WELCOME

We deeply appreciate your attendance at this 27th Annual Goat Field Day of the E (Kika) de la Garza American Institute for Goat Research of Langston University. The Field Day is one of the most important things we do each year. The primary purpose of the Field Day is for education and extension in areas of greatest interest to clientele of the Institute. Thus, please share your thoughts with us on today's activities and suggestions for the Field Day next year. In addition to extension and education, the Field Day provides an excellent opportunity for the staff of the Institute to meet other people that work with goats. Such interaction helps make our program the most appropriate it can be for the people it serves. The proceedings of the Field Day is a very useful tool for the Institute beyond impact realized from the program today. First, there are reports on Field Day presentations. After this information, there are highlights of research, extension, and international activities of the Institute in the past year. This section is an aid to assess our recent progress, display current activities, and contemplate future directions to be followed. This year's general theme is "State of the Goat Industry".

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

The morning program consists of:

- **Report on the USDA Goat Management Survey** *Dr. Katherine Marshall*
- **American Goat Federation: A Unified Voice for the Goat Industry** *Mr. Tom Boyer*

The afternoon workshops are:

- **Neglected Biosecurity and Strategic Use** *Dr. Katherine Marshall*
- **Zoonotic Diseases of Importance for Producers** *Dr. Katherine Marshall*
- **American Goat Federation and What it Can Do for the Goat Producer** *Mr. Tom Boyer*
- **Basic Herd Health** *Dr. Lionel Dawson*
- **Nutrition for Health and Production** *Dr. Steve Hart*
- **Internal Parasite Control** *Dr. Steve Hart*
- **Goat Reproduction** *Dr. Dave Sparks*
- **Goat Farm Budgeting** *Mr. Roger Sahs*
- **Cheese-making Overview** *Mr. Neville McNaughton*
- **Pack Goats** *Mr. Dwite Sharp*
- **Mortality Composting** *Dr. Roger Merkel*
- **DHI Training** *Ms. Eva Vasquez*
- **Oklahoma Department of Agriculture Food and Forestry Programs** *Ms. Chris Kirby*
- **Fitting and Showing for Youth and Adults** *Ms. Kay Garrett*
- **USDA Government Programs** *Mr. Dwight Guy*
- **Fun Tent** *Ms. Sheila Stevenson*

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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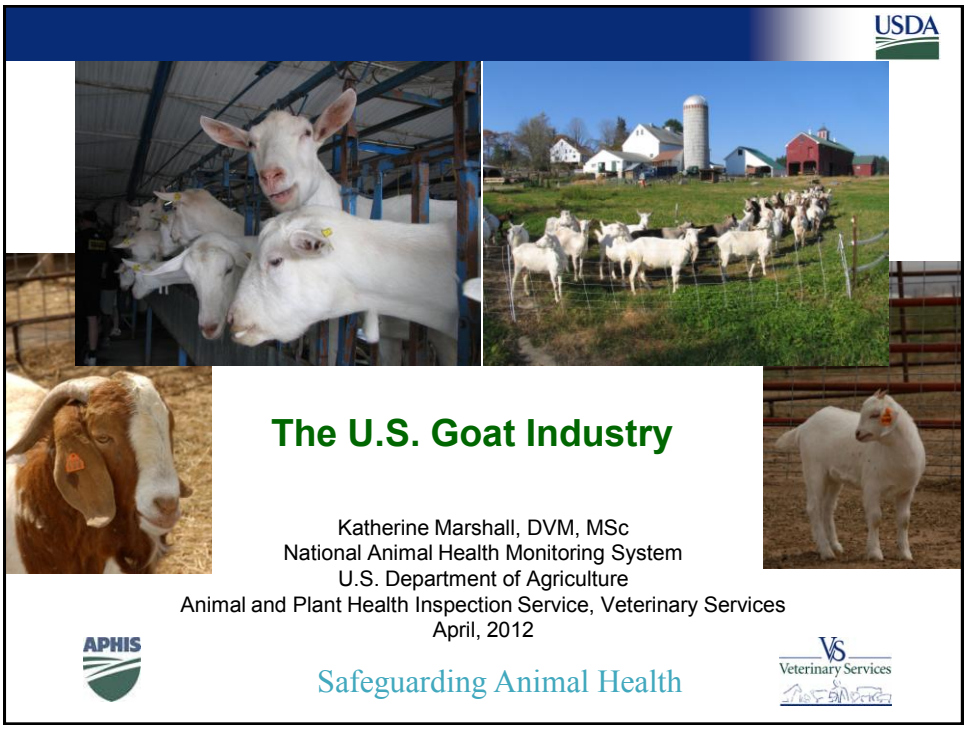
The U.S. Goat Industry

Dr. Katherine Marshall
USDA/APHIS Veterinary Services
Centers for Epidemiology and Animal Health
Fort Collins, CO


USDA
The U.S. Goat Industry
Katherine Marshall, DVM, MSc
National Animal Health Monitoring System
U.S. Department of Agriculture
Animal and Plant Health Inspection Service, Veterinary Services
April, 2012
APHIS
Safeguarding Animal Health
Veterinary Services


USDA
Goat Industry Structure in the US
1987 - 2007
• Only industry to experience an increase in number of animals AND number of farms
• Meat goats increased over 400 percent
• Dairy goats almost nonexistent in 1987 increased to 0.4 million in 2007
• Angora predominant in 1987 but declined about 88 percent between 1992 – 2007
• Largest population increase in Southeast U.S.
APHIS
Safeguarding Animal Health
Veterinary Services
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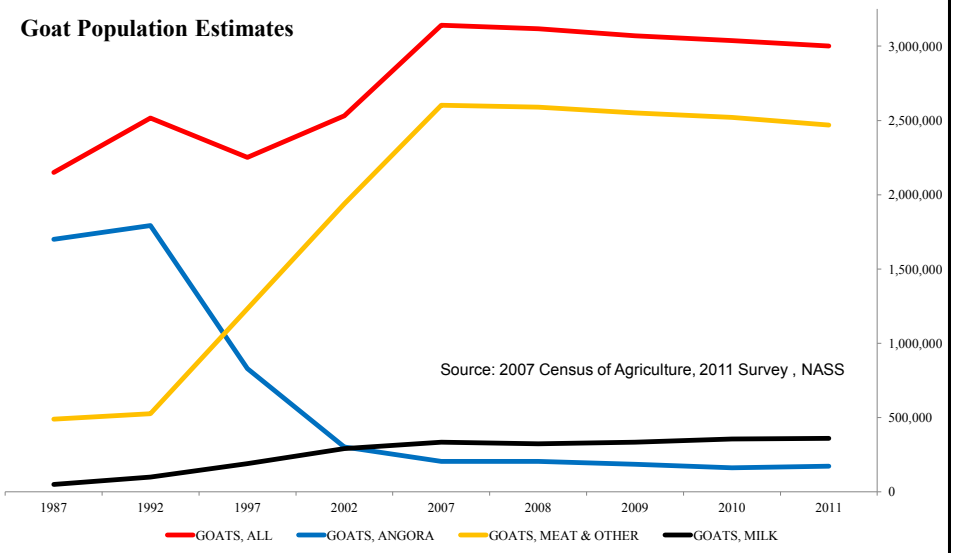
Goats in the U.S.

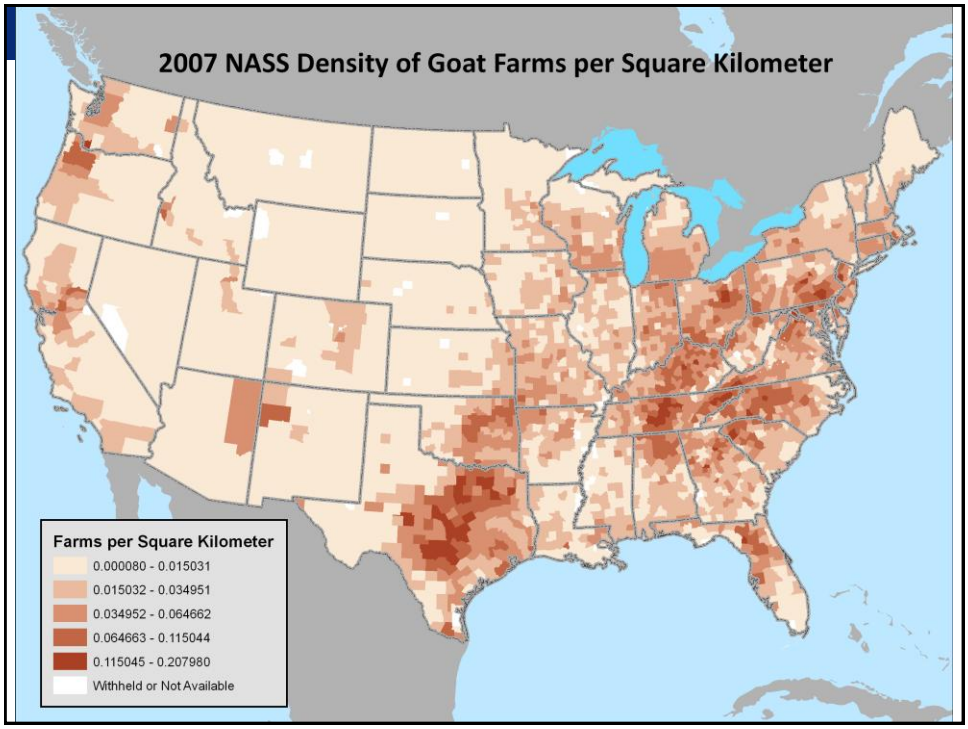
Switch in production away from angora to meat and other types

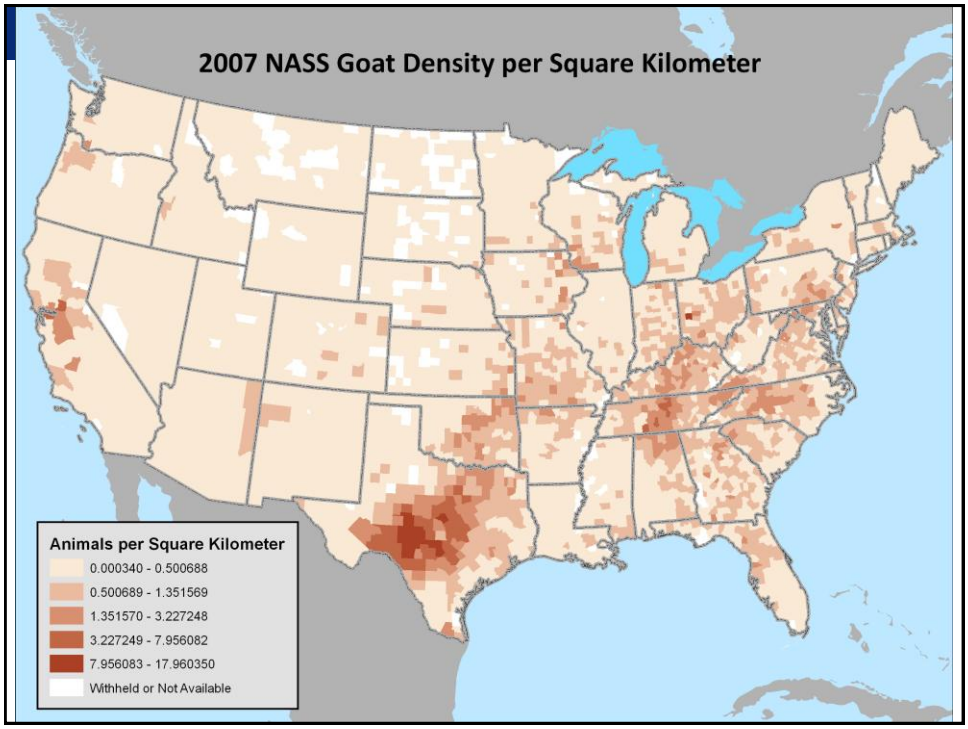


Goat Population Expansion

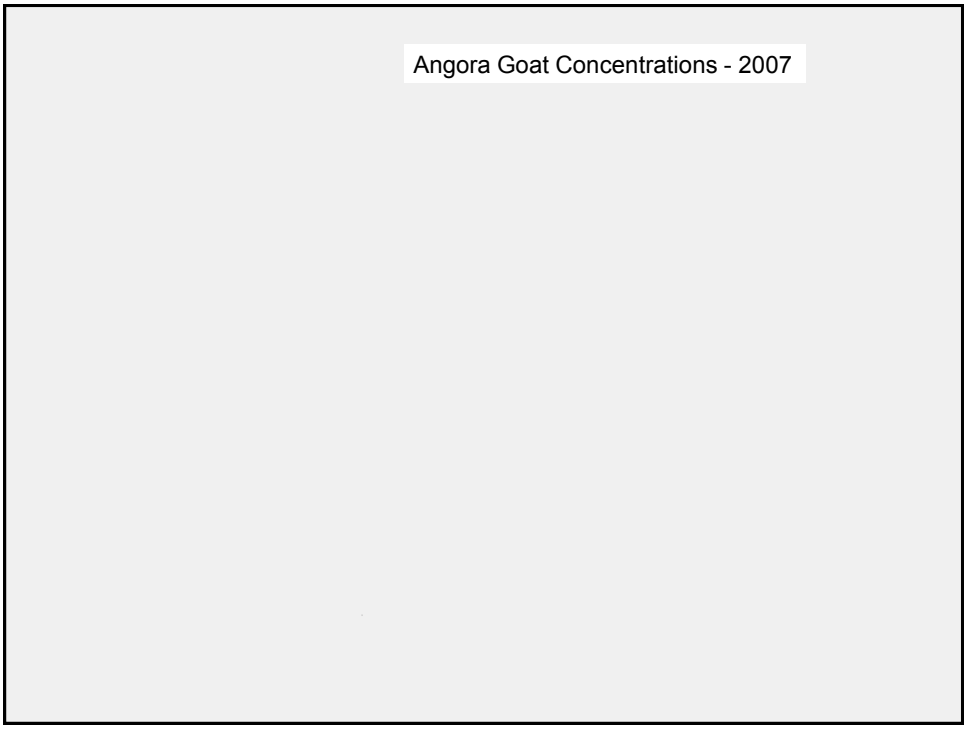
- Desirable for operations with limited acreage
- Easier to manage and less costly to raise than many livestock species
- Rapid growth of ethnic groups in the United States in which goat meat is widely consumed
- Tobacco buyout program – state offered incentives for tobacco farmers to move into other areas of production agriculture.
- Growing popularity of Mexican, Caribbean, and Indian cuisine

APHIS Safeguarding Animal Health Veterinary Services 4


2007 NASS Density of Goat Farms per Square Kilometer
Farms per Square Kilometer
0.000080 - 0.015031
0.015032 - 0.034951
0.034952 - 0.064662
0.064663 - 0.115044
0.115045 - 0.207980
Withheld or Not Available


