW, Low-SLW, and Mod-SLW, respectively; SEM=54.5). Similarly, recovered energy (RE) decreased linearly with increasing TDS for MAT-G (P=0.037; 0.73, 0.66, 0.18, 0.96, and -0.86; SEM=0.534) and MAT-S (P=0.042; -0.58, -1.54, -2.20, -2.02, and -2.67; SEM=0.645) and increased linearly and changed quadratically (P≤0.048) for GRO-G (0.56, -0.63, -1.40, -1.01, and -0.51 MJ/d for 0-BRW, 50-BRW, 100-BRW, Low-SLW, and Mod-SLW, respectively; SEM=0.576). In conclusion, ME intake and RE for growing goats were more adversely affected by increasing BRW level compared with mature small ruminants because of decreased digestibility. Conversely, decreases in ME intake and RE for MAT-S with increasing TDS primarily related to decreasing feed intake, with relatively small effects for MAT-G associated with the Mod-SLW treatment.

Effects of different levels of lespedeza and supplementation with monensin, coconut oil, or soybean oil on ruminal methane emission by mature Boer goat wethers after different lengths of feeding

R. Puchala[1], S. LeShure[1], T. A. Gipson[1], K. Tesfai[1], M. Flythe[2], and A. L. Goetsch[1]*

[1]American Institute for Goat Research, Langston University, Langston, Oklahoma, USA
[2]Forage Animal Production Research Unit, ARS, USDA, Lexington, Kentucky

Thirty-six mature Boer goat wethers were supplemented with 0.5% BW (DM) of rolled corn and consumed pelleted alfalfa hay (CON), pelleted Sericea lespedeza hay (HSL; 6.4% condensed tannins), a 1:1 mixture of alfalfa and lespedeza (MSL), or alfalfa with monensin (ION; 22 mg/kg), coconut oil (CCO; 4%), or soybean oil (SBO; 4%). Total DMI in the 20-wk study (3.86, 3.75, 3.52, 3.69, and 3.64% BW; SEM = 0.157) and total tract OM digestibility determined every 5 wk (72.8, 69.5, 70.3, 72.0, and 71.1%; SEM = 1.80) were not affected by treatment (P > 0.05), although there were differences (P < 0.05) in N digestion (77.5, 70.7, 67.0, 77.0, 75.7, and 73.6% for CON, MSL, HSL, ION, CCO, and SBO, respectively; SEM = 1.76). Ruminal methane emission was not influenced by period or treatment × period (P > 0.05) but was greatest among treatments for CON expressed

as percentages of gross (10.3, 6.8, 6.3, 7.2, 6.5, and 6.5%; SEM = 0.35) and digestible energy (14.8, 10.2, 9.3, 10.6, 9.8, and 10.1% for CON, MSL, HSL, ION, CCO, and SBO, respectively; SEM = 0.62). In conclusion, with rolled corn at 14-15% of the diet a 1:1 mixture of pelleted alfalfa and a source of lespedeza, with a low to moderate level of CT, had similar effect on ruminal methane emission as lespedeza as the sole forage (31 and 37% decreases relative to DE intake, respectively). Inclusion in basal alfalfa diets of monensin at approximately 22 mg/kg DMI and coconut and soybean oils at 4% elicited similar decreases in methane emission (28, 34, and 32%, respectively). There was no evidence of adaptation to any of the modifiers, with methane emission determined in wk 5, 10, 15, and 20.

Effects of lespedeza condensed tannins alone or with monensin, soybean oil, and coconut oil on feed intake, growth, digestion, ruminal methane emission, and heat energy by yearling Alpine doelings

H. Liu,[1,2] R. Puchala[2], S. LeShure[2], T. A. Gipson[2], and A. L. Goetsch[2]

[1]College of Animal Science and Veterinary Medicine, Shenyang Agricultural University, Shenyang 110866, China
[2]American Institute for Goat Research, Langston University, Langston, Oklahoma

Fifty-four Alpine doelings (31.7±0.38 kg BW and 306±1.9 d) consumed 75% forage diets ad libitum in a 12-wk trial with 2 6-wk periods. Alfalfa was the forage in control (C) and other diets consisted of Sericea lespedeza with 1.25% DM of quebracho extract in concentrate, for a condensed tannin level of 8.4%. Lespedeza treatments were no additive (L) and inclusion of monensin (I) at 22 mg/kg (DM; L-I), soybean oil (SBO) at 3% (L-S), coconut oil (CCO) at 3% (L-N), I and 3% SBO (L-I-S), I and 3% CCO (L-I-N), 1.5% SBO and 1.5% CCO (L-S-N), and I, 1.5% SBO, and 1.5% CCO (L-I-S-N). The C diet averaged 16.7% CP, 43.8% NDF, and 8.8% ADL, and the L diet was 12.7% CP, 42.8% NDF, and 13.2% ADL. There were no treatment×period interactions (P>0.05). Intake of DM was 1.47, 1.27, 1.29, 1.19, 1.33, 1.14, 1.08, 1.14, and 0.98 kg/d (SEM=0.064) and ADG was 122, 79, 89, 83, 100, 76, 70, 78, and 65 g for C, L, L-I, L-S, L-N, L-I-N, L-S-N, and L-I-S-N, respectively (SEM=9.7). Total tract digestibilities of OM (57.4, 50.9, 51.8, 52.7, 50.3, 52.1, 52.1, 51.9, and 49.8%; SEM=1.42) and N (59.1, 31.2, 32.5, 37.1, 31.6, 38.3, 30.4, 38.4, and 34.1% for C, L, L-I, L-S, L-N, L-I-N, L-S-N, and L-I-S-N, respectively; SEM=2.21) were greater for C than for lespedeza treatments (P<0.05). Ruminal methane emission was lower (P<0.05) for diets with lespedeza relative to GE (5.92, 3.27, 3.49, 3.19, 2.84, 2.91, 3.20, 3.20, and 3.27%; SEM=0.165) and DE (11.19, 6.98, 7.40, 6.38, 5.90, 5.69, 6.37, 6.38, and 6.70% for C, L, L-I, L-S, L-N, L-I-N, L-S-N, and L-I-S-N, respectively; SEM=0.400). In conclusion, the effect of tannins on methane did not diminish over time and was not influenced by monensin, soybean oil, or coconut oil.

Effects of Gestation Nutritional Plane and Diet Nutritive Value During Lactation on Feed Intake and Digestion in Lactating Alpine Goats

L. P. S. Ribeiro, R. Puchala, T. A. Gipson, R. C. Merkel, and A. L. Goetsch

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

Fifty-five Alpine goats (27 primiparous and 28 multiparous) were used in an experiment with a 2 × 2 factorial treatment arrangement to evaluate effects of nutritional plane during gestation for 28 wk (High- and Moderate-GES) and diet nutritive value (High- and Moderate-LAC) during 16 wk of lactation (beginning at 2.8 ± 0.24 d in milk) on feed intake and digestion. Initial BW and body condition score (BCS; 1-5) in gestation was 56.7 ± 8.23 kg and 2.32 ± 0.22, respectively. At 11 d before kidding, BW was 78.2 and 73.5 kg (SEM = 1.67) and BCS was 3.17 and 3.02 (SEM = 0.043) for High-GES and Moderate-GES, respectively. Both lactation diets included 20% alfalfa hay and 10% cottonseed hulls, whereas High-LAC and Moderate-LAC contained 10 and 20% grass hay, 12.9 and 10% wheat middlings, 12.9 and 10% rolled oats, 3 and 2.5% soybean oil, and 5 and 2.5% molasses, respectively. The High-LAC and Moderate-LAC diets were 16.2 and 14.2% CP, 30.2 and 34.7% NDF, and 72.7 and 64.4% calculated TDN, respectively. Feces was collected to estimate digestibility in wk 3 and 12. Intake of DM (3.74, 3.56, 4.15, and 3.74% BW; SEM = 0.201), OM digestibility (78.0, 75.8, 78.3, and 78.8%; SEM = 1.62), NDF digestibility (33.0, 38.3, 37.6, and 45.4%; SEM = 3.94), N digestibility (80.2, 77.9, 79.9, and 81.0%; SEM = 1.52), and digested OM intake (1,911, 1,883, 2,204, and 1,881 g/d for High-GES/High-LAC, High-GES/Low-LAC, Low-GES/High-LAC, and Low-GES/Low-LAC, respectively; SEM = 113.6) were not affected by gestation nutritional plane, diet nutritive value during lactation, or their interaction (P > 0.05). In conclusion, although not significant, numerical differences in digested OM intake suggest poten-

tial benefit from use of a high quality diet during lactation subsequent to a moderate nutritional plane during gestation.

