PROCEEDINGS OF THE 32nd ANNUAL

GOAT FIELD DAY

April 29, 2017

Agricultural Research and Extension Program
Langston University
Langston, Oklahoma 73050

WELCOME

We deeply appreciate your attendance at this 32nd Annual Goat Field Day of the E (Kika) de la Garza American Institute for Goat Research of Langston University. Goat Field Day is one of the most important things we do each year. The primary purpose of Goat Field Day is for education and extension in areas of greatest interest to stakeholders of the Institute. Thus, please share your thoughts with us on today's activities and suggestions for Goat Field Day next year. In addition to extension and education, Goat Field Day provides an excellent opportunity for the staff of the Institute to meet other people who work with goats. Such interaction helps make our program the most appropriate it can be for the people it serves. The proceedings of Goat Field Day is a very useful tool for the Institute beyond impact realized from the program today. First, there are reports on Goat 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 Field Day is "Selection: from Eyeball to Genomics."

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

The morning program consists of:

- **Genetic Resources for Your Dairy Breeding Program** — *Ms. Lisa Shepard*
- **Importance of Data in Selection** — *Dr. Ken Andries*
- **Genomics and the Goat Producer** — *Dr. Brian Sayre*

The afternoon workshops are:

- **Dairy Goat Production Evaluations** — *Ms. Lisa Shepard*
- **Dairy Goat Type Evaluations** — *Ms. Lisa Shepard*
- **Combining Information for a Selection Index** — *Ms. Lisa Shepard*
- **Getting Started Collecting and Using Data in Meat Goats** — *Dr. Ken Andries*
- **Using Performance Ratios and EBVs for Selection in Meat Goats** — *Dr. Ken Andries*
- **Value of Performance in your Herd: A Look at the Cost and Returns of Using Data in Selection** — *Dr. Ken Andries*
- **Applied Animal Genomics** — *Dr. Brian Sayre*
- **Internal Parasite Control** — *Dr. Barry Whitworth*
- **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/AMS: Market Strategies** — *Ms. Tina Colby*
  - **Perry Livestock: Livestock Auctions** — *Mr. Travis Perin*
  - **USDA/NRCS: Conservation Programs** — *Mr. Nick Jones*
  - **USDA/FSA: Farm Loans** — *Mr. Phil Estes*
  - **USDA/APHIS: Animal ID** — *Dr. Julie Aebi*
  - **USDA/NASS: Animal Inventories** — *Mr. Troy Marshall*
- **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

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Genetic Resources for Your Dairy Goat Breeding Program

Ms. Lisa M. Shepard
Performance Programs Manager
American Dairy Goat Association
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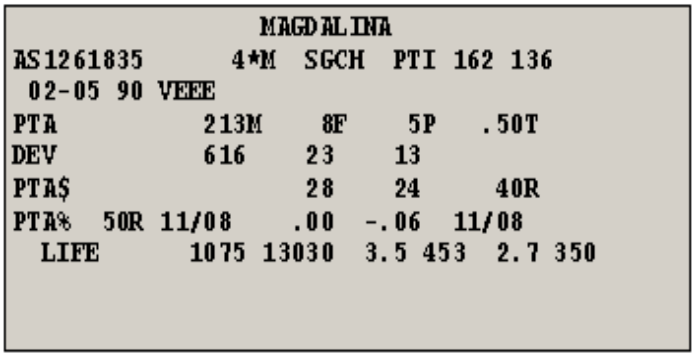
Introduction

Genetics are a fundamental to breeding, whether you actively participate in genetic evaluations or breed naturally. Either way, the animals you breed pass on their characteristics, both good and bad, to their offspring. Having goals that you intend to meet may be most critical for the breeding program. Once your goals have been established and you have a target that you are shooting for, it is important to determine the performance and potential of your current herd. The genetic makeup of your animals affects the ultimate quality. While four basic criteria are generally used in selecting does or bucks (physical and reproductive soundness, visual appraisal and performance information), we will focus on the performance information, emphasizing the genetics that the animal will pass on to its offspring. It becomes a wise decision to invest the time and effort into improving the value of your animals through use of genetic resources. In today's world, we expect resources to be easily accessed and user friendly in order to meet these goals. What is available for use in your breeding program?

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

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



```
                MAGDALINA
AS1261835      4*M  SGCH  PTI 162 136
 02-05 90 VEEE
PTA          213M    8F    5P   .50T
DEV          616    23    13
PTA$                28    24     40R
PTA%  50R 11/08    .00  -.06  11/08
  LIFE      1075 13030  3.5 453  2.7 350
```

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

A few suggested ADGA links:

- http://adga.org/steps-to-genetic-success-with-dairy-goats
- http://adga.org/production-evaluations-what-records-are-used/
- http://adga.org/performance-programs/genetic-evaluations
- http://adga.org/breeding-by-the-numbers
- http://www.caldairygoats.com/readperfped.htm

GENETIC TESTING. The Veterinary Genetics Laboratory (VGL) provides animal parentage verification, identification, forensics services, genetic diagnostics and genetic disease research as a self-supporting unit of the School of Veterinary Medicine at the University of California, Davis. Breeders can go through the registry for possible reduced test fees or work directly with VGL.

Tests	Info	Form
DNA Typing - Parent Verification		
Alpha-S1 Casein		
Freemartin		
G6-Sulfatase Deficiency (G6-S MPSIIID)		

Web link: https://www.vgl.ucdavis.edu/services/goat.php

CDCB (Council on Dairy Cattle Breeding) houses the section that ADGA works with on genetic and pedigree information and based upon the previous AIPL at the USDA Animal Research Service.

As an ADGA partner in providing genetic evaluation information pedigree information (no ownership information) and linear scores are provided to CDCB. In return, genetic information on milk production and type traits are provided using the laboratory resources to provide this complex statistical information as all known relatives are taken into account when determining the predicted transmitting abilities of these qualities. Accuracy of pedigree relationship is critical.

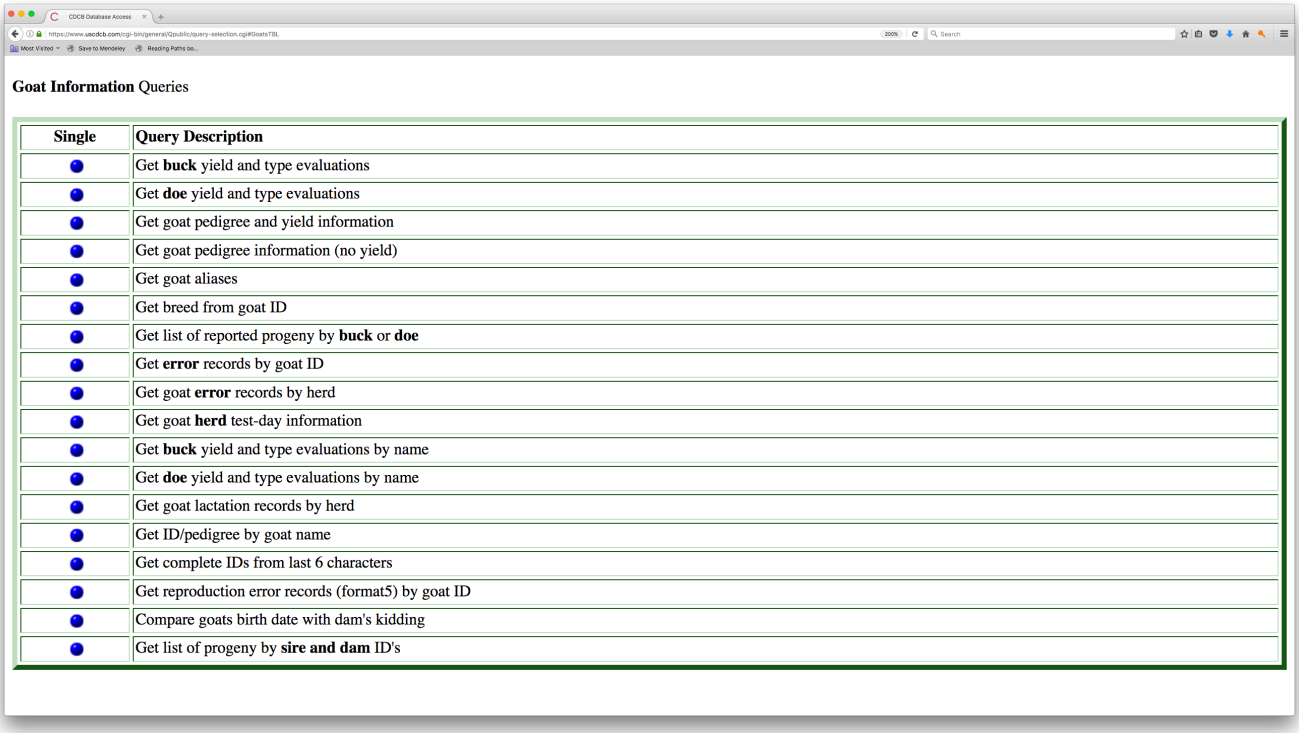
CDCB Database Access for General Public

https://www.uscdcb.com/

Bull Information Queries ¦ Cow Information Queries

General Animal Queries ¦ Goat Information Queries

Other Information: Additional Info ¦ CDCB Home Page



Goat Information Queries

Single	Query Description
●	Get **buck** yield and type evaluations
●	Get **doe** yield and type evaluations
●	Get goat pedigree and yield information
●	Get goat pedigree information (no yield)
●	Get goat aliases
●	Get breed from goat ID
●	Get list of reported progeny by **buck** or **doe**
●	Get **error** records by goat ID
●	Get goat **error** records by herd
●	Get goat **herd** test-day information
●	Get **buck** yield and type evaluations by name
●	Get **doe** yield and type evaluations by name
●	Get goat lactation records by herd
●	Get ID/pedigree by goat name
●	Get complete IDs from last 6 characters
●	Get reproduction error records (format5) by goat ID
●	Compare goats birth date with dam's kidding
●	Get list of progeny by **sire and dam** ID's

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

Pedigree information, progeny information, genetic evaluation information and milk test information are available.

While not the reason for the CDCB to provide this information, it can be of assistance to those on production testing as there are queries to help find if there are errors in the communication between the record centers and CDCB. This can be looked up by animal ID or by herdcode.

Herd queries can be used to make sure test type, supervision levels, etc. are all correct.

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

Lac	Fresh	DIM	Herd	CtrlNo	Proc_Date	Mod_Date	DRPC
1	2015/03/04	291	93100624	301	2016/02/14	2008/08/27	10

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

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

	DIM	Milk	Fat%	Prot%	SCS	Freq	Test Date
1	5	7.3	5.6	4.2	2.2	2	2015/03/08
2	32	12.2	3.5	2.6	2.7	2	2015/04/04
3	60	11.7	2.7	2.5	4.9	2	2015/05/02
4	95	10.4	2.8	2.2	2.2	2	2015/06/06
5	etc.						

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

Output from “Get doe yield and type evaluations”

Doe Yield Evaluation

Information shown is from the 1611 run.

ENUSA000001261845

Doe	Sire	Dam		Birth	DRPC	Ctrl#	Herd
EN001201835	EN001065962	EN000930291	2	003/04/11	10	301	99100624

Kidding	DIM	MFP$	Pctile	Inbred %
2016/02/23	248	+24	89	4

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

Doe Type Evaluation

Information shown is from the 1611 run.

Doe	Appraisals	Eval Date
ENUSA000001261845	1	0716

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

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

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

In summary, annual genetic evaluations of dairy goats are calculated from yield data and from type and pedigree data supplied by the American Dairy Goat Association (ADGA). Evaluations for type have been calculated since 1986 for final score and since 1989 for linear type traits.

Evaluations are computed for Alpine, Experimental, La Mancha, Nigerian Dwarf, Nubian, Oberhasli, Saanen, Sable and Toggenburg breeds and for crossbred animals from these breeds. Only animals with registered sires are evaluated.

Finally, the most used website is the **ADGA GENETICS** web application.

ADGA provides this same pedigree information on this site as is given to CDCB along with additional registry known information such as SG designation, polled, black, DNA on file and buck collection on file. ADGA provides the production/type index numbers as well from their own formulas for this calculation. COI is a built in function on the website. Genetic evaluation information as provided by ADGA is included on the site as well as being provided on the CDCB site.

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

The web application provides tools to help dairy goat owners make informed herd management decisions. The application combines registry data from ADGA and production and type evaluation data from CDCB. The site is organized into several sections.

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

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

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

They are made up of a combination of drop down lists, textboxes and buttons that allow you to set search criteria for the current page.

Some filters may automatically refresh results when a new value is selected.

They are by default set to the least restrictive values (return the most results). You can narrow your search and number of results returned by changing the filter values.

Filter values, once set, are remembered across different pages for your current browser session.

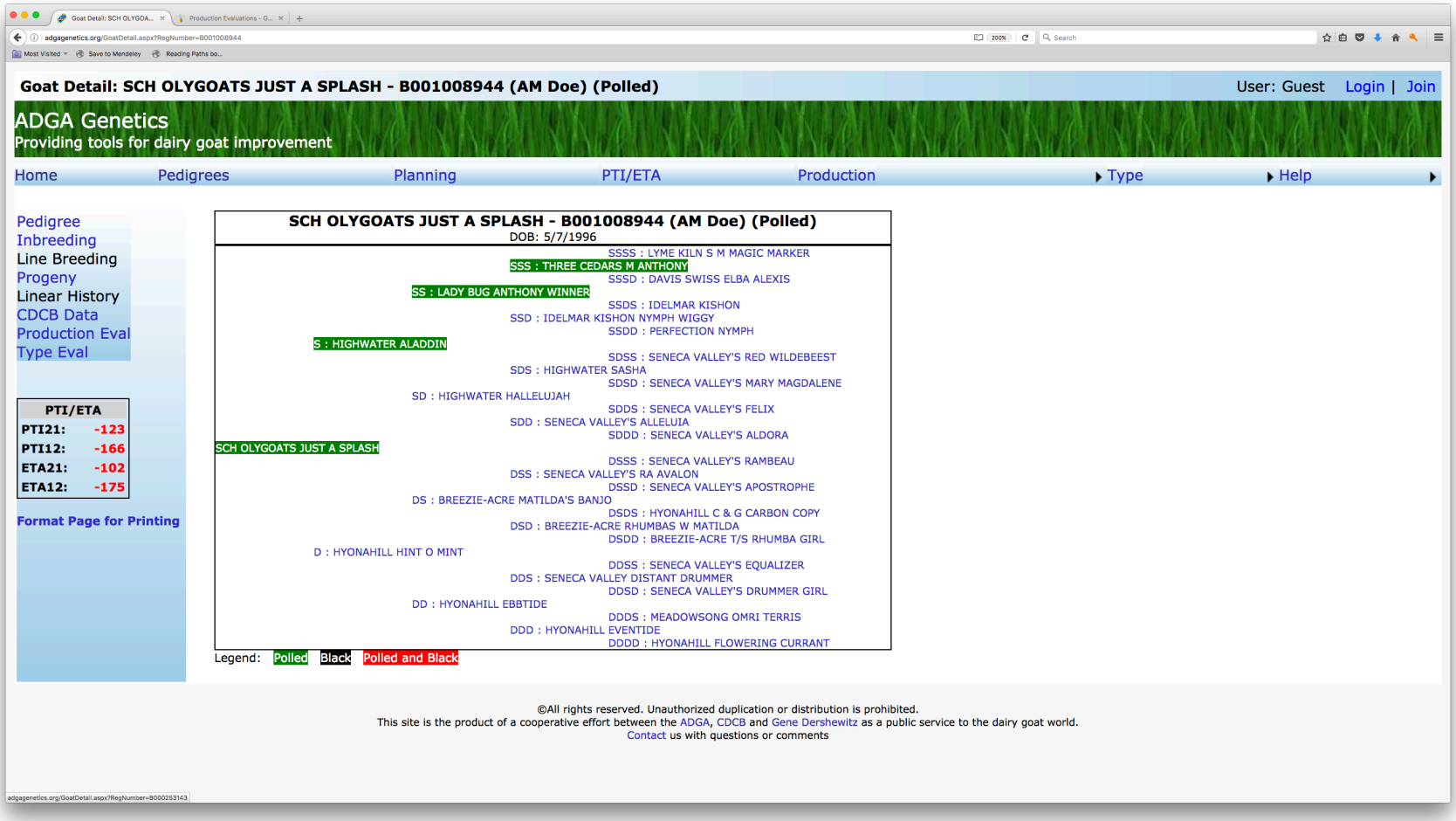
Search Results generally appear in tables in the Content Area just below any filters that may be present. Here are some features that are common to most results tables:

All columns are sortable by clicking any column heading. Clicking the same column a second time will sort results in the opposite direction based on the column clicked.

A registered name can be clicked to take you to the Goat Details page for that animal.

Results are displayed up to 20 records per page. If more than 20 records are returned for your filter settings, a page navigation control will be visible just under your results.

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



Web Link: www.adgagenetics.org

Getting Started Collecting and Using Data in Meat Goats

Dr. Kenneth M. Andries

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Frankfort, KY

Introduction

The ultimate goal of any enterprise is to generate a profit through their production. To do this, it is critical that each producer set specific production goals based on their desired type of production system. This will allow you to target specific traits and increase production and profitability. When setting goals remember that research has shown that reproduction is the most economically important trait in production herds of livestock unless you are strictly a stocker or feedlot enterprises. Growth is second most important in all types of livestock enterprises. Health plays a critical part in both of these traits so it is included as well.

Many goat producers do not have a good set of goals that they are working towards. It is important to start by writing down a set of goals and planning how to progress towards those goals. As part of that you will need to know where you stand currently for the traits of interest. If you want to improve reproduction for example it is critical to know your current conception and kidding rate. Without that information how do you know if you are setting your goals above your current production?

When you start collecting data it is also important to think about your management system and how a record keeping system will fit into your program without major disruptions. If it is not easy to do you most likely will not follow through and that will result in failure in the end. There are a growing number of programs available that will assist with record keeping. Smart phone apps as well as computer programs are very common for some types of data collection.

The next step is to get the necessary equipment to collect the data. This should include a scale, but for many producers the starting point is a set of ear tags to provide ID on your animals. Without the ability to be sure of the identification of every animal each time you collect data it is not possible to have good data. While I know some people can remember each animal, an ear tag insures that others know who you are referring to as well, it also makes records easier to manage.

After you have your animal ID taken care of, data collection should start at birth. You should record the number of kids born to each doe as well as the ID of those kids. What sex the kids are and make note of any issues or observations you have that may impact survival or desirability in the future. Collect a birth weight on each kid and record this information. A simple fish scale and bucket is all it takes to get birth weight or you can use a bathroom scale with the bucket.

If you lose a kid, record when it died or was noticed to be missing. This helps you in the future to know specific times that may be higher risk. You also should record some weights before weaning to know how kids are growing and of course a weaning weight. While a scale is needed, there are ways to build a scale for lower cost than the ones advertised. There may also be ways to borrow scales or have a “group use” scale with a local association. The important thing is to know the weight. You should also record the weight of your

does at least once a year. Remember that all treatments, other than vaccines, are based on animal weight, so you need to know what they weigh to properly treat for parasites or other issues.

The data recorded between birth and weaning needs to be used for two things. First it needs to be used to identify animals you want to save for replacements in your herd. You should select kids from multiple births to help improve twinning and reproduction and those that grow faster to improve weaning weights (market weight). The second use is to help identify dams that are not as productive as you need them to be. This can be those that only raise singles or that have kids and don't take care of them. I have seen a lot of producers think they can remember, but keep breeding the same problem animals over years because they don't keep a record or decide to pull her off the trailer because she looks good when they go to load the culls.

The use of records depends on a good record system. For a good basic record keeping system we still utilize paper and a simple computer program. We utilize an Excel spread sheet to record data and barn sheets in the barn. We start with a kidding sheets that records the kid ID, Dam ID, date of birth, sex, type of birth, birth weight, and any comments. We then take weights, body condition score, and eye color score on our goats on a regular basis and record these. We weigh the kids at 60 and 90 days to measure progress and record any losses as they happen. We put everything into a spread sheet that is evaluated at weaning to determine which doe kids to keep and which dams to cull.

We participate in an on-farm testing program as well as the National Sheep Improvement Program (NSIP) program and we utilize the information from those sources to assist with selection. The EBVs provided by the NSIP program are our best indicators and they allow us to select for reproduction and parasite resistance which can be very difficult to measure directly on every animal. We also evaluate our sires using these systems as we utilize individual sire breeding pastures so we know who the sire of each kid is. This all starts with basic data collection and it is the foundation of all performance based selection.