2007 NASS Goat Density per Square Kilometer
Animals per Square Kilometer
0.000340 - 0.500688
0.500689 - 1.351569
1.351570 - 3.227248
3.227249 - 7.956082
7.956083 - 17.960350
Withheld or Not Available


Milk Goat Concentrations, 2007


Angora Goat Concentrations - 2007

USDA

Goat populations

- Meat goat populations concentrated in Texas, Oklahoma, and other southeast states
- Dairy goat populations concentrated in Wisconsin, Minnesota, California
- Angora goat populations concentrated in Texas, New Mexico

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Veterinary Services

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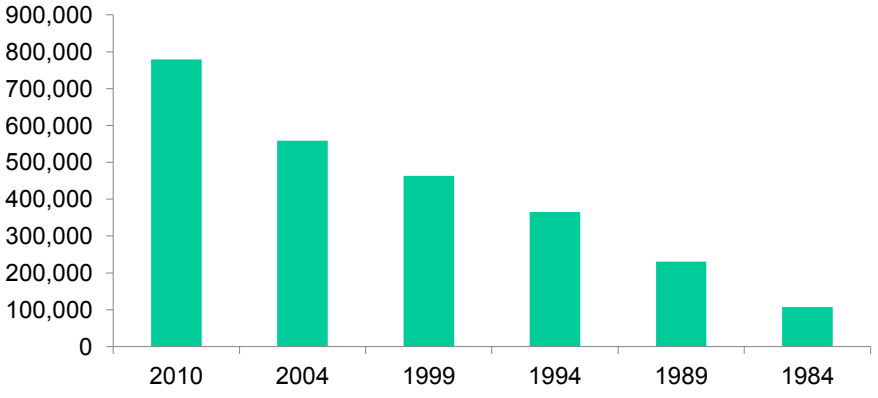
USDA

Goat Carcasses Federally Inspected



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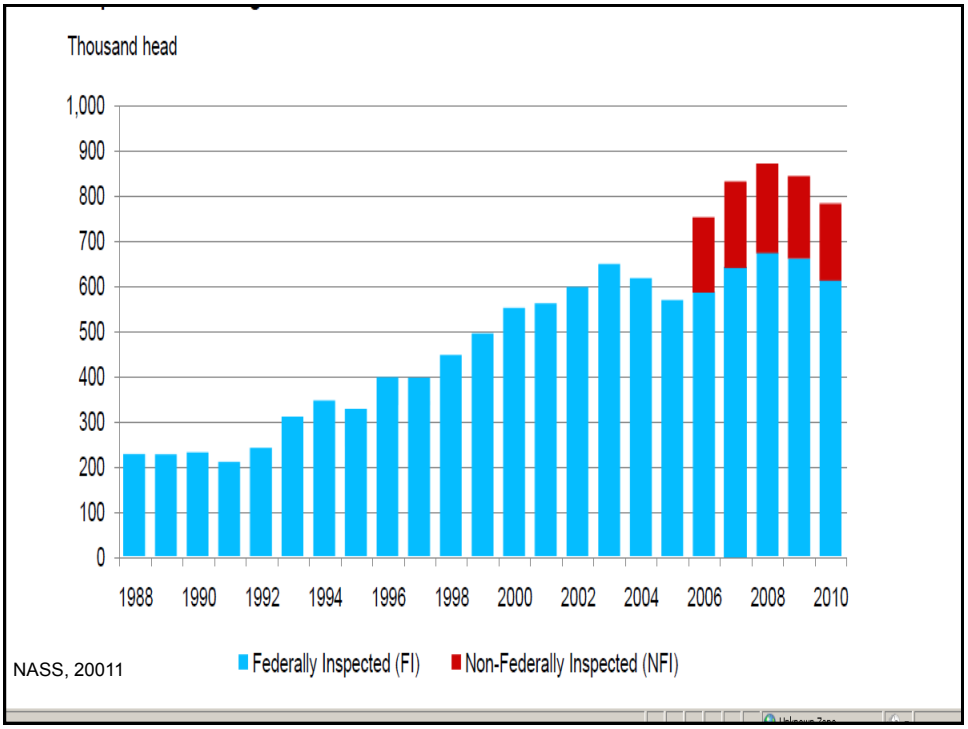

USDA

Reasons for national study

- Increasing goat populations
- Need for benchmark information
- Producers largely new to animal agriculture
- Expectation for industry to continue growth
  - Ability to convert low-quality forage to high-quality protein
  - Ability to produce commodities for valuable niche markets
  - Smaller acreage requirement
  - Easier to manage for older and female producers
- Interest from the goat industry – American Meat Goat Association, American Dairy Goat Association, American Goat Federation

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VS Veterinary Services

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USDA

What is NAHMS?

- USDA-APHIS-Veterinary Services:
  National Animal Health Monitoring System
  - One of three centers within the Centers for Epidemiology and Animal Health, Fort Collins, CO
  - Collect and analyze animal health data to provide information on:
    - Overall health status of U.S. animals
    - Diseases and risk factors
    - Productivity, management, and biosecurity practices of U.S. livestock industry

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USDA

NAHMS

Studies developed in collaboration with industry partners

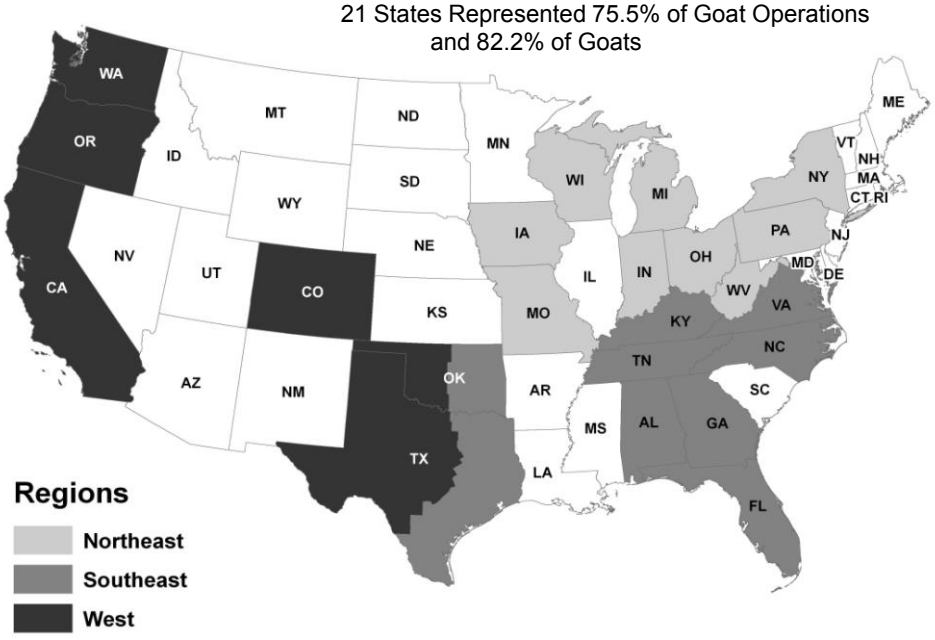
USDA

NAHMS – a 20 year history

Year	Commodity
1990, 1995, 2000, 2006, 2012	Swine
1992, 1996, 2002, 2007, 2014	Dairy
1993, 1997, 2008	Beef cow/calf
1994, 1999, 2011	Beef feedlot
1995, 2001, 2011	Sheep
1996, 1999, 2004, 2010	Poultry
1997, 2003, 2010	Catfish
1998, 2005, 2015	Equine
2007, 2011	Small scale operations
2009	Goat

Goat 2009 Participating States

21 States Represented 75.5% of Goat Operations and 82.2% of Goats



USDA

Needs Assessment

- What are important issues for the goat industry?
- What diseases are the most important?
  - Need better tests
  - Identify risky management practices
  - Vaccination practices

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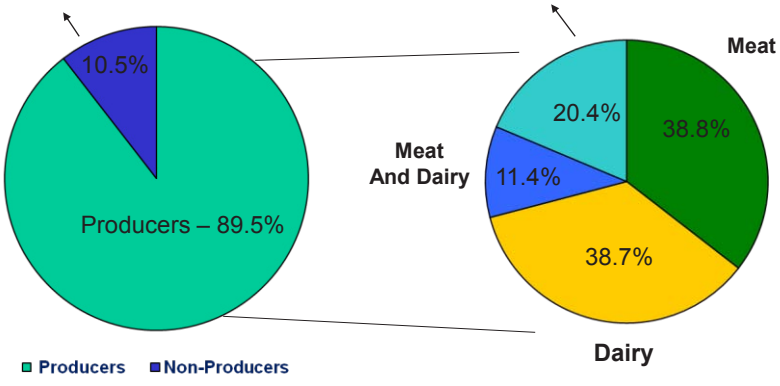
USDA

Needs Assessment – Goat 2009

Non-producers – veterinarians, nutritionists, university/extension, federal/state govt

Other – breeding stock, 4-H owners, show or hobbyist



APHIS

Total = 1264 responses

Safeguarding Animal Health

Veterinary Services

Management Issue Findings

USDA

Percent of respondents indicating the listed issues as being the top 3 priorities for study

	All Respondents	Meat	Dairy
Predator Control	2.1	2.1	0.9
Organic Meat/Milk Production	3.2	2.5	4.2
Animal Welfare	3.6	3.1	3.1
Reproductive Health	4.4	3.8	5.6
Biosecurity/Disease Prevention	5.1	3.8	4.7
Antimicrobial Use/Resistance	5.4	6.4	4.3
Kid Health Management	10.1	11.6	10.3
Nutrition Feed Mangement	11.7	9.9	14.1
Doe Health Management	13.5	14.5	14.9
Marketing	14	16.9	12.3
Infectious Disease	16.4	15.2	17.5

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VS Veterinary Services

USDA

DISEASE FOCUS FOR NAHMS GOAT 2009: TOP THREE CHOICES

ALL RESPONDENTS		DAIRY		MEAT	
Johne's	5.6	Clostridium perf, D	6.0	Pregnancy toxemia	6.4
Respiratory Dz	6.1	Johne's	9.1	Scours	7.0
Mastitis	7.2	Nutritional	11.0	Lameness, Hoof Health	8.0
Nutritional	8.2	Mastitis	15.0	Nutritional	11.9
CAE	11.8	Ext/Int Parasites	16.4	Respiratory Dz	12.6
CL	15.8	CL	17.3	CL	25.0
Ext/Int Parasites	16.4	CAE	25.2	Ext/Int Parasites	29.0

ALL PRODUCERS		NON PRODUCERS	
Johne's	7.2	E. coli	7.1
Respiratory Dz	8.9	Scours	8.0
Mastitis	10.5	Nutritional	9.2
Nutritional	11.9	CAE	13.0
CAE	17.1	Johne's	13.4
CL	21.9	Ext/Int Parasites	24.4
Ext/Int Parasites	22.5	CL	24.8

Study Results

- Provide a baseline description of animal health, nutrition, and management practices in the U.S. goat industry.
  - How do your management practices compare to other goat producers?
  - What management practices do you perform?

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Percent of US Goat Inventory and Goat Farms by Herd Size