Herbicide Effectiveness for Redcedar Control in Oklahoma and Missouri

R. V. Lourencon, S. P. Hart, and T. A. Gipson

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

In a research study using goats to control redcedar (Juniperus virgiana), herbicide was used as a treatment. The objective of the study was to measure the degree of control of redcedar provided by herbicide in the South-Central U.S. There were three research plots in Oklahoma: Langston, Oklahoma City and Mannford, and one in Neosho, Missouri, all 0.81 hectares. The redcedar population was inventoried, quantified as to height, width and GPS coordinates. Trees over 0.61m in height were individually treated in November 2016 with Velpar® herbicide, in accordance with recommendations of the manufacturer, a syringe was used to administer (3 mL per 0.91m of basal diameter) to the base of the tree. Percentage green cover of the cedars was measured 8 months after application. The percentage of dead (0% green) or live trees according to size (short; ≤ 1.83m or tall; > 1.83m) were analyzed using Chi-Square statistics. A subsequent multiple regression analysis was conducted for tree height, tree width, and herbicide dose against the percentage of green canopy cover. Trees in Mannford and Oklahoma City had the least percentage green (4 and 8%, respectively, $P = 0.1386$), followed by Langston (14%, $P < 0.05$) and then Neosho (31%, $P < 0.001$). In all locations, the herbicide was more effective with shorter than taller trees ($P < 0.001$). Herbicide killed 68% of trees shorter than 1.83m, as compared with 31% the trees taller than 1.83m. Shorter trees averaged 10% of green canopy, while the taller trees averaged 18%. For each 0.366m of increase in tree height, there was 2% increase in green canopy cover. This may indicate that tall trees need a higher dose of herbicide than used in this study.

Goats for Controlling Redcedar in Oklahoma and Missouri

R. V. Lourencon, S. P. Hart, and T. A. Gipson

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

The objective of this study was to evaluate the degree of redcedar control by goats at sites in Oklahoma and Missouri. There were three research plots in Oklahoma with eight goats each: Langston, Oklahoma City and Mannford, and one in Neosho, Missouri, with 12 goats, all plots were 0.81 hectares. The redcedar population was inventoried, quantified as to height, width, and GPS coordinates during the summer of 2016. One year later, trees were scored for browsing: 0 being unbrowsed, between 1 and 5 medium browsed and from 5 to 9 was considered severely browsed. Percent of trees dead (0% green) or live according to size (short; ≤ 1.83m or tall; > 1.83m) were analyzed using Chi-Square statistics. A subsequent multiple regression analysis was conducted for tree height, tree width, and browsing score. The goats in Neosho killed 18% of the trees, as compared to 1% at other locations ($P < 0.001$). A greater percentage of trees in Neosho were more severely browsed than the average at the three sites in Oklahoma, 60% and 8% respectively ($P < 0.001$). In Mannford, the shorter trees were most scored as medium browsing than the taller trees (1.97% vs 1.68%, $P < 0.05$). In Oklahoma City, the taller trees were more severely browsed than the shorter trees (6.88% vs 4.93%, $P < 0.05$), although more short trees were killed by browsing ($P < 0.05$). This may indicate that shorter trees are more sensitive to browsing. Redcedar trees were more effectively controlled by goats in Neosho, Missouri.

Effect of Water Restriction on Intake and Body Weight Responses in Hair Sheep Breeds

A. H. Hussein[1,2], R. Puchala[1], I. Portugal[1], T. A. Gipson[1], B. K. Wilson[2], and A. L. Goetsch[1]

[1]Langston University, American Institute for Goat Research, Langston, Oklahoma
[2]Oklahoma State University, Department of Animal Science, Stillwater, Oklahoma

Forty-three Dorper (initial BW = 60 ± 2.6 kg), 45 Katahdin (63 ± 2.4 kg), and 44 St. Croix (45 ± 2.1 kg) ewes (0.9-9.5 yr) from 45 commercial farms in the Midwest, Northwest, Southeast, and central Texas were used to evaluate resilience to water restriction. Sheep were housed individually and fed a 51% concentrate pelleted diet (18% CP) at 160% of their calculated ME requirement for maintenance. In period 1 (2 wk in duration), ad libitum water intake was determined, followed by 25 and 50% decreases in water availability in periods 2 and 3 that were 2 and 5 wk in duration, respectively. Water was offered daily at 0700 h and BW was measured at 1300 h on Monday, Wednesday, and Friday each week. Weekly data in period 3 were analyzed with initial age and average period 1 values serving as covariates, and means were separated by least significant difference. From wk 1-5 of period 3, average water intake was 1,749, 1,745, 1,747, 1,746, and 1,749 g/d (SEM = 4.8). Week affected ($P < 0.05$) DMI (1,075, 1,016, 1,013, 1,028, and 1,069 g/d; SEM = 17.4), BW (56.4, 56.1, 56.6, 57.0, and 57.8 kg; SEM = 0.17), and the ratio of water intake relative to DMI (1.68, 1.80, 1.81, 1.80, and 1.70 for wk 1, 2, 3, 4, and 5, respectively; SEM = 0.045). Breed did not affect DMI ($P = 0.21$) or BW ($P = 0.51$). In conclusion, neither DMI nor BW data indicated breed differences in resilience to restricted drinking water availability.

Effects of Water Restriction on Feed Intake and Digestion by St. Croix Sheep

A. H. Hussein[1,2], R. Puchala[1], T. A. Gipson[1], D. Tadesse[1], B. K. Wilson[2], and A. L. Goetsch[1]

[1]Langston University, American Institute for Goat Research, Langston, Oklahoma
[2]Oklahoma State University, Department of Animal Science, Stillwater, Oklahoma

Eleven St. Croix ewes (49 ± 8.5 kg initial BW) were used in a crossover design to evaluate effects of restricted drinking water availability on feed intake and digestion. Ewes were housed indoors and fed a 51% concentrate pelleted diet containing 18% CP and 33% NDF at 160% of their calculated ME requirement for maintenance of 44.4 g/kg $BW^{0.75}$ DMI. Periods were 4 wk, with 3 wk for adaptation and 1 wk for total collection of feces. Ad libitum or baseline water intake by individual ewes was determined for 2 wk before the study (3,761 ± 144 g/d). In each period, 5 or 6 ewes were offered water at 75% of baseline intake for 1 wk and subsequently restricted to 50% (RE), while the other ewes were offered the baseline amount (AL). Some water was refused in wk 4, with intake of 2,442 and 1,688 g/d for AL and RE, respectively (SEM = 171.7). Intake of DM was similar ($P = 0.582$) between treatments (860 and 811 g/d for AL and RE, respectively). Apparent total tract digestibility of DM (67.2 and 62.1%; SEM = 1.30), OM (68.1 and 63.0%; SEM = 1.30), and NDF (44.3 and 34.0%; SEM = 2.46) were greater ($P < 0.05$) for RE vs. AL, and CP digestibility tended ($P = 0.072$) to differ (71.1 and 67.2% for RE and AL, respectively; SEM = 1.16). In conclusion, restricted drinking water availability did not influence intake of a 51% concentrate pelleted diet but increased digestibility, presumably by increasing digesta residence time in the gastrointestinal tract.