In conclusion, record keeping needs to start with a sound ID program for your animals and then start recording at birth. Simple paper and spread sheets work well if you keep up with them but there are a number of commercial programs that are getting better at data keeping for goats. Sheep programs can be used because they allow for twin births, you just would not have wool weights to include. A simple scale can be built for low cost though a group use scale is something to consider. Production records are very critical in reaching goals based on measurable outcomes. You need to know where you are and how you progress and records are how you get that information.

The Importance of Data in selection

Dr. Kenneth M. Andries
Assistant Professor and Extension Specialist
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Frankfort, KY

Introduction

"In each generation of animals in his herd or flock, the breeder must select those to be saved for breeding from those to be used for other purposes. Perhaps he will also select animals from other herds for use as breeders in his. These are the most important things he does."

Breeding Better Livestock. Rice, Andrews, and Warwick 1953.

The rationale behind the above quote is that the genetics of our kids are fixed at conception. We are not able to adjust or change those genetics after that point. While there are other factors that impact animal performance and health, genetics are a very critical and often the most misunderstood portion of what we see. Genetics for growth, health and survival, as well as reproductive performance all play a role in the economic success of your livestock enterprise.

Genetic progress depends on objective measurements of important traits. We must then use that information to make informed selection decisions and cull underperforming animals. Data collection is critical to this process and each producer needs to collect basic data and incorporating that into their selection process to improve their herd. The data collected is considered raw data and can be useful but adjusted data provides a clearer picture of genetic potential.

Raw data has limited use in selection because of differences in environmental factors such as age of dam, litter size at birth and weaning, and sex. These are all factors that we know impact growth and performance of young animals. To be accurate in evaluating animals we need to adjust the raw data for these factors. This adjusted data is known as standardized performance data and it is used to conduct what is known as on-farm performance testing.

To help improve the effectiveness of data, there have been a number of programs over the years that adjust for known environmental factors. However the first step is collection and reporting of data by the producer. Even raw data have value if used correctly.

Raw or adjusted data provide producers with information on the progress towards production goals and helps provide information on past history and difficult to measure but important traits. Data on reproduction and health traits can be collected over time and animals culled or specific female lines selected based on performance of their parents as well as individual performance. How you utilize the data is critical to success and progress in the system.

Data need to be maintained and reviewed. The type of data collected need to be focused on the specific goals of your herd. Collect data that will allow you to identify animals that are moving you towards that goal. In the long term you need to have data that are easy to utilize and understand. There are a number of good quality record keeping programs out there but you have to make sure the one chosen records the important traits of your herd and will provide you with the reports you need to improve selection.

To make data useful you need to review the data at least once a year. This is the time when you are making selection decisions for your herd. Look at the data to see which doe kids are out of multiple births and had good growth rates pre-weaning. Look for those out of dams that have done well in the past as well. These are the ones you need to be selecting for replacements.

At this same time evaluate your doe herd to look for individuals that are losing productivity or are not producing enough to cover their maintenance cost. Also look for those that have noted issues or have had health problems above average to be removed from the herd. Mark these individuals and keep a record of why until you market them.

While different types of performance data program provide different levels of information and the use of those data differs, any data are better than no data. Through the use of data collected we have been able to reduce the number of parasite treatments on our doe herd to an average of less than once per year. We have increased from an average liter size at weaning from 1.3 to 1.6 kids per doe that kidded as well. These were achieved through the use of performance data in our herd. While this is important, we would not have been able to achieve this nor would we be able to know the differences without the data we collect and use for selection.

Finally, as a producer it is important to remember that we cannot manage what you don't measure. To be successful in your goat enterprise you need to measure performance and work towards a set of goals that are based on your market, management, and are measureable. Using performance data will help you reach those goals. It is important that you start using a program and use the data correctly if you are to be successful in the long term.

Using Performance Ratios and EBVs for Selection in Meat Goats

Dr. Kenneth M. Andries

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Introduction

There is a quote I like to use when talking to producers about the importance of data in selection from Dr. J.L. Lush's book Breeding Better Livestock and it states: "*In most commercial pedigrees little information of any kind is included except the names and identifying numbers of the animals. Such a pedigree is useful only to the extent that one knows or can find from some other source how meritorious or mediocre those ancestors were.*" While this quote is over 60 years old, goat registration papers and goat selection is still at this level. To get away from this we need to start collecting and utilizing sound performance data to improve the success of our selection practices.

There currently are a couple of on-farm performance testing programs available for goat producers to participate in which are similar to the old beef improvement programs in cattle. There are also programs to calculate expected breeding values (EBV) or expected progeny differences (EPD). However these programs are not well known and have low to very low participation from breeders of all types.

Most good on-farm performance testing programs provide weights that are adjusted for differences in the age of the kids, birth/rearing type, sex, and age of the dam. The adjusted weights are more accurate in comparing individuals within a contemporary group (group of individuals born on the same farm within a set number of days and managed the same). The adjustments remove most of the differences caused by factors that have a fairly consistent and know impact animal growth and performance. This allows you to make more accurate comparisons of the genetic potential of the individual.

Some of these programs go an additional step by providing performance ratios for specific weights. These ratios are simply based on the difference between the individual and the average of the group. While this is simple to calculate it helps people identify the top and bottom 25% of individuals. This is important when you are looking to select replacements or cull low performing animals out of the herd. The limitations is that you are still only able to accurately compare within the one contemporary group.

These programs are generally very basic programs and the cost of participation is very small if there is any charge. However you are limited in what you can actually gain from these types of programs. They are often used as a starter program and help producers start moving forward in performance selection.

I work with one of these programs directly called the Goat Herd Improvement Program (GHIP). While the program seems basic, producers report improved weaning weights, greater reproduction, and overall improved productivity as they utilize the program. They report that they are able to identify top and bottom producing dams easier and find some that surprise them as to which side they are on when they start. The benefits seem to be in finding better replacements within the herd and doing a better job at culling. There are still limits though.

The next step in performance data is to move to national evaluation programs that are able to calculate Expected Breeding Values (EBV) or Expected Progeny Differences (EPD). The program that is doing this in the goat industry is actually the National Sheep Improvement Program (NSIP). The program generates EBV for sheep flocks and goat herds that participate in the program on all the economically important traits. While the use of the data is limited due to low producer participation in the goat industry, it is still very valuable and provides greater information than the performance data can directly. The use of data on relatives and offspring as well as parents we are able to get a better estimation of genetic potential for the animals than through on-farm data alone. The program has resulted in some dramatic improvements in some of the sheep flocks using it. For example, in 2014 the NSIP chairman Reid Redden, indicated that based on NSIP data, the Katahdin breed had seen an increase in lambs weaned per ewe and parasite resistance by 10%; the Polypay breed saw a 5.9 kg increase in amount of lamb weaned per ewe; and the Suffolk breed saw a 2.7 kg increase in post-weaning weight gain with improved carcass traits. These changes were achieved through use of the NSIP program by producers between 2004 and 2013. With greater participation from goat producers we can see similar improvements in meat goats.

All programs are tools that a producers can use when making selection choices. As with any tool, we need to use that tool correctly if we are going to have a positive outcome. No program of data collection can be effective if the results are not utilized and used correctly. It is critical to remember that even the EBVs are limited until we get more connection between herds. The EBVs do allow for comparisons between individuals on the same farm that are not in the same contemporary group while the ratios do not. Also, the more data that are collected and submitted the less any missing or incorrect data will have in the overall process.

As a producer you also need to remember that you still need to look at the animal and judge for structure and temperament. Data cannot tell you if a yearling doe will be a good mother or if she will breed. What we are doing is improving the odds of making the correct choice. It is often a very humbling experience the first year people collect data on their herd. It is important to use that as part of the learning process. You need to know where your herd is to know if new additions can actually move you in the right direction. It is critical that each producer have goals if they are going to be successful in selection as well. Your selection program needs to move you towards those goals.

The Goat Herd Improvement Program (GHIP) conducted by Kentucky State University has collected data from many herds for over 10 years. From this data we are able to provide information on average production levels of different traits which should be used in creating goals by producers. Tables 1 and 2 list the top and bottom 25% marks and the average values for traits of interest in meat goats from GHIP.

Table 1. Performance of kids in the GHIP program.

Trait[a]	Number of Records	TOP 25%	MEAN	BOTTOM 25%
BWT	5472	8.6	7.57	6.5
WNWT	4680	44.0	37.30	29.8
ADG	4564	0.40	0.33	0.25
ADJ WNWT	4579	49.37	42.81	34.32

[a] BWT = birth weight; WNWT = Actual weaning weight, ADG = average daily gain, ADJWNWT = adjusted weaning weight.

Table 2. Dam performance from the GHIP program.

Trait[a]	Number of records	TOP 25%	MEAN	BOTTOM 25%
# BORN	3057	2	1.84	1
BWT	2906	16.75	13.64	9.5
# WEANED	2955	2	1.56	1
WNWT	2702	76.4	61.38	41
ADJ WNWT	2093	89.02	69.70	43.34
SURVIVAL	3055	100	83.72	75
DOE WT@WN	1586	117	101.22	84
EFFECIENCY	1545	75.64	60.54	24.22

[a] # BORN = average number of kids born per dam; BWT = birth weight; # Weaned = average number of kids weaned per dam; WNWT = actual weaning weight; ADJWNWT = adjusted weaning weight; DOE WT@ WN = dam weight taken at weaning time; efficiency = total kid weaning weight divided by doe weight taken at weaning.

You can utilize these numbers as benchmarks for setting goals and evaluating where you stand in regard to data. Also remember that if you think you are better than average, be sure to take the measurements to see where you actually stand. I have had a lot of producers surprised about where they actually are compared to where they think they are in terms of performance.

Value of Performance: A Look at the Cost and Returns of Using Data in Selection

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Introduction

As the goat industry is looking to move forward and improve availability and productivity, the use of sound selection practices becomes more critical at all times. In many other livestock industries producers would not consider selection of replacements and planning breeding without using information on the performance of the sires and dams being considered. If the meat goat industry is to make the transition to a successful and sustainable livestock business, it is critical that producers start utilizing performance data in their selection. While there is cost associated with doing these practices, there are also benefits that cannot be achieved without this change in practice.

While the influence of a sire on the herd is profound, there are also important female traits that are difficult to measure directly until after the doe is in production. Traits like fertility, probability of multiple births, and mothering ability are all critical to the success of a replacement doe and the profitability of your herd. However, we cannot measure these directly until after she is in production, and in some cases after multiple years in production. We must have better ways of estimating the possibility of individuals on these economically critical traits.

Costs of purchasing equipment and participation in performance programs is the most common reason producers indicate they choose not to participate in performance programs. This includes cost of a scale to weigh animals, equipment to work animals, and the time to take and record data. If you move past the personal on–farm records there is often a cost to participate in programs such as NSIP. These cost are generally lower than most producers think and often have greater benefits than they realize until they have the equipment and spend the time doing the records.

When we look at the overall cost of keeping and using data, it appears that in the goat world, people are willing to pay thousands of dollars for breeding stock but don't want to take the time to use a spreadsheet or purchase a scale to know if they were worth the investment. Others have spent a lot of money on computer programs that only record pedigree information and no performance data. To be successful it is critical to spend money where you will get the most returns and to know what is working and this includes your breeding stock.

Good data collection on your farm has two main benefits. First, it allows you to know where you stand in terms of performance of traits that are economically important to your herd. This includes reproduction, growth, and health traits. It can tell you what animals are not pulling their fair share and provide you the information you need to cull and improve your performance. The second thing is it gives you the ability to identify female lines that are more productive and select within those lines. This is how you improve reproduction over time in your herd. As an extra benefit from this you also get a benchmark to evaluate performance of other herds which can help when selecting new sires or does for your program.

If you move to the more advanced program such as NSIP, you get Estimated Breeding Values (EBV) on your animals for growth and reproduction traits. Yes it takes time to get data to be able to get good numbers, but the sooner you start the sooner you will be there. These provide you with information on future performance of young stock. This includes reproduction and parasite resistance. Those numbers are more directly comparable between groups and years. With more producers participating, it can be across herds and areas as well in the future.

All of this saves you from investing time and resources into animals that are not expected to perform. You will never be 100% accurate or correct, but the fewer mistakes the better for your herd. To show some of these issues I want to look at data from the Kentucky State University goat herd. We have been collecting performance data in selection from 2005 and we joined NSIP in 2014. We did add large numbers of does to the herd in 2010 and 2011 as well to diversify our breed evaluation project.

To show the impact of information we will look at three sires purchased in 2006. These were three Boer sires purchased from a replacement animal sale that year. At the time we did not have a lot of data on our herd and there was no data on any animals in the sale other than pedigree and some show results.

While the bucks did not cost the same amount at the sale, they all had good pedigrees and buck 146 was just a few points away from being "Ennobled". The other two had won several shows around the area as well so they had similar backgrounds. Table 1 shows the average weaning weight of kids from each of these sires and the value of those kids at a $2.00/lb. price. The other part of the table shows what the value of different numbers of kids would be so it is an even comparison. Based on these figures, there is a $207.20 difference in potential returns for 20 kids per sire between the top and bottom sire. This value increase to $518.00 if we get 50 kids out of each sire. This is well within a one year potential kid crop from these sires.

Table 1. Expected value of kids produced by sires.

ID	WWT	Value[a]	$/20 Kids[a]	$/30 Kids[a]	$/40 Kids[a]	$/50 Kids[a]
146	33.53	$67.06	$1,341.20	$2,011.80	$2,682.40	$3,353.00
616	38.71	$77.42	$1,548.40	$2,322.60	$3,096.80	$3,871.00
859	34.15	$68.30	$1,366.00	$2,049.00	$2,732.00	$3,415.00

[a] Value used is $2.00/lb. for kids.

While this type of data on sires is not possible before we use them, EBVs provided by NSIP can provide us with some useful information. When we joined NSIP data was submitted on all past years so I was able to get EBVs for these sires based on the performance of their kids and the offspring of those kids over the years in the herd. The EBVs for the sires are presented in Table 2.

Table 2. Expected Breeding Values (EBV) for sires.

ID	BWT	WWT	MWWT	NLB	NLW
146	-0.22	-1.32	-0.136	-0.19	-0.17
616	0.03	0.81	0.24	0.19	0.17
859	0.02	0.36	0.16	0.03	0.03

BWT = Birth Weight, WWT = Weaning Weight, MWWT = Maternal Weaning Weight, NLB = Number live Born, NLW = Number Live Weaned

These data would have pointed out the differences between the sires and would have made it very difficult to have selected sire 146 to add to the herd. I cannot say if these were the best sires in the sale as I don't have any data on the other sires that were not added to our herd. But we could have saved the cost of the one sire and improved the productivity of our herd if we had had data to use in selection.

In conclusion, utilization of sound data collection practices will benefit producers and will improve the value of your goats on the market as potential replacements. By using good data collection and practices you can avoid many issues and will be able to increase production through improved reproduction and growth traits. This is critical regardless of the type of producer you are. The cost of these programs, the equipment, and time needed is recovered in improved performance if you use the data correctly. The sooner you start and the more you learn about the data the sooner you will benefit from it. The alternative is to not advance your herd or the industry.

What is the Goat Genome Reference and the Future of Goat Production

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Introduction

As the world climate and population levels continue to evolve, a high demand is placed on current livestock production systems, especially those in developing countries (FAO 2011). Small ruminants, especially goats, are critical to the small-scale producer as they are easy to acquire and maintain in sparse pasture and marginal crop regions that cannot easily sustain other livestock. There is an increasing need to improve overall efficiency and productivity of livestock production systems in traditionally low producing regions, as it is critical to communities, human nutritional status, and economic development in developing countries. Predictions are that by 2025, global meat and animal protein demand will increase by almost 40%. The increased demand for animal protein has been linked to an increase in cereal grain production, land use and health concerns (Moomaw et al 2012). However, the goat provides an opportunity for production of healthy animal protein with reduced impact on other sectors. To meet the challenge of the increased demand for animal protein, it is important that the scientific community address issues related to livestock production between the developed and developing parts of the world (FAO 2011).

Major advances in sustainable food production and availability can be achieved through the application of new technologies and investment in research to address the upcoming challenges (Godfray et al 2010). Current small ruminant production systems around the world depend heavily on locally adapted breeds. While indigenous small ruminant genetics are relatively uncharacterized, most have undergone generations of adaptation and genetic isolation or bottlenecks, creating a large genetic reservoir of variation in genes and genetic markers. Identifying genes and genetic markers associated with disease susceptibility and resistance in locally adapted breeds is necessary to preserve local germplasm and to apply state of the art genomic-based strategies to meet global food security challenges.

The goat (*Capra hircus*) is an ideal animal species for comparative and population genomic studies. There is supporting evidence that all the different breeds of goats are derived from a single wild ancestor, the bezoar (Naderi et al., 2008), unlike cattle, which are derived from two different sub-species (Elsik et al., 2009). In order to provide the genomic tools necessary for research on the genetic improvement of goats, a research group generated a reference assembly using short-read assembly methods with optical maps to scaffold their contigs (Dong et al., 2013). We have recently published a revised assembly paradigm that uses a combination of single-molecule (PacBio) contigs with a combination of Irys optical maps and Phase Genomics Hi-C interaction clustering in order to generate a near-finished reference for the domestic goat (Bickhart et al., 2017).

What is the Goat Genome?

The genome is the collection of genetic material (DNA) present within an individual that was inherited from the individual's parents. The genome is organized into segments called chromosomes. The goat has 60 chromosomes or 30 pairs of chromosomes (one from each parent) within each cell in the body. During the process of making the gametes (sperm and egg), the genome is split into half with a random mixing of

the chromosomes. Additional mixing of the genome occurs through a process called "crossing over", which leads to exchanges of segments of the parent chromosomes. These events produce a gamete that has only 30 chromosomes that are a mixture of the parent genome available. At fertilization, the partial genome of the male parent in sperm is combined with the partial genome of the female present in the egg to produce a new individual that has a new genome made up from the two parents. This process of random chromosome selection, crossing over, and random selection of sperm and egg for fertilization leads to the variation in traits that we can observe within our goat herds.

The variation we can measure as traits in individual goats is present because of differences in the genome mixing that occurred during fertilization. However, it is important to remember that this mixing of the genome material happens with the exchange of large segments of DNA, so individuals are also inheriting many of the same variations that are found with in their parents. The parents inherited variations from their parents, and so on. Thus, the farther apart that two individuals are on a pedigree tree the more likely they are to have differences in their genome and the traits that we can observe. Breeds are a population of goats selected for specific traits and that are more related to each other than they are to individuals in another breed.

The most common form of variation within the genome is a single nucleotide polymorphism (SNP). This is defined as a change in one unit of DNA, a nucleotide, from one of the four possible units to another unit. The SNP variation sometimes occurs in an area of the genome where it has no effect on the traits observed, but can often be found within a gene, which then may effect the observed trait. If the SNP modifies the effect of the gene then a difference in the observed trait can be associated with this SNP. Observing this SNP difference in a population of animals with a consistent association to a change in the trait allows for us to select for this SNP and trait. The inheritance of the SNP can be in the form of homozygous, the same in the chromosomes from both parents, or heterozygous, different between the chromosomes from the parents. The more homozygous the chromosomes are within an individual the higher the level of inbreeding in that individual.

Selection of the Goat for the Reference Genome

For selection of the sequenced goat, efforts focused on selection of a male goat with a known high level of inbreeding. Goats were initially selected for sampling through discussions with researchers and producers to identify potential sequencing candidates. Male goats (n=15) were sampled via venous blood sampling from four breeds (San Clemente, Boer, Myotonic, Kiko) in the U.S. with the potential for inbreedness. Genomic DNA was harvested from samples and subjected to assay on the International Goat Genome Consortium (IGGC) Illumina 52K Goat SNP panel. Inbreeding was assessed as a genomic coefficient of inbreeding (F_{ROH}) using the runs of homozygosity (ROH) analysis with a SNP threshold for ROH of 15 SNPs and 1 Mb. The F_{ROH} was defined as the proportion of genome in ROHs divided by the overall length of the genome covered by the SNPs [ROH distance / Total SNP distance (2.35 Gb)].