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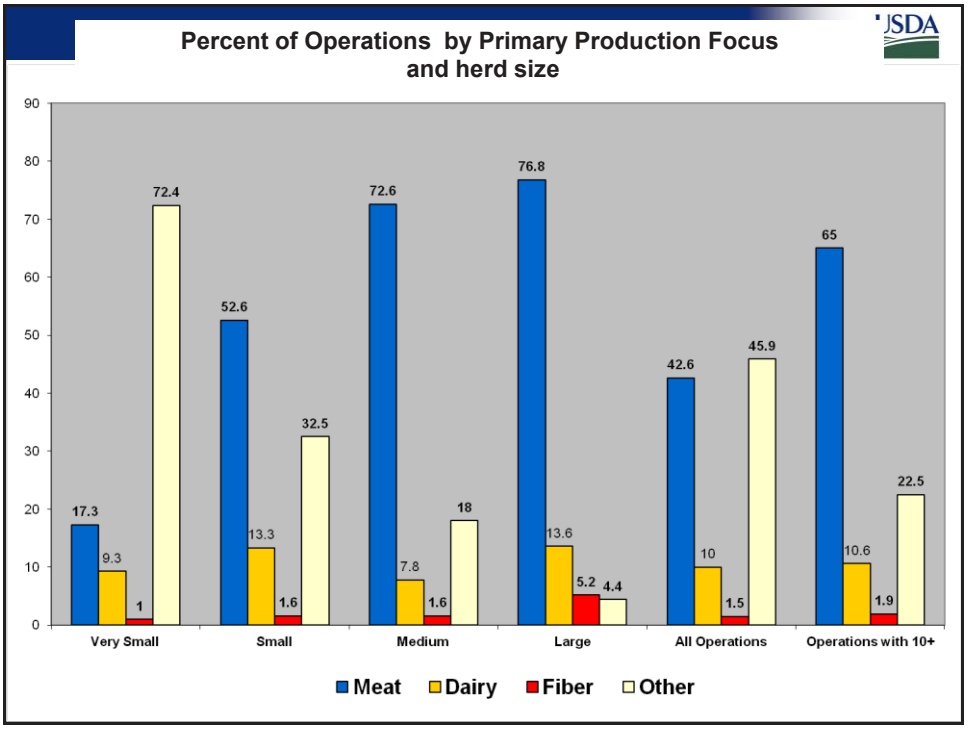
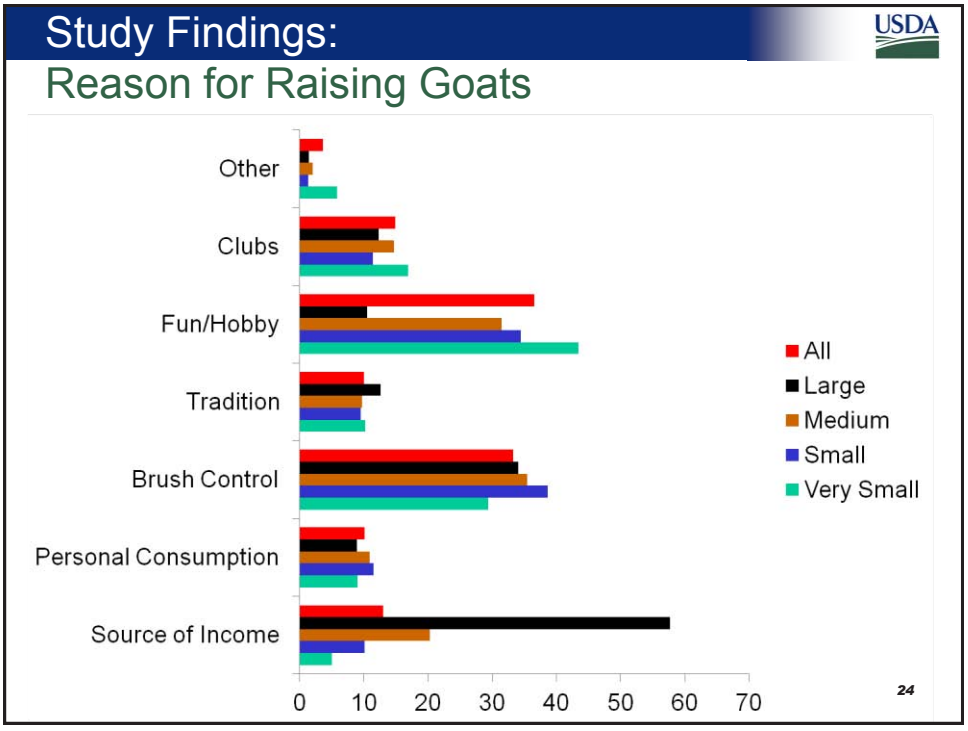
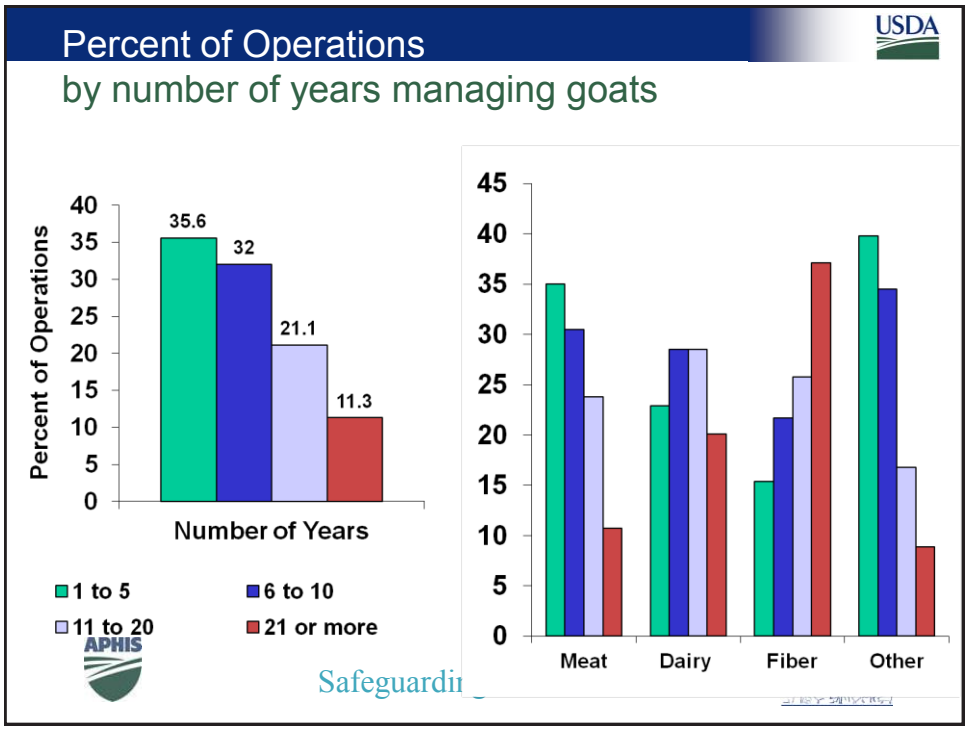
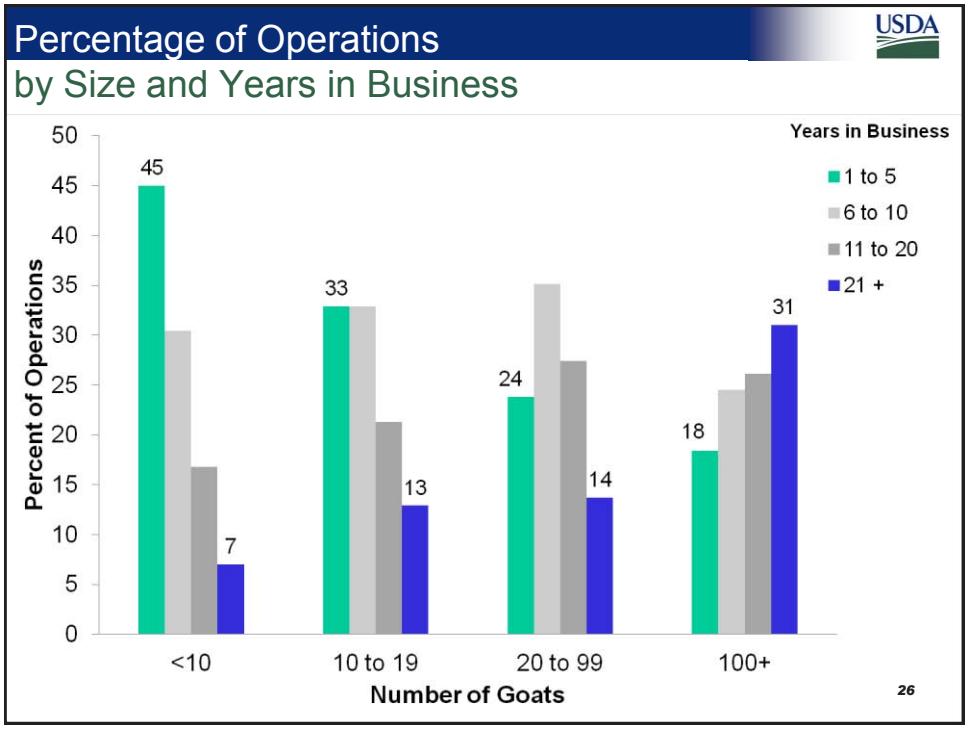
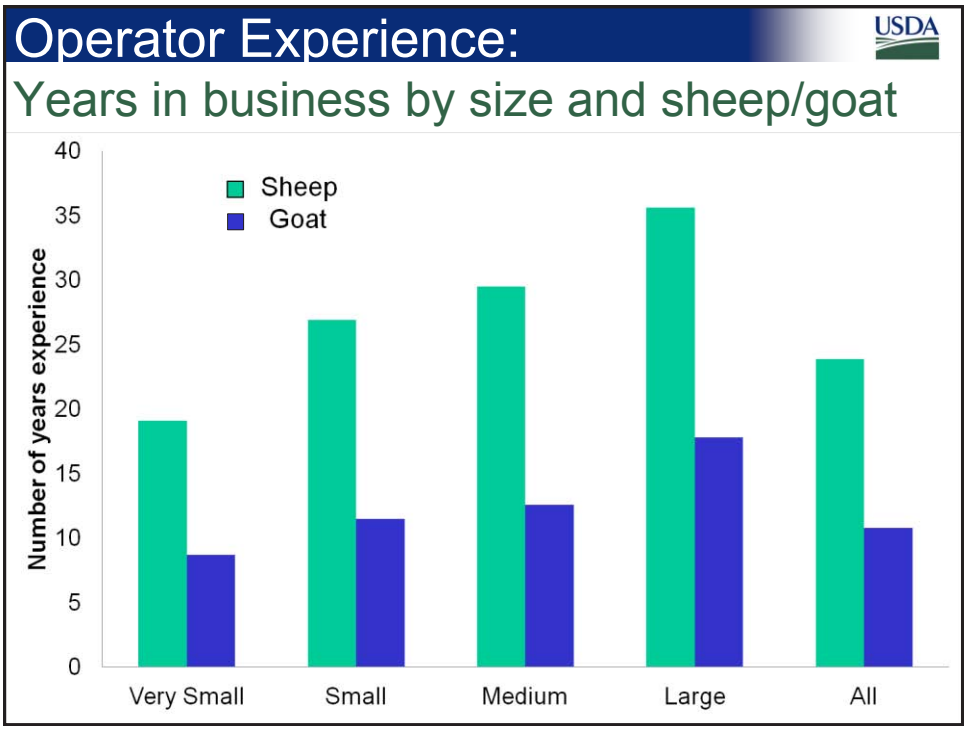
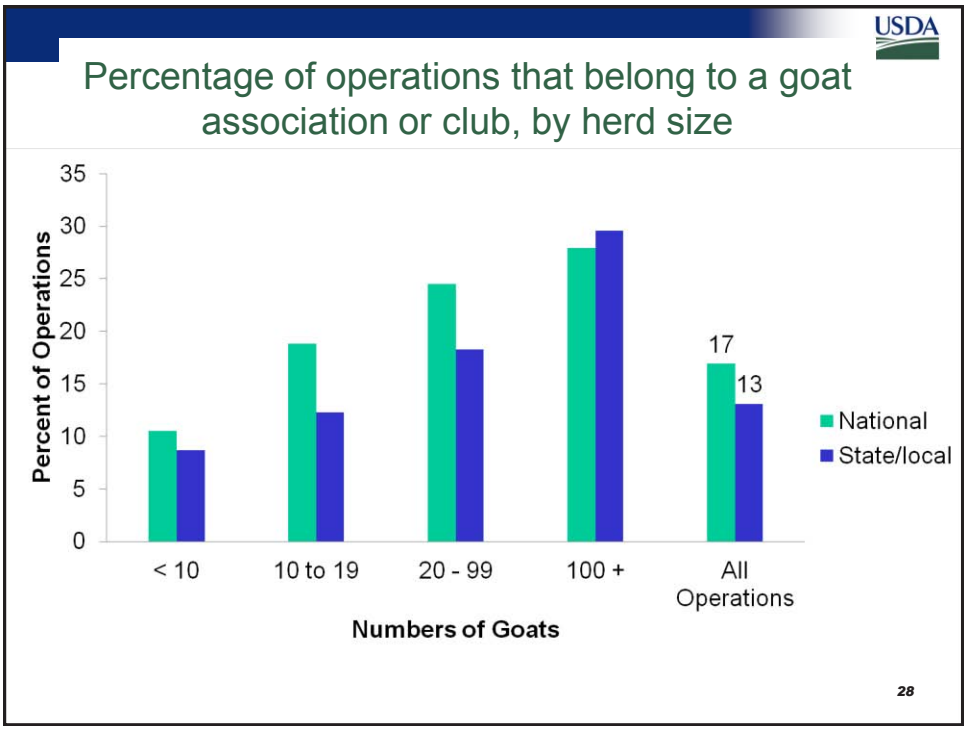

Percent of Operations by Primary Production Focus and herd size
USDA
90
80
70
60
50
40
30
20
10
0
17.3
9.3
1
72.4
52.6
13.3
1.6
32.5
72.6
7.8
1.6
18
76.8
13.6
5.2
4.4
42.6
10
1.5
45.9
65
10.6
1.9
22.5
Very Small
Small
Medium
Large
All Operations
Operations with 10+
Meat
Dairy
Fiber
Other

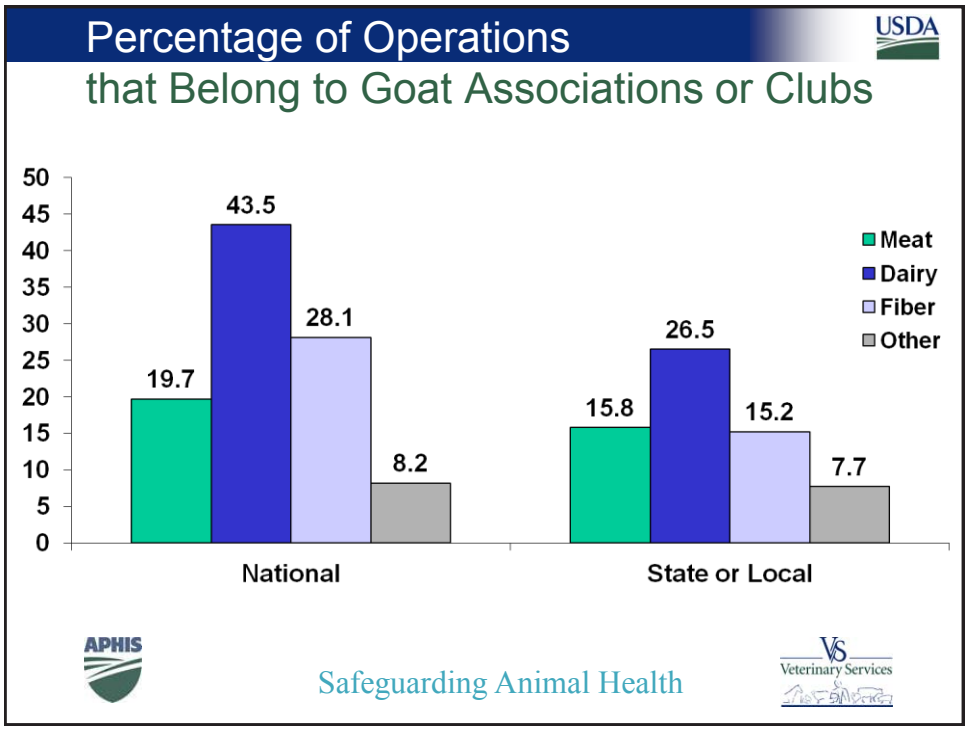

Study Findings:
USDA
Reason for Raising Goats
Other
Clubs
Fun/Hobby
Tradition
Brush Control
Personal Consumption
Source of Income
All
Large
Medium
Small
Very Small
0
10
20
30
40
50
60
70
24

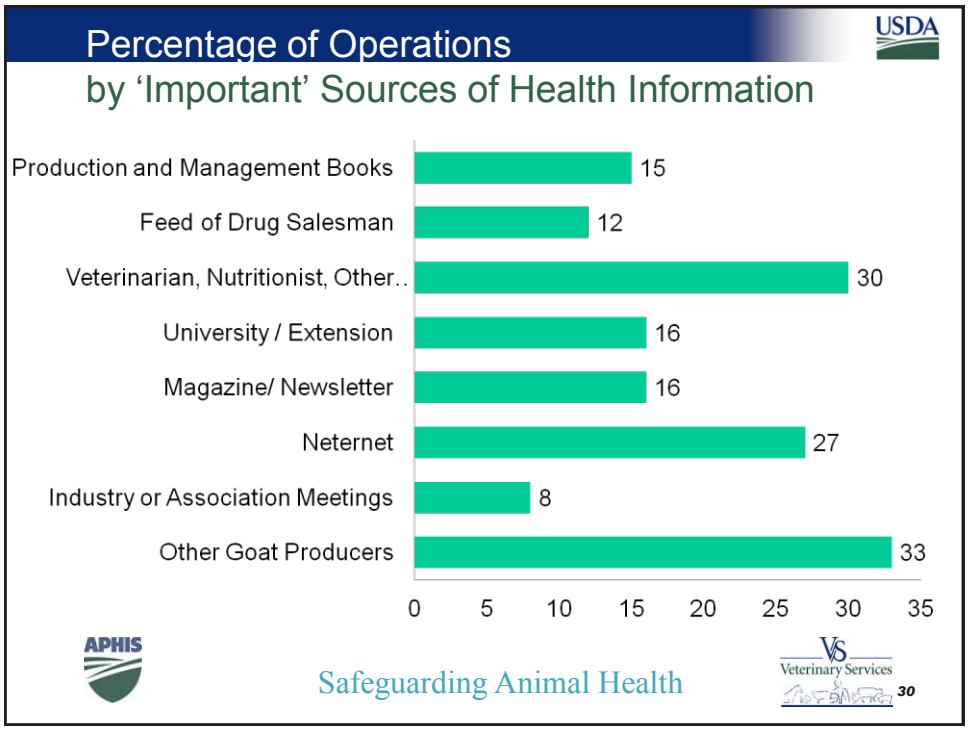

Percent of Operations
by number of years managing goats
USDA
Percent of Operations
40
35
30
25
20
15
10
5
0
35.6
32
21.1
11.3
Number of Years
1 to 5
6 to 10
11 to 20
21 or more
APHIS
45
40
35
30
25
20
15
10
5
0
Meat
Dairy
Fiber
Other