Effects of Zelnate® and Zoledronic Acid on Immunity in Goats Infected with *Haemonchus Contortus*

Q. Yang[1,2], Z. Wang[1], Y. Tilahun[1], R. C. Merkel[1], A. L. Goetsch[1], H. Liu[1,2], T. Sahlu[1], L. J. Dawson[1,3], and M. Campbell[4]

[1]American Institute for Goat Research, Langston University, Langston, Oklahoma
[2]College of Animal Science and Veterinary Medicine, Shenyang Agricultural University, Shenyang, China
[3]Department of Veterinary Clinical Sciences, Oklahoma State University, Stillwater, Oklahoma
[4]Bayer Animal Health, Shawnee Mission, Kansas

Thirty-six 6.5-month-old Alpine wethers (28±2.4 kg initial BW) were used to determine effects of Zelnate® (Z) and zoledronic acid (ZA) on immunity of goats infected with *Haemonchus contortus* during a 5-wk period. Wethers were housed in a confinement facility, supplemented with 400 g/d of a concentrate-based pellet, and offered alfalfa and grass hay free-choice. Thirty wethers were given 2 doses of 5,000 L3 H. contortus by gavage on 2 sequential days, and the other 6 were the noninfected normal control (NI-C). The infected control wethers (I-C) were not treated with Z or ZA. Other treatments were 1 injection of Z (2 ml/goat) on d -1 of L3 infection (Z1), 2 injections of Z on d -1 and 13 (Z2), 5 injections of ZA (75 µg/kg BW each time) on d -6, 2, 6, 13, 20 (ZA), and 1 injection of Z and 5 injections of ZA (Z1-ZA). Infection reduced ADG ($P = 0.05$), which was alleviated by Z and ZA (54, 14, 23, 23, 32, and 40 g for NI-C, I-C, Z1, Z2, ZA, and Z1-ZA, respectively; SEM=13.5). Although FEC was similar among treatments ($P > 0.05$), the percentage of female adult worms in the abomasum was lower in wethers treated with Z or ZA ($P < 0.01$). The hematocrit and concentrations of hemoglobin, WBC, and neutrophils were lower for I-C vs NI-C ($P < 0.05$) but concentrations of neutrophils for treatments with Z or ZA were similar to that for the NI-C. The percentage of female worms was negatively correlated with concentrations of neutrophils ($r = -0.55$, $P < 0.01$) and lymphocytes ($r = -0.65$, $P < 0.01$). The findings imply that H. contortus infection alters the immunity in goats and that effects may be reversed by immune modulators such as Z and ZA.

Summaries of Recent Journal Articles
(2017 and Accepted/In press)

Effects of supplemental concentrate level and forage source on intake, digestion, and behavior of growing and yearling Boer goat wethers and evaluation of a method of predicting negative feedstuff associative effects

A. T. Dolebo, R. Puchala, T. A. Gipson, L. J. Dawson, T. Sahlu, and A. L. Goetsch

Journal of Applied Animal Research 45:470-479. 2017.

Effects of supplemental concentrate level and three sources of grass hay were determined to evaluate a method (www2.luresext.edu/goats/research/suppconc.html) of predicting impact of negative associative effects between feedstuffs on metabolizable energy (ME) intake by Boer goat wethers. Forage DM intake (g/kg $BW^{0.75}$) was similar between growing and yearling wethers (34.9 and 30.8) and ranked 0 and 15 > 30 > 45 g/kg $BW^{0.75}$ of concentrate dry matter (48.5, 41.8, 25.9, and 15.2, respectively). Age and concentrate level interacted in NDF digestibility (57.3, 60.6, 61.4, and 58.4% for growing and 56.6, 62.9, 56.8, and 30.0% for yearling wethers with 0, 15, 30, and 45 g/kg $BW^{0.75}$, respectively). There was a tendency (P = 0.074) for an interaction in ME intake between age and concentrate level (361, 530, 634, and 709 for growing and 363, 547, 541, and 555 kJ/kg $BW^{0.75}$ for yearling wethers with 0, 15, 30, and 45 g/kg $BW^{0.75}$; values predicted for treatments with supplement were 563, 631, and 619 for growing and 575, 684, and 697 kJ/kg $BW^{0.75}$ for yearling wethers with 15, 30, and 45 g/kg $BW^{0.75}$, respectively. In conclusion, ME intake was accurately predicted for the low level of supplementation and moderate level with growing wethers.

Simple methods to estimate the maintenance feed requirement of small ruminants with different levels of feed restriction

A. L. Goetsch, R. Puchala, A. T. Dolebo, T. A. Gipson, Y. Tsukahara, and L. J. Dawson

Journal of Applied Animal Research 45:104-111. 2017.

Ten Katahdin sheep and ten Spanish goat wethers were used to develop a simple method to estimate dry matter intake (DMI) required for maintenance (DMI_m) with feed restriction. Grass hay was fed in a 5-wk Maintenance phase, initially at 51 and 54 g/kg $BW^{0.75}$ for Katahdin and Spanish, respectively, and then varied by 0-5% every 2-3 days to maintain constant body weight (BW). Individual wether DMIm was the intercept of regressing DMI against BW change in 2- and 3-day periods of wk 3 and 4. In the subsequent 8 wk, wethers consumed hay at 70 or 55% of their Maintenance DMI_m. Restricted DMI_m was average DMI in wk 8 when no individual wether intercept of regressing BW against day differed from 0. Maintenance DMI_m was not influenced by animal type (52.0 and 49.6 g/kg $BW^{0.75}$ for Katahdin and Spanish, respectively; S.EM. = 0.73). Animal type and restriction level tended (P = 0.084) to interact in Restricted DMI_m (34.1, 38.6, 30.7, and 39.0 g/kg $BW^{0.75}$ for Katahdin-55%, Katahdin-70%, Spanish-55%, and Spanish-70%, respectively; S.E.M. = 1.03), suggesting greater ability of Spanish to lessen energy use with appreciable feed restriction. Correlation coefficients of 0.89, -0.06, 0.96, and 0.85 (P = 0.041, 0.927, 0.009, and 0.066, respectively) between DMI_m in the two phases for Katahdin-55, Katahdin-70, Spanish-55, and Spanish-70, respectively, suggest preference for the 55% level for evaluating resilience to feed restriction. In conclusion, frequent determinations of BW and DMI can be used to compare DMI_m of individual animals with restricted feeding.

Effects of pasture access regime on performance, grazing behavior, and energy utilization by Alpine goats in early and mid-lactation

A. Keli, L. P. S. Ribeiro, T. A. Gipson, R. Puchala, K. Tesfai, Y. Tsukahara, T. Sahlu, and A. L. Goetsch

Small Ruminant Research. 154:58-69. 2017.

Twenty-eight Alpine goats were used to evaluate the effects of different pasture access regimes on lactation performance, grazing behavior, and energy utilization in a 16-wk experiment with four 4-wk periods beginning at 26 ± 2.5 days in milk. Treatments were access to grass and(or) legume pasture continually other than during milking in the morning and afternoon (CG); from the time leaf surfaces were dry (measured by leaf wetness sensors) until afternoon milking and thereafter to sunset (ND-D); from the time leaf surfaces were dry until afternoon milking (ND-M); and between morning and afternoon milking (SET). The SET, CG, and ND-M goats were supplemented with approximately 1.5% BW (DM) of concentrate immediately following the afternoon milking and ND-D goats were supplemented at sunset. Organic matter digestibility, ADG, fecal egg count, and FAMACHA© score were not affected by treatment ($P > 0.05$). Milk concentrations of protein, fat, and lactose and milk energy yield (5.41, 5.06, 5.34, and 5.55 MJ/day for CG, ND-D, ND-M, and SET, respectively; SEM = 0.340) were similar among treatments ($P > 0.05$). Treatment affected ($P < 0.05$) time spent grazing (7.43, 6.93, 5.86, and 6.18 h for CG, ND-D, ND-M, and SET, respectively; SEM = 0.342). Intake of ME was similar among treatments ($P > 0.05$; 1111, 1010, 1043, and 874 kJ/kg $BW^{0.75}$; SEM = 89.1), daily heat energy was greatest among treatments for CG ($P < 0.05$) (743, 686, 632, and 667 kJ/kg $BW^{0.75}$; SEM = 12.0), and milk energy as a percentage of ME intake was greatest ($P < 0.05$) for SET (30.2, 28.3, 27.9, and 36.3% for CG, ND-D, ND-M, and SET, respectively; SEM = 1.52). In conclusion, there appeared potential to improve efficiency of milk production by pasture access between morning and afternoon milking compared with continuous grazing and there were no clear benefits from delaying pasture access until leaf surfaces were dry.

Conditions to evaluate differences among individual sheep and goats in resilience to high heat load index

U. L. Mengistu, R. Puchala, T. Sahlu, T. A. Gipson, L. J. Dawson, and A. L. Goetsch

Small Ruminant Research 147:89-95. 2017.