The San Clemente Island goat breed was found to have the highest overall inbreeding (Table 1) and the individual with the greatest amount of inbreeding (Table 2). Each of these breeds were thought to have experienced a genetic bottleneck, but discussions with the breeders of the San Clemente goats indicated a strong likelihood for high levels of inbreeding that was indicated in the runs of homozygosity analysis. The individual selected for sequencing was 'Papadum' from the San Clemente Island goat breed.

Table 1. Inbreeding of U.S. goat breeds based on the genomic coefficient from runs of homozygosity analysis.

Breed	Ave. # of runs	Ave. length of run	F_{ROH}
San Clemente	104	9621	0.424
Boer	51	5926	0.126
Myotonic	38	6397	0.115
Kiko	15	6959	0.049

Table 2. The best candidate for sequencing within each goat breed based on the genomic coefficient from runs of homozygosity analysis.

Breed	Individual	F_{ROH}
San Clemente	SC12	0.4602
Boer	MD003	0.2135
Myotonic	M3	0.1962
Kiko	1368K	0.0459

What are Potential Genomic Tools and Future Use?

Currently the scientific community is developing methods to take advantage of our knowledge of the genome for livestock production. Some examples are determining parentage and identification of genomic markers, such as SNPs, with variation in observed traits for improved selection. The cattle, swine, and poultry industries are beginning to see great improvements in genetic selection due to these tools. However, the goat industry is just beginning to create some of these tools and procedures. For example, genomic evaluation approaches are being developed to hasten genetic gains within dairy cattle populations. The potential of genomic evaluations was evident in the accelerated and improved accuracy of genetic improvements that are possible in dairy cattle industries (Van Raden et al 2009). However, this industry has benefited from an emphasis on data collection for production traits and investment in national infrastructure capabilities to implement genetic improvement programs. The goat industry needs to increase its organization for similar identification of traits and data collection. This is underway, but will require some time to be able to see the benefits.

The development of a high quality reference genome may not initially seem to be important to the average goat producer. The investment in understanding the genome better will be realized with the development of improved methods for selection of animals and improved production outcomes. These improved methods are available for other livestock species and have been beneficial to their production industries. Goats have advantages with the recent development of one of the highest quality reference genomes available for any species and high degree of variation across the industry to allow for identification of markers associated with traits and increased gains from genomic selection for the future.

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Genomic Tools for Parentage, Breed Identification, and Selection

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Introduction

As the world climate and population levels evolve, high demands are placed on livestock production systems. Small ruminants, especially goats, are critical to the small-scale producer as they are easy to acquire and maintain in sparse pasture and marginal crop regions that cannot easily sustain other livestock. Current small ruminant production systems around the world depend heavily on locally adapted breeds. While indigenous small ruminant genetics are relatively uncharacterized, most have undergone generations of adaptation and genetic isolation or bottlenecks, creating a large genetic reservoir of variation in genes and genetic markers. Identifying genes and genetic markers associated with disease susceptibility and resistance in locally adapted breeds is necessary to preserve local germplasm and to apply state of the art genomic-based strategies to meet global food security challenges. Of particular interest are the genes or genetic markers involved in resistance to internal parasites and disease, and resilience to climate differences. The aim of the current small ruminant genetics and genomics research is the development and utilization of state-of-the-art genomic-based evaluation tools for characterization of sheep and goat populations, development of sustainable strategies for improved production, and increased education and research opportunities. International collaborations have led to the development of *de novo* genome assembly projects, a Illumina SNP panels and, for goats, a collaborative database for submission and access to goat SNP and re-sequencing data for breeds and populations worldwide (ADAPTmap). These tools establish the baseline necessary for the development and application of marker-based selection to the sheep and goat industry.

Cheesemaking

Dr. Steve Zeng

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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 clothes 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 °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 °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 °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 °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 °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 °F in next 30 min. As a rule of thumb, increase the temperature by 2 °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 °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 & 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 1 to 2 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 2 to 3 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)

Parasite Management in Small Ruminants

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Introduction

Gastrointestinal parasites are the most common cause of disease in small ruminants. With resistance to chemical dewormers so prevalent, controlling internal parasites is very difficult. Deworming in a sustainable way is even more of a challenge. Producers must use management and not rely solely on dewormers to stay on top of this problem.

The major nematodes (roundworms) encountered with small ruminants are:

Haemonchus contortus (Barber Pole worm) Abomasum

Teladorsagia (Ostertagia) circumcincta (Brown Stomach worm) Abomasum

Trichostrongylus columbriformis (Bankrupt Worm) Small Intestine

The acronym "HOT" representing Haemonchus, Teladorsagia (Ostertagia), and Trichostrongylus are the most prevalent, with Haemonchus being the most devastating.

The following list is of nematodes that on occasion cause problems in small ruminants:

Trichostrongylus axei

Cooperia

Nematodirus

Oesphogostomum

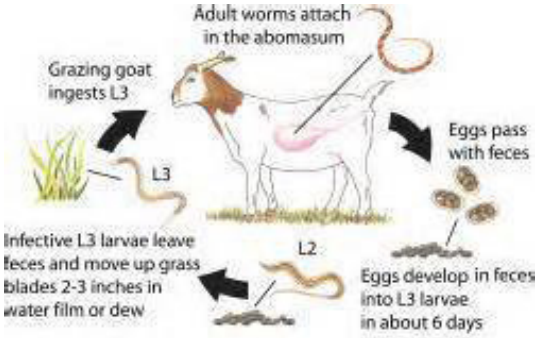
Bunostomum

Trichuris ovis

Strongyloides papilosus

Parasite Life Cycle

Understanding the parasite life cycle will help producers better control them.



Life Cycle of Haemonchus contortus, the barber pole worm

Courtesy of www.acsrpc

The life cycle of the roundworms has three stages which are the development stage, prepatent or pre-adult stage, and the patent or adult stage. Development stage requires heat and humidity. Ideal temperature ranges from 70 to 80 degrees Fahrenheit (F), but any temperature above 45 degrees F will allow for development. Temperatures above 85 degrees F or below 45 degrees F will begin to hamper development. Humidity needs to be 80% or higher. The eggs are excreted in the fecal pellets. The egg hatches into the first stage larvae (L1). L1 molts (sheds cuticle or skin) to L2. L1 and L2 survive by eating bacteria in the feces and soil. L1 and L2 are susceptible to dying in cold, hot, and dry conditions. L2 molts to L3 which has a protective sheath and is less susceptible to the elements. L3 is the infective form of the parasite. L3 must have moisture to free itself from the fecal pellet. Once free, it rides a wave of water on to a blade of grass up to a height of 2 to 3 inches. Once ingested, this begins the prepatent or pre-adult stage. Two molts take place during this stage (L3 to L4 and L4 to L5). If conditions are not favorable for survivability of offspring, L4 will go into an arrested development stage (hypobiosis) for a period of time. The patent or adult stage is the mature breeding adult. By understanding the parasite life cycle, a producer is aware of the environmental conditions that favor the production of parasites. The producer now can make management decisions to try to combat the parasites.

Disease

The roundworms attach and live in certain locations in the digestive tract. *Haemonchus* and *Teladorsagia* live in the abomasum. *Trichostrongylus* survive in the proximal part of the small intestine. Clinical signs of disease are associated with damage done at the site in the digestive tract. The damage done to the intestinal tract results in an inability to break down nutrients and failure to absorb nutrients. This results in diarrhea and poor performance. *Haemonchus* is a blood sucker which causes in anemia. Anemia will manifest as weakness and poor performance and death if severe enough.

Dewormers

Producers have two approved chemical dewormers to use in goats. Fenbendazole (Safeguard, Panacur) and Morantel (Rumantel, Positive Pellet). Other chemical dewormers may be used in an extra label manner with a prescription from a veterinarian. A prescription may only be issued with a proper veterinary-client-patient-relationship (VCPR).

Resistance

Unfortunately, the misuse of chemical dewormers has led to parasite resistance in most goat flocks. This is a worldwide problem and is the biggest threat to the goat industry.

Monitoring

Producers need to have some way of monitoring the parasite burdens in their flocks. A fecal egg count (FEC) is a good way of accessing parasite burdens. Another monitoring device is checking eye score (FAMACHA). FAMACHA checks for anemia by observing the eye for paleness. The producer has to remember that it only checks for *Haemonchus* and no other roundworms. The five-point-check uses FAMACHA and 4 other observations to access parasite burdens. The four other observations are body condition score (BCS), dag score (fecal soiling of tail), hair coat (appearance), and jaw (bottle jaw). By adding the other four observation to the FAMACHA score, the producer has a better chance of not missing other roundworms that cause problems in goats.

Alternative to Chemical Dewormers

Much research has been performed on other forms of dewormers. Tannin-rich forage have been used to control *Haemonchus*. Nematode trapping fungus has been used in Europe but a good delivery system has not

been established. Copper oxide wire particles (COWP) are being used and do a good job on *Haemonchus*. Vaccinations against roundworms is being researched in Australia. All of these alternatives are available or may be in the future.

Management

In the future, parasite control will need to rely more on management and the careful use of chemical dewormers. Some of the following management strategies will aid in the control of parasites:

- Keep good records to find those problem goats
- Stocking rates of 2 head per acre
- Good nutrition strengthens the immune system
- Monitor worm burdens (FEC, FAMACHA, Five-point-check)
- Rotational grazing provide 6 weeks rest between grazing
- Proper use of chemical dewormers
- Provide browse
- Haymaking and tillage
- Tannin-rich forage
- Graze with cattle or horses
- Do not graze to close to the grown

Conclusion

Gastrointestinal parasites will continue to be a major problem for goat producers in the future. Producers will need to rely more on management and less on chemical dewormers to control parasites in the future.

Meat Goat Herd Health and Management

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Introduction

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

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

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

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 in the goat's skin. The tattoo ink is forced into the punctures and remains visible after the puncture wounds heal. It is a good idea to sterilize the equipment and clean the goat's ears to help prevent the spread of some blood-borne diseases. On older animals some tattoos may be difficult to read; holding a bright light source such as a flashlight behind the ear when reading may make the tattoo more legible.

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

Ear tags

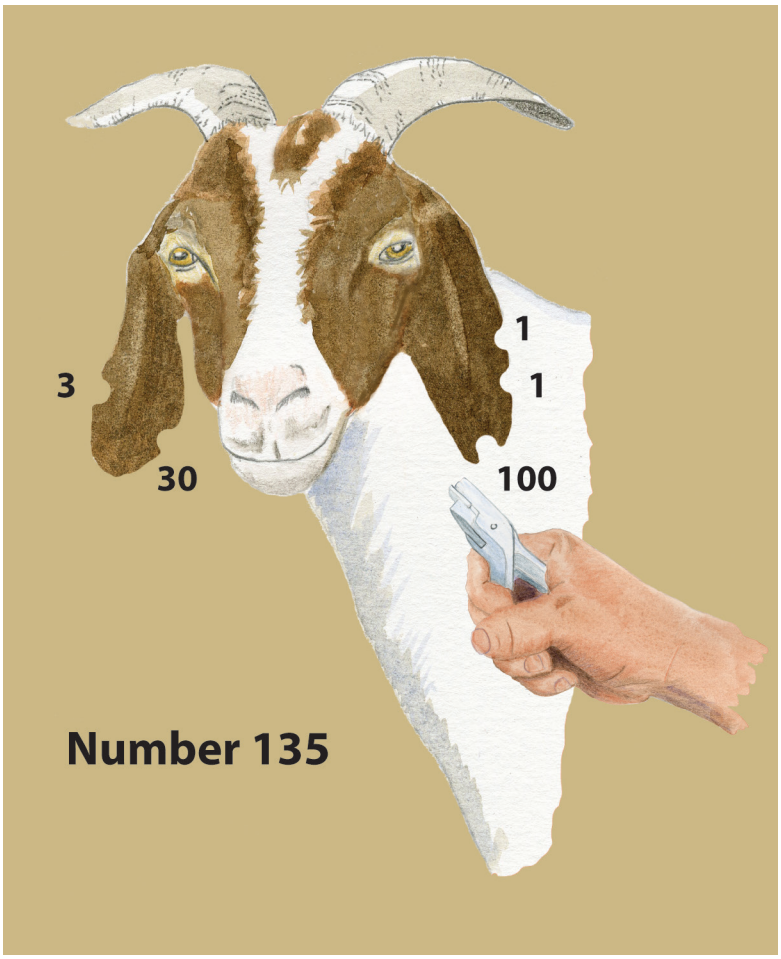
Ear tags are an easy way to identify each goat in the herd. Unlike tattoos, they can be read without actually having to catch the goat. Unfortunately, unlike tattoos, they can break or be ripped out of the goat's ear. Some producers use two ear tags because of this problem. Goats that are shipped are 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.*

Meat Goat Nutrition

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Introduction

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

The ruminant stomach

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

Iron (Fe) 35 - 500 ppm

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

Copper (Cu) 10 - 50 ppm

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

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

Cobalt (Co) 0.11 - 25 ppm

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

Zinc (Zn) 40 - 500 ppm

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

Manganese (Mn) 40 - 1000 ppm

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

Selenium (Se) 0.1 - 20 ppm

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

Molybdenum (Mo) 0.1 - 5 ppm

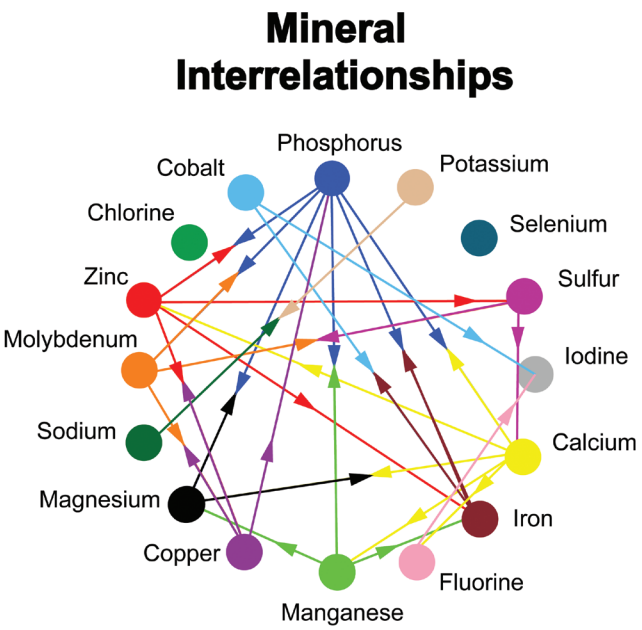
Molybdenum deficiencies are very rare. Toxicity occurs above 3 ppm due to reduced copper absorption, resulting in a copper deficiency. The copper level must be four times the molybdenum level to overcome this effect. High dietary levels of molybdenum are usually related to soil content. Molybdenum (as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

Iodine (I) 0.5 - 50 ppm

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

Mineral nutrition considerations

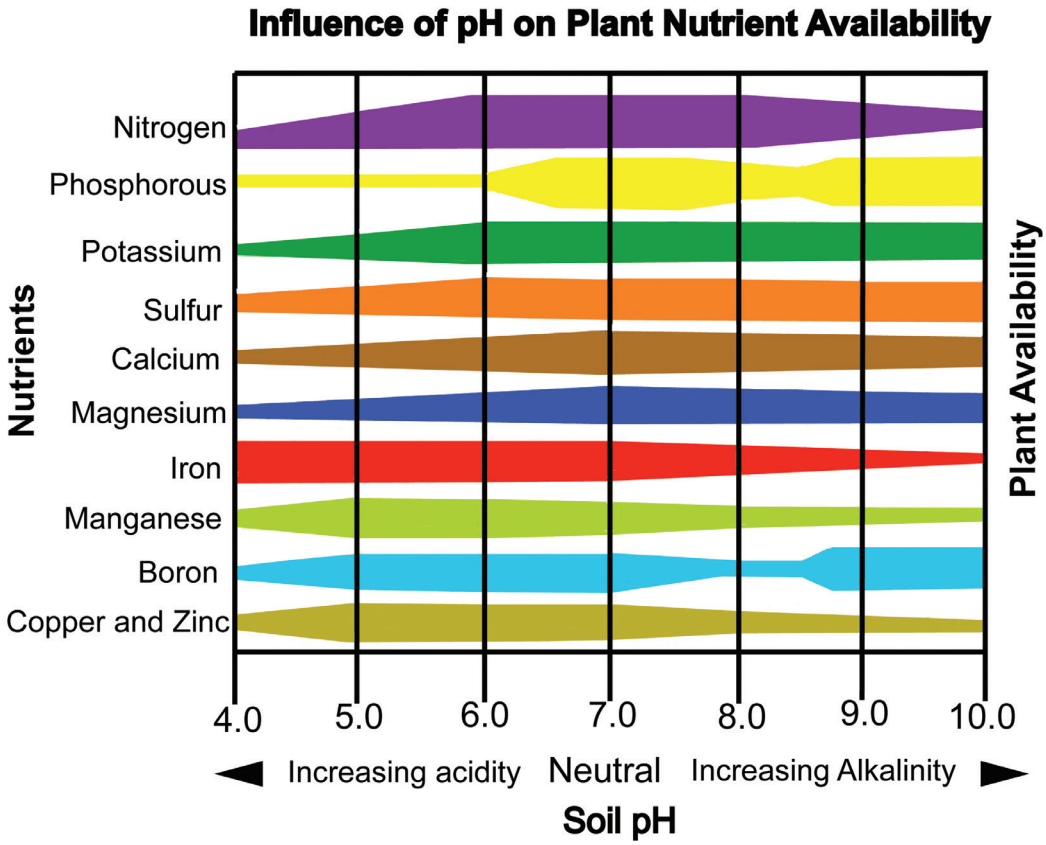
Plants are a major source of minerals for the goat, requiring all minerals that goats require except iodine. However, plant requirements for minerals, such as cobalt and selenium, may be much lower than the level required for animals. Some soils are inherently deficient in some minerals such as iodine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



Drawing by K. Williams.

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

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



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

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

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

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

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

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

Choosing a mineral supplement

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

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

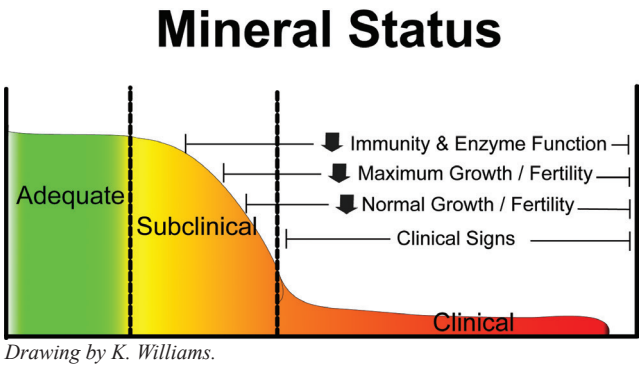
Current approximate wholesale costs for supplying 100% of mineral needs of a 150 lb goat for various minerals in 1 year are as follows:

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

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

Diagnosing mineral deficiencies or toxicities

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



Drawing by K. Williams.

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

Take home lessons on mineral nutrition

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

Body Condition Scoring

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

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

pad at the sternum. Body condition scores range from 1 (very thin) to 5 (obese) in one-half score increments. Langston University has information on the American Institute for Goat Research website describing Body Condition Scoring of Goats (see http://www2.luresext.edu/goats/research/bcshowto.html) and Examples of Body Condition Scores in Goats (see http://www2.luresext.edu/goats/research/bcs.html).