Percentage of Operations
by Size and Years in Business
USDA
Years in Business
1 to 5
6 to 10
11 to 20
21 +
Percent of Operations
50
45
40
35
30
25
20
15
10
5
0
45
7
33
13
24
14
18
31
<10
10 to 19
20 to 99
100+
Number of Goats
26


Operator Experience:
USDA
Years in business by size and sheep/goat
Number of years experience
40
35
30
25
20
15
10
5
0
Sheep
Goat
Very Small
Small
Medium
Large
All


USDA
Percentage of operations that belong to a goat association or club, by herd size
Percent of Operations
35
30
25
20
15
10
5
0
17
13
National
State/local
< 10
10 to 19
20 - 99
100 +
All Operations
Numbers of Goats
28


Percentage of Operations
that Belong to Goat Associations or Clubs
USDA
50
45
40
35
30
25
20
15
10
5
0
43.5
28.1
19.7
8.2
26.5
15.8
15.2
7.7
Meat
Dairy
Fiber
Other
National
State or Local
APHIS
Safeguarding Animal Health
Veterinary Services


Percentage of Operations
by 'Important' Sources of Health Information
USDA
Production and Management Books
15
Feed of Drug Salesman
12
Veterinarian, Nutritionist, Other..
30
University / Extension
16
Magazine/ Newsletter
16
Neternet
27
Industry or Association Meetings
8
Other Goat Producers
33
0
5
10
15
20
25
30
35
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Safeguarding Animal Health
Veterinary Services
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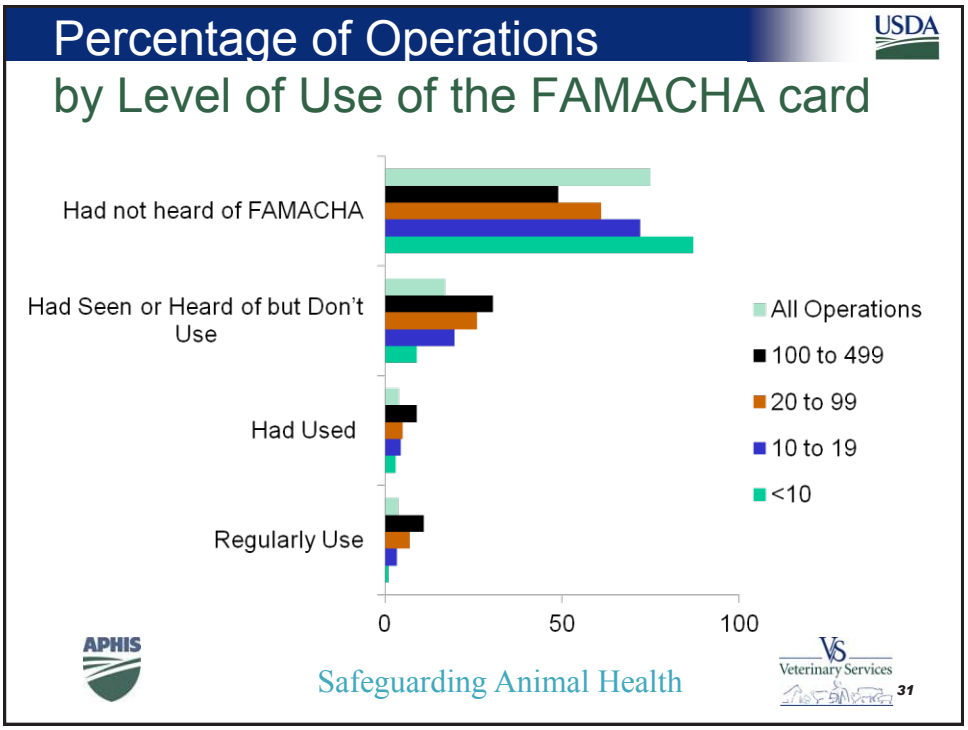
Percentage of Operations
by Level of Use of the FAMACHA card
USDA
Had not heard of FAMACHA
Had Seen or Heard of but Don't Use
Had Used
Regularly Use
All Operations
100 to 499
20 to 99
10 to 19
<10
0
50
100
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Safeguarding Animal Health
Veterinary Services
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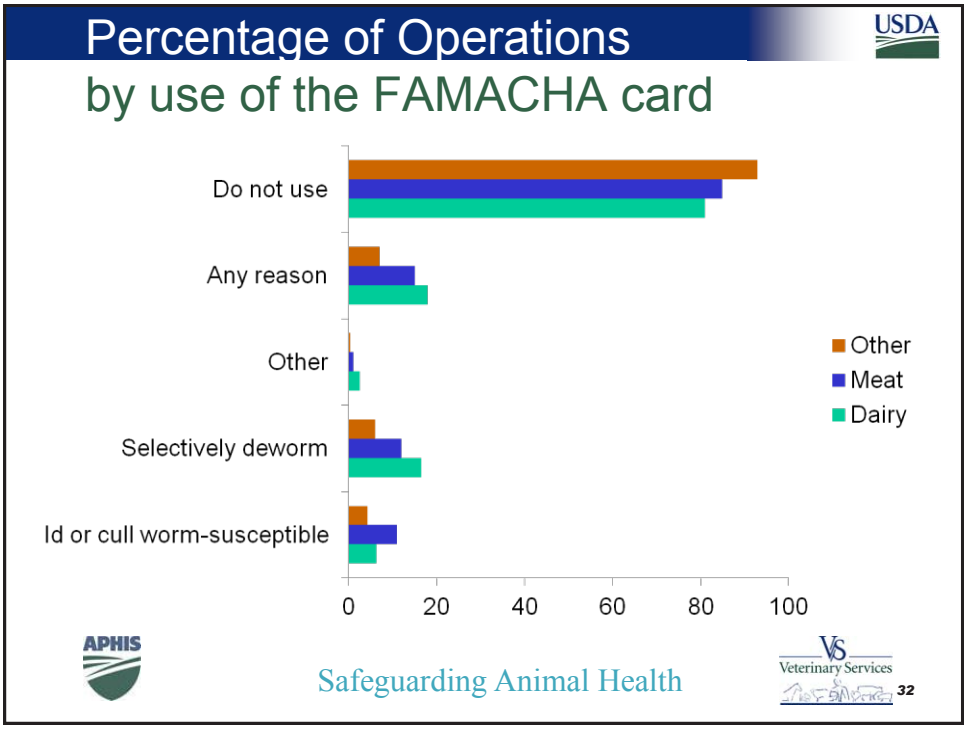
Percentage of Operations
by use of the FAMACHA card
USDA
Do not use
Any reason
Other
Selectively deworm
Id or cull worm-susceptible
Other
Meat
Dairy
0
20
40
60
80
100
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Veterinary Services
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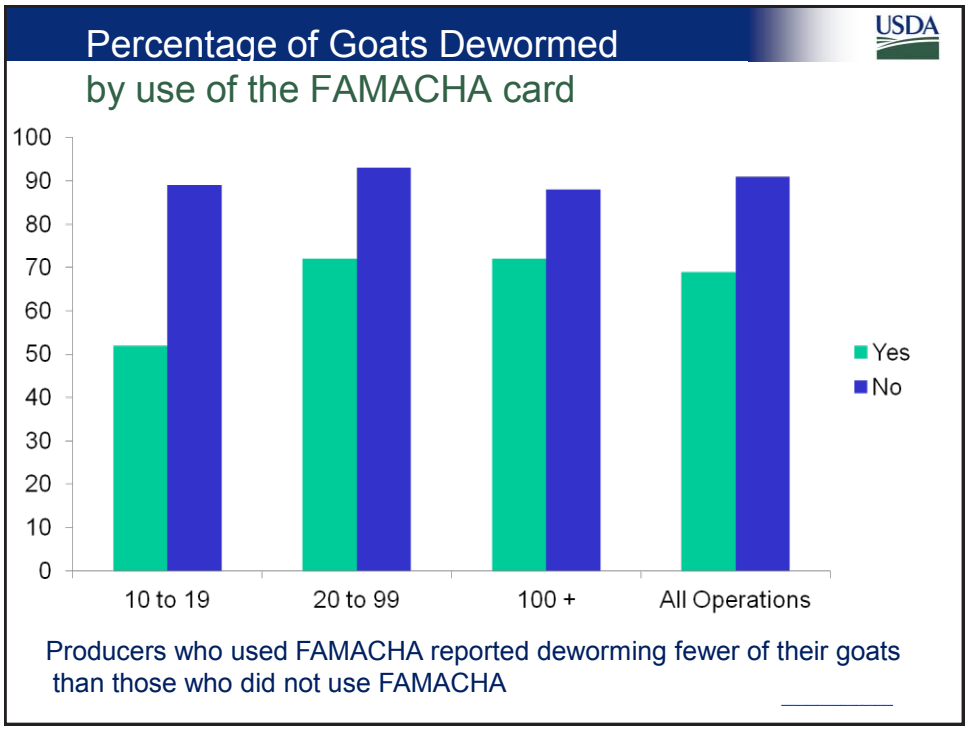
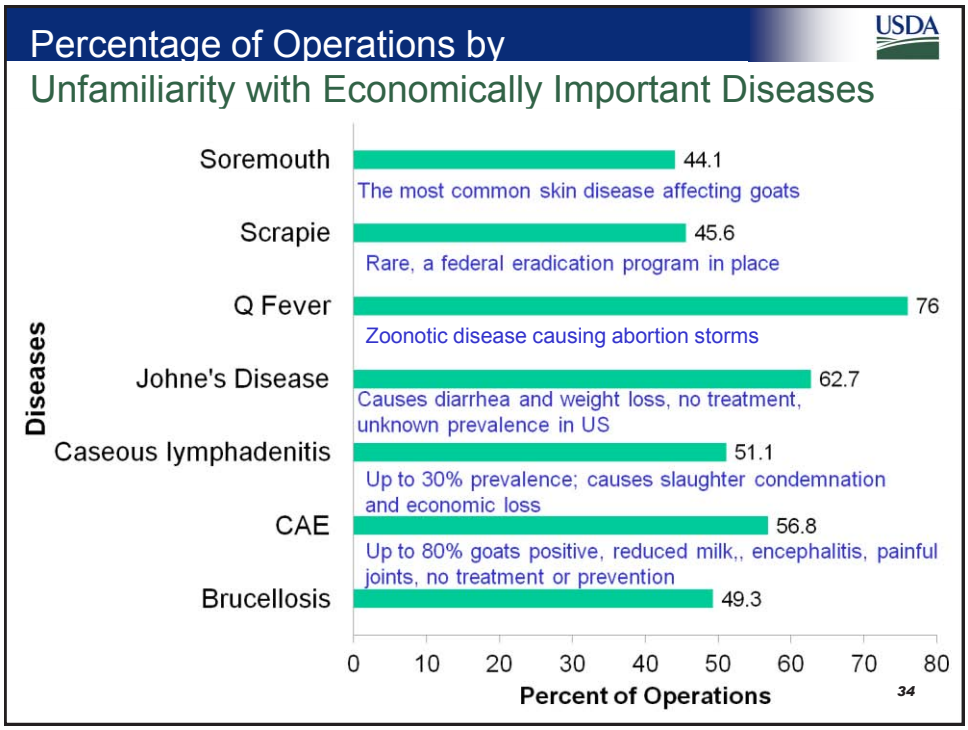

Percentage of Goats Dewormed
by use of the FAMACHA card
USDA
100
90
80
70
60
50
40
30
20
10
0
10 to 19
20 to 99
100 +
All Operations
Yes
No
Producers who used FAMACHA reported deworming fewer of their goats than those who did not use FAMACHA


Percentage of Operations by
Unfamiliarity with Economically Important Diseases
USDA
Diseases
Soremouth
44.1
The most common skin disease affecting goats
Scrapie
45.6
Rare, a federal eradication program in place
Q Fever
76
Zoonotic disease causing abortion storms
Johne's Disease
62.7
Causes diarrhea and weight loss, no treatment, unknown prevalence in US
Caseous lymphadenitis
51.1
Up to 30% prevalence; causes slaughter condemnation and economic loss
CAE
56.8
Up to 80% goats positive, reduced milk,, encephalitis, painful joints, no treatment or prevention
Brucellosis
49.3
0
10
20
30
40
50
60
70
80
Percent of Operations
34

Conclusions

- Large percentage of producers are new to goat production – especially true for meat goat producers
- Veterinarians important source of information for producers
- Dairy producers more likely to belong to a state or national association
- Dairy producers tend to be better informed, practice better biosecurity
- Plenty of opportunity for education

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NAHMS Goat 2009 Study

- Part I: Reference of Goat Management Practices in the US.
  - Printed in December 2010
- Part II: Reference of Goat Health and Marketing Practices in the US
  - Printed in April 2011
- Available on the web at
  - http://www.aphis.usda.gov/animal_health/nahms/

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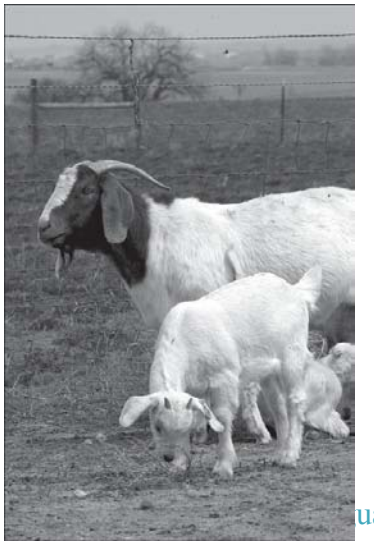
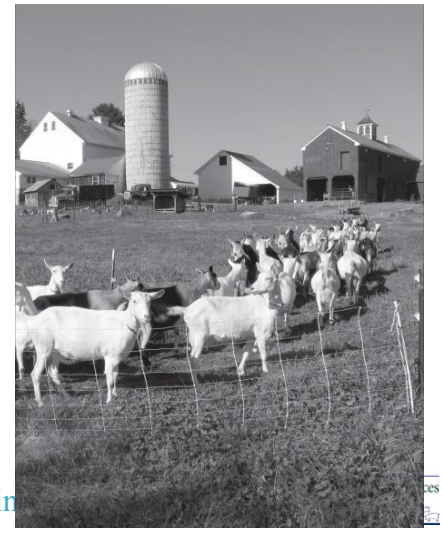
Goat 2009
Part I: Reference of Goat Management Practices in the United States, 2009