Thirty-three yearling Katahdin sheep (KAT, 38.9 kg) and Boer (BOE, 28.6 kg) and Spanish goat wethers (SPA, 22.7 kg) were used to determine conditions appropriate for evaluating resilience to high heat load index (HLI). Grass hay (69% NDF and 9.5% CP) was consumed ad libitum with concentrate supplemented at 0.5% BW. Period 1 was 2 wk and periods 2-5 were each 1 wk. Target HLI for the five periods during the day/night was 70/70, 80/70, 90/76.5, 95/80.75, and 100/85, and measured HLI was 66/66, 80/75, 92/84, 97/86, and 101/89, respectively. Respiration rate increased with advancing period except from period 4 to 5 when there was a smaller decline for KAT than for BOE or SPA. Rectal temperature also increased as the experiment progressed until period 4 and was similar among animal types in period 5 when values for BOE and SPA were lower than in period 4, in contrast to similar values for KAT. Respiration rate at 13:00 and 17:00 h increased with advancing period up to a plateau at 150-155 breaths/min converse to much lower rates (i.e., 32-83) at 06:00 in periods 2-5. Respiration rate at 06:00 h differed more among days of period 5 than at 13:00 or 17:00 h, with values increasing from day 1 to 3 and thereafter generally declining from 118 to 37 breaths/min on day 7. Rectal temperature for KAT was lower than for goats early in period 5 but similar among animal types on days 6 and 7. In conclusion, a HLI in the range of 95/80.75 and 100/85 seems appropriate, periods longer than 1 wk appear necessary for full adaptation, and measures should occur during both night and day.

Effects of gender and age on energy use by young Boer goats

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

Livestock Science 199:86-94. 2017.

Boer goats (7/8 and 1/8 Spanish breed) were used to characterize effects of gender and age on the ME requirement for maintenance (ME_m). There were eight animals of each gender, doelings, intact males, and wethers castrated at 2 mo of age. Kids were weaned at 3.7 mo and thereafter consumed a 50% concentrate pelleted diet ad libitum while in group pens at most times. Measurement periods consisted of three segments of 12, 10, and 4 days with consumption ad libitum and near ME_m and while fasting, respectively. Maintenance segment measures began at 4.9, 7.8, 11.7, and 14.8 mo of age in periods 1, 2, 3, and 4, respectively. Feed intake data, feces and urine collections, and a calorimetry system were used to determine ME intake and heat energy (HE). The ME_m estimate was based on fasting HE and the slope (km) of the regression of recovered energy (RE) against ME intake with intake near ME_m and while fasting, and kg was RE with ad libitum intake relative to ME intake above ME_m. BW (kg) during the maintenance segment was 20.6, 30.8, 46.5, and 57.1 for doelings, 25.9, 40.1, 67.3, and 76.9 for males, and 23.1, 35.1, 53.9, and 65.0 for wethers in periods 1, 2, 3, and 4, respectively (SE = 1.85). km was similar among genders and periods ($P > 0.05$; 70.2, 69.5, and 69.7% for doelings, males, and wethers, respectively; SE = 1.25). Fasting HE and ME_m were affected by gender × period interactions ($P < 0.001$). Fasting HE (kJ/kg $BW^{0.75}$) was 277, 272, 281, and 281 for doelings, 288, 327, 334, and 398 for males, and 274, 303, 274, and 305 for wethers (SE = 10.1); ME_m (kJ/kg $BW^{0.75}$) was 382, 390, 399, and 420 for doelings, 412, 469, 492, and 569 for males, and 384, 417, 426, and 439 for wethers in periods 1, 2, 3, and 4, respectively (SE = 14.2). kg tended ($P = 0.067$) to vary among genders (61.5, 48.1, and 52.7% for doelings, males, and wethers, respectively; SE = 3.91). In conclusion, ME_m was not greatly different between doelings and wethers and increased for both as the study progressed, whereas that for males was greater, with the difference increasing considerably as age rose.

Case Study: An assessment of anthelmintic resistance through in vivo fecal egg count reduction test and in vitro egg hatch test on small ruminant farms in the southcentral United States

Y. Tsukahara, Y., Z. Wang, T. A. Gipson, S. P. Hart, L. J. Dawson, R. Puchala, T. Sahlu, and A. L. Goetsch

Professional Animal Scientist 33:627-633. 2017.

An in vivo fecal egg count reduction (FECR) test was conducted on 5 farms in the southcentral United States participating in an animal resistance selection project to assess internal parasite resistance to anthelmintics. Seventy-six Kiko does on farm G1, 54 Spanish does (G2), 37 Katahdin sheep (S1), 61 Dorper ewes (S2), and 80 St. Croix sheep (S3) were randomly allocated within farm to control and 3 classes of anthelmintics. After determining initial fecal egg count (FEC), recommended doses of anthelmintics were given and FEC was assessed 7 to 8 days later. Resistance to eprinomectin was detected on all farms, with FECR < 63%. There was no levamisole resistance on sheep farms (FECR > 95%). There was resistance to albendazole on 4 farms (FECR < 95%). An egg hatch test (EHT) was conducted to evaluate resistance to albendazole using composite fecal samples from untreated animals of G1, S1, S2, and S3 farms as well as control eggs from susceptible larvae. Final concentrations of albendazole were 0.00005, 0.0005, 0.005, 0.05, 0.5, and 2.0 μg/mL. After 48 h of incubation at 25 °C, numbers of unhatched eggs and larvae per well were counted. The hatched percentage of susceptible larvae was 96% in the control wells. Drug concentration affected ($P < 0.01$) the percentage of unhatched eggs for S2 and S3, whereas values were similar ($P > 0.10$) for G1 and S1. In conclusion, resistance to common anthelmintics varied considerably among farms and products, suggesting need for such testing rather than general treatment recommendations.

Effects of restricted periods of feed access on feed intake, digestion, behavior, heat energy, and performance of Alpine goats

N. C. D. Silva, R. Puchala, T. A. Gipson, T. Sahlu, and A. L. Goetsch

Journal of Applied Animal Research. 46:994-1003. 2018.

Fifty Alpine goats at 125±3.0 days-in-milk were given access in Calan gate feeders to a 40% forage diet for 12 wk continuously (Control), during daytime (Day) or night (Night), or for 2 or 4 h/day after milking in the morning and afternoon (2Hour and 4Hour, respectively), resulting in few significant effects. In a second 12-wk experiment, ADG by 40 Alpines at 14±0.7 days-in-milk (73, 39, 11, 24, and 21 g) was greater for Control than for the average of other treatments, milk yield was similar among treatments, milk fat was lower (P=0.089) for Control (3.41, 3.88, 4.21, 3.70, and 3.49%), and milk energy was not affected (8.20, 7.36, 9.53, 8.56, and 6.91 MJ/day for Control, 2Hour, 4Hour, Day, and Night, respectively). Metabolizable energy intake (31.25, 22.69, 25.92, 26.69, and 23.46 MJ/day) and heat energy (17.51, 13.34, 14.09, 15.54, and 15.25 MJ/day) were greater and milk energy relative to ME intake was lower for Control (26.0, 31.9, 37.6, 31.4, and 30.0% for Control, 2Hour, 4Hour, Day, and Night, respectively). In conclusion, continuous diet access of dairy goats in early to mid-lactation can affect partitioning of nutrients between milk synthesis and tissue accretion differently than some restricted feeder access treatments.

Effects of level of brackish water and salinity on feed intake, digestion, heat energy, ruminal fluid characteristics, and blood constituent levels in growing Boer goat wethers and mature Boer goat and Katahdin sheep wethers

H. Yirga, R. Puchala, Y. Tsukahara, K. Tesfai, T. Sahlu, U. L. Mengistu, and A. L. Goetsch

Small Ruminant Research. Accepted. 2018.

A study was conducted to evaluate effects of the level of a brackish water source (5596 mg/l total dissolve salts; TDS) and higher levels of TDS through addition of NaCl on feed intake, digestion, and heat energy in growing Boer goat wethers (GRO-G) and mature Boer (MAT-G) and Katahdin sheep wethers (MAT-S). Five GRO-G (22.1 ± 2.50 kg; 0.76 ± 0.121 yr of age), five MAT-G (52.2 ± 4.99 kg), and five MAT-S (65.5 ± 4.17 kg) were assigned to three simultaneous 5 × 5 Latin squares with 3-wk periods. Treatments within squares were ad libitum intake of fresh water (0-BRW), 50% fresh water and 50% brackish water (50-BRW), 100% brackish water (100-BRW), 100-BRW plus 3450 mg/l NaCl (Low-SLW), and 100-BRW plus 6900 mg/l NaCl (Mod-SLW). Total water intake was not influenced by TDS level with GRO-G or MAT-S but increased linearly with increasing TDS (P=0.004) for MAT-G (952, 1087, 1284, 1192, and 1372 g/day for 0-BRW, 50-BRW, 100-BRW, Low-SLW, and Mod-SLW, respectively; SEM = 147.7). Organic matter (OM) intake was not influenced by water treatment with GRO-G but changed quadratically as TDS increased (P = 0.049) with MAT-G (744, 749, 785, 732, and 703; SEM = 76.3) and linearly (P = 0.065) with MAT-S (870, 867, 835, 788, and 694 g/day for 0-BRW, 50-BRW, 100-BRW, Low-SLW, and Mod-SLW, respectively; SEM = 80.0). Total tract OM digestion in MAT-G and MAT-S was not influenced by water TDS level but decreased linearly (P = 0.004) and tended to change quadratically (P = 0.054) in GRO-G (59.3, 55.5, 47.8, 47.0, and 49.5% for 0-BRW, 50-BRW, 100-BRW, Low-SLW, and Mod-SLW, respectively; SEM = 4.67). Intake of metabolizable energy (ME) decreased linearly with increasing TDS for MAT-G (P = 0.014; 458, 458, 441, 449, and 381; SEM = 34.2) and MAT-S (P = 0.045; 384, 361, 328, 317, and 289; SEM = 33.2) and increased linearly and changed quadratically (P ≤ 0.031) for GRO-G (519, 402, 321, 319, and 363 kJ/kg $BW^{0.75}$ for 0-BRW, 50-BRW, 100-BRW, Low-SLW, and Mod-SLW, respectively; SEM = 54.5). In conclusion, increasing TDS concentration in drinking water had effects on intake and digestion that differed among animal types, with ME intake of growing goats more adversely affected by increasing brackish water level compared with mature small ruminants because of decreased digestibility. Conversely, decreases in ME intake for MAT-S with increasing TDS primarily related to decreasing feed intake, with relatively small effects for MAT-G associated with the Mod-SLW treatment.