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

Using the Langston Interactive Nutrient Calculator

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

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

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

Getting started

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

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

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

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

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

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

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

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

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

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

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

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

Providing needed nutrients

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

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

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

Feeding Different Classes of Goats

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

Feeding bucks

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

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

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

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

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

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

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

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

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

Feeding replacement bucks and does

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

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

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

Feeding does throughout their life cycle

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

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

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

Flushing meat goats

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

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

Winter feeding of does

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

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

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

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

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

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

Feeding does in late gestation

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

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

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

Feeding the lactating doe

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

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

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

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

Creep feeding

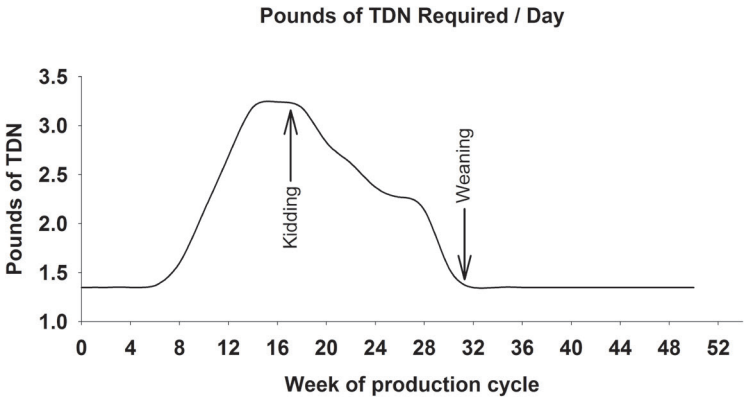
Creep feeding is a method of providing feed for the kids only. This is accomplished by fencing around a feeder and using a creep gate that has holes about 5 inch wide by 1 ft high. These holes are small enough so that kids can enter the feeder, but adults are excluded because they are too big to go through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

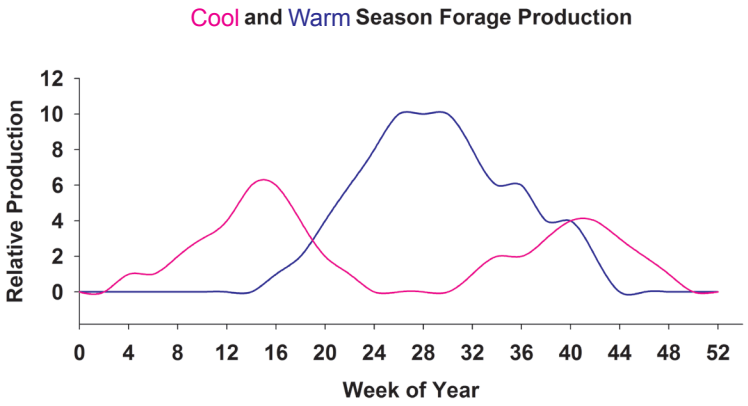
An alternative to grain-based creep feeds that is used in the beef cattle industry is to creep graze calves, using a creep gate that allows calves access to ungrazed high quality pasture. This may have application for goats using high quality pastures (crabgrass or sudangrass that is planted for the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

Effect of Kidding Season on Nutrient Requirements

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

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





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

Artificial Raising of Kids

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

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

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

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

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

Considerations in Ration Formulation

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

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

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

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

Feeding Systems

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

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

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

Nutritional Disorders

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

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

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

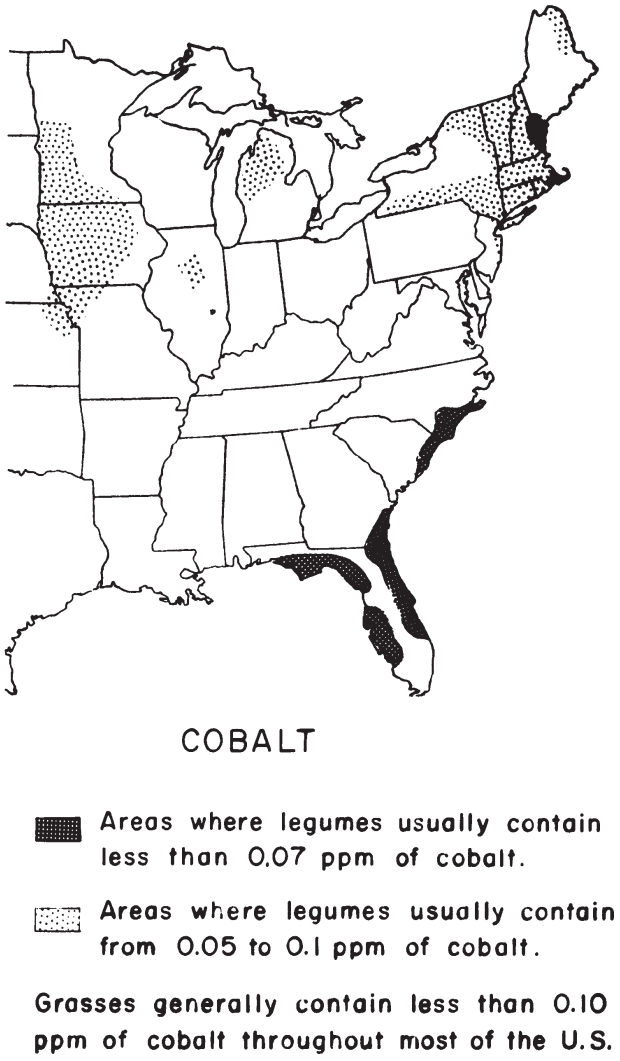
Enterotoxemia is caused by bacteria in the intestine that grow rapidly and produce an endotoxin in response to high levels of starch (grain) in the diet. Animals are in extreme pain from the effect of the endotoxin and often die quickly. Vaccination will help prevent this disease.

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

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

Soil-Related Nutritional Problem Areas for Grazing Animals

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



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

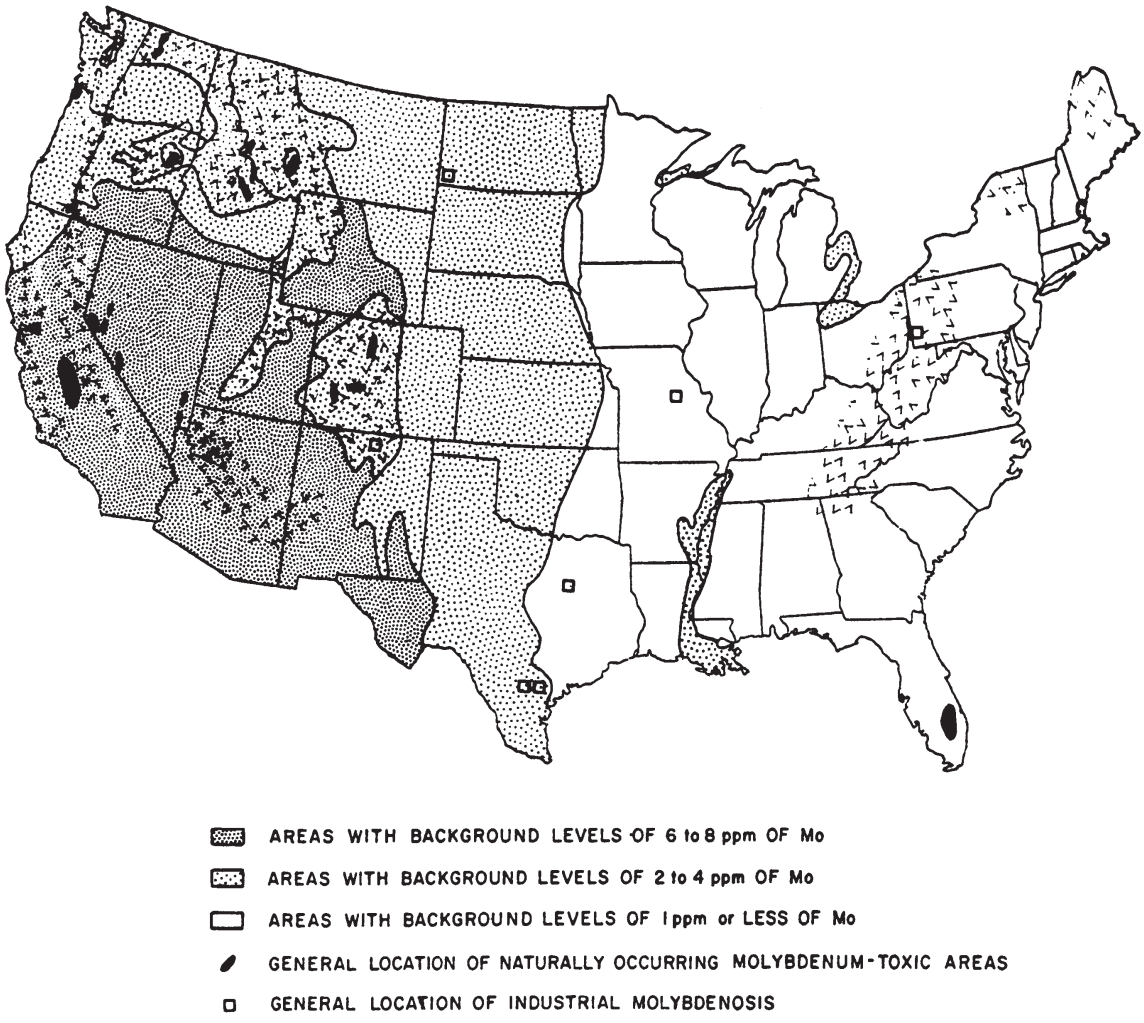


Figure 6. Generalized regional pattern of molybdenum concentration in legumes of the United States (ppm = 1 $\mu g/ g^{-1}$). From Kubota, 1977, by courtesy Marcel Dekker, Inc.

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

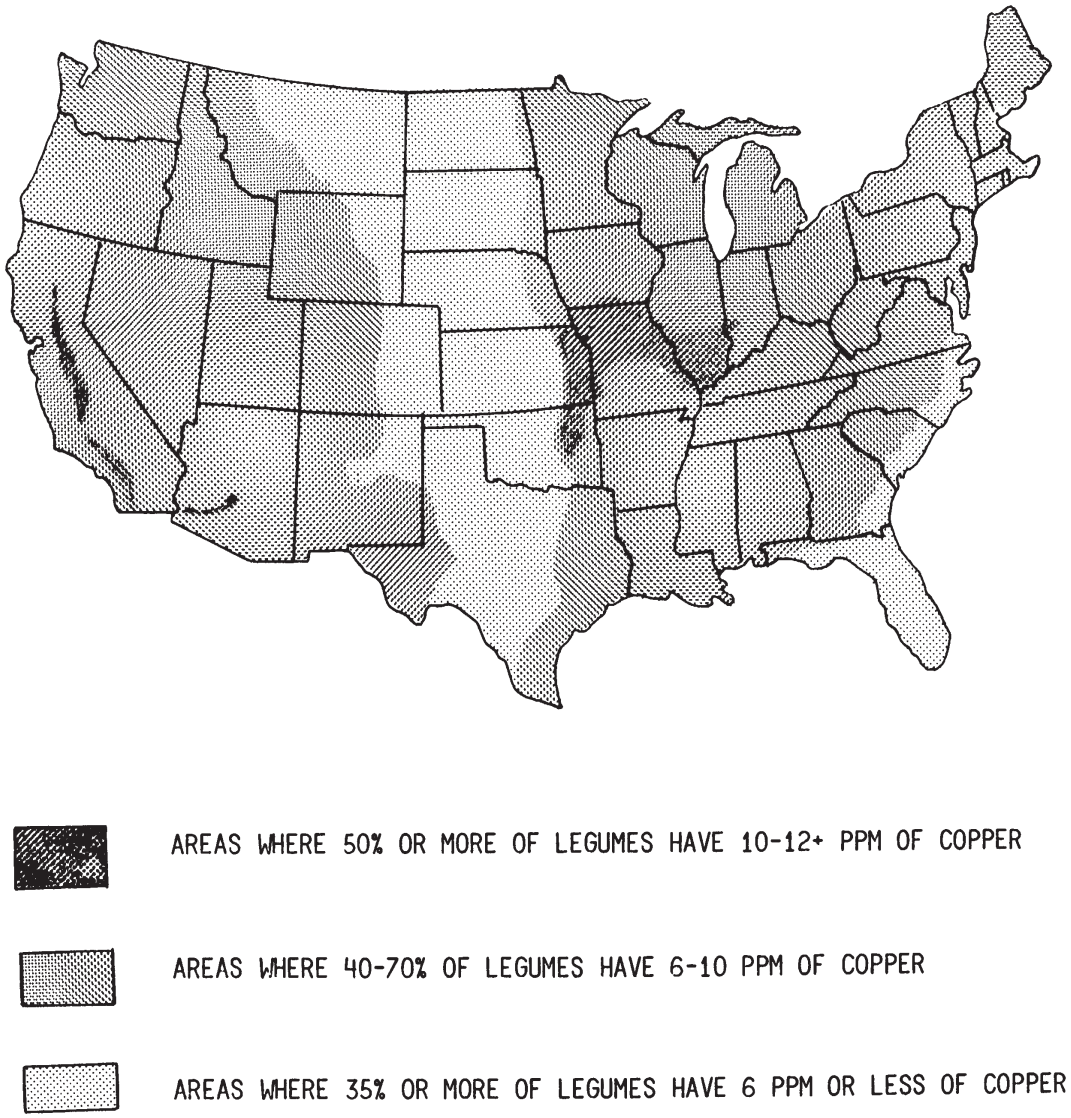


Figure 7. Generalized distribution of copper concentration in legumes of the United States (ppm = 1 $\mu g/ g^{-1}$). From Kubota, 1983a, by permission Amer. Society of Agronomy.

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

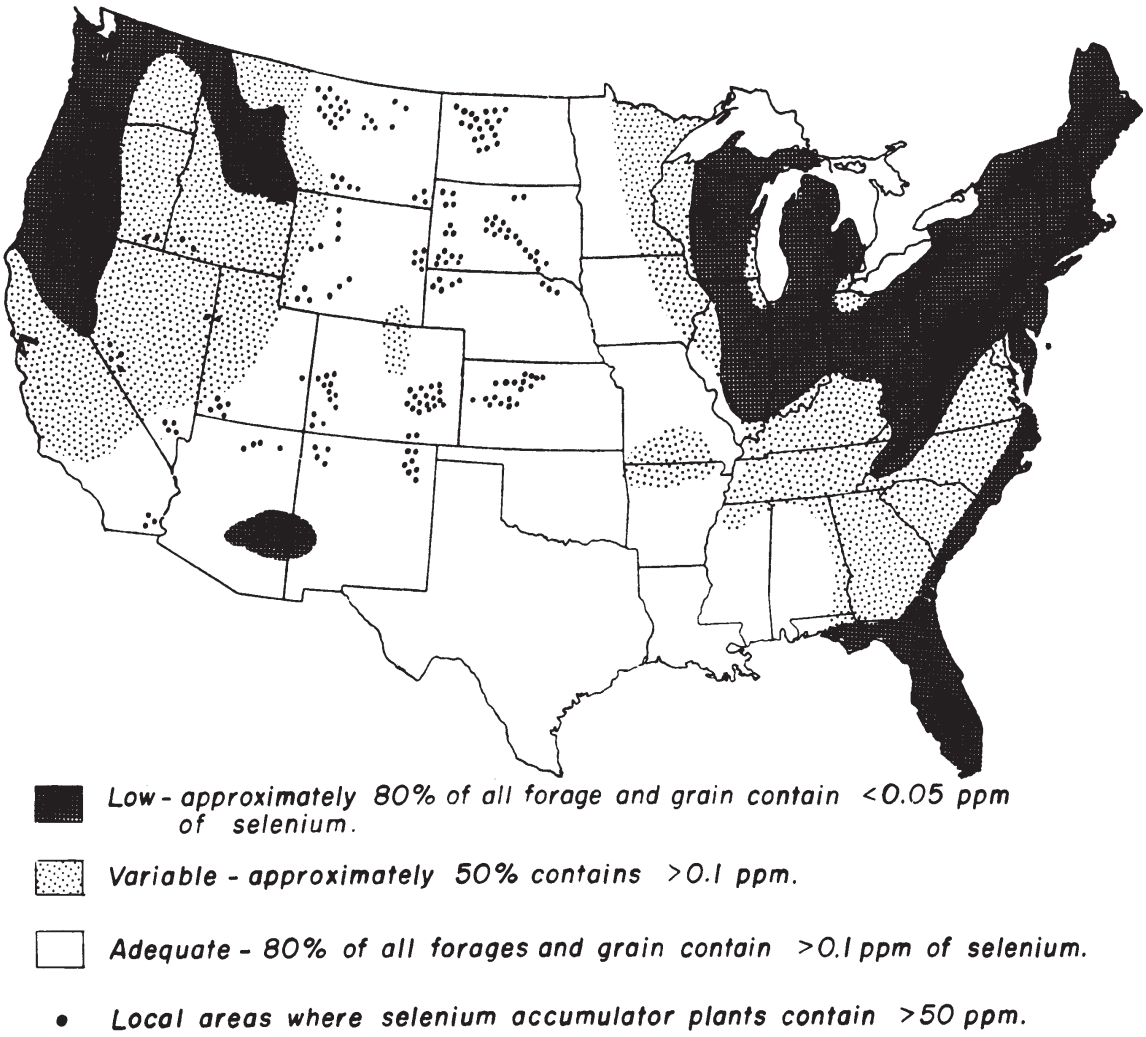


Figure 8. Geographical distribution of low-, variable-, and adequate-Se areas in the United States (ppm = 1 μg/g). From Kubota and Allaway, 1972, by permission Soil Science Society of America.

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

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	Entire Herd Milked 3X
Pickup 1					
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	Milking 2nd	Milking 3rd	Feed Prg or Conc. Fed 2	CAR	Conc. Fed 1	Sample No.	Batch	Barn Name	New Status: Code	New Status: Date Changed Mo	Date Changed Day	New Repro Status: No. Br.	Repro Code	Bred or Heat Date Mo	Bred or Heat Date 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_____ 2017 Langston DHI Supervisor Test
Must return by Mar. 1, 2017 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**
- **USDA/CSREES PROJECTS**
- **EXPERIMENTS**
- **ABSTRACTS**
- **ARTICLE SUMMARIES**
- **VISITING SCHOLARS, GRADUATE STUDENTS, AND INTERNS**
- **INTERNATIONAL OVERVIEW**

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Extension Overview

Dr. Terry A. Gipson
Goat Extension Leader

The year 2016 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 30, 2016 at the Langston University Goat Farm with registration beginning at 8:00 a.m. This year's theme was Keeping Your Goats Healthy and our featured speakers were Dr. Lionel Dawson and Dr. Katie Simpson.

Dr. Dawson received his D.V.M. from Madras Veterinary College and after completing veterinary school, Dr. Dawson moved to Iowa where he did graduate work in Theriogenology at the School of Veterinary Medicine at Iowa State University. Dr. Dawson then did his residency in Theriogenology at the School of Veterinary Medicine at the University of Missouri specializing in reproduction of farm animals. Since 1982, Dr. Dawson has been a faculty member in the Department of Veterinary Medicine and Surgery in the College of Veterinary Medicine of Oklahoma State University. He has taught a number of courses including Reproductive Herd Health, Obstetrics, Theriogenology and Male Breeding Soundness, and has been an advisor to more than 25 graduate students and residents. Dr. Dawson is board certified with the American College of Theriogenologists. In July of 1998, Dr. Dawson received a joint appointment between Oklahoma State University and Langston University. Dr. Dawson's responsibilities at Langston University include participating in research trials, conducting and assisting in experimental surgeries, managing the health program for the fiber, meat and dairy goat herds and provide veterinary extension education for goat producers.

Dr. Simpson did her undergraduate studies (Animal Science) at Texas A&M where she also received her D.V.M. She was selected for an internship at Oklahoma State University in Food Animal Medicine and Surgery, which she completed in 2007. Dr. Simpson then applied for and was accepted for a further three-year residency in Food Animal Medicine and Surgery at Oklahoma State University. She passed the highly competitive Large Animal Internal Medicine boards (DACVIM) in 2010, and also was awarded an MS in biomedical studies. Dr. Simpson then worked at the veterinary school at Oklahoma State University as a Clinical Instructor in Food Animal Medicine and Surgery for three more years and was awarded outstanding 4th year clinical instructor. She then accepted an Assistant Professorship in Food Animal Medicine and Surgery at the Ohio State University. Starting as a veterinary intern, she has actively published and is on many research and clinical papers. She is also on national veterinary committees dealing with resident training in large animal internal medicine. While in Ohio, her Oklahoma clients continued to contact her regarding the lack of a mobile farm animal veterinarian. In 2015, she decided to return to central Oklahoma to open a state-of-the-art large animal ambulatory practice. Dr. Simpson has a strong interest in internal and emergency medicine, surgery, lameness, gastrointestinal disease, urolithiasis, reproductive care and neonatology.