Goat 2009
Part II: Reference of Goat Health and Marketing Practices in the United States, 2009



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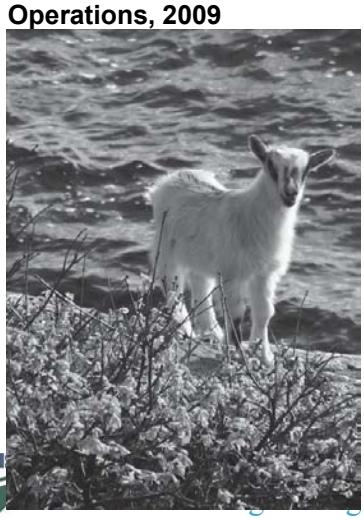
Goat 2009
Part III: Biosecurity and Disease-prevention Practices on U.S. Goat Operations, 2009

United States Department of Agriculture
Animal and Plant Health Inspection Service
Veterinary Services
National Animal Health Monitoring System
January 2012



Small-scale U.S. Goat Operations, June 2009

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Collaborators

- Alicia Anderson, CDC
- Tom Besser, Wash State U
- Paula Cray, ARS Athens
- JR Dubey, ARS Bethesda
- Michelle Emery, NVSL
- Ray Kaplan, U Georgia
- Don Knowles, ARS Pullman
- Alan Huddleston, VS
- Jim Logan, WY/ASI
- Paula Menzies, U Guelph, Canada
- Janet Peyeur, NVSL
- Paul Plummer, Iowa State U
- Mary Reynolds, CDC
- Paul Rodgers, ASI
- Diane Sutton, VS
- Cindy Wolfe, U Minn
- Qijing Zhang, Iowa State U

Safeguarding Animal Health

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Thank you

- All documents available on the web at: http://www.aphis.usda.gov/animal_health/nahms/goats/index.shtml
- Questions:
  - Katherine.L.Marshall@aphis.usda.gov

Safeguarding Animal Health

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Neglected Biosecurity and Strategic Use

Dr. Katherine Marshall
USDA/APHIS Veterinary Services
Centers for Epidemiology and Animal Health
Fort Collins, CO

APHIS **Info Sheet**

Veterinary Services
Centers for Epidemiology and Animal Health

VS

March 2012

Biosecurity on U.S. Goat Operations

Biosecurity is a system of practices designed to reduce the risk of disease introduction into a herd and prevent the spread of disease within a herd. Because disease transmission to even one animal can affect the health of the entire herd, biosecurity practices are an important part of the health management plan of all operations. Good biosecurity practices include proper handling of new animals and visitors; regular veterinary consultations; limiting contact with other animals; use of animal identification; and management of kidding areas and kidding products to minimize environmental contamination. Ideally, goat producers should work with a veterinarian experienced in goat production to develop practical and cost effective biosecurity practices that reduce disease risk.

The NAHMS Goat 2009 study was the first national study of the U.S. goat industry and was conducted in 21 of the Nation's major goat-producing States.[1] These States represented 75.5 percent of U.S. goat operations and 82.2 percent of U.S. goats (NASS 2007 Census of Agriculture). Data for the study were collected from a stratified random sample of goat operations that kept at least one goat for meat, dairy, fiber, or other purposes. A total of 2,484 operations completed the study's first survey questionnaire and 634 completed a second mail-in questionnaire. The second questionnaire was limited to operations with 10 or more goats.

Herd additions

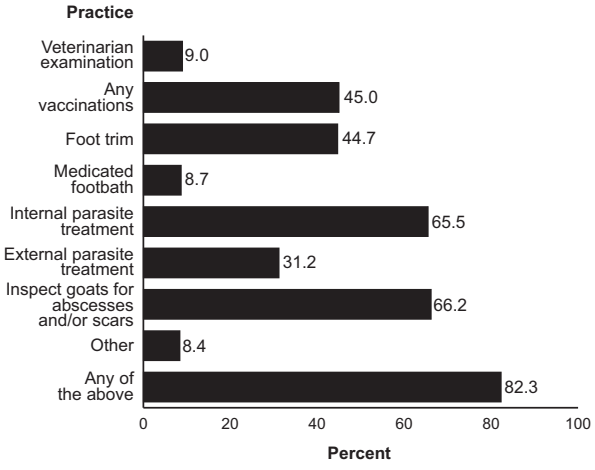
Adding new animals to a herd can introduce disease. One way an operation can prevent disease introduction is to keep a closed herd (adding animals only through kidding on the operation), although adding new animals from outside the herd is a great way to improve stock and bring in new bloodlines. When added, new animals should be quarantined and monitored for signs of disease. The duration of isolation must be sufficient for diseased animals to show clinical signs; however, it is important to be aware that infected animals may shed viruses without showing clinical signs.

Overall, 21.5 percent of operations had added goats or kids to the operation in the 12 months prior to the study (July 1, 2008 to June 30, 2009). Most operations that added adult goats obtained goats directly from another goat operation (72.8 percent of operations) or purchased goats at an auction market (23.5 percent of operations). Goats or kids obtained at an auction market or from another goat operation are considered a high risk for disease transmission compared with goats born on operation. Overall, 48.6 percent of operations that added goats or kids always isolated new additions, while 39.5 percent never isolated new additions. On average, new additions were isolated for a minimum of 21 days before introduction into the herd. A minimum of 30 days is recommended, and a longer quarantine is more likely to reduce transmission of previously unrecognized infections.

Another good practice is to require health management measures prior to introducing new animals. These measures can include veterinary examination, disease testing, deworming, and vaccinations. For operations with 10 or more goats that added goats in the previous 12 months, the most common health management practices used were inspecting new goats for abscesses or scars (66.2 percent of operations) and internal parasite treatment (65.5 percent of operations) [figure 1]. Only 9.0 percent of operations required a veterinary examination, and only 11.6 percent required any individual animal testing for specific diseases.

[1] **States and Regions:**
Northeast: Indiana, Iowa, Michigan, Missouri, New York, Ohio, Pennsylvania, Wisconsin
Southeast: Alabama, Florida, Georgia, Kentucky, North Carolina, Oklahoma (east), Tennessee, Texas (east), Virginia
West: California, Colorado, Oklahoma (west), Oregon, Texas (west), Washington

Figure 1. For operations* that added goats during the previous 12 months, percentage of operations by health management practices required for new additions



*Operations with 10 or more goats.

Of operations that did not add any goats or kids during the previous 12 months, 40.6 percent had added goats or kids in the past 1 to 2 years and 54.8 percent had added goats or kids in the past 3 to 9 years.

Needle usage

Note: Data in this section represent only operations that had 10 or more goats.

Using the same needle when giving injections to several animals increases the risk of disease transmission between animals. The best practice is not to reuse needles. If this is not possible, disinfecting needles between animals can reduce the risk of disease transmission. Overall, 61.8 percent of operations had given at least one injection in the previous 12 months. Of operations that gave injections, nearly 49.6 percent used the same needle on more than one goat. Of these operations, 59.8 percent never chemically disinfected needles between animals. About one-fourth of operations (22.8 percent) always disinfected needles between animals, and the same needle was used on an average of 5.1 goats.

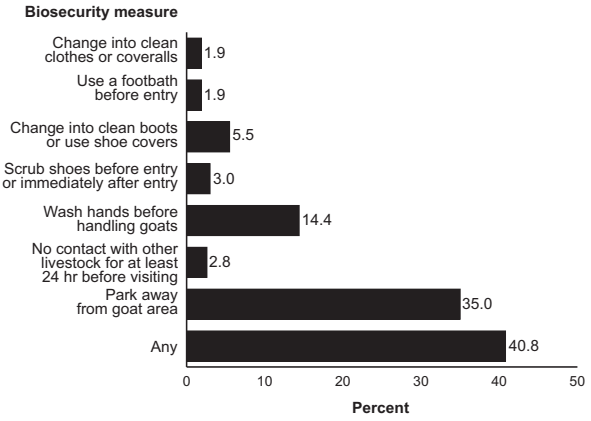
Use of veterinarian

A veterinarian experienced in livestock production can help develop practical and cost-effective biosecurity measures, and can be a good source of information about goat health and current issues in the goat industry. During the previous 12 months, about one-third of operations (34.8 percent) had consulted a veterinarian for reasons related to goat health, productivity, or management. One reason so few operations had consulted a veterinarian could be difficulty in finding a veterinarian experienced in goat production. The percentage of operations that consulted a veterinarian increased with operation size[2], ranging from 28.7 percent of very small operations to 42.4 percent of large operations. A higher percentage of operations in the Northeast region[1] (41.6 percent) consulted a veterinarian compared with operations in the Southeast region (30.8 percent).

Visitors

Visitors to goat operations include veterinarians, extension agents, nutritionists or feed company consultants, customers, renderers, and others. Visitors can contribute to disease spread from one location or herd to another by carrying disease agents on their vehicles, clothing, hands, or instruments. Overall, 66.7 percent of operations had visitors during the previous 12 months. Of these operations, 59.5 percent had visitors that entered the goat production area. The biosecurity measures always used for visitors by the highest percentages of operations were to have visitors park away from the goat area (35.0 percent) and to have visitors wash their hands before handling goats (14.4 percent) [figure 2].

Figure 2. For operations on which any visitors entered the goat production area during the previous 12 months, percentage of operations that always required the following biosecurity measures



[2]**Operation size:**
Very small: 1 to 9 goats
Small: 10 to 19 goats
Medium: 20 to 99 goats
Large: 100 or more goats

A higher percentage of very small operations (45.3 percent) required any of the biosecurity measures listed in figure 2 compared with large operations (29.7 percent). This finding is especially concerning because a higher percentage of large operations (74.0 percent) than very small operations (58.7 percent) had visitors, and a higher percentage of large operations with visitors than very small operations allowed visitors to enter the goat production area (64.7 and 53.4 percent, respectively). A higher percentage of dairy goat operations always required at least one biosecurity measure to prevent disease introduction by visitors who entered the goat production area (59.7 percent) compared with meat operations (35.1 percent).

Physical contact with other animals

Domestic and wild animals often serve as reservoirs (sources) of disease and minimizing contact with these animals is another important biosecurity measure. During the previous 12 months, almost 9 of 10 goat operations (88.8 percent) had dogs or cats on the operation and more than 5 of 10 (52.9 percent) had horses or donkeys. More than half of large operations (59.9 percent) had beef or dairy cattle. One-third of large operations (31.2 percent) had poultry, compared with about half of very small operations. A lower percentage of operations in the Southeast region (8.9 percent) had domestic sheep than operations in the West and Northeast regions (22.2 and 23.6 percent, respectively).

Overall, goats on 71.2 percent of operations had fence-line contact with or commingled with dogs, cats, raccoons, skunks, or opossums during the previous 12 months. Also, goats on more than 4 of 10 operations (43.9 percent) had commingled with or had fence-line contact with predators. Goats on one-third of operations (32.9 percent) had been in contact with deer, elk, antelope, or exotic hoof stock. In the West region, goats on one of five operations (21.2 percent) had fence-line contact or commingled with domestic sheep or goats from another operation, and goats on more than one-third of operations (37.2 percent) had contact with beef or dairy cattle from another operation.

Animal identification

The use of individual animal identification (ID) [a unique number assigned to each goat] and/or herd ID (farm name, farm logo, or a number unique to the farm) can be important tools in disease management and control. ID helps producers monitor important production parameters and makes it possible to trace an animal to its herd of origin if disease is diagnosed after an animal has been moved. Certain forms of ID are required by the USDA and/or individual States when animals are sold or when they are moved from their herd of origin. The percentage of operations that used either herd or animal ID increased with herd size, ranging from about one of three very small operations (30.7 percent) to three of four large operations (74.3 percent). Scrapie tags were the most common form of herd ID (15.6 percent of operations, representing 25.7 percent of goats and kids).

Kidding management

Note: Data in this section represent only operations with 10 or more goats that had kids born alive.

Does that become infected with certain pathogens for the first time while pregnant may abort, kid early, or have small or abnormal kids. Therefore, keeping first-kidding does away from others until after they have kidded may reduce the risk of infection. Overall, 38.1 percent of goat operations separated first-time kidders from older does during kidding. Using the kidding area as a place to house sick goats is convenient when facilities are limited; however, this can also increase the risk of spreading infections within the herd.

Overall, 90.3 percent of operations did not house sick goats in the kidding area during the previous 12 months. This practice was less common on large operations (83.0 percent) than on small operations (95.1 percent). Ideally, manure and waste bedding should be cleaned from the kidding area after every birth, although doing so is not always practical, especially on large operations. One of four operations (25.7 percent) cleaned manure and waste bedding from the kidding area after each doe during the last kidding season, and 28.9 percent of operations never cleaned manure and waste bedding from the kidding area. A lower percentage of operations in the Northeast region (9.4 percent) than in the Southeast or West regions (34.1 and 35.3 percent, respectively) never cleaned manure and waste bedding from the kidding area.

Good biosecurity includes prompt removal of placentas and aborted fetuses. Placentas and aborted fetuses can harbor thousands of infectious organisms that can spread infections to other goats within the herd or to other animals on the farm. Dogs or cats can move placentas to areas that might contaminate feed, promoting transmission of infectious organisms.

A lower percentage of small and medium operations left placentas and aborted fetuses in the field or birthing areas (36.2 and 37.4 percent, respectively) than large operations (64.2 percent). A higher percentage of operations in the West and Southeast regions (52.6 and 41.6 percent, respectively) left placentas and aborted fetuses in the field and birthing areas than operations in the Northeast region (21.6 percent).

Summary

Introduction of disease to a naïve herd can have serious economic consequences. Biosecurity measures can help reduce the risk of disease introduction. Goat producers can benefit from working with a veterinarian experienced in goat production to develop a cost-effective biosecurity plan for the operation. Recommended biosecurity practices include isolating new animals for 30 days, disinfecting needles between animals, limiting contact with outside animals, limiting visitor access to goat production areas, using animal identification, and managing kidding areas and kidding products to minimize environmental.