Visiting Scholars, Graduate Students, and Interns (2017 and 2018)

Ms. Amanda Manley
- Graduate Student (MS; cooperative with Oklahoma State University
- Research Project: Boer Goat Selection for Residual Feed Intake

Dr. Raquel Lourencon
- Visiting Scholar
- Native of Brazil
- Research Project: Red Cedar Control with Goats
- Experiment: SH-15-07

Dr. Luana P. S. Ribeiro
- Visiting Graduate Student (PhD; Sandwich program; cooperative with Federal University of Bahia, UFBA) and Visiting Scholar
- Native of Brazil
- Research Projects: Effects of Body Condition at Kidding on Performance of Lactating Dairy Goats, Sustainable Control of Greenhouse Gas Emission by Ruminant Livestock, and Effects of Feed Access Treatments and Diet Quality on Performance of Lactating Dairy Goats
- Experiment: LR-15-02, LR-17-14, LR-17-16, LR-18-01

Mr. Mesfin M. Gobena
- Graduate Student (MS; cooperative with University of Florida)
- Native of Ethiopia
- Research Project: Sustainable Small Ruminant Production Through Selection for Resistance to Internal Parasites and Resilience in Sheep and Goats to Climatic Stress Factors

Dr. Shirron LeShure
- Visiting Scholar
- Research Projects: Enhancing Wellbeing and Productivity of Dairy Goats Using Smart Technology; Sustainable Control of Greenhouse Gas Emission by Ruminant Livestock
- Experiments: SL-16-01, SL-16-03, SL-16-07, SL-17-01, SL-17-08

Dr. Dereje Tadesse
- Native of Ethiopia
- Visiting Scholar
- Research Project: Resilience in Sheep and Goats to Climatic Stress Factors
- Experiments: DT-16-04, DT-16-08, DT-16-11, DT-17-03, DT-17-09, DT-17-11, DT-17-15

Mr. Ali Hussein
- Graduate Student (PhD; cooperative with Oklahoma State University)
- Research Project: Resilience in Sheep and Goats to Climatic Stress Factors
- Experiments: AH-16-05, AH-17-02, AH-17-10, AH-17-12

Mr. Miguel Angel Rojas
- Native of Bolivia
- Visiting Scholar
- Emphasis Areas: Animal management and reproduction
- Experiment: EL-17-07, EL-17-13, MR-17-18, EL-17-20

Dr. Haiying Liu
- Native of China
- Visiting Scholar
- Research Project: Sustainable Control of Greenhouse Gas Emission by Ruminant Livestock
- Experiment: HL-16-12

Dr. Qunhui Yang
- Native of China
- Visiting Scholar
- Research Project: Immunity to Internal Parasitism (OKLUSAHLU2017)
- Experiment: ZW-17-17

Mr. Rommel Mauricio Calle
- Native of Bolivia
- Emphasis Area: Hair Sheep Production

International Overview

Dr. Roger Merkel
International Program Leader

Goats and goat products are part of the livelihood of a majority of the world's population and are an important resource for poor farmers in many countries of the world. Part of the mission of the E (Kika) de le Garza American Institute for Goat Research is to effect positive change in goat production throughout the world. To fulfill this aspect, the Institute has developed and maintains many strong ties with research and academic institutions around the world. In addition to collaborative work with foreign institutions, the Institute has hosted visiting scientists from over 30 foreign countries to conduct research activities. Training for foreign livestock workers and scientists as well as for U.S.-based persons who will travel and work overseas are other ways in which the Institute is active in the international arena.

International research and training, hosting foreign scientists, and training those who will teach others are internationally-focused activities that give the Institute unique opportunities to not only increase knowledge of foreign production systems and constraints, but also to positively impact agricultural development in foreign countries and help alleviate poverty and hunger. General objectives of the Institute's international program are to: 1) increase our knowledge of goat production systems worldwide and current constraints to increased production; 2) build human capacity through training foreign scientists and agricultural workers in goat production, thereby allowing them to more effectively carry out their missions of teaching, research, and extension; 3) increase Langston University and the Institute's involvement in agricultural development and impact on human welfare; and 4) enhance the Institute's knowledge of development and development issues.

Japanese Graduate Student

The American Institute for Goat Research had the opportunity to host Ms. Sanae Ishii, a graduate student from Nihon University in Kanagawa, Japan during the month of August, 2017. Sanae is completing a Master's degree studying goat management conditions in Japan. She wished to come to the Institute to learn our management procedures and other production techniques.

During her time at the Institute, Sanae had the opportunity to practice hands-on management techniques with both meat and dairy goats. She learned about milk sampling, methods of determining somatic cell count, how to plate milk samples for bacterial growth, and the California Mastitis Test. Sanae made goat milk cheese and tanned goatskins with the hair on and for leather. Internal parasites, nutrition, kid rearing, recordkeeping, artificial insemination, and research methodology were other topics in her training.

Sanae participated in a research project led by Drs. Terry Gipson and Luana Ribeiro and presented preliminary results at a research conference in Japan. Finally, Sanae visited several goat farms including a goat dairy and meat goat farm, the Oklahoma Animal Disease and Diagnostic Laboratory and Boren Veterinary Medical Hospital at Oklahoma State University, and Reproduction Enterprises, Inc., located in Stillwater, OK. Sanae enjoyed her time at the Institute and learned a great deal. She hopes to continue her studies in goat production and to establish a small goat dairy in Japan.

Simplified Artificial Insemination for Sheep and Goat Producers

Current procedures used by the artificial insemination (AI) industry for breeding sheep and goats with thawed, frozen semen are based on transcervical or laparoscopic-aided intrauterine insemination, which is costly and technologically challenging for small ruminant producers in many developing countries and can be technologically challenging for small ruminant producers in the United States as well. The main goal of

this project is to develop a simplified technique for artificial insemination, which would allow farmers easily to inseminate their females themselves and to genetically improve their herds/flocks with minimal costs, inputs, and technical skills. This simplified technique has the potential to impact millions of small ruminant producers worldwide and their families because more productive small ruminant herd/flock equates to more animal-source products such as meat, milk, or cheese for the household and a steadier generator of income. Langston University in Oklahoma and Egerton University in Kenya will partner together to develop this simplified technique by utilizing cooled, fresh semen and vaginal insemination, both of which require very little technical expertise, are inexpensive, and sustainable. This project will build upon the successful partnership between Langston University and Egerton University established by the U.S./Africa/India Tri-Lateral University Partnership project (2012-2014) entitled "Enhancing Capacity of Bunda College of Agriculture in Malawi and Egerton University in Kenya for Research, Extension, and Teaching Activities with Small Ruminants", which was funded by USAID and coordinated by the USDA FAS and on the USDA FAS Borlaug Fellowships entitled "Genomic Selection in Dairy Goats: Langston University's Expression of Interest for the Norman E. Borlaug International Agricultural Science and Technology Fellowship Program (Borlaug Fellowship Program) for Africa: Animal Breeding and Genetics" and "Applied Reproductive Technologies for Caprine Embryo and Gamete Management: Langston University's Expression of Interest for the Norman E. Borlaug International Agricultural Science and Technology Fellowship Program for Africa: Animal Breeding and Genetics" Dr. Terry Gipson, PI, was the mentor on the former Fellowship and Dr. Erick Loetz, Co-PI, was the mentor on the latter Fellowship.