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

- Common Abortions in Goats – diagnosis of causes and proper sample submission with Dr. Lionel Dawson (1:30 p.m. and 3:30 p.m. ONLY).
- Extra-label Drug Use - why it is important and what to know with Dr. Lionel Dawson (2:30 p.m. ONLY).
- CAE and Mastitis - prevention and control of these very important diseases with Dr. Katie Simpson (1:30 p.m. ONLY).
- CL and Urinary Calculi - prevention and control of these very important diseases with Dr. Katie Simpson (2:30 p.m. and 3:30 p.m. ONLY).
- The art of cheesemaking with Ms. Gianaclis Caldwell.
- Internal Parasite Control - sustainable internal parasite control program with Dr. Barry Whitworth.
- Basic Goat Husbandry - hoof trimming, body condition scoring, FAMACHA scoring, farm management calendar, etc. with Mr. Jerry Hayes.
- Nutrition for Health and Production - calculation of energy, protein and feed intake requirements with Dr. Steve Hart.
- Goat Farm Budgeting - basics of budgeting and financial recordkeeping with Mr. Brent Ladd.
- Pack Goats - basic goat training as a pack animal and equipment needs with Mr. Dwite Sharp.
- DHI Training - supervisor/tester training for dairy goat producers including scale certification with Ms. Eva Vasquez.
- USDA/NASS: Animal inventories with Mr. Wil Hundl and USDA/AMS: Market strategies with Mr. Cole Snider (1:30 p.m. and 2:30 p.m. ONLY).
- USDA/NRCS: Conservation programs with Mr. Kenneth Hitch and USDA/FSA: Farm loans with Mr. Phil Estes (1:30 p.m. and 3:30 p.m. ONLY).
- USDA/WS: Wildlife programs with Mr. Kevin Grant and OK Depart of Ag: Home Slaughtering regulations with Mr. Stan Stromberg (2:30 p.m. and 3:30 p.m. ONLY).
- Fitting and Showing for Youth and Adults - tips and pointers on fitting and show ring etiquette with Messrs. Robbie and Coleman Sanders (this was a half-day afternoon workshop).

The Langston University E (Kika) de la Garza American Institute for Goat Research provided 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.

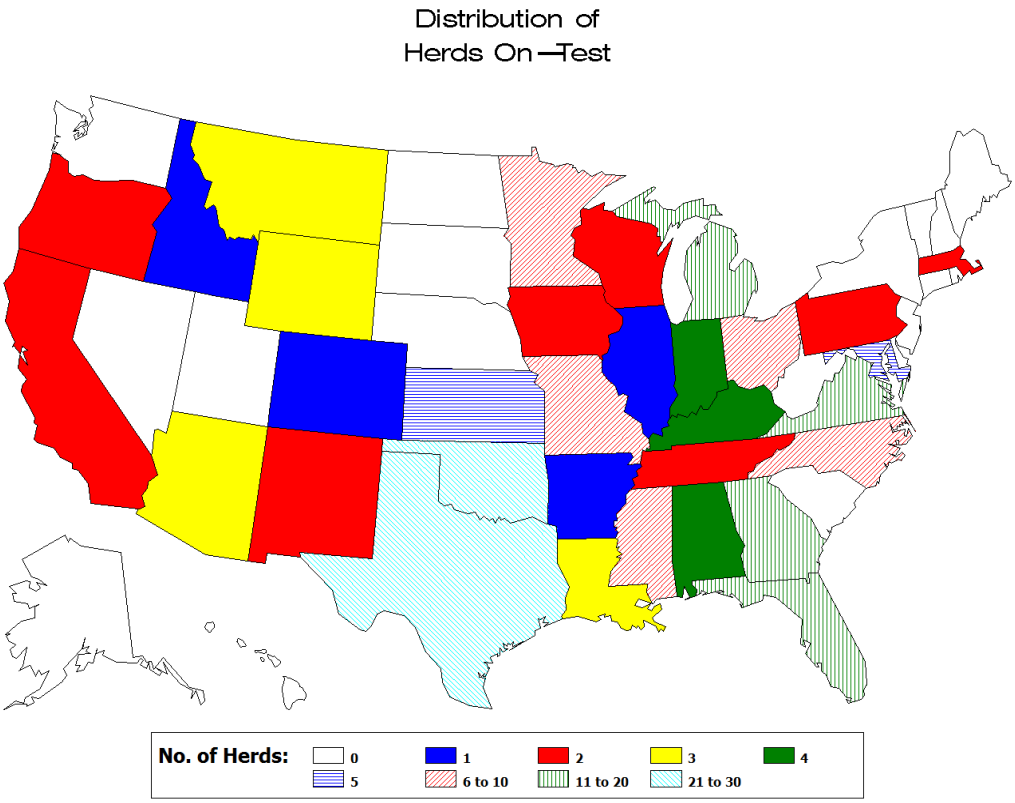
Cheese Manufacturing Workshop

Our ever-popular goat milk cheesemaking workshop was scheduled for Friday, April 29, 2016 (the day before our annual Goat Field Day on April 30). Mrs. Gianaclis Caldwell, Owner/President of Pholia Farm Creamery was our distinguished Invited Instructor for this year's workshop. Ms. Caldwell is an internationally renowned goat cheese entrepreneur, creator, designer, marketer and author in the world of cheese. She has owned a goat farm, designed cheese plants and managed cheese operation in her unique and creative manners. She is also an excellent instructor and speaker with vast personal experiences. She shared with us her rich background, hands-on experience and masterful skills in small-scale cheese manufacture, particularly goat milk cheeses. She demonstrated basic principles and practical skills of making soft, semi-soft and hard cheeses using our own Grade "A" goat milk. Milk quality, cheesemaking facility and marketing strategies were also discussed.

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 are serving a 30 state-area that includes a majority of the eastern states. Currently, we have 102 producer herds in these 30 states enrolled in the Langston Goat Dairy DHI Program. In 2016, the DHI laboratory processed more than 10,000 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 2016. Interest in the newsletter has grown and we currently have over 1,600 subscribers to our free quarterly Goat Newslet-

ter 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 2016, an AI workshops was held in October at the Langston University campus. Seventeen participants were trained.

Dairy Goat Production Handbook

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. Important topics covered in the Dairy Goat Production Handbook include dairy goat quality assurance, doe and kid management, nutrition, herd health management and diseases with a separate chapter on mastitis, parasites of goats, goat milking facilities and systems, goat milk regulations, record keeping and financial management of the dairy goat business, reproduction and genetic improvement, and an overview of lactation and the biology of goat milk production. Other chapters provide an overview of legal issues faced by dairy goat producers, carcass disposal options, marketing considerations, and how to make cheese, goat milk soap, and yogurt. Partial funding to develop the Dairy Goat Production Handbook was from USDA/NIFA grant #2011-38821-30952 (OKLXMERKEL11).

Meat Goat Production Handbook

The first edition Meat Goat Production Handbook has been sold-out and the revised second edition is available. Even though Langston University has taken the lead in this revision project, this handbook is not the product of one person nor of a single university. Our collaborating project institutions/organizations, which include Alcorn State University, American Boer Goat Association, American Meat Goat Association, Florida A&M University, Fort Valley State University, Kentucky State University, Langston University, Prairie View A&M University, Southern University, Tennessee Goat Producers Association, Tennessee State University, Tuskegee University, United States Boer Goat Association, University of Arkansas Pine Bluff, and Virginia State University. Handbook contributing institutions/organizations include Allen Veterinary Clinic, American Boer Goat Association, American Meat Goat Association, BIO-Genics, Ltd., Bountiful

Farm, Cornell University, Fort Valley State University, Kentucky State University, Langston University, Law Office of Wheeler and Mueller, Louisiana State University, Louisiana State University AgCenter, NCAT / ATTRA National Sustainable Agriculture Information Service, North Carolina State University, Oklahoma State University, Texas A & M University, United States Boer Goat Association, and Virginia State University. The Meat Goat Production Handbook was partially funded by USDA/FSIS/OPHS project #FSIS-C-10-2005.

Dairy Goat Production Basics

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. Fourteen of the 29 chapters from the full Dairy Goat Production Handbook were chosen, resulting in 176 pages. Each chapter contains illustrations to help explain concepts. The Dairy Goat Production Basics is targeted for clientele who would like dairy goat information but would not wish to read the full handbook. The basics book would be ideal for youth groups such as 4-H or FFA, students, producers, and others interested in dairy goats. Partial funding to develop the Dairy Goat Production Basics was from USDA/NIFA grant #2011-38821-30952 (OKLXMERKEL11).

Producción de Cabras Lecheras Conceptos Básicos

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).

Meat Goat Production Basics

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. That book is available for purchase from UPRM (http://www.uprm.edu/cms/index.php?a=file&fid=12080).

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)

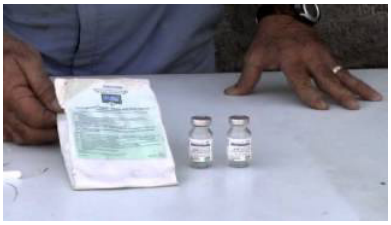
This video explains basic hoof care for goats.

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.

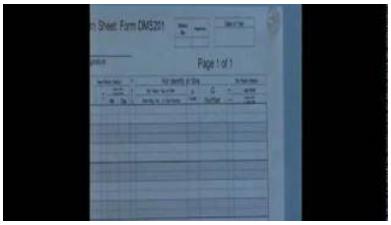


Estrous Synchronization in Goats (length 5:08)

This video explains estrous synchronization for artificial insemination in goats.

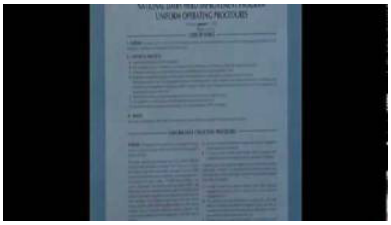
Langston DHI Tester Training - Part 1 (length 9:24)

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). 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 prac-

tical knowledge of the tanning process that will help them when trying tanning skins at home. In 2014, one tanning goatskins workshop was held at Langston University in March.

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 embedded in each page of the web site and Google Analytics module was added to the new Drupal server. Overall in 2016, there were 76,599 visits (down 4.9% from 2015). Visitors spent an average 2 minutes and 47 seconds on the old site and on 2 minutes and 00 seconds on the new site for each visit, which is essentially the same time as 2015. The United States accounted for 70.0% of all visits for the old site but only 57.9% for the new site. Top ten countries are listed in Table 1.

Country	# Sessions on old server	# Pages / Session on old server	Avg. Session Duration on old server	# Sessions on new server	# Pages / Session on new server	Avg. Session Duration on new server
United States	38747	2.68	0:02:56	12303	2.66	0:02:22
India	1331	1.91	0:02:10	696	1.54	0:00:54
Canada	1183	2.21	0:02:36	368	1.97	0:01:05
Philippines	1082	1.58	0:01:44	727	1.59	0:01:32
United Kingdom	876	1.68	0:01:04	454	1.43	0:00:30
Mexico	820	4.78	0:06:37	133	2.57	0:01:26
Australia	635	2.39	0:02:19	235	1.92	0:01:24
Kenya	624	1.62	0:01:06	425	1.33	0:01:10
Malaysia	497	1.82	0:01:54	218	1.46	0:01:16
Nigeria	440	1.82	0:02:08	298	1.41	0:01:43

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.

State	# Sessions on old server	# Pages / Session on old server	Avg. Session Duration on old server	# Sessions on new server	# Pages / Session on new server	Avg. Session Duration on new server
Texas	4817	2.21	0:02:02	1918	2	0:01:25
Oklahoma	2555	4.16	0:03:52	1834	5.3	0:06:23
California	2194	2.04	0:01:53	722	1.66	0:01:06
North Carolina	1887	4.07	0:06:07	386	6.17	0:05:27
Georgia	1459	2.42	0:02:59	332	2.32	0:01:40
Ohio	1414	2.81	0:03:07	276	1.86	0:01:26
Illinois	1377	2.68	0:02:55	357	2.23	0:01:19
Missouri	1352	2.56	0:02:34	381	2.41	0:01:51
Florida	1342	2.49	0:02:47	423	2.01	0:01:20
Tennessee	1155	2.32	0:01:58	285	2.01	0:01:06

Web-based Training for Meat Goat Producers

Meat goat production is one of the fastest growing sectors of the livestock industry in the United States. New producers, as well as some established ones, have an expressed need for current, correct information on how to raise goats and produce safe, wholesome products in demand by the public. As the meat goat industry grows and evolves, a quality assurance program is essential. Such a QA program ensures the production of a wholesome product that satisfies consumers and increases profit for the meat goat industry.

Langston University was awarded funding by the Food Safety and Inspection Service of USDA to develop training and certification for meat goat producers. Langston University organized and led a consortium of 1890 universities and producer associations in this project. The consortium identified the subject topics most pertinent and pressing for the instructional modules. The consortium then identified experts on the selected subject topics and pursued these experts as module authors. These authors represent the most qualified persons in their field in academia as well as in the industry. Langston University translated the sixteen instructional modules into web pages with accompanying images, and pre- and post tests for those producers wishing to pursue certification. All modules are also available in pdf for easy printing and the introductory module is available as a podchapter for downloading and listening on your favorite mp3 player. The web-site (http://www2.luresext.edu/goats/training/qa.html) was unveiled in late 2005.

Even though this web-site (http://www2.luresext.edu/goats/training/qa.html) was only unveiled in 2007, more than 1,500 producers have enrolled for certification and 292 have completed the certification process. These instructional materials will best serve meat goat producers in assisting them to produce a safe, wholesome, healthy product for the American consumer. Funding source for this project was USDA/FSIS/OPHS project #FSIS-C-10-2004 entitled "Development of a Web-based Training and Certification Program for Meat Goat Producers."

State/Country	***Number Certified***
UNITED STATES	
AL	5
AR	11
AZ	2
CA	3
CO	2
CT	1
FL	25
GA	18
IA	5
ID	1
IL	5
IN	8
KS	11
KY	9
LA	3
MA	2
MD	4
MI	9
MN	4
MO	14
MS	3
MT	2
NC	17
NE	4
NH	1
NJ	2
NV	3
NY	7
OH	11
OK	33
OR	7
PA	10
SC	6
SD	2
TN	13
TX	40
UT	2
VA	11
VT	1
WA	5

State/Country	***Number Certified***
WI	5
WV	6
WY	4
CANADA	
AB	2
BC	4
MB	3
NS	1
ON	3
BOTSWANA	1
INDIA	1
MALAYSIA	4
MEXICO	2
PAKISTAN	1
SAUDI ARABIA	1
SOUTH AFRICA	1
SURINAME	1
UK	2
ZIMBABWE	2
Total	***370***

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[1], S. Hart[1], R. Merkel, T. Sahlu,
Institution:	[1]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.

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 2016 and 2017, some of the abstracts to be presented at meetings in 2017, and summaries of scientific articles that were published in 2016, 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

2016 and Current Research Projects

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

Title:	Sustainable Small Ruminant Production Through Selection for Resistance to Internal Parasites
Type:	USDA 1890 Institution Capacity Building - Integrated Extension and Research
Project Number:	OKLXSAHLU12
Period:	2012-2016
Investigators:	T. Sahlu[1], A. L. Goetsch[1], T. A. Gipson[1], S. P. Hart[1], Z. Wang[1], R. Mateescu[2], and E. DeVuyst[2]
Institutions:	[1]Langston University, and [2]Oklahoma State University
Objectives:	1) Determine early progress in selection of small ruminants for resistance to internal parasitism 'on-station' and 'on-farm' 2) Characterize changes performance due to selection; develop and implement a new second generation central sire performance test for small ruminants at Langston University 3) Develop early-life genetic indicators of resistance and assess changes in physiological conditions affected by selection 4) Evaluate economic and management considerations of whole herd/flock selection; disseminate potential benefits of selection and associated economic and management considerations for adoption by small ruminant producers

Title:	Genomics of Resilience in Sheep to Climatic Stressors
Type:	USDA 1890 Institution Capacity Building - Integrated (Research and Education)
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[2], T. Sahlu[1], and P. Oltenacu[2]
Institutions:	[1]Langston University and [2]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 – Integrted (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 Institute
Objectives:	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
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 anthelmintics

2016/2017 Experiments

Title:	Effects of forage quality and breed on rumination time in goats
Project Number:	OKLUTGIPSON2014
Experiment Number:	SL-16-01
Investigators:	S. LeShure, T. A. Gipson, R. Puchala, A. L. Goetsch, and T. Sahlu
Objective:	Model rumination time based on video observation in goats

Title:	Sustainable small ruminant production through selection for resistance to internal parasites – on-farm and on-station selection and use of a small ruminant central performance test in year 4
Experiment Number:	YT-16-02
Project Number:	OKLXSAHLU12
Investigators:	Y. Tsukahara, A. L. Goetsch, T. A. Gipson, S. P. Hart, L. J. Dawson, Z. Wang, R. Puchala, and T. Sahlu
Objective:	Determine early progress in selection of small ruminants for resistance to internal parasitism in the south-central US

Title:	Long-term effects of lespedeza condensed tannings, monensin, soybean oil, and coconut oil on ruminal methane emission, feed intake, feeding behavior, digestion, energy metabolism in Boer goat wethers
Project Number:	OKLXGOETSCH14
Experiment Number:	SL-16-03
Investigators:	S. LeShure, R. Puchala, I. Portugal, M. D. Flythe, G. E. Aiken, and A. L. Goetsch
Objectives:	Determine if there is adaptation in goats to the inhibition of ruminal CH_4 production by naturally occurring condensed tannins in lespedeza forage, the ionophore monensin, coconut oil as a rich source of medium chain fatty acids, and soybean oil high in long-chain polyunsaturated fatty acids when fed for a prolonged period of time and characterize changes in ruminal conditions responsible

Title:	Evaluation of resilience of hair sheep breeds from different regions of the USA to high heat load – trial 2 and animal set 4
Project Number:	OKLXGOETSCH2013
Experiment Number:	DT-16-04
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:	Evaluation of resilience of hair sheep breeds from different regions of the USA to restricted availability of drinking water - trial 2 and animal set 1
Project Number:	OKLXGOETSCH2013
Experiment Number:	AH-16-05
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:	Effects of forage quality and breed on rumination time in goats
Project Number:	OKLUTGIPSON2014
Experiment Number:	SL-16-07
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:	Effects of level of intake of a 50% concentrate pelleted diet on metabolizability and energy utilization by Katahdin wethers
Project Number:	OKLXGOETSCH2013
Experiment Number:	DT-16-08
Investigators:	D. Tadesse, R. Puchala, I. Portugal, A. Hussein, and A. L. Goetsch
Objectives:	Determine effects of level of intake (near the energy requirement for maintenance and 55% of this level) of a 50% concentrate pelleted diet on metabolizability and energy utilization by Katahdin wethers

Title:	Sustainable small ruminant production through selection for resistance to internal parasites – detection of anthelmintic resistance through in vivo fecal egg count reduction test and in vitro egg hatch test
Experiment Numbers:	YT-16-10
Project Number:	OKLXSAHLU12
Investigators:	Y. Tsukahara, A. L. Goetsch, T. A. Gipson, S. P. Hart, L. J. Dawson, Z. Wang, R. Puchala, and T. Sahlu
Objective:	Evaluate resistance of internal parasites to three types of broad-spectrum anthelmentics on herds and flocks used in the project via fecal egg reduction test and in vitro egg hatch test

Title:	Evaluation of resilience of hair sheep breeds from different regions of the USA to high heat load – trial 3 and animal set 3
Project Number:	OKLXGOETSCH2013
Experiment Number:	DT-16-11
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 lespedeza condensed tannins, monensin, soybean oil, and coconut oil alone and in combinations on ruminal methane emission, feed intake, feeding behavior, energy metabolism, and growth performance by growing Alpine doelings
Project Number:	OKLXGOETSCH14
Experiment Number:	HL-16-12
Investigators:	H. Liu, R. Puchala, S. LeShure, I. Portugal, T. A. Gipson, T. and A. L. Goetsch
Objectives:	1) Determine if combinations of condensed tannins of Sericea lespedeza, an ionophore (i.e., monensin), soybean oil (high in long-chain polyunsaturated fatty acids), and coconut oil (high in medium-chain polyunsaturated fatty acids) have greater effect of ruminal methane emission by growing Alpine doelings than singular supplementation 2) Determine effects of the diets on feed intake, feeding behavior, digestion, energy metabolism, and growth performance

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

Abstracts

2017 National Meetings of the American Society of Animal Science in Baltimore, Maryland
(The American Society of Animal Science has copyright ownership and the Journal of Animal Science is the source of this information.)