For more information, contact:

USDA–APHIS–VS–CEAH
NRRC Building B, M.S. 2E7
2150 Centre Avenue
Fort Collins, CO 80526-8117
970.494.7000
Email: NAHMS@aphis.usda.gov
http://nahms.aphis.usda.gov

#640.0112

Zoonotic Causes of Disease in Goats and Risks to You

Dr. Katherine Marshall
USDA/APHIS Veterinary Services
Centers for Epidemiology and Animal Health
Fort Collins, CO

- Zoonoses are diseases that can be transmitted from animals to people
  - Rabies and influenza are commonly known zoonotic diseases
  - Q fever, Sore mouth, Toxoplasmosis, Salmonella, Campylobacter, Chlamydophila, are less common goat infections which also cause human illness
- Be informed
- Protect your health and that of your family and friends!

<u>Common</u> Zoonotic Diseases of Goats

- Skin
  - **Orf**
  - Ring Worm
- Abortion causing
  - **Q fever**
  - **Toxoplasmosis**
  - Campylobacter
  - Salmonella
  - Chlamydophila
- Raw Milk
  - Listeria
  - Campylobacter
  - E coli
  - Salmonella
- Kid scours
  - E coli
  - Cryptosporidium
  - Salmonella
  - Giardia
- Other
  - Caseous Lymphadenitis
  - Rabies

Producer exposures to zoonoses

- Handling goats with skin lesions without gloves
- Wearing barn clothes in the house
- Drinking unpasteurized milk
- Kidding environment – especially during an abortion storm when handling aborted material
- Handling contaminated hay, feed, manure

Orf or Sore Mouth

- **The Barnyard Perspective**
- Also known as: Contagious ecthyma, sore mouth, scabby mouth, contagious pustular dermatitis
- Worldwide distribution
- Common skin disease in US sheep and goats

  - 40% sheep operations*
  - 15% goat operations*
- Incubation period: 2-3 days
- Transmission:
  - Direct or indirect
    - Live virus found in dried scabs years after shed (12 years**)
    - Animal handling equipment
- Extremely infectious
  - Up to 90% of flock become ill
  - Mild loss of condition
  - Sores on lips and mouth
  - Lambs and kids greater risk for more serious lesions
- Orf Clinical Signs
  - Papules, pustules, scabby lesions found commonly on lips and skin of face
- **Human perspective**
  - Often initially misdiagnosed as cutaneous anthrax
  - Risks for infection
    - Vaccination (live vaccine)
    - Contact with infected sheep or goats
  - Lesions may be painful
  - Persons with compromised immune systems may develop serious infection
- Prevention and Control
  - Keep closed herd
  - Do not purchase from known infected herd
  - Quarantine newly purchased animals
    - Some animals may be silent shedders (no clinical signs)
  - Do not allow contact with other goats at shows
- If herd is infected
  - Vaccinate 2 months prior to kidding to reduce chance of outbreak during nursing
  - Vaccinate to limit duration of outbreak if herd newly infected
  - Vaccinate at least six weeks prior to shows to reduce chance of outbreak during show
- Prevention and Control
  - Vaccine may transmit infection to humans
    - Wear gloves when handling vaccine
    - Wear gloves when handling newly vaccinated animals
  - Scabs may be infectious
    - Wear gloves when handling animals with scabby mouths, udders

Goat Herd Abortions

- Abortion rates in an unaffected herd typically < 2%
- Abortion storm
  - 15 to 70% pregnancies affected
  - Often clustered in time
- Endemic infection
  - 5 to 7%
  - Mistaken as “normal”

Q Fever: An Agricultural Perspective

Animal reservoirs

- Primary reservoirs - Cattle, sheep, goats
  - Reduced fertility
  - Sporadic, late-term abortions

Other reservoirs -

  - Argasid and Ixodes ticks transmit during feeding, survives in feces up to 6 years
  - Cats, rats, rabbits, mice, filth flies, deer, other wild animals
    - Iowa State U evaluating white tail deer role in bringing into operations

- Forms hardy spore-like form
  - Survives heat, cold, dessication
  - Wool, clay, sand

Ruminant shedding

- Milk, fecal, placental fluids, fetal tissues, vaginal mucus, urine
- Ruminant species variation
  - Cattle shed more in milk and for longer periods[1,2]
    - Vaginal mucus shedding limited in time
  - Sheep/Goats shed periparturiently (wks - months post partuition)[2]
    - Caprine
      - Milk main route
      - Vaginal mucus and feces less common
    - Ovine
      - Feces, milk, and vaginal mucus shedding
      - Most shed by all routes simultaneously
- Studies
  - Goats with reproductive failure…abortions*
    - 1st year – 30% abortions, 25% shedding (PCR)
    - 2nd year – 9% abortions, 94% shedding (PCR)
  - Goat herd abortion episode*
    - 11-17% of goats aborted
    - seronegative on ELISA, tissues positive on PCR
- Little current information on Q fever incidence or geographic distribution in the US
- Message
  - Can have animals with clinical abortions but seronegative
  - Can have animals with no clinical signs that are shedding
  - Animals don't have to be seropositive to shed organism

Transmission

- Oral ingestion – unclear risk[1]
  - Seroconversion in humans after exposure
  - Pathogenesis unknown
- Tick – not major route of transmission between animals
- Animal to animal transmission common especially around time of abortion
  - Shedding in environment via urine, feces, placental fluid
  - Organism shed in absence of clinical signs
  - Rat reservoirs implicated in Netherlands[2]
- Persistent environmental contamination
- Aerosolization – common cause of human infection
  - Current data out of Netherlands confirms
    - 59% of human cases occurred in individuals that live within 5 km (3miles) of infected farms while only 12% of population
    - RR of infection is ~ 31 x's more likely to be infected if live within 2km of infected farm than if lived >5km away
    - Arable land, lack of vegetation and low soil moisture
- Testing Procedures
- Serological testing
  - National Veterinary Services Laboratory
  - 3,000 – 4,000 serological samples / year
    - 2010 – 3076 submissions, 85 positive (2.8%)
  - Complement fixation USDA licensed / official
    - ELISA testing – exports
    - Test comparison: CF and ELISA results
      - 88% agreement between CF and ELISA
    - IFA testing – phase I / phase 2 antibodies

Testing Nationally

- Many veterinary diagnostic labs test for C burnetii
  - Serologic tests
    - Some sent to NVSL for confirmation
  - PCR testing sometimes sent to CDC
- Washington State
  - Raw milk farms required to test for Coxiella
- Reportable to state animal health agency in 44 states

Prevalence U.S. Cattle

- 2003 CDC study demonstrated 22/24 (92%) seropositive bulk tanks (IFA) from vet school dairy cattle herds[1]
- 2001-2003 study in mostly Northeast dairy herds demonstrated 94% of dairy cattle bulk tanks positive by PCR (3 yr period)[2]
  - Mostly NY but 18 other states represented
- 2007 NAHMS study in 17 states – PCR of raw bulk tank milk samples[3]
  - % operation positive increased as herd size increased
    - 69.8% small operations (<100 head) positive
    - 98.8% large operations (500+ head) positive
    - Overall 76.9% herds positive

Current studies

- NAHMS 2011 study included Coxiella serology and soil samples collected from farms
  - 22 states, 13,249 sheep, 563 operations
    - ELISA at NVSL
    - IFA at Iowa State University
      - positives, equivocals, subset negatives
    - Soil PCR at Iowa State University
      - Dirt samples in or around sheep pens
- NOAA – seal/sea lions
- USGS – sea otters
- Washington State University – prevalence in WA goat herds

Prevalence U.S. Sheep and Goats

- Sheep and goat rates in US are unknown at present
  - Newfoundland study – 60% seroprevalence goats[1]
  - Goats – small population studies highest seroprevalence of ruminant reservoirs[2]
    - Preliminary data from Iowa State diagnostic lab suggests herd level shedding may be high ~45%[3]
    - Dr Paula Menzies data collected from both bulk tank and abortion samples submitted to lab[4] ~45%
- Netherlands outbreak in 2007- 2009
  - Began with abortions on goat farms 2005 – 2007
    - 15 dairy goat farms, 1 dairy sheep farm
  - In 2007, there were 168 human cases
  - In 2008, there were 1,000 human cases
  - In 2009, there were 2,357 human cases
- What happened?
  - Increase in goat populations (10 fold increase from 1998 2008), naïve human population, good conditions for aerosol spread, other?

Human Perspective

- Organism is highly infective
- 1 organism can infect a human when inhaled
- Major human outbreaks often associated with
  - Parturient small ruminants
  - Dusty and windy conditions
  - Close proximity (<2 miles) to farms with aborting does
- Incubation period: usually 2-3 weeks

- Asymptomatic (~50% of infected persons)
- Acute illness
    - Fever, chills, severe sweats, cough, malaise, headache, chest pain, weight loss
    - Pneumonia or hepatitis
- Chronic disease (rare; 1-5% of all infections)
    - Primarily endocarditis
    - Chronic hepatitis, recurrent miscarriages, bone or liver infections
    - Risk factors: pregnancy, pre-existing heart valve defect, immunosuppression
    - Chronic fatigue syndrome
- Considered to be an occupational risk
    - Slaughterhouse workers
    - Biomedical research
    - Veterinarians
    - Producers…..
- Overall seroprevalence 3.1%
    - Higher in older age groups
    - Higher in Mexican-Americans (7.4%)
- Outbreak of Q Fever, 2011
    - Traced goats from Farm A to 20 additional farms
        - Included WA, MT, and OR
        - 17 of 21 total farms participated in investigation
    - Detected *C. burnetii* in herds at 16 of 17 farms
    - Identified 20 human infections (11 WA; 9 MT)
        - 15 (75%) were symptomatic
        - 4 hospitalized; no deaths
    - Genetic analysis identified same strain (type 8) in 3 specimens
        - Index goat placenta, MT goat, WA environmental swab
    - Risk factor analysis in progress

Control of Coxiella - goats

- Non-specific
    - Education
    - Reduce Contamination of the Environment
        - Isolation of affected animals and their progeny
        - Reduce manure spread on farms
        - Prompt removal of placentas/aborted fetus'
- Specific
    - Antibiotics
        - Limit abortions but do not suppress transmission[1]
    - Vaccination – not available in the US
        - Reduces abortions and transmission if given to non-pregnant animals

Prevention of Q Fever - humans

- Protective clothing, masks, gloves
- Reduce potential to bring into the home by changing barn clothing and boots before entering home
- Use disinfectant hand wash

Toxoplasmosis

- Naïve cats become infected by eating infected rodents, birds, aborted material
- Cats pass oocysts for ~ 5 to 14 days.
- Sporulated oocysts infective for up to 18 mo.
    - Contaminate feed & pasture with feces
- Naïve does mount an immune response
    - If pregnant will infect placenta & fetuses
    - Mummies / abortions / stillbirths /weak & small kids
    - Lesions on placentas

- Does may abort more than once

Toxoplasmosis in Humans

- Prevalence – 22.5% of US population 12 years and older
- Transmission
  - Foodborne
    - Eating undercooked meat (mostly lamb, pork,venison)
    - Not washing hands well after working with uncooked meat
  - Zoonotic transmission
    - Cats play important role – contaminate soil, water, barn environment, goat feed
      - Shed millions of oocysts for up to three weeks after infected
    - Humans become infected when in contact with feces
      - Cleaning litter boxes
      - Working with contaminated hay, goat feed
      - Working with soil, eating vegetables contaminated with soil
  - Congenital toxoplasmosis (to fetus) from new infection while pregnant
  - Organ donation or blood transfusion – Rare

Human Illness from Toxoplasmosis

- Fetal infection
  - Signs:
    - Premature birth or underweight fetus
    - Damage to brain and eyes
    - Milder damage not apparent until older
- Post-Natal Infection
  - Usually mild illness with fever and swollen glands
- Infection is life-long
- If impaired immune system
  - Encephalitis
  - Retinal damage
  - Altered mental state

Control of Toxoplasmosis

- Cats – Spay them
  - Operations on which cats had litters were highest risk for toxoplasmosis*
- Rodent control
  - Infected mice will pass to offspring
- Feed protection from feces
  - Grain in containers
  - Don't feed top bales to pregnant ewes
  - Purchased feed may contaminated

General Precautions

- Handling of aborted tissues and females
  - Wear mask & gloves
- Protection when assisting births especially:
  - Pregnant women
  - Very young and very old
  - Immuno-compromised
- Wear dedicated protective clothing
  - Includes hat, coat, boots
  - Change clothing before entering home
- Wash hands and arms with disinfectant after goat work
- Safer to drink pasteurized milk
- Practice Good Biosecurity - always

AGF – Past, Present & Future

Mr. Tom Boyer
American Goat Federation

AGF – Past, Present & Future

Where We Have Been

&

Where We Are Going

2010

- Board Appointed
- Bylaws Created
- Mission Statement
  - **The American Goat Federation promotes and facilitates the development of all segments of the goat industry including dairy, meat and fiber, by encouraging sound public policy, enhancing production and marketing of goat products, and promoting research beneficial to our member organizations and all producers.**
- Incorporation Completed
- Planning Meeting – Louisville
- 1st Annual Meeting in Nashville

2011

- Annual Meeting – Reno
- ARS/NIFA Stakeholder - Baltimore
- NIAA – San Antonio
- Foot & Mouth Planning – Beltsville
- May Hill Visits – Washington DC
- NSIIC Grant
- National Scrapie Program Update
- Elections

Where We Are Now

- Newly Elected Board
  - Will Getz
  - Mary Pryde
  - Jan Carlson
  - Linda Campbell
  - Gil Engdahl
  - Sam Abney
  - Anita Dahl
  - Robin Saum
  - Tom Boyer

- Strategic Planning
- Business Planning
- Membership Drives
- Communications
- Public Policy
- Marketing
- Education & Research

The Future

- The 9 Billion-People Question
  - Doubling World Food Production
  - Anything for Dinner?
  - The End of Cheap Food Era
  - Production in the next 40 years will need to exceed the amount grown in the previous 500
  - Yield Curb
  - Organic?

- -Water
- Waste
- Climate Change
- Animals
  - China – Meat Consumption doubled 1980-2005
  - Increasing Demand at an Increasing Rate!
  - Income Incentives

- Genomics
  - Corn
  - Wheat
  - Livestock

Sheep & Goats

- Converting Forage into Consumable Protein

Kodak & Fujifilm

- Kodak = Google [1880]
- Kodak - 1976 = 90% of Film Sales & 85% of Camera Sales
- Kodak – Revenue peaked at $16B in 1996, 2011 Revenue was $6.2B
- The Last Kodak Moment?

Fujifilm

- 2011 Market Capitalization = $12.6B – Kodak = $220M
- 3 Pronged Strategy
  - Squeeze Film Profits
  - Switch to Digital
  - Develop New Business Lines

Kodak – Complacent Monopolist

- Fujifilm Capitalized on that Weakness
- Successful Diversifications
- Spirit of Place

Future Strategies for Sheep & Goats

- Industry Unification
- Adaptation of Technology
  - Marketing & Promotion
  - Production
  - Communications
  - Public Policies
  - ???