LINC Training in Indonesia

From April 29 through May 8, 2017, Dr. Arthur Goetsch traveled to Indonesia to conduct a workshop entitled 'Improvement of Researchers Competence and Knowledge On Computerizing Feed Formulation Based on Local Resources and Goat Industry Situation & Challenges in Global Climate Change.' The training, funded by a World Bank development program, was organized by the Indonesia Center for Animal Research and Development (ICARD) and held in Medan, located in the Indonesian province of North Sumatra. Approximately 30 people attended the workshop from ICARD, the Indonesia Agency for Agricultural Research and Development, and the Indonesia Ministry of Agriculture, originating from nearly all provinces of the country. The main focus of the workshop was use of the web-based goat nutrient requirement calculation system of the Institute, commonly referred to as LINC for 'Langston Interactive Nutrient Calculation' program.

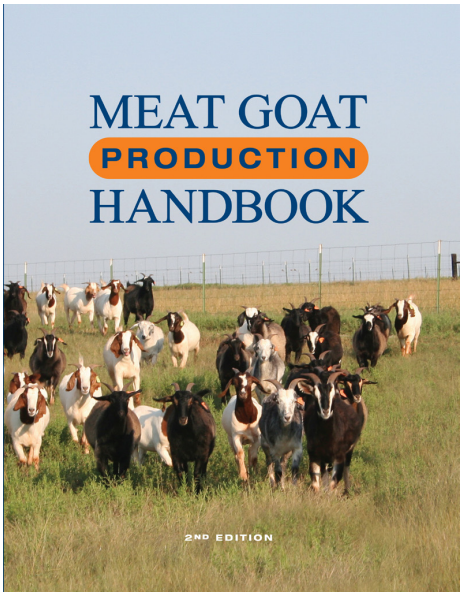
During his time in Indonesia, Dr. Goetsch had the opportunity to visit the Sei Putih Goat Research Institute in North Sumatra where Dr. Roger Merkel of the American Institute for Goat Research conducted his doctoral research. Other visits were to the ICARD Research Institute for Animal Production and local goat and sheep farms near Bogor located south of Indonesia's capital Jakarta on the island of Java. It is hoped that this trip will lead to future collaboration among the Institute and various Indonesian animal research organizations.

The End Result

The E (Kika) de al Garza 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.

Current International Project

Title:	Sustainable Genetic Improvement via Simplified Artificial Insemination for Sheep and Goat Producers
Type:	USDA Foreign Agriculture Service/Scientific Cooperation and Research Program
Project Number:	FX17SR-10961R002
Period:	2017-2019
Investigators:	T.A. Gipson, E. Loetz
Institution:	Langston University
Objective:	1) Investigate the effect of management (species, breed, age, parity, body condition, etc.) on success rate (non-return to estrus [NRE] and pregnancy rates [PR]) of vaginal insemination using cooled, fresh semen in goats and sheep. 2) Investigate the effect of total number of spermatozoa on success rate (NRE and PR) of vaginal insemination using cooled, fresh semen in goats and sheep. 3) Investigate the effect of volume on success rate (NRE and PR) of vaginal insemination using cooled, fresh semen in goats and sheep. 4) Investigate the effect of extender on success rate (NRE and PR) of vaginal insemination using cooled, fresh semen in goats and sheep. 5) Investigate the effect of motility activator on success rate (NRE and PR) of vaginal insemination using cooled, fresh semen in goats and sheep.



Meat Goat Production Handbook

Order Form

Name: _____

Address: _____

_____

City: _____

State: _____ Zip: _____

Telephone: _____ Country: _____

Email: _____

The pricing of the handbook depends upon the binding* and the shipping destination.

_____ number of copies of **spiral-bound** MGPH shipped to **US** address at **$50** each = $ _____

_____ number of copies of **case-bound** MGPH shipped to **US** address at **$60** each = $ _____

_____ number of copies of **spiral-bound** MGPH shipped to **International** address at **$65** each = $ _____

_____ number of copies of **case-bound** MGPH shipped to **International** address at **$75** each = $ _____

Grand Total $ _____

* *see next page for definitions and examples of binding*

Mail order form to:

MGP Handbook
Langston University
Box 730
Langston, OK 73050
USA

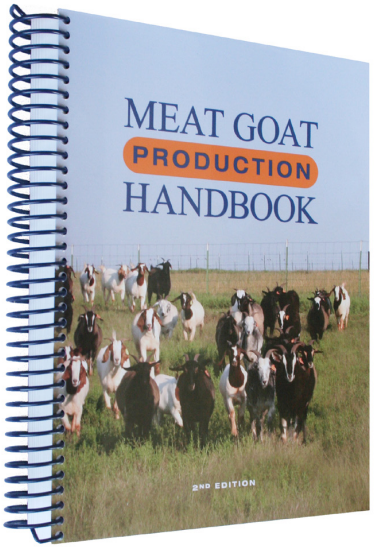
Make Checks or Money Orders payable to
Langston University/Research Sales.

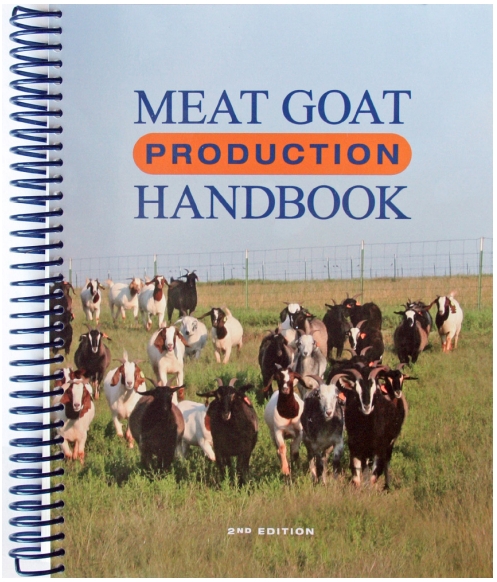
Price of the handbook includes shipping and handling.

Sorry but we **CANNOT** accept credit card orders, or C.O.D. orders, or currency other than US dollars.

If you include your email address, an email confirming that your order has been received and that your order has been processed will be sent.

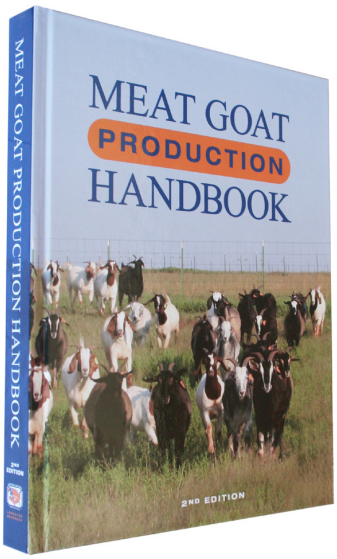
Spiral-bound (softback)

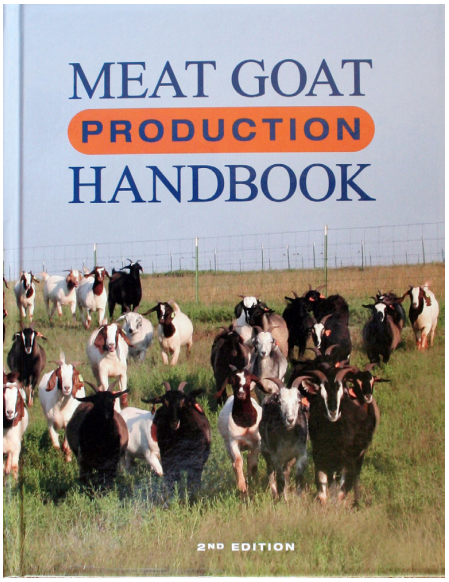




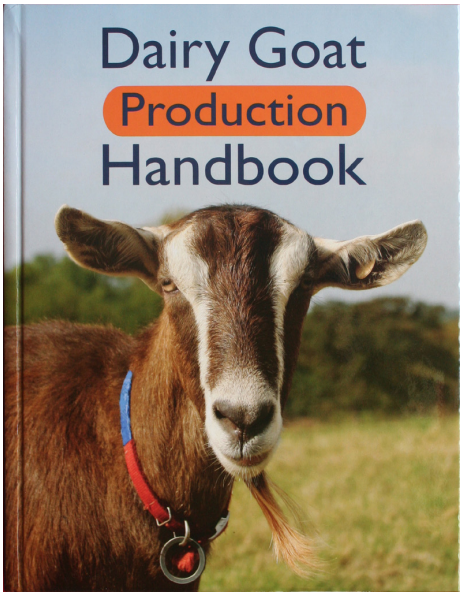
Pages are held together along one edge by a continuous piece of plastic wire (spiral) that passes through holes in the pages. This handbook will lie flat and will fold upon itself.