Effects of Restricted Periods of Diet Access on Feed Intake, Digestion, and Performance of Alpine Goats in Early Lactation

N. C. D. Silva,[1,2] R. Puchala,[1] T. A. Gipson,[1] T. Sahlu,[1] and A. L. Goetsch[1]

[1]American Institute for Goats Research, Langston University, Langston, Oklahoma
[2]Universidade Estadual Paulista Julio de Mesquita Filho, Jaboticabal, Brazil

Restricting periods of diet access to lactating dairy goats could influence level or efficiency of production and offer different management options. Therefore, 40 Alpine goats (12 and 28 of parity 1 and ≥ 2, respectively) with initial BW of 58.0 kg (SEM = 1.50) and 14.2 days in milk (SEM = 0.72) were offered a 40% forage diet (16.6% CP and 37.5% NDF; 20% alfalfa pellets, 10% cottonseed hulls, 10% coarsely ground grass hay, 12.9% wheat middlings, 12.9% rolled oats, 12.9% rolled corn, 11.0% soybean meal, 3.0% soybean oil, 5.0% molasses, and 2.3% other ingredients) free-choice in Calan gate feeders for 12 wk. Feed access was continuous other than during morning and afternoon milking (Control), during the day for 8 h (Day) or night for 16 h (Night), or for 1 or 2 h after morning and afternoon milking (2Hour and 4Hour, respectively). Digestibilities were not influenced by treatment (e.g., OM: 73.1, 76.9, 77.1, 76.3, and 77.3%; SEM = 1.81), DMI was greater (P < 0.05) for Control than for most treatments (2.07, 2.23, 2.70, 2.33, and 2.01 kg/d; SEM = 0.157), and ADG was greater (P = 0.019) for Control than for the mean of restricted feeder access treatments (39, 11, 73, 24, and 21 g for 2Hour, 4Hour, Control, Day, and Night, respectively; SEM = 17.7). Milk yield was similar among treatments (2.60, 3.24, 3.05, 3.07, and 2.58 kg/d; SEM = 0.375), fat concentration tended (P = 0.089) to be lower for Control than for other treatments (3.88, 4.21, 3.41, 3.70, and 3.49%; SEM = 0.208), and milk energy yield was not affected by treatment (7.36, 9.53, 8.20, 8.56, and 6.91 MJ/d for 2Hour, 4Hour, Control, Day, and Night, respectively; SEM = 1.071). Intake of ME (22.69, 25.92, 31.25, 26.69, and 23.46 MJ/d; SEM = 2.184) and heat energy (13.34, 14.09, 17.51, 15.54, and 15.25 MJ/d; SEM = 0.921) were greater (P ≤ 0.011) for Control than for other treatments, resulting in milk energy that was 31.9, 37.6, 26.0, 31.4, and 30.0% of ME intake for 2Hour, 4Hour, Control, Day, and Night, respectively (SEM = 3.08). In conclusion, continuous diet access may affect partitioning of nutrients between milk synthesis and tissue accretion differently than some restricted feeder access treatments, particularly 4Hour.

Lying and Standing Behavior of a Small Herd of Goats in a Woodland Pasture

T. A. Gipson,[1] and C. Clifford-Rathert[2]

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[2]Department of Agriculture and Environmental Sciences, Lincoln University, Jefferson City, Missouri

Lying and standing behavior is an excellent indicator of animal well-being. The objective of this study was to evaluate breed and temporal effects on lying (L) and standing (S) behavior in a small herd of goats. Nineteen goats (4 Boer, 5 Kiko, 5 Savannah, and 5 Spanish) were fitted with Icetags, which are 3-axis accelerometers that record percentage lying, standing, and active behavior every minute, and were released into one of three 0.5-ha wooded paddocks. Goats were assigned to the same paddocks each year. Icetags were deployed for 7 d during the late spring for three consecutive years (maximum=29°C, minimum=16°C for yr 1; maximum=24°C, minimum=13°C for yr 2; maximum=26°C, minimum=14°C for yr 3). Overall, average percentages were 56% lying, 34% standing, and 10% active per minute. Individual 1-min intervals (483,840 observations) were aggregated into hours (8,064 observations). Hours between 0600 and 2000 were coded as day and all other hours were coded as night. Mixed model methodology was used to evaluate the effects of breed (Boer, Kiko, Savannah, Spanish), year (1, 2, and 3), day (2 to 8), daytime (day or night), and all two-way interactions, with animal and paddock as random effects on behavior. For lying, standing, or active, all two-way interactions, except breed×day and except breed×daytime for active were highly significant (P<0.01). For lying, Spanish during night had the greater min/h (P<0.05) from Spanish during day, Kiko during day, Savannah during night, and Savannah during day (39.5 vs. 33.5, 29.3, 28.8, and 27.6 min/h, respectively;

SEM=3.65). Kiko during night, Boer during night, Boer during day were intermediate and not different (P>0.10) than the other breed×daytime means (35.9, 34.8, and 33.7 min/h, respectively). Conversely for standing, Savannah during night had greater min/h (P<0.05) from Spanish during night (25.9 vs. 15.6 min/h; SEM=2.99). Savannah during day, Kiko during day, Boer during night, Boer during day, Spanish during day, and Kiko during night were intermediate and not different (P>0.10) than the other breed×daytime means (24.4, 23.1, 21.4, 20.4, 19.7, and 19.5 min/h, respectively). Goats were more active (P<0.01) during the day than at night (7.1 vs. 4.4 min/h; SEM=0.55). These results indicate that breed and time of day may affect the lying and standing behavior in goats and these differences in behavior should be taken into account when ascertaining wellbeing criteria.

Effects of High Heat Load Conditions on Body Weight, Dry Matter Intake, and Blood Constituent Levels of Dorper, Katahdin, and St. Croix Sheep from Different Regions of the USA

D. Tadesse,[1] R. Puchala,[1] T. A. Gipson,[1] I. Portugal,[1] T. Sahlu,[1] L. J. Dawson,[1,2] and A. L. Goetsch[1]

[1]American Institute for Goats Research, Langston University, Langston, Oklahoma
[2]Center for Veterinary Health Sciences, Oklahoma State University, Stillwater, Oklahoma

Thirty-seven Dorper, 35 Katahdin, and 31 St. Croix ewes (57, 58, and 44 kg; SEM = 2.2) from 45 commercial farms in the Midwest (MW), Northwest (NW), Southeast (SE), and central Texas (TX), between 2.2 and 3.4 yr of age, were used to evaluate responses to high heat load index (HLI) conditions. There were four sequential 2-wk periods with target HLI during day/nighttime of 70/70, 85/70, 90/77, and 95/81. A 15% CP and 50% concentrate pelleted diet was fed at 120% of the ME requirement for maintenance, and water was offered free-choice. Body weight was measured three times each week, and blood was sampled at 1300 h on the last day of each period. There was an interaction (P < 0.001) between period and week within period in BW, with slightly greater values in wk 2 vs. 1 of periods 3 and 4 and a greater difference between period 1 and 4 values in wk 2 than 1 (53.1, 54.1, 54.9, and 55.4 kg in wk 1, and 53.0, 54.2, 55.4, and 56.1 kg in wk 2 in periods 1, 2, 3, and 4, respectively; SEM = 0.85). There was an interaction (P = 0.037) in DMI (g/kg $BW^{0.75}$) among region, period, and week, with values generally similar between weeks in periods 1 and 2 relative to those in periods 3 and 4 (51.0, 52.4, 51.0, and 51.2 in period 3 and wk 1, 49.5, 52.1, 50.8, and 51.6 in period 3 and wk 2, 49.6, 52.1, 50.6, and 49.4 in period 4 and wk 1, and 48.9, 52.0, 49.7, and 46.3 in period 4 and wk 2 for MW, NW, SE, and TX, respectively; SEM = 1.09). Neither blood glucose nor lactate concentration was affected by breed (P > 0.05), but there were breed differences (P < 0.02) in serum concentrations of creatinine (0.91, 0.81, and 0.77 mg/dL; SEM = 0.023), total protein (6.13, 6.42, and 6.81 g/dL; SEM = 0.156), and urea N (17.4, 18.0, and 20.0 mg/dL for Dorper, Katahdin, and St. Croix, respectively; SEM = 0.54). In conclusion, some blood constituent levels suggest breed differences in resilience to high HLI. Differences among periods and weeks in BW presumably relate to increased water consumption with high HLI. The interaction in DMI may reflect differences among regions in rate of adaptation to high HLI and the contribution of decreased feed intake to coping with high HLI.

Effects of Level of Intake of a 50% Concentrate Pelleted Diet on Digestion and Energy Utilization by Katahdin Wethers

D. Tadesse, R. Puchala, I. Portugal, A. Hussein, and A. L. Goetsch

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Nine mature Katahdin (KAT) wethers (70 ± 1.5 kg initial BW) were used in a crossover experiment to evaluate effects on digestion and energy utilization of levels of feed intake being employed in studies addressing the maintenance energy requirement with limited nutrient intake. A 50% concentrate pelleted diet composed of 20.0% ground alfalfa, 29.1% cottonseed hulls, 9.0% cottonseed meal, 20.0% ground corn, 13.0% wheat middlings, 5.0% pelleting agent, and 3.9% other ingredients was fed near the ME requirement for maintenance (Control; DMI = 44.4 g/kg $BW^{0.75}$) and at 55% of this level (Restricted; DMI = 24.4 g/kg $BW^{0.75}$). Periods were 4 wk in length, with 3 wk for adaptation, measures in the final week when situated in metabolism cages, and 2 d for gas exchange measurement via a head-box respiration calorimetry system. Apparent total tract digestibilities of DM (65.8 and 73.9%; SEM = 1.92), OM (76.3 and 81.7%; SEM = 1.48), CP (72.1 and 78.5%; SEM = 1.70), NDF (32.3 and 49.0%; SEM = 3.34), and gross energy (64.7 and 73.0%; SEM = 1.97) were greater (P < 0.05) for Restricted than for Control intake. Expressed in MJ/d, quantities of energy in urine (0.94 and 0.72; SEM = 0.320) and ruminally emitted methane (1.02

and 0.76; SEM = 0.085) were greater for Control vs. Restricted intake ($P < 0.05$), but as a percentage of DE they tended to be greater for Restricted intake (urine: 8.1 and 10.8%, SEM = 3.52, and $P = 0.056$; methane: 9.0 and 11.1% for Control and Restricted intake, respectively, SEM = 0.75, and $P = 0.096$). As a consequence, ME intake as a percentage of gross energy intake did not differ ($P = 0.301$) between treatments (53.5 and 57.3% for Control and Restricted intake, respectively; SEM = 2.88). The difference in heat energy (447 and 379; SEM = 15.1) was less than that in ME intake (395 and 225 kJ/kg $BW^{0.75}$ for Control and Restricted intake, respectively; SEM = 21.4). In conclusion, restricted feed intake had marked influence on digestibility, although effect on metabolizability was tempered by changes in urinary and methane energy, the former presumably impacted by lean tissue mobilization. Based on the magnitude of difference between ME intake and heat energy with restricted intake, lower heat energy and less tissue mobilization would be expected with longer periods.

Effects of High Heat Load Conditions on Rectal Temperature, Panting Score, and Respiration Rate of Hair Sheep Breed from Different Regions of the USA

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Thirty-seven Dorper (DOR), 35 Katahdin (KAT), and 31 St. Croix (STC) ewes (57, 58, and 44 kg; SEM=2.2) from 45 commercial farms in the Midwest (MW), Northwest (NW), Southeast (SE), and central Texas (TX), between 2.2 and 3.4 yr of age, were used to evaluate responses to high heat load index (HLI) conditions. There were four sequential 2-wk periods (8 wk total) with target HLI during day/nighttime of 70/70, 85/70, 90/77, and 95/81, with weekly measures at 0700 (before increased daytime HLI), 1300, and 1700h (preceding lower nighttime HLI). Rectal temperature (RT; ºC) was affected (P=0.003) by breed×time (38.58, 38.92, and 39.07 for DOR, 38.67, 38.92, and 39.05 for KAT, and 38.45, 38.69, and 38.85 for STC at 0700, 1300, and 1700h, respectively; SEM=0.034). There were interactions between week and time (P<0.001) in respiration rate (RR; breaths/min; 52, 72, 66, and 85 at 0700h, 120, 130, 151, and 144 at 1300h, and 116, 123, 141, and 142 at 1700h; SEM=3.1) and panting score (0-4; 0.05, 0.03, 0.11, and 0.28 at 0700h, 0.48, 0.86, 1.61, and 1.47 at 1300h, and 0.76, 0.91, 1.54, and 1.51 at 1700h in wk 5, 6, 7, and 8, respectively; SEM=0.042). Breed×time RR (P=0.008) means were 57, 107, and 103 for DOR, 55, 101, and 96 for KAT, and 47, 88, and 90 for STC at 0700, 1300, and 1700h, respectively (SEM=3.1); however, there was an interaction (P=0.007) among breed, region, and time (MW DOR 57, 110, and 101, KAT 59, 110, and 108, and STC 43, 89, and 88; NW DOR 65, 113, and 111, KAT 54, 104, and 96, and STC 56, 92, and 94; SE DOR 49, 93, and 96, KAT 52, 105, and 96, and STC 45, 79, and 87; TX DOR 57, 110, and 104, KAT 54, 83, and 84, and STC 46, 91, and 89 at 0700, 1300, and 1700h, respectively; SEM=6.1). In conclusion, RT of STC was low at all times compared with DOR and KAT even with lower RR. There appeared to be considerable adaptation from wk 1 to 2 during the two highest HLI periods via evening respiration. Region effects varied with breed, such as relatively high RR by STC from the NW to maintain low RT, lower RR of DOR from the SE than other regions, and a smaller difference among times in RR of KAT from TX.

Effects of Selecting Growing Male Hair Sheep of Different Flocks for Internal Parasite Resistance on Performance

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Katahdin, Dorper, and St. Croix male lambs from farms (2 Katahdin, farms A and B; 1 Dorper and 1 St. Croix) in the south-central US were categorized as resistant (R), moderately resistant (M), and susceptible (S) to Haemonchus contortus based on artificial larvae challenge in a central performance test at Langston University over 3 consecutive years. Animal groups consisted of 17, 15, and 15 Katahdin-A (initial age 3.9 mo and 38.8 kg); 18, 7, and 8 Katahdin-B (3.7 mo, 18.9 kg); 20, 15, and 16 Dorper (5.5 mo, 34.2 kg); and 13, 14, and 19 St. Croix (4.2 mo, 19.2 kg) in yr 1, 2, and 3, respectively. Males were randomly selected in yr 1, whereas progeny of R and M sires were evaluated in yr 2 and 3. The test entailed 2 wk of adjustment and 8 wk of data collection, with free access to a 15% CP and 50% concentrate diet in automated feeders. During adaptation, anthelmintic treatment resulted in low fecal egg count (FEC; <600 eggs/g), after which 10,000 infective larvae were adminis-

tered orally. Body weight and packed cell volume (PCV) were measured weekly, and FEC was determined 4 to 5 times in wk 6-8. The cubic clustering criterion of SAS® was used for resistance categorization, which resulted in 49, 35, and 37 R; 38, 33, and 39 M; and 28, 17 and 36 S in yr 1, 2, and 3, respectively. The statistical model included animal group, resistance classification, year, interactions, and covariates; GENMOD of SAS® was used for mean FEC. There were interactions ($P<0.05$) in mean FEC between animal group and resistance classification (R: 473, 928, 1089, and 297; M: 1793, 3058, 2199, and 1084; S: 4198, 5073, 3164, and 2176 eggs/g; SEM=144.7) and between animal group and year (yr 1: 1573, 2261, 3196, and 1388; yr 2: 2417, 4793, 1932, and 1006; yr 3: 2475, 2005, 1325, and 1163 eggs/g for Katahdin-A, Katahdin-B, Dorper, and St. Croix, respectively; SEM=146.0). The PCV ranked ($P<0.01$) R>M>S (29.9, 28.0, and 26.9%; SEM=0.25). Intake of DM, ADG, and ADG:DMI were similar among resistance classifications ($P>0.05$) and were not correlated with FEC or PCV ($P>0.05$). In conclusion, hair sheep can be selected for resistance to internal parasites without adversely affecting growth performance, and selection progress appeared greatest for the Dorper flock though FEC were relatively low for the St. Croix farm.

Comparison of Methods of Evaluating Udder Health in Lactating Alpine Does

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Udder infection in dairy goats can affect milk yield, composition, and result in economic losses. Early detection of mastitis while still in the subclinical stage assists in designing appropriate treatment. Milk from Alpine does was screened approximately 1 wk prior to the trial to identify animals having high (> 1.5 million cells/mL) and low somatic cell counts (SCC). Twelve Alpine does in their third parity (4 yr of age) were selected. Milk from each udder half of each doe was sampled for 4 consecutive mornings for the following determinations of normal vs. abnormal milk. Test methods included SCC using a Bentley Instruments SomaCount DairySpec Milk Component and Somatic Cell Detection machine (BSC) with SCC ≤ 1.5 million determined as normal; California Mastitis Test (CMT) score with score below 2 as normal; SCC using DeLaval cell counter (DCC) with a score ≤ 1.5 million determined as normal; electrical conductivity using the Mas-D-Tec® (MDT) with a conductivity score < 5 determined as normal; estimation of SCC using PortaSCC® (PSC) for Goats with score < 2 determined as normal; and lactate dehydrogenase levels using UdderCheck™ (LUC) that estimates level of lactate dehydrogenase using color strips (developed for dairy cattle) with a score < 3 determined as normal. Doe temperature was taken rectally and at 2 to 3 different places on the udder using an infrared thermometer. Because normal/abnormal milk is a binary response variable, a categorical analysis was conducted using a mixed model with fixed effects of method (BSC, CMT, DCC, MDT, PSC, or LUC), day (1, 2, 3, or 4), and side (left or right). Animal was the random effect and temperatures (rectal and average of udder) and days in milk (DIM) were used as covariates. Rectal temperature ($P=0.28$), average udder temperature ($P=0.98$), and side of udder ($P=0.30$) did not affect the determination of normal/abnormal milk; however, as DIM increased ($P<0.01$) so did the incidence of abnormal milk. If BCS is considered to be the benchmark for test method comparison, then only the PSC ($P=0.35$) gave comparable results; however, PSC tended to overestimate the frequency of abnormal milk samples. When analyzed within method, day of sampling did not affect determination for BSC ($P=0.25$), CMT ($P=0.17$), LUC ($P=0.36$), or PSC ($P=0.13$); however, the determination of normal/abnormal milk was affected by day for DCC ($P<0.02$) and MDT ($P<0.01$). In conclusion, PSC appears to be a reliable substitute for the expensive BSC system.

Comparison of High Resolution Aerial Photography to Manual Field Collection in Assessing the Control of Red Cedar Using Goats

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In a research study using goats to control red cedar (Juniperus virgiana), it was necessary to catalog trees in the study area by GPS coordinates and basal diameter in order to monitor their control by goats. The purpose of this study was to compare the accuracy of high resolution aerial photography to manual field GPS collection. A X8-M multicopter drone with a 12-megapixel Canon® camera was used to take high-resolution aerial pictures (2 cm/pixel). The images were taken in the winter when red cedar is usually the only green plant in the field. An onboard GPS unit facilitated assembly of individual pictures into an orthomosaic using Pix4Dmapper® software. The orthomosaic and the manual field GPS data were brought into ArcMap® as layers and tree diameter was calculated as shapefiles on the orthomosaic layer of the selected tree GPS data points. For field measurements, a Trimble® GEO 7X was used to determine tree GPS coordinates and the radius was measured and doubled for diameter. The difference (DIFF) between the diameter measured by the GPS field data and that diameter calculated based on the orthomosaic, the distance (DIST) between the GPS coordinate in the field and the centroid of the shapefile, and the compass point position (BEAR) of the shapefile centroid relative to the GPS point were calculated. Regression analysis was used to determine linear relationships between DIFF, DIST, and BEAR using R (R Core Team, 2013). There was no significant relationship between DIFF and DIST or between DIFF and BEAR ($P > 0.10$). Therefore, no discernible bias exists between the two methods. The diameter measured by aerial photography showed a positive correlation ($R2 = 0.59$; $P < 0.05$) with the diameter calculated from the manual field GPS collection. However, since some dispersion of the shapefiles on the orthomosaic was observed, aerial photography, at this time, cannot replace the manual field collection of the data.