Your Role in the Future

- Peter Principle & The 80/20 Rule
- 20% – Finding Them - Fujifilm
- 80% – Ignoring Them – Kodak - Incompetence
- Action – Moving the Train out of the Station
- The Role of AGF

Lack of Approved Pharmaceutics Restrains US Goat Industry

Mr. Tom Boyer
American Goat Federation

What is the "goat industry?"

Cattle: non-selective grazers (grass)

Sheep: temperate grazing (intermediate selectivity)

Goats: intermediate feeders, tend toward highly selective browsing/grazing

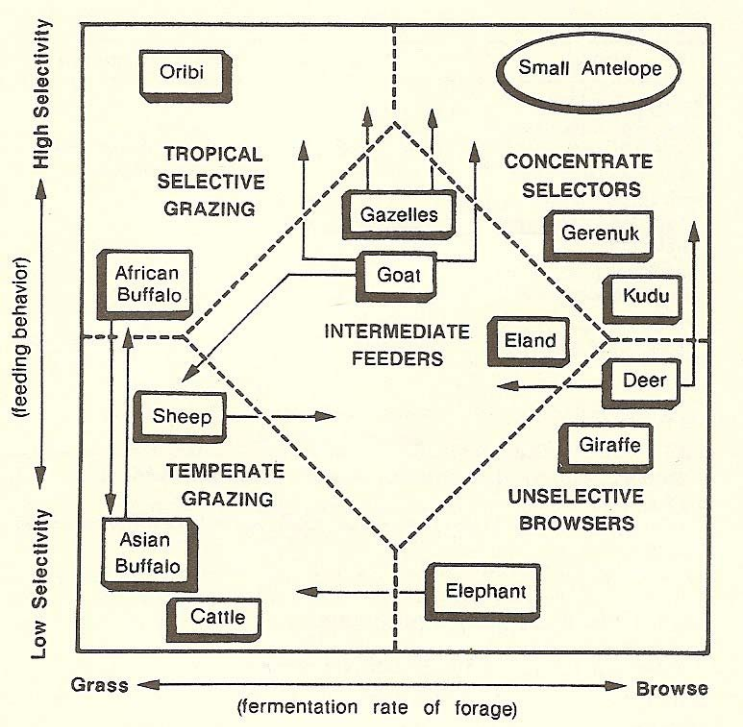


Figure 3.2. Herbivorous mammals classified by diet (from Van Soest and Demment, 1983; see also Van Soest, 1988b). The axes are the degree of feeding selectivity and the amount of grass versus browse in the diet. The arrows indicate mobility of a species with respect to these axes.

1. The Goats and their purposes:
   a. Meat
      i. Boer
      ii. Kiko
      iii. Spanish
      iv. Savannah
      v. Tennessee Meat/Myotonic

b. Dairy
    i. Alpine
    ii. Lamancha
    iii. Nubian
    iv. Nigerian Dwarf
    v. Oberhasli
    vi. Sable
    vii. Saanen
    viii. Toggenburg
c. Fiber
    i. Angora
    ii. Cashmere
d. Prescribed/selective Herbivory (Browsing)
    i. Kiko, any breed
    ii. Fire fuel suppression
    iii. Clear undesirable species
    iv. Urban forest
    v. Riparian areas
    vi. Crop residue
    vii. Clear vegetation in rough terrain
e. Companion
    i. Pygmy (often in suburbs, small lots/acerage)
    ii. Goat packing on public lands (goats interface with wildlife, may share parasites, infectious disease)

2. The People:
    a. Commercial/extensive dairy, meat or fiber herds
    b. Commercial/intensively managed dairy or meat herds
    c. Seedstock operations (usually smaller scale)
    d. Research or Biomedical uses
        i. Animal model for human disease (rheumatoid arthritis, HIV, trauma, orthopedics, etc.)
        ii. Antibodies
        iii. Goat reagents
        iv. Transgenic goats
            1. Spider silk
    e. Small flock
        i. Sustainable

ii. Organic
iii. Homestead
iv. Youth projects
1. 4H
2. FFA
3. Family Hobby
4. Science literacy for youth

3. The Products:
a. Milk
b. Cheese
c. Cajeta
d. Soap
e. All dairy products
f. Angora
g. Mohair
h. Hides
i. Leather
j. Meat
k. Meat products
l. Biomedical reagents
m. Fire safety
n. Ecosystem maintence
4. The Challenge: Only a small number of drugs available for use in goats.
a. Types of drugs needed:
i. Antibiotics
ii. Antiparasitics (both internal & external)
iii. Anti inflammatories/analgesics
iv. Reproductive management (for estrus synchronization and out of season breeding)
v. Anesthetics
b. If not labeled, then what? ELUD
c. Use drugs with proper knowledge
d. Get them approved
i. How does that happen?
ii. Vet Rx, vet uses FARAD for withdrawl times
iii. Where does this information come from?
1. ENTER….. NRSP-7
5. Why not just use cow/sheep drug labeling in an extralabel fashion?

a. A goat is not a little cow

b. A goat is not a hairy sheep

6. Examples where drugs can be used improperly by extrapolating:

a. Asprin (human isn't a goat)

b. Banamine (a cow isn't a goat) if you don't give it often enough, the goat suffers

c. Antibiotics (goats clear it faster) if you don't give it often enough you select for resistant microbes and don't treat the disease properly.

d. Toxic to goat – Xylozine (Rompun), Lidocaine, Micotil (if you give a cow does, you will have a dead goat.

7. Reasons we need more drugs

a. Relieve animal suffering

b. Promote wellness

c. Reduce production losses

d. Keep supply up, cost of production down

e. Trade barriers; If products are produced in other countries using these tools, that are not available in the US, this puts goat producers at an economic disadvantage.

i. Cheese, in France. The French government will treat your goats with sponges and PMSG to provide year-around breeding and thus year-around cheese production.

ii. Meat, in Australia. Year-around breeding and kidding, therefore year-around meat production.

8. How are animal drugs approved for use in the US?

a. Minor Use Animal Drug

i. Pharmacokinetic studies

ii. Pre-projects (pilot projects), to design projects for MUMS.

iii. Data for FARAD global

b. MUMS

c. FDA Approval

i. Target Animal Safety

ii. Efficacy

iii. Human Food Safety

1. Meat residue

2. Milk residue

iv. Company labeling

9. But WAIT! It get's worse:

a. There is no buget funding for NRSP7

b. There is no budget funding for FARAD

c. And it's not just the goats that will suffer

i. Sheep

ii. Deer
iii. Elk
iv. Bison
v. Fish
vi. Other aquatic species
vii. Honey bees
viii. Llamas
ix. Alpacas

d. Even the cattle will lose (site cattle study under NRSP7)

10. What can we do?
    a. Explain
11. SUMMARY
    a. Who we are/what good we do in society
    b. The problem
    c. The solution

Goat Farm Budgeting

Mr. Roger Sahs
Oklahoma State University

Introduction

Investing in a farm is often an expensive undertaking and can be financially stressful. Land ownership in particular is costly. Historical rates of return to agricultural assets average 4 to 5% making it difficult to make principal and interest payments on land notes with farm income only. Hence, business planning is especially important in ranching operations even if the decision to produce goat meat is a lifestyle choice or hobby rather than strictly an economic one. An expensive hobby may create a serious financial drain on the producer's checking account.

The agricultural producer or farm manager is challenged when organizing and managing farm resources to maximize economic returns to owned or controlled resources. Resources include land (owned and rented) and associated improvements, capital (borrowed and owned), and labor (hired, farm operator, and additional family). The manager is responsible for combining available resources and knowledge to best achieve the desired goals and objectives of the farm business.

As a key component of a business plan, budgeting is a management tool that helps the beginning producer evaluate the feasibility of a proposed venture and helps established producers identify areas for improvement. Budgets identify financial resources needed for both farm investment and annual operating costs. With budgets, management can begin to answer such questions as:

- How may the available resources best be used?
- What enterprises (crops and/or livestock) can be produced and which will contribute most to returns to owned resources?
- How much of the controlled land should be devoted to each enterprise?
- What equipment and machinery will be needed to produce the potential enterprises?
- What production practices should be used to produce each of the enterprises?
- How much labor (both family and hired) will be needed on the farm?
- What are the capital requirements?

Budgets help ensure that investors make decisions based on realistic data, not just emotions. Knowledge of budgeting and the ability to use them will help make the right decision.

Enterprise Budgets

Questions may arise as to whether goats will help supplement farm income or if a larger operation is even technically feasible. In an enterprise with seasonal and cyclical price changes, sensitivity to variable grain and hay prices, and a vulnerability to weather, appropriate management practices and an identification of key cost components are important. Circumstances over which the producer has no control can wreak havoc in the short run if a producer neglects strategic planning and risk management.

An enterprise budget estimates the full economic costs and returns projected to accrue to an activity - raising livestock or producing grain - for some period, generally one year. Enterprise budgets incorporate information about the specific resources, management practices, and technology used in the production process. Budgets help provide a decision framework for assessing both short- and long-range economic analyses of production agriculture. Budgeting allows producers to evaluate options before committing resources. Budgets can also be used to estimate potential income and the size of farm needed to earn a specified return or to compare the profitability of two or more systems of production. Budgets provide the documentation neces-

sary to project cash flows and obtain/maintain credit-worthiness. Budgets can also be used to estimate the amount of rent that can be paid for land or machinery.

A goat enterprise budget is a statement of what is generally expected from a set of particular production practices, listing the expected revenue and expenses incurred. It is designed to show profitability, not just cash flow. Profit is shown as residual earnings after resources utilized in the operation have been assigned a payment. The enterprise budget shown in Table 2.1 lists anticipated costs of operating inputs plus fixed costs (interest, depreciation, taxes, and insurance) on machinery, equipment, and livestock along with expected production per doe. Since the budget documents variable and fixed costs, it is useful in calculating profitability, break-even values, and the potential return on an investment.

An enterprise budget should contain several components. A detailed description should include a production goal, the production techniques to be employed, the land resource required, and even something about the capital and labor requirements. An enterprise budget should include all costs and all returns associated with the defined enterprise.

Production

Historically, a lack of a developed nationwide marketing system in the United States caused seasonal price fluctuations and wide variations by location. Goat meat is favored by a number of ethnic groups who have immigrated to this country and many producers have traditionally supplied goat meat to these populations on an individual basis. However, with goat meat demand steadily increasing and domestic producers raising more goats to meet this growing appetite, market outlets such as livestock sales auctions are becoming more common. Slaughter prices are still higher in the early spring months, but this seasonality is not as pronounced as it once was.

A sample budget considering a herd size of 50 does and two bucks is shown in Table 2.1. The kids are marketed at four months of age. The total quantity of production is multiplied by the actual or expected price to determine value of production. Gross or total receipts are the sum of production values for individual items. For example, the expected returns in the budget are averaged for reporting on a per doe basis. A herd technically does not market 40.5 male kids for sale. This is a statistical result of the averaging process for the herd. The averaging process yields a realistic estimate of the budget unit (doe) returns to the entire herd given the assumed kid crop percentage, death loss, and cull doe replacement rates.

Table 2.1 – Meat Goat Budget, 50 Head Unit, 180% Kid Crop, 10% Kid Death Loss, 20% Doe Replacement Rate, Central Oklahoma Native Pasture, Per Doe Basis. Market kid and culled buck prices reflect 2007-11 OK averages.

	Weight	Unit	Price/Cwt	Quantity	Total	$/Head
PRODUCTION						
Male Kids	70.0	Lbs.	$106.49	40.50	$3,019	$60.38
Female Kids	70.0	Lbs.	$106.49	30.50	$2,274	$45.47
Cull Does	85.0	Lbs.	$90.00	7.00	$536	$10.71
Cull Replacement Doe Kids	70.0	Lbs.	$175.00	0.00	$0	$0
Cull Bucks	135.0	Lbs.	$92.63	0.00	$0	$0
Total Receipts					$5,828	$116.56
OPERATING INPUTS		Unit	Price	Quantity	Total	$/Head
Pasture		Head	$1.60	1	$80	$1.60
Hay		Head	$13.44	1	$672	$13.44
Grain		Head	$0.00	1	$0	$0.00
Protein Supplement		Head	$42.76	1	$2,138	$42.76
Salt/Minerals		Head	$0.57	1	$29	$0.57
Vet Services/Medicine		Head	$2.03	1	$101	$2.03
Vet Supplies		Head	$3.25	1	$163	$3.25
Marketing		Head	$8.50	1	$425	$8.50
Mach/Equip Fuel, Lube, Repairs		Head	$8.39	1	$420	$8.39
Machinery/Equipment Labor		Hours	$10.25	0.90	$462	$9.23
Other Labor		Hours	$10.25	2.00	$1,025	$20.50
Annual Operating Capital		Dollars	6.50%	51.39	$167	$3.34
Total Operating Costs					$5,680	$113.61
Returns Above Total Operating Costs					$148	$2.95
FIXED COSTS		Unit	Rate		Total	$/Head
Machinery/Equipment						
Interest at		Dollars	6.00%		$89	$1.78
Taxes at		Dollars	1.00%		$26	$0.51
Insurance		Dollars	0.60%		$9	$0.18
Depreciation		Dollars			$206	$4.11
Livestock						
Interest at		Dollars	6.00%		$403	$8.06
Taxes at		Dollars	1.00%		$94	$1.87
Insurance		Dollars	0.60%		$41	$0.81
Depreciation		Dollars			$88	$1.75
Land			$0			
Interest at		Dollars	0.00%		$0	$0
Taxes at		Dollars	0.00%		$0	$0
Total Fixed Costs					$954	$19.07
Total Costs (Operating +Fixed)					$6,634	$132.68
Returns Above all Specified Costs					$(806)	$(16.12)

Source: OSU Enterprise Budget Software.

Production Costs

Three general types of costs comprise the total cost of producing any type of farm commodity. They are variable (operating), fixed, and overhead expenses. Overhead expenses (also known as indirect costs) are difficult to allocate among individual enterprises. Examples include telephone, electricity and accounting services. Overhead expenses are included in whole-farm budgets, but are generally excluded in enterprise budgets.

Variable Costs

Variable costs are those operating inputs that vary as the level of production changes. They are items that will be used during one operation year or one production period. Examples include feed, fuel, vet medicine and supplies. They would not be purchased if production were not undertaken.