Case-bound (hardback)





Pages are held together along one edge by gluing sewn sheets into a separately made hard cover.



Dairy Goat Production Handbook

Order Form

Name: _____

Address: _____

_____

City: _____

State: _____ Zip: _____

Telephone: _____ Country: _____

Email: _____

The pricing of the handbook depends upon the binding* and the shipping destination.

_____ number of copies of **spiral-bound** DGPH shipped to **US** address at **$50** each = $ _____

_____ number of copies of **case-bound** DGPH shipped to **US** address at **$60** each = $ _____

_____ number of copies of **spiral-bound** DGPH shipped to **International** address at **$65** each = $ _____

_____ number of copies of **case-bound** DGPH shipped to **International** address at **$75** each = $ _____

Grand Total $ _____

* *see next page for definitions and examples of binding*

Mail order form to:

DGP Handbook
Langston University
Box 730
Langston, OK 73050
USA

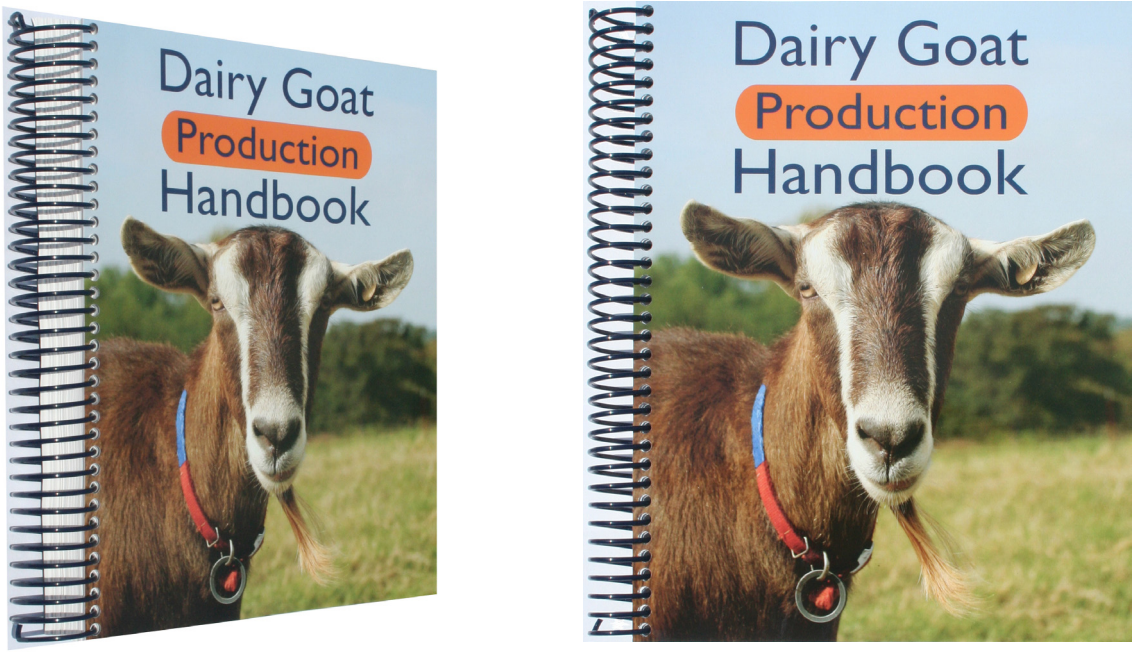
Make Checks or Money Orders payable to
Langston University/Research Sales.

Price of the handbook includes shipping and handling.

Sorry but we **CANNOT** accept credit card orders, or C.O.D. orders, or currency other than US dollars.

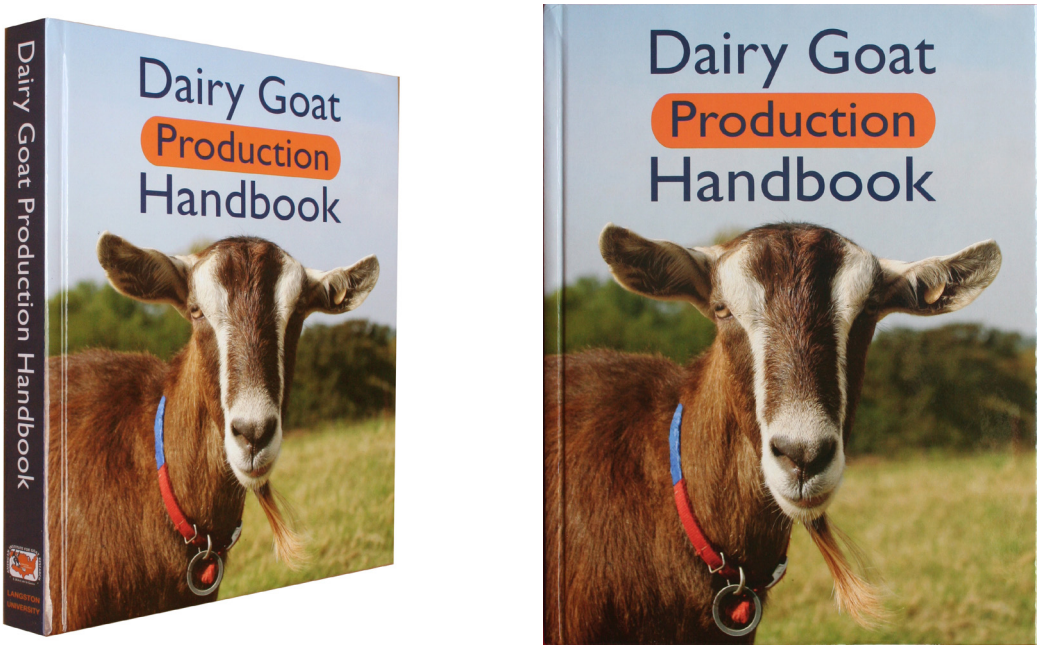
If you include your email address, an email confirming that your order has been received and that your order has been processed will be sent.

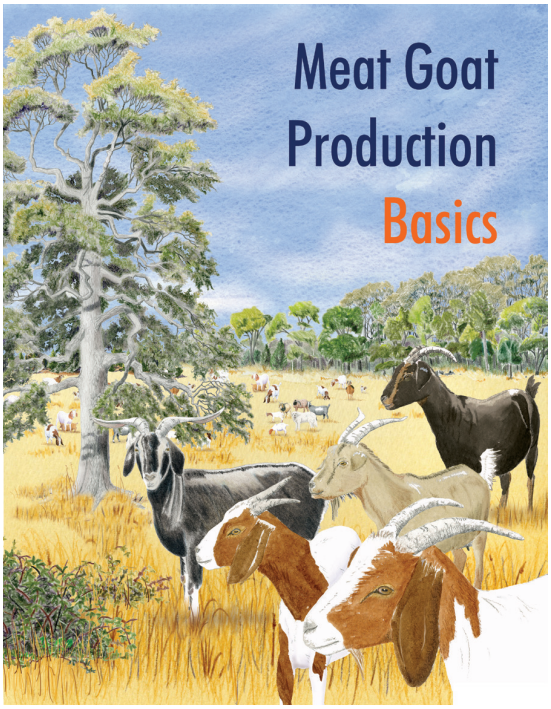
Spiral-bound (softback)



Pages are held together along one edge by a continuous piece of plastic wire (spiral) that passes through in the pages. This handbook will lie flat and will fold upon itself.