Effect of Water Restriction on Hair Sheep Breeds from Different Regions of the United States

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Twenty-four Dorper (DOR; initial BW = 60 ± 2.8 kg), 23 Katahdin (KAT; BW = 63 ± 2.6 kg), and 21 St. Croix (STC; BW = 40 ± 2.7 kg) female sheep (0.9-8.9 yr) from 45 commercial farms in the Midwest, Northwest, Southeast, and central Texas were used to evaluate resilience to water restriction. Animals were housed individually and fed a 15% CP, 50% concentrate pelleted diet at 160% of the 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 at 0700 h and blood was sampled at 0800 and 1400 h on the last 2 d of each week. Data presented are means of values within periods, with breed and region means separated by least significant difference and linear and quadratic contrasts addressing period effects. There were no effects of or interactions involving region for the variables analyzed. During the baseline period, water intake was 3.59, 3.79, and 3.00 kg/d for DOR, KAT, and STC, respectively (SEM = 0.140) and DMI averaged 58.6 ± 0.98 g/kg $BW^{0.75}$. There were linear decreases ($P < 0.01$) in DMI from period 1 to 3 of similar magnitude for DOR and KAT (134 and 153 g/d, respectively), whereas there was no change for STC ($P = 0.52$; 27 g/d; pooled SEM = 41.5). Plasma osmolality (mOsmol/kg) was 301, 307, and 303 for DOR, 302, 307, and 305 for KAT, and 306, 308, and 307 for STC in periods 1, 2, and 3, respectively (SEM = 1.4), with a quadratic effect of advancing period for DOR ($P < 0.01$) and linear and quadratic effects ($P < 0.05$) for KAT. There were no effects on packed cell volume ($P > 0.05$). Serum protein concentration changed quadratically ($P < 0.001$) as period advanced for each breed (7.1, 6.0, and 7.2 g/dL in periods 1, 2, and 3, respectively; SEM = 0.11). In conclusion, there were no indications of influences of region on resilience to water restriction based on period means, and the lack of change in DMI by STC with limited water availability suggests relatively high resilience for this breed.

Summaries of Recent Journal Articles
(2016 and 2017)

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 (DMIm) 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 DMIm. Restricted DMIm was average DMI in wk 8 when no individual wether intercept of regressing BW against day differed from 0. Maintenance DMIm 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 DMIm (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 DMIm 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 DMIm 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

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Small Ruminant Research. Accepted. 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 MEm 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 BW0.75) 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.

Factors influencing estimates of heat energy associated with activity by grazing meat goats

M. -E. Brassard, R. Puchala, T. A. Gipson, T. Sahlu, and A. L. Goetsch

Livestock Science 193:103-109. 2016.

Ten yearling Boer goat wethers (45.4 ± 0.92 kg) grazed a 0.8-ha grass pasture or were individually confined in a crossover experiment with 3-wk periods to evaluate factors influencing heat energy (HE) associated with activity (AEC) when grazing and to evaluate different methods of estimating the AEC. Fresh forage offered to confined wethers was 15.9 and 13.4% CP and 65.0 and 67.4% NDF in periods 1 and 2, respectively. Based on forage and fecal acid detergent insoluble ash, digestibility of gross energy in forage by confined wethers averaged 67.9 and 56.5% in periods 1 and 2, respectively. From these values and fecal DM, least squares means of ME intake were 405 and 484 kJ/kg $BW^{0.75}$ for confined and grazing wethers, respectively (SE = 15.4). HE determined from heart rate (HR) measured over 1 day and the ratio of HE to HR estimated earlier was less ($P < 0.001$) for confined than for grazing wethers (482 and 642 kJ/kg $BW^{0.75}$; SE = 17.2). The AEC estimated by subtraction from HE of ME required for maintenance (MEm; 427 kJ/kg $BW^{0.75}$), HE expended for tissue energy gain based on recovered energy (RE) when greater than 0, an efficiency of ME use for gain (i.e., [0.0423 × forage ME in MJ/kg DM] + 0.006; 0.40 ± 0.009), and the same efficiency of use for maintenance (km; [0.019 × forage ME in MJ/kg DM] + 0.503; 0.68 ± 0.004) of energy from forage and mobilized tissue with RE less than 0 was 39 and 213 kJ/kg $BW^{0.75}$ for confined and grazing wethers, respectively (SE = 21.9; Partitioning approach). The AEC determined as the difference between HE by grazing and confined wethers was 165 ± 19.3 kJ/kg $BW^{0.75}$ (Confinement approach), and that based on time spent in different activities (i.e., lying, standing, grazing, and walking) multiplied by corresponding HE and assuming that AEC resulted from HE when standing, grazing, and walking was 46 ± 4.85 kJ/kg $BW^{0.75}$ (Lying approach). In conclusion, method of estimation can have marked impact on the AEC, with a relatively low value for the Lying method because of lower HE while lying when confined than on pasture. Determining the AEC by the Confinement approach relies on similar conditions to minimize confounding, and the Partitioning method is influenced by specific assumptions of energy requirements and efficiencies of use for different physiological functions.

Current areas of research of feeding practices for lactating goats

A. L. Goetsch

Professional Animal Scientist 32:725-735. 2016.

Dietary concentrate level, forage quality, and production system can have great impact on tissue loss and gain by lactating goats in addition to milk yield and composition. Opportunities for enhanced performance with high concentrate levels are greater in early than late lactation with high milk production potential, although there might be an advantage in efficiency of energy use in late lactation when tissue is often replenished. Effects of byproduct and alternative feedstuffs on conditions such as ruminal methane emission, milk fat content and fatty acid (FA) composition, and antioxidant status depend on major and minor constituents and what they are substituted for. Research of minor dietary ingredients such as probiotics and plant secondary metabolites is likely to increase with decreased use of synthetic antimicrobials, although specific components responsible for effects are sometimes unclear. In addition to the FA profile of feedstuffs, conditions including dietary concentrate level, supplemental FA sources, and levels of plant secondary metabolites can influence bioactive ruminal biohydrogenation intermediates that decrease de novo FA synthesis in the mammary gland. Supplementation with sources of conjugated linoleic acid has been studied, but use is not common probably because of less change in milk fat content and FA composition compared with cattle, different considerations regarding tissue mobilization in early lactation with appropriate feeding management practices, and limited or no benefit from low-fat milk. However, inclusion of moderate dietary levels of oils and other fat sources for purposes such as increased energy density, improved palatability, and decreased dustiness is widespread.

Comparison of different levels and lengths of restricted drinking water availability and measurement times with Katahdin sheep and Boer and Spanish goat wethers

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

Small Ruminant Research 144:320-333. 2016.

Thirty-six yearling Boer goat (BOE), Katahdin sheep (KAT), and Spanish goat wethers (SPA) were used to study conditions for evaluating resilience to restricted drinking water availability. Moderate quality grass hay was consumed ad libitum with concentrate (80% corn, 20% soybean meal) supplemented at 0.5% BW. Baseline conditions were determined in the last 2 wk of a 3-wk period (i.e., 100% level). Thereafter, water availability was decreased by 10% every 1 (1X) or 2 wk (2X) to 40% of baseline intake (i.e., 90, 80, 70, 60, 50, and 40% levels), but also with 2 wk at 40% for the 1X restriction treatment. There was an interaction ($P < 0.001$) between animal type (AT) and restriction level in hay DM intake, with values of 346, 360, 358, 276, 286, 235, and 176 g/day for BOE, 656, 592, 592, 469, 522, 407, and 307 g/day for KAT, and 392, 390, 368, 273, 298, 298, and 219 g/day for SPA at levels of 100, 90, 80, 70, 60, 50, and 40%, respectively (SE = 29.1). Moreover, hay DM intake by 2X wethers was much lower in wk 2 vs. 1 at the 40% level (week × level interaction, $P = 0.008$; 409, 369, 345, 377, 336, and 276 g/day in wk 1 and 428, 398, 312, 352, 310, and 203 g/day in wk 2 at 90, 80, 70, 60, 50, and 40% levels, respectively; SE = 23.4). Restriction level affected ($P < 0.001$) plasma cortisol concentration in 2X wethers on the last day at each level (12.4, 14.0, 23.3, 26.4, and 32.6 nmol/L for 100, 70, 60, 50, and 40% levels, respectively; SE = 3.62). Plasma vasopressin concentration in 2X wethers at the end of each week at 60, 50, and 40% levels was affected by an interaction ($P = 0.006$) between week and level (3.98, 5.61, and 7.84 for wk 1 and 6.40, 7.22, and 7.06 pmol/L for wk 2, respectively; SE = 0.564). In conclusion, there was some indication that DM intake by KAT was more subject to adverse effects of very low water availability but not mild restriction compared with goats. Based on vasopressin concentration, a length of at least 2 wk rather than 1 with a set level(s) of restricted water availability seems desirable, which might also increase meaningfulness of measures such as BW. Results for DM intake and cortisol concentration suggest appropriateness of a maximum restriction level of 50%.

Behavior effects of mixing different breeds to evaluate electric fence strand additions to barbed wire fence to contain mature and growing meat goats

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

Professional Animal Scientist 32:854-860. 2016.

In Exp. 1, 80 Boer and 80 Spanish does were used to evaluate effects of grouping method, single breed (SGL) and breeds combined (COM), on behavior when exposed to electric fence treatments (FT). Five evaluation pens with 1 side consisting of a 5-strand barbed wire fence for cattle had electric fence strands added at 15 and 43 (LowHigh), 15 and 23 (LowMed), 15 (Low), 23 (Med), and 43 cm (High) from the ground. After 5 wk for becoming accustomed to measurement conditions, does were divided into 2 replication sets per grouping. Each of 5 evaluation pens held 4 does for 1-h exposure to FT while behavior was observed. Grouping method and FT interacted ($P<0.01$) in % of does exiting pens (Boer-COM: 0, 50, 50, 88, and 75%; Boer-SGL: 0, 13, 13, 50, and 63%; Spanish-COM: 25, 88, 100, 100, and 100%; and Spanish-SGL: 75, 100, 63, 100, and 63% for LowHigh, LowMed, Low, Med, and High, respectively; SE=13.2). In Exp. 2, 78 Boer and 80 Spanish growing kids were used with similar procedures. Grouping method and FT interacted ($P=0.01$) in pen exit (Boer-COM: 50, 25, 75, 86, and 43%; Boer-SGL: 13, 75, 88, 75, and 100%; Spanish-COM: 63, 63, 76, 88, and 75%; and Spanish-SGL: 25, 38, 88, 100, and 100% for LowHigh, LowMed, Low, Med, and High, respectively; SE=15.4). In conclusion, grouping mature but not growing Boer and Spanish goats together was effective in decreasing breed differences in behavior for evaluating electric fence strand treatments.

Effects of level of brackish water on feed intake, digestion, heat energy, and blood constituents of growing Boer and Spanish goat wethers

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

Journal of Animal Science 94:3864-3874. 2016.

Twenty Boer (6.1 mo and 21.3 kg) and 20 Spanish goat wethers (6.6 mo and 19.7 kg) were used to determine effects of brackish water on feed intake, digestion, heat energy, and blood constituents. Brackish water had 6,900 mg/L total dissolved salts, 1,885 mg/L Na, 75 mg/L Mg, 1,854 mg/L chloride, 2,478 mg/L sulfate, and 9 mg/L boron. Brackish water levels were 0% (control), 33% (33-BR), 67% (67-BR), and 100% (100-BR). Water and a moderate quality grass hay (8.5% CP and 68% NDF) were offered free-choice. The experiment consisted of 14 d of adaptation, 5 d for metabolizability measures, and 2 d for determining gas exchange and heat energy. There were no interactions ($P > 0.05$) between breed and water treatment. Water (931, 942, 949, and 886 g/d; SE = 59.1) and DM intakes (525, 556, 571, and 527 g/d for control, 33-BR, 67-BR, and 100-BR, respectively; SE = 31.0) were similar among treatments ($P = 0.876$ and 0.667, respectively). Urinary water was greater for brackish water treatments than for control ($P = 0.003$; 211, 317, 319, and 285 g/d; SE = 25.6) and fecal water content was similar among treatments ($P = 0.530$; 247, 251, 276, and 257 g/d for control, 33-BR, 67-BR, and 100-BR, respectively; SE = 19.0), implying less water loss by other means such as evaporation when brackish water was consumed. Total tract OM digestibility was lower ($P = 0.049$) for treatments with than without brackish water (64.2, 61.5, 58.6, and 59.3%; SE = 1.86), although ME intake was similar among treatments ($P = 0.940$; 4.61, 4.57, 4.60, and 4.31 MJ/d for control, 33-BR, 67-BR, and 100-BR, respectively; SE = 0.394). Daily heat energy in kJ/kg $BW^{0.75}$ was less with than without brackish water ($P = 0.001$; 474, 436, 446, and 445; SE = 7.7), although values in MJ were similar among treatments ($P = 0.588$; 4.36, 4.12, 4.22, and 4.18 for control, 33-BR, 67-BR, and 100-BR, respectively; SE = 0.124). Body weight of wethers consuming brackish water decreased less than that of wethers consuming control water ($P = 0.006$; -37, -14, -7, and -16 g; SE = 7.2), but recovered energy was similar among treatments ($P = 0.923$; 0.25, 0.45, 0.38, and 0.13 MJ/d for control, 33-BR, 67-BR, and 100-BR, respectively; SE = 0.356). In conclusion, brackish water inclusion in drinking water had a number of effects, but it does not appear that consumption of this source would adversely impact performance of growing meat goats.

Effects of method of conditioning on behavior of Boer and Spanish goats in pens with barbed wire and electric fence strands

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

Small Ruminant Research 137:130-137. 2016.

In the first experiment, 40 Boer (B) and 40 Spanish (S) does were used to evaluate effects of treatments in the interval (IT) between periods of a Latin square design on behavior when exposed to fences with barbed wire strands for cattle and added electric fence strands for goats. The desire was to determine if an IT would eliminate period or carryover effects so that a Latin square could be used for consistent and accurate evaluation of different electric fence strand treatments. Breeds were split into two sets with five groups of four does. Evaluation pens (5; 2.4 × 3.7 m) had one side of barbed wire strands at 30, 56, 81, 107, and 132 cm from the ground. Fence treatments (FT) were electrified strands (6.0 kV) at 15 and 43 (LowHigh), 15 and 23 (LowMed), 15 (Low), 23 (Med), and 43 cm (High). Behavior was assessed once every 2 wk with different FT in the five periods of a 5 × 5 Latin square experiment. In the week between measurements, one set of each breed was exposed to a pen with no electric strands as IT-Yes and other sets were not (IT-No). There were interactions ($P < 0.05$) in the percentage of goats exiting pens of IT × period (28, 38, 18, 0, and 18% with IT-Yes and 45, 13, 0, 0, and 0% with IT-No in period 1, 2, 3, 4, and 5, respectively; SE = 4.9), IT × FT (5, 8, 15, 33, and 40% with IT-Yes and 5, 3, 18, 23, and 10% with IT-No for LowHigh, LowMed, Low, Med, and High, respectively; SE = 4.9), and IT × breed (8 and 32% with IT-Yes and 15 and 8% with IT-No for B and S, respectively; SE = 3.8). In the second study, 80 B and 75 S wethers and doelings were used to investigate effects of preliminary treatments (PT) on behavior when later exposed to different FT. Breeds were divided into two sets, each with five groups consisting of three or four animals and use of the same FT. The PT were imposed in five weekly and sequential exposures to evaluation pens: a common treatment for one set of each breed with moderate exposure to electric fence strands (BC and SC); mild exposure for the other set of B (BU); and greater exposure for the other set of S (SU). BU was designed to increase and SU to decrease later interaction with fence strands and pen exit relative to BC and SC, respectively. Each group was thereafter exposed to one FT for 1 h in period 1 and 7 wk later in period 2. Set (BC, BU, SC, and SU) affected ($P < 0.05$) pen exit (21, 52, 57, and 8%; SE = 7.0), receipt of a shock (19, 30, 7, and 4%; SE = 4.8), and pen exit with a shock (6, 14, 6, and 2%, respectively; SE = 2.8). Period affected ($P < 0.01$) the percentage of animals exiting with shock (13 and 1%; SE = 2.0) but not the percentage exiting. In conclusion, exposing goats to barbed wire fence without electric strands between measurement periods was not sufficient to eliminate differences among periods of a Latin square design. Use of the same PT for B and S resulted in different behavior when later exposed to FT. The BU PT affected pen exit as anticipated; however, SU caused animals to be highly reluctant to exit and was not suitable for use.

Visiting Scholars, Graduate Students, and Interns (2016 and 2017)

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

Dr. Yoko Tsukahara
- Visiting Scholar
- Native of Japan
- Research Projects: Establishing a Langston University Testing Center for Electric Fence Modifications of Cattle Barb Wire Fence for Goat Containment; Sustainable Small Ruminant Production Through Selection for Resistance to Internal Parasites
- Experiments: YT-16-02, YT-16-10

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

Ms. Luana P. S. Ribeiro
- Visiting Graduate Student (PhD; Sandwich program; cooperative with Federal University of Bahia, UFBA)
- Native of Brazil
- Research Project: Effects of Body Condition at Kidding on Performance of Lactating Dairy Goats
- Experiment: LR-15-02

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

Ms. Carla Linera, Yahaira Lebrón, and Cristina Coriana
- Visiting Undergraduate Student Interns
- Native of Puerto Rico

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

Ms. Hirut Yirga
- Native of Ethiopia
- Visiting Graduate Student (PhD; Haramaya University, Ethiopia)
- Research Project: Brackish and Saline Drinking Water for Small Ruminants
- Experiment: HY-15-10

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

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

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

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

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.

IGA

Every four years, the International Goat Association hosts the International Conference on Goats (ICG), where scientists gather together and learn from each other. This past September, the 12th ICG was held in Antalya, Turkey (http://icg2016.org/en/). Drs. Terry Gipson, Arthur Goetsch, Ryszard Puchala, Tilahun Sahlu, Yoko Tsukahara, and Zaisen Wang attended the 12th ICG and presented research findings.

Collaboration with Northwest Agriculture and Forestry University, China

In October, 2015, Dr. Goetsch traveled to the Northwest Agriculture and Forestry University (NWAFU) in Yangling, China. The primary purpose of the visit was collaborative research in accordance with a Memorandum of Understanding between the two institutions established many years ago. Dr. Goetsch provided assistance in initiating experiments dealing with emission of the greenhouse gas methane by dairy goats. One of studies was with a portable box system that an individual animal is situated in for 30 minutes, with gas concentrations measured at the beginning and end of the period. The difference in concentration of methane multiplied by volume of the unit is used to determine emission, which is then expressed on a daily basis. The other trial was conducted in environmental chambers allowing quantification of not only consumption and emission of different gases by animals, in this case groups rather than individuals, but also emission of gases such as ammonia from feces and urine. In addition to this collaborative research, Dr. Goetsch gave a presentation on current areas of emphasis of small ruminant research to faculty, staff, and students of the University and on practical feeding considerations for dairy goats to farmers of a local dairy goat association.

In May, 2016, Dr. Goetsch again traveled to the NWAFU. The primary purpose of the visit was to attend and make a plenary presentation at the 3rd Asian-Australasian Dairy Goat Conference and to provide a

presentation at an associated workshop on use of the Langston University interactive nutrient calculation system for goats.

Continuing the Ethiopia Connection

In August of 2016, Drs. Roger Merkel and Terry Gipson participated in a Workshop on Promoting Higher Education Linkages Between American and Ethiopian Universities on Agriculture and Food Security co-organized by the Ministry of Foreign Affairs and Ministry of Education of Ethiopia and the U.S. Embassy of Ethiopia. Dr. Merkel was a panel member for a session on Challenges to Linkages between U.S. and African Universities. Many U.S. and Ethiopian institutes of higher education attended the workshop. Prior to and after the 'Linkage' workshop mentioned immediately above, Drs. Merkel and Gipson traveled to several Ethiopian livestock research centers to meet with officials and discuss continuing or potential collaboration. The Institute scientists first visited the Oromia Agricultural Research Institute, Addis Ababa to discuss their breeding program concentrating on Horro sheep. They then traveled north to the Debre Berhan Agricultural Research Center and its Sheep Breeding and Multiplication Center to discuss a breeding program on Menz sheep and see their herds of Awassi and Dorper sheep. The Dorper sheep are being distributed to villagers through a community based breeding program. While in Debre Berhan, Drs. Merkel and Gipson visited Debre Berhan Agricultural Research Center and Debre Berhan University and its Ataye Research Station to see their Boer goats and discuss potential collaboration. The duo then went south to visit the SARI and renew ties with researchers there and learn about their village community based breeding program. Finally, the pair visited Haramaya University in eastern Ethiopia to meet with Dr. Mengistu Urge, M.S., Hirut Yirga, and other scientists.