Case-bound (hardback)





Meat Goat Production Basics

Order Form
$20 per copy

Name: _____

Address: _____

_____

City: _____

State: _____ Zip: _____

Telephone: _____ Country: _____

Email: _____

_____ number of copies of the MGPB @ $20 each = $ _____

Mail order form to:

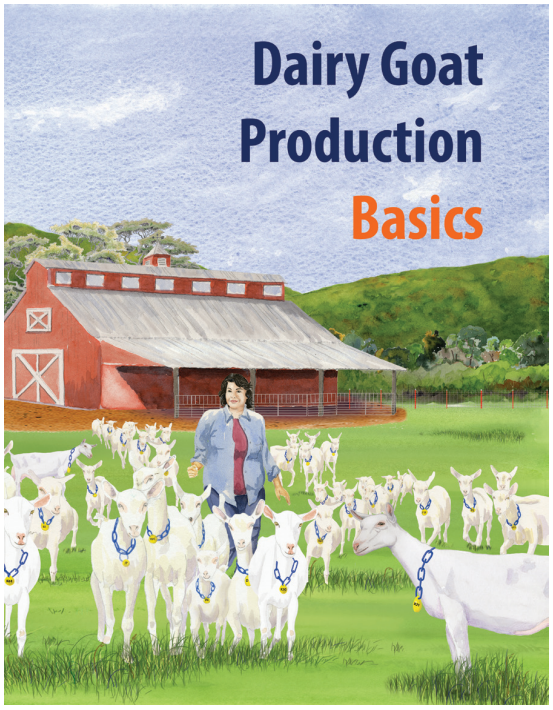
MGP Basics
Langston University
Box 730
Langston, OK 73050
USA

Make Checks or Money Orders payable to
Langston University/Research Sales.

Price of the handbook includes shipping and handling. International orders should include an extra $15 per copy for international shipping.

Sorry but we **CANNOT** accept credit card orders, or C.O.D. orders, or currency other than US dollars.

If you include your email address, an email confirming that your order has been received and that your order has been processed will be sent.



Dairy Goat Production Basics

Order Form
$30 per copy

Name: _____

Address: _____

_____

City: _____

State: _____ Zip: _____

Telephone: _____ Country: _____

Email: _____

_____ number of copies of the DGPB @ $30 each = $ _____

Mail order form to:

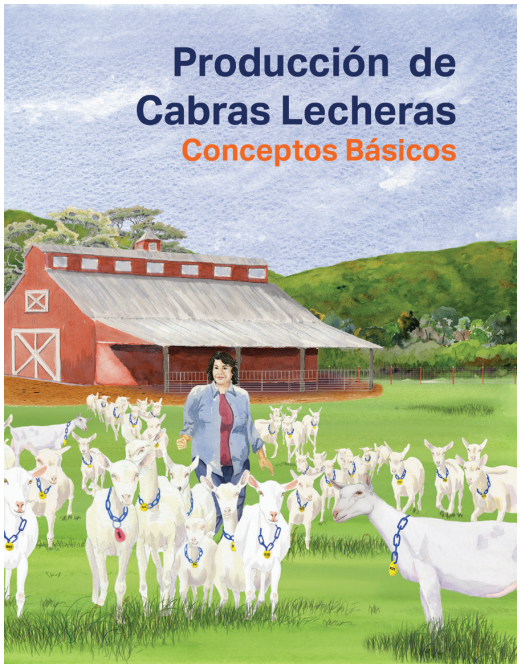
DGP Basics
Langston University
Box 730
Langston, OK 73050
USA

Make Checks or Money Orders payable to
Langston University/Research Sales.

Price of the handbook includes shipping and handling. International orders should include an extra $15 per copy for international shipping.

Sorry but we **CANNOT** accept credit card orders, or C.O.D. orders, or currency other than US dollars.

If you include your email address, an email confirming that your order has been received and that your order has been processed will be sent.



Producción de Cabras Lecheras
Conceptos Básicos

Formulario de Pedido
$30 por copia

Nombre: _____

Dirección: _____

_____

Ciudad: _____

Estado: _____ Código de área: _____

Teléfono: _____ País: _____

Correo electrónico: _____

_____ Número de copias de DGPB @ $ 30 cada una $ _____

Haga su pedido a:

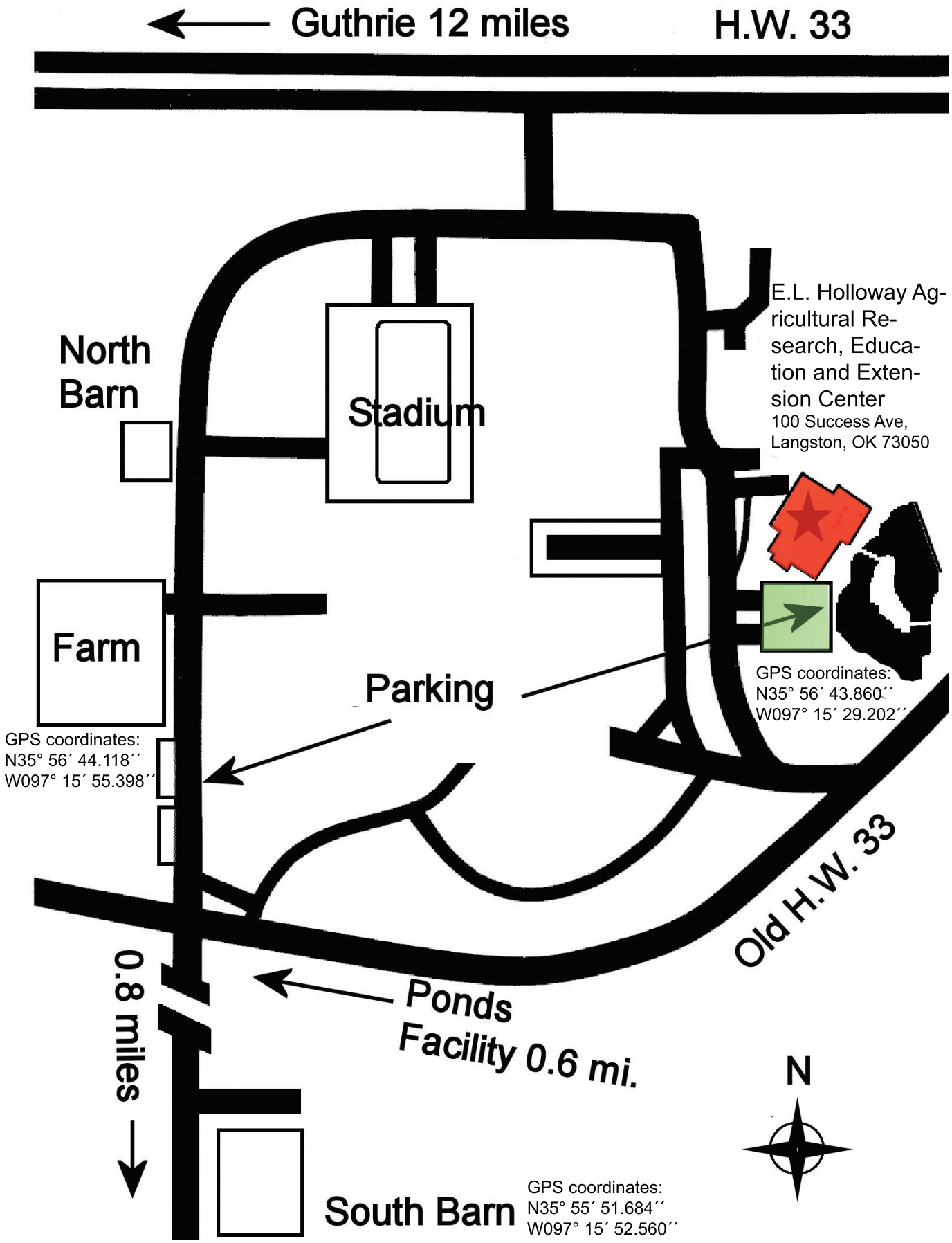
DGP Basics
Langston University
Box 730
Langston, OK 73050
USA

Emita su cheque personal u giro bancario a nombre de:
Langston University/Research Sales.

El precio del manual incluye costo de envío y manipulación. Pedidos internacionales deben incluir $15 adicionales por copia para cubrir costo de envío internacional.

Lo sentimos pero NO PODEMOS aceptar pedidos utilizando tarjetas de crédito o pedidos COD (efectivo a la entrega) o moneda que no sea dólares americanos.

Si usted incluye su correo electrónico se le enviará una comunicación confirmando que su pedido ha sido recibido y que el mismo será procesado y será enviado.


Guthrie 12 miles
H.W. 33
North Barn
Stadium
E.L. Holloway Agricultural Research, Education and Extension Center
100 Success Ave,
Langston, OK 73050
Farm
Parking
GPS coordinates:
N35° 56´ 43.860´´
W097° 15´ 29.202´´
GPS coordinates:
N35° 56´ 44.118´´
W097° 15´ 55.398´´
Old H.W. 33
0.8 miles
Ponds
Facility 0.6 mi.
N
South Barn
GPS coordinates:
N35° 55´ 51.684´´
W097° 15´ 52.560´´