In addition to the aforementioned activities, Dr. Tilahun Sahlu, Institute Director, has met with scientists at universities, regional agricultural research institutes, and attended conferences to strengthen and further the Institute's Ethiopian ties. Examples of his activities are attending the International Conference on Enset organized by Addis Ababa University, meeting scientists at the Ethiopian Biotechnology Institute, and conversing with various university administrators to discuss mutual research and training cooperation.

Training Philippine Extension Personnel

In April 2016 the Institute hosted four extension training personnel from the Agriculture Training Institute of the International Training Center on Pig Husbandry for a one-week training on goat production including reproduction, nutrition, health, and management. Participants also had the opportunity to observe extension services and how the Institute disseminates research and technology to farmers and our local community.

During their time at the Institute the visitors interacted with and received training from Institute scientists and the research farm staff. Overall, the visitors were very impressed with the amount of technology used at the institute's facilities. The participants also had visited goat farms and spoke with producers.

When describing the AIGR staff the visitors felt the team was incredibly organized, knowledgeable and approachable. They expressed how they appreciated the teamwork and level of accommodation the AIGR staff shared with them. They felt more than confident to share what they learned during their stay because of the assurance of successful practices used at the AIGR. They were so pleased with their experience and they would encourage, without hesitation, producers, lawmakers, and policy makers in the Philippines to come to Langston University and participate in this program. They all felt very fortunate to have had the opportunity to come to the Institute and expressed how their time here has exceeded their expectations.

In January, 2017, the Institute hosted an additional five extension personnel from the Philippines for training in goat production and management. The group was composed of three veterinarians and two live-

stock extension agents. Their training program was sponsored by the Agricultural Training Institute of the International Training Center on Pig Husbandry (ATI-ITCPH) of the Philippine Department of Agriculture.

The group arrived to subfreezing temperatures, a new experience for them. However, they enjoyed their first time seeing snow. Their training program began with a visit to the Institute Director, Dr. Tilahun Sahlu; an overview of the Institute's research, extension, and international activities; and a tour of the research laboratory facilities. Much of the group's time was spent at the research farm. The group learned how the research farm is organized and operations maintained along with animal management and recordkeeping. The group learned about the artificial insemination program of the research farm through practice with animals and discussions on estrus synchronization and detection.

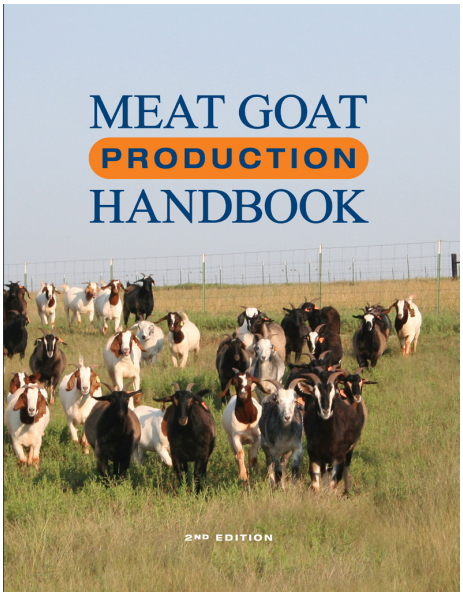
The group was trained by Dr. Lionel Dawson of Oklahoma State University along with several veterinary students in how to conduct an epididymectomy to make a teaser buck. The group learned about semen evaluation with the opportunity to manually count spermatozoa in a semen straw by using a hemocytometer. Fresh semen was collected and used to fill semen straws as if for insemination. The use of fresh semen is a good method for inexperienced AI technicians to hone their skills before using more expensive frozen semen. It is also a method of biosecurity to prevent the possibility of disease spread among breeding animals.

Other topics of training included milking procedures and mastitis detection methods, herd health and disease, mortality composting, internal parasites and control, nutrition, and animal selection and genetic improvement. The group also practiced pregnancy detection using ultrasound.

The group learned a great deal during their time at the Institute. The hands-on nature of the training was very beneficial to the group in the transfer of knowledge from trainers to participants. In addition to the training, the group of first-time visitors to the US experienced a range of weather from snow on the ground when they arrived, temperatures about 70° midweek, and an ice storm on Friday and Saturday. It was the first time each of them had the opportunity to scrape ice off a windshield. It was an enjoyable and fun-filled week that left quite an impression with them. The Institute would like to thank Dr. Ruth Miclat-Sonaco of the ATI-ITCPH for sending the participants and the Institute hopes to continue a collaborative relationship with that organization.

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.



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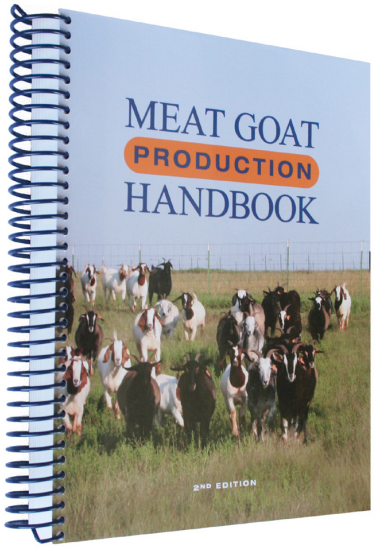

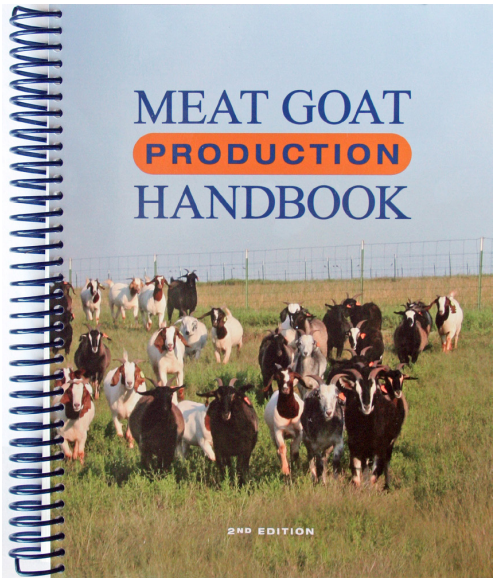

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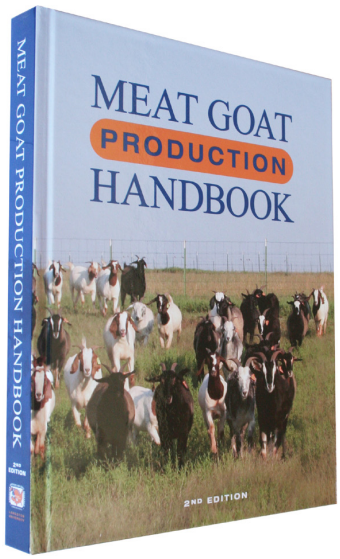

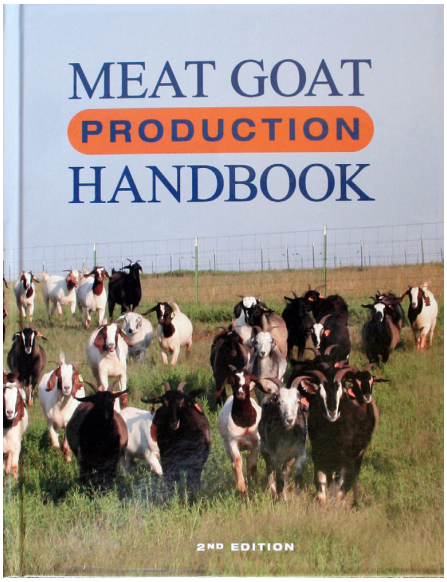

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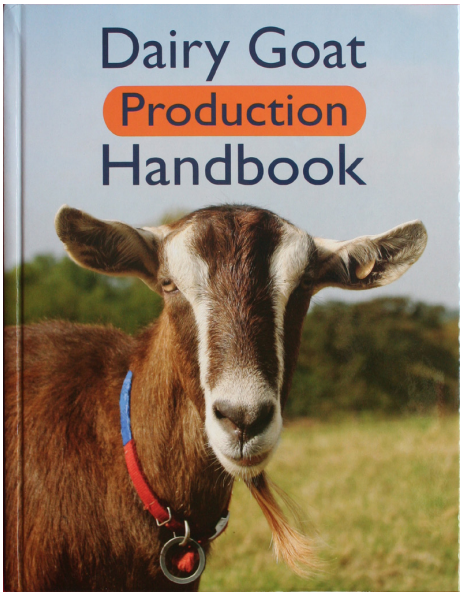

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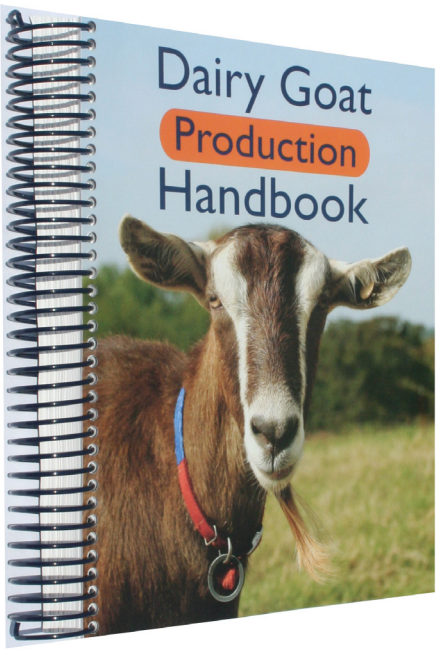

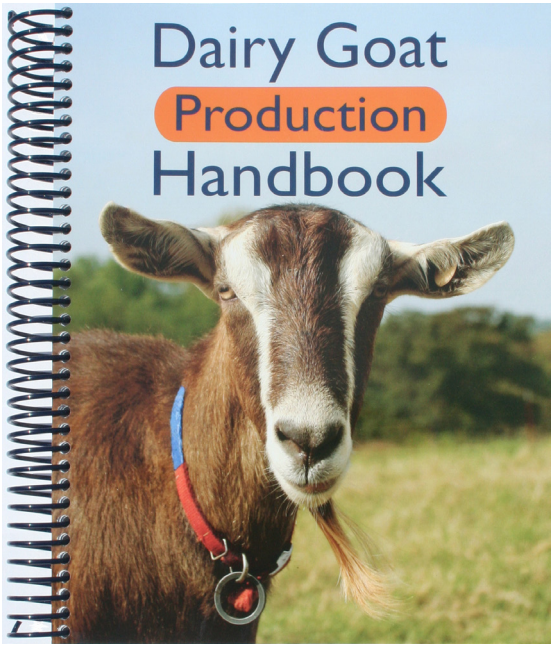

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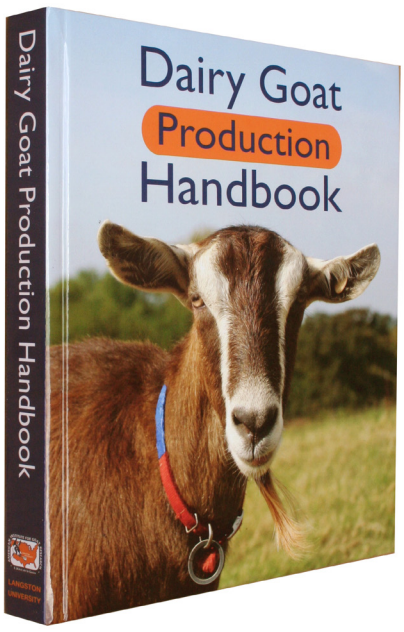

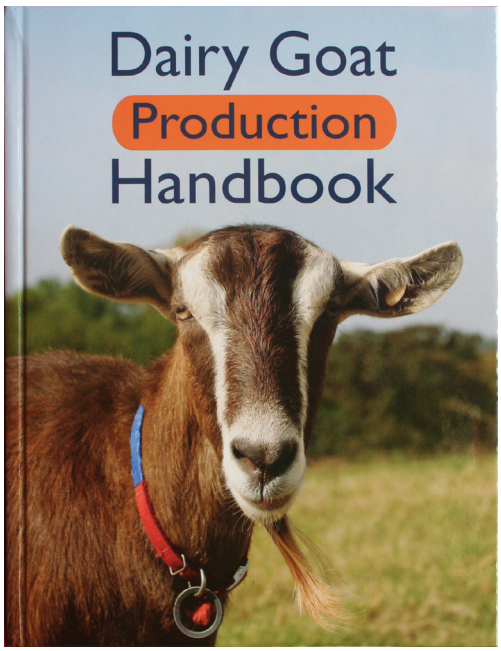

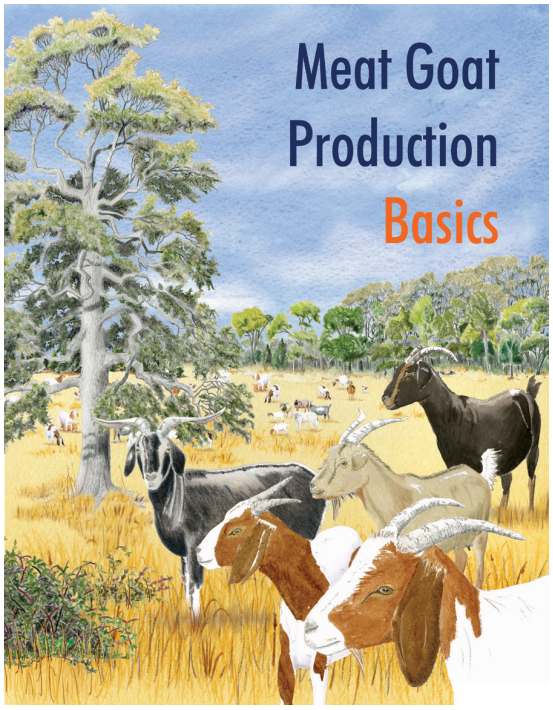

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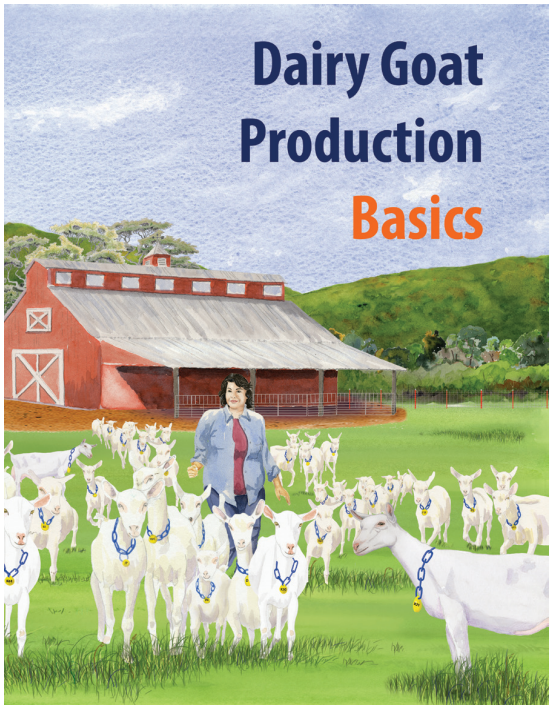

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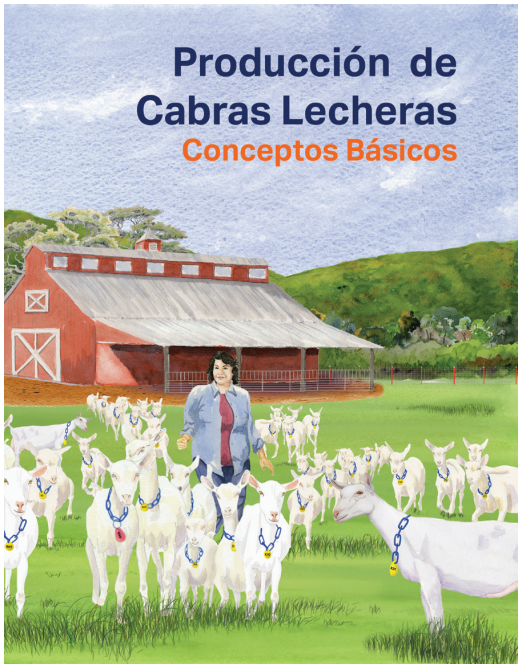

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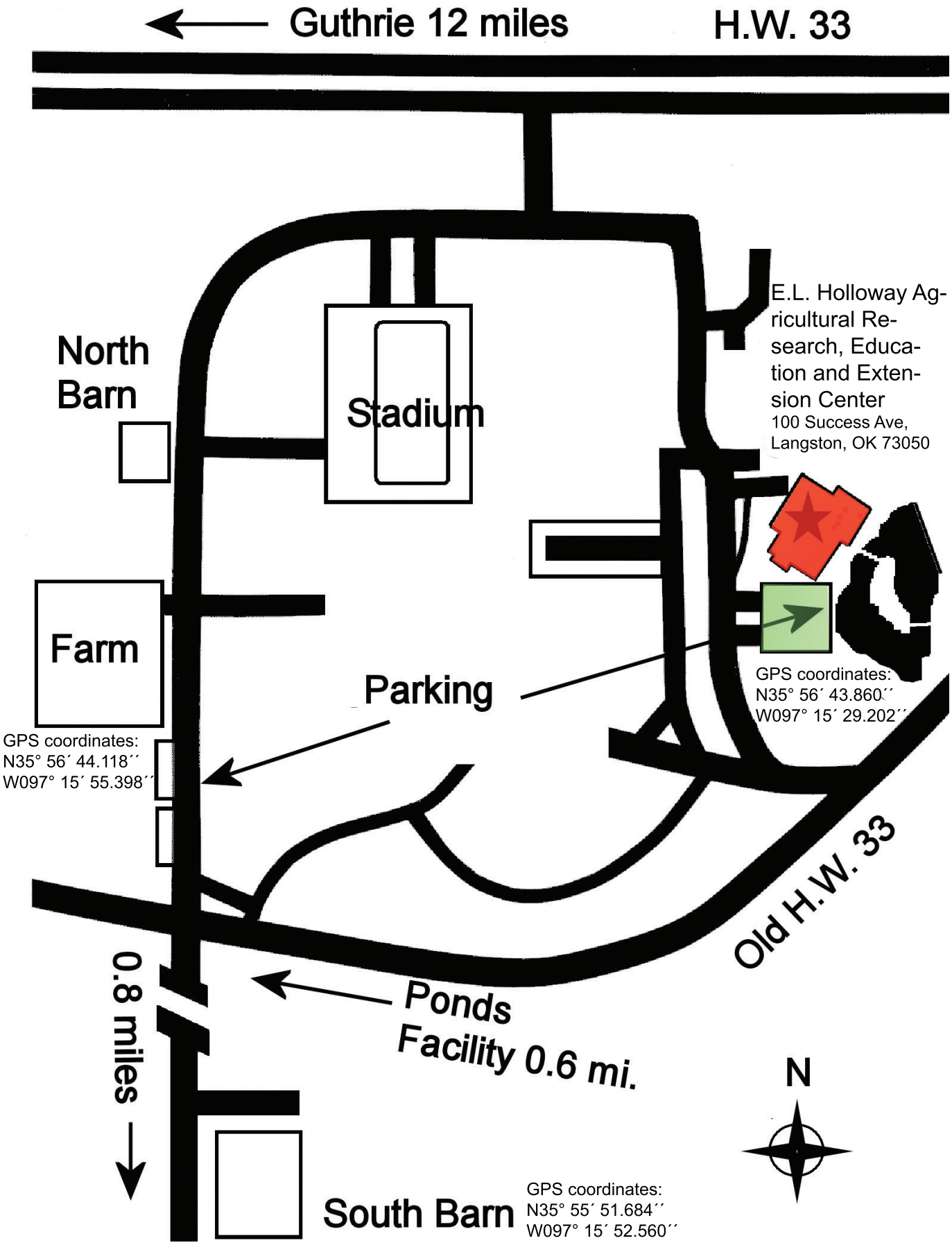
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Parking
GPS coordinates:
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W097° 15´ 29.202´´
GPS coordinates:
N35° 56´ 44.118´´
W097° 15´ 55.398´´
Old H.W. 33
0.8 miles
Ponds
Facility 0.6 mi.
N
South Barn
GPS coordinates:
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W097° 15´ 52.560´´

Notes

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