Variable costs may also be classified as cash or non-cash in nature. For instance, labor expenses are included in the operating input section of Table 2.1. No differentiation between owner supplied or hired labor is assumed. If the farm operator or a family member supplies labor, a wage rate or salary that represents earnings if employed elsewhere would be shown. This illustrates one of the most important concepts in economics – opportunity costs. Every resource used in the production process has one true cost, its opportunity cost. The opportunity cost of labor is the return the resource can earn when put to its best alternative. If the operator decides not to assign a charge to the labor item, residual earnings (as defined by Returns Above Total Operating Costs) includes labor income. The producer can then determine whether the return is adequate compensation for his/her labor efforts.

Fixed Costs

Fixed costs are not affected by short-term enterprise decisions and do not vary with the level of production. Generally, fixed costs are those ownership costs associated with buildings, machinery, and equipment that are pro-rated over a period of years. Fixed costs may also be cash or non-cash in nature. Real estate taxes, personal property taxes, and insurance on buildings are examples of cash fixed costs. Non-cash costs include depreciation and interest on capital investment.

The interest charge for capital assets such as machinery, equipment, and breeding livestock used in the goat operation is based on the average amount of capital invested over the ownership period, usage per year, and an interest rate. It is important to note that money invested in purchased capital assets has an opportunity cost as well – the return they can earn from their best alternative use. This interest on investment reflects a payment to a farmer's owned resources.

Depreciation represents an attempt to spread the investment costs or purchase price of durable assets over their productive lifetime. It is typically the largest cost associated with asset ownership. For example, when a tractor is worn out, it should have been completely "paid for" by depreciation. A producer must, in effect, save this much every year or reinvest it in machinery and equipment, or he/she will eventually end up with worn out items and no cash reserves to replace them.

Taxes vary by region but are generally a function of average value. In the goat budget, the annual charge for taxes is based on 1% of the purchase price.

Insurance policies are usually carried on more expensive machines while the farmer generally assumes the risk of loss on the simpler, less expensive assets. The insurance costs are based on the average amount of capital invested times an insurance rate.

Returns Above Total Operating Costs

The return to fixed costs, risk, and man¬agement (that is, the returns above total operating costs) is computed by subtracting total operating costs from total receipts. When returns above operating costs are positive, production is economically rational for an established enterprise. Positive returns above total operating costs (as shown in Table 2.1) indicate that the enterprise generates enough revenue to cover all variable costs and some portion of fixed costs. If returns above total operating costs are negative, the enterprise is not generating enough revenue to cover even variable costs. Unless the producer is willing to subsidize the operation (for instance, by contributing off-farm income), eliminating this enterprise will increase profits or decrease losses on the overall farm business. The return above total operating costs is also known as gross margin.

Returns Above All Specified Costs

In determining overall enterprise profitability, fixed costs also have to be part of the profit equation. The return above all specified costs is calculated by subtracting total variable and fixed costs from operating revenues. This amount represents residual earnings for management, risk, and to land (because land costs can have a large variation within a region, land costs are excluded). A positive return above all specified costs indicates that the operation is self-supporting and shows an amount available for reinvestment in the business or family living. Each individual must decide whether this return is a sufficient reward for management skills, risk exposure, and to land devoted to the enterprise. Will returns earned in the long run be sufficient to replace breeding livestock and the machinery/equipment devoted to the enterprise while also contributing to family living and overall farm maintenance? While a loss may create cause for concern, it may only be temporary. The operator should monitor this "bottom line" periodically to determine whether this enterprise has the ability to survive in the long-run. It should be noted that since non-cash items may be included in fixed costs, operating profits are not the same as net cash or operating receipts as shown in a cash flow statement.

Building on budgets to determine break-even prices or yields and view sensitivity analysis is helpful in evaluating the financial risk associated with an enterprise. The break-even price is the price at which all costs will be covered given average production; the break-even yield is the level of production needed to cover all costs given average market prices. Break-evens above variable costs and above all costs both provide useful information. With sensitivity analysis, income variability due to price and production risk is demonstrated, typically with tables of numbers showing returns under different price and yield scenarios. This information helps the managers assess their willingness to assume the risk of these variations.

One of the most important keys to successful goat operations is to be as cost effective as possible. As mentioned previously, one needs to periodically evaluate the contributions of all resources used in the operation. Look at possibilities for improving cost control through new technologies or cultural practices. Identify key leverage points that can generate the "most bang for the buck". Are there ways to reduce the number of trips to the feed store while still meeting nutritional requirements? Try to minimize harvested or supplemental feedstuffs with improved grazing management. A goat is a forage harvesting machine and grazing will always be cheaper than providing harvested forages. There is no single management practice that affects livestock profitability more than stocking rate. Can you do a better job of animal husbandry instead of regular visits from the veterinarian? Benchmark what other producers are doing. Spending dollars wisely given the appropriate management practice can generate major dividends that impact the bottom line. After all possibilities to improve the budget have been exhausted and long-run earnings still appear unsatisfactory, the best decision may be to exit the enterprise and employ resources in a different enterprise or investment.

OSU software is available to develop a customized budget for an individual operation (http://agecon.okstate.edu/budgets). The Microsoft Excel-based software provides users access to important agricultural references during an "interactive" budget building process. Through a series of links and pop-up menus, users may override defaults with their own values to customize the budget if their experience and farm records indicate different values and production practices. Where possible, web-links are built into the spreadsheets to provide users important economic and agricultural science information on the Internet. Link examples include OSU Extension publications, Oklahoma Agricultural Statistics Service data, and Langston University goat information.

The software is designed to be flexible and user-friendly. After specifying a base livestock budget setting via a start-up form, the budget (as shown in Table 2.1) may be further customized by clicking on any budget item which links to a corresponding supporting sheet within the workbook. For example, to access and change the default kidding percentage for the herd, one may click on any of the production items linking to the Production sheet. The Production sheet summarizes herd information, kid retention and sales, culling and replacement practices, and herd buck information. Default values for kidding percentages, kid death losses, and average sale weight are based on information from the E. (Kika) de la Garza Institute for Goat Research at Langston University. Kidding percentages can then be tailored to match a particular operation on the screen.

Other Aids to the Process

Education

The producer needs to know what they are doing or raising goats will be a painful lesson in the pocketbook. You will need to have an eye for detail, be able to follow set procedures, and understand the risks involved. Use the best information available and include all decision makers in the business planning process. Talk to local producers and Extension personnel. Other sources of information are books/periodicals on meat goat production and industry, commodity organizations, and meat goat websites such as Langston University . The National Ag Risk Education Library provides risk management education on a variety of topics including goats. Focus on financial management as much as production performance. Realize that alternatives that appear profitable for one producer may not work for another. Everyone's experience levels, managerial abilities, and willingness to assume risk is different. Do your homework!

Financial Records

Records are the foundation for accurate budgets, financial statements, and tax reports. While tax reporting is the primary motivation for record keeping for many producers, research has shown positive returns to investments in record keeping and analysis in support of farm and ranch decisions. The sample budget previously discussed may be tailored to fit an individual producer's operation, but its reliability as a planning tool is only as good as the quality of the data.

Since budgets should be based on the best information possible, the producer's own records are a good place to start. A variety of tools are available to assist producers in keeping financial records. The record-keeping system that a farm manager should use depends on the cost - time, effort, and cash – in obtaining a system, maintaining it, and the value of the output as a decision tool. Farm record systems vary in the amount of information collected, the method of entering data, and the structure of final reports. Goat producers should choose the method appropriate to the size and complexity of their operation.

Computerized record-keeping systems are affordable and especially useful for manipulating data for different types of reports. Although a computerized system may not reduce the amount of time spent keeping records, computerized records make financial summaries simple, more efficient and effective for management needs. For instance, an annual or monthly cash flow statement based on actual income and expenses can be

generated in a matter of seconds. Income and expenses can be sorted by enterprise so that farm managers know where "profit centers" are on the farm. Whole farm or enterprise budgets can be prepared and compared to actual transactions so that financial progress can be monitored at regular intervals. Graphs prepared with a few keystrokes can show where cash is coming from and where it is going and are invaluable in getting a quick feel for the farm's financial situation.

A number of user-friendly commercial software products are now available that can be adapted for farm use. One such software program that is appropriate for farms and ranches requiring only cash records is Quicken®. Quicken® is user-friendly, widely available, and inexpensive. More information on using Quicken® for farm financial record keeping is available from the OSU Department of Agricultural Economics at http://agecon.okstate.edu/quicken/. Producers who need a payroll system plus the ability to invoice and maintain accounts payable and receivable may want to use QuickBooks®, which is a small business double-entry accounting system, or a comparable package. Cash flow features and investment tracking are lacking in QuickBooks.

Hand record books are available through the Oklahoma Cooperative Extension Service and from many lenders. The OSU Agricultural Economics website offers a book from which individual pages are available to be printed as needed: http://agecon.okstate.edu/farmbook/.

Oklahoma farmers and ranchers can call on the Intensive Financial and Management Planning Support (IFMAPS) program to receive free, confidential assistance in farm business planning, including analyzing the potential for a new farm business. Trained financial specialists work with families one-on-one to develop financial statements and evaluate alternative plans. The plans typically include budgets for the farm enterprise(s), a cash flow plan, income statement, balance sheet, debt worksheet, and financial measures. Contact your local agricultural Oklahoma Cooperative Extension Educator or call the IFMAPS Center at 1-800-522-3755.

Budget Limitations

Although "best estimates" should be used to develop budgets for use in farm business analysis, it is important to remember that projections are influenced by production and price uncertainty. Such variability creates risk to the operator and puts pressure on the reliability of the estimates used in the enterprise budgets. Everything doesn't proceed just like you planned it. Even under careful use, errors can compound themselves to the point where budgets can have little or no value. This element of risk should be considered and evaluated by the manager when determining the solutions that best meet the goals and objectives of the farm family. Successful farm managers adjust their numbers throughout the year at regular intervals by comparing actual outcomes versus planned. This internal evaluation will help identify existing or potential problems and will result in fewer unpleasant surprises.

Budget preparation is time consuming, but it can pay major dividends. It requires pencil and calculator activity as well as searching data sources for information to be used in preparing the budget. Software is also available to assist in budget calculations. Not only is it important to work hard, but also to work smart.

Conclusion

Budgets are management tools to help evaluate the farm business. Like a puzzle, each budget brings to the table an important piece that will help address how available resources best fit together on the farm. Specific questions such as how and what to produce, production levels, and achieving goals can be answered once the puzzle is completed.

Business management requires that producers focus on financial management as much as production performance. For an enterprise with seasonal and cyclical price changes, sensitivity to variable grain and hay

prices, and a vulnerability to drought, successful managers discover that life is a whole lot easier saving money through budget planning. Goat producers interested in being profitable should expect to do no less.

References

Doye, D. (2009) Budgets: Their Use in Farm Management. OSU Extension Facts AGEC-139, Cooperative Extension Service, Oklahoma State University. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-1682/AGEC-139web.pdf

Doye, D. (2009) From Cash Records to Cost of Production, OSU Extension Facts AGEC-242, Cooperative Extension Service, Oklahoma State University. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-1663/AGEC-242web.pdf

Doye, D. (2009) Information Systems for Oklahoma Farmers, OSU Extension Facts AGEC-302, Cooperative Extension Service, Oklahoma State University. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2483/AGEC-302web.pdf

Doye, D. (2011) Quicken for Farm Financial Records. OSU Extension Current Report CR-324, Cooperative Extension Service, Oklahoma State University. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-1799/CR-324-2011.pdf

Doye, D. and R. Sahs (2009) Using Enterprise Budgets in Farm Financial Planning. OSU Extension Facts AGEC-243, Cooperative Extension Service, Oklahoma State University. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-1658/AGEC-243web.pdf

OSU Enterprise Budget Software. http://agecon.okstate.edu/budgets/.

Meat Goat Nutrition

Dr. Steve Hart
Langston University

Introduction

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

The ruminant stomach

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

The reticulum and rumen form a large fermentation vat that contains microorganisms, mainly bacteria, that breakdown and digest feedstuffs, including the fibrous component of grass, forbs, and browse that cannot be digested by monogastric animals. Some of the breakdown products produced through digestion of feed by bacteria are absorbed by the animal through the rumen wall and can supply a large part of an animal's 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, the concentrate level in the diet should be increased 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 goats 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 as co-factors in many metabolic processes. The 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, there is no need to supplement goats 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 10 to 50% of the daily minimal requirement. This is adequate if the animal's diet is marginal in a mineral but inadequate if that mineral is severely deficient. Unless a documented deficiency exists, it is best not to provide 100% of a trace mineral, because an excess of one mineral may depress the absorption of another creating a deficiency. Excess supplementation of some minerals can cause toxicity problems, especially with copper.

Iron (Fe) 35 - 500 ppm

The major function of iron is as a component of hemoglobin, required for oxygen transport. It is also a component of certain enzymes. The major iron deficiency symptom is anemia. Anemia can also be caused by blood loss due to several factors, including injury, internal parasites (barberpole worm or liver fluke), and a bad case of external parasites such as lice. Iron is stored in the liver, spleen, and bone marrow. Milk is very low in iron; therefore, kids raised for a long time on milk alone will develop anemia. Soil contamination on forages can provide significant levels of dietary iron. Iron sulfate, which is red, 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 copper 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. Injection of BoSe is often given to kids at birth, but an excess of BoSe can be quite toxic.

Molybdenum (Mo) 0.1 - 5 ppm

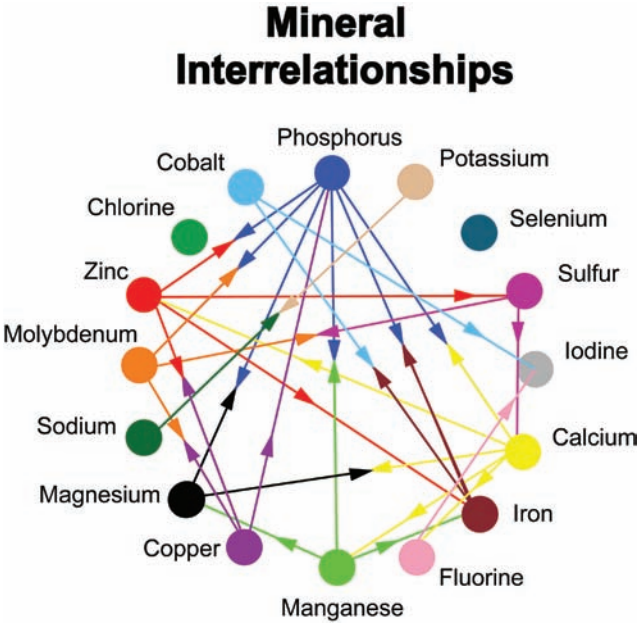
Molybdenum deficiencies are very rare. Toxicity occurs above 3 ppm due to reduced copper absorption, resulting in a copper deficiency. The copper level must be four times the molybdenum level to overcome this effect. High dietary levels of molybdenum are usually related to soil content. Molybdenum (as 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 and some Boer kids, but shrinks after several months and mistakenly called milk goiter). 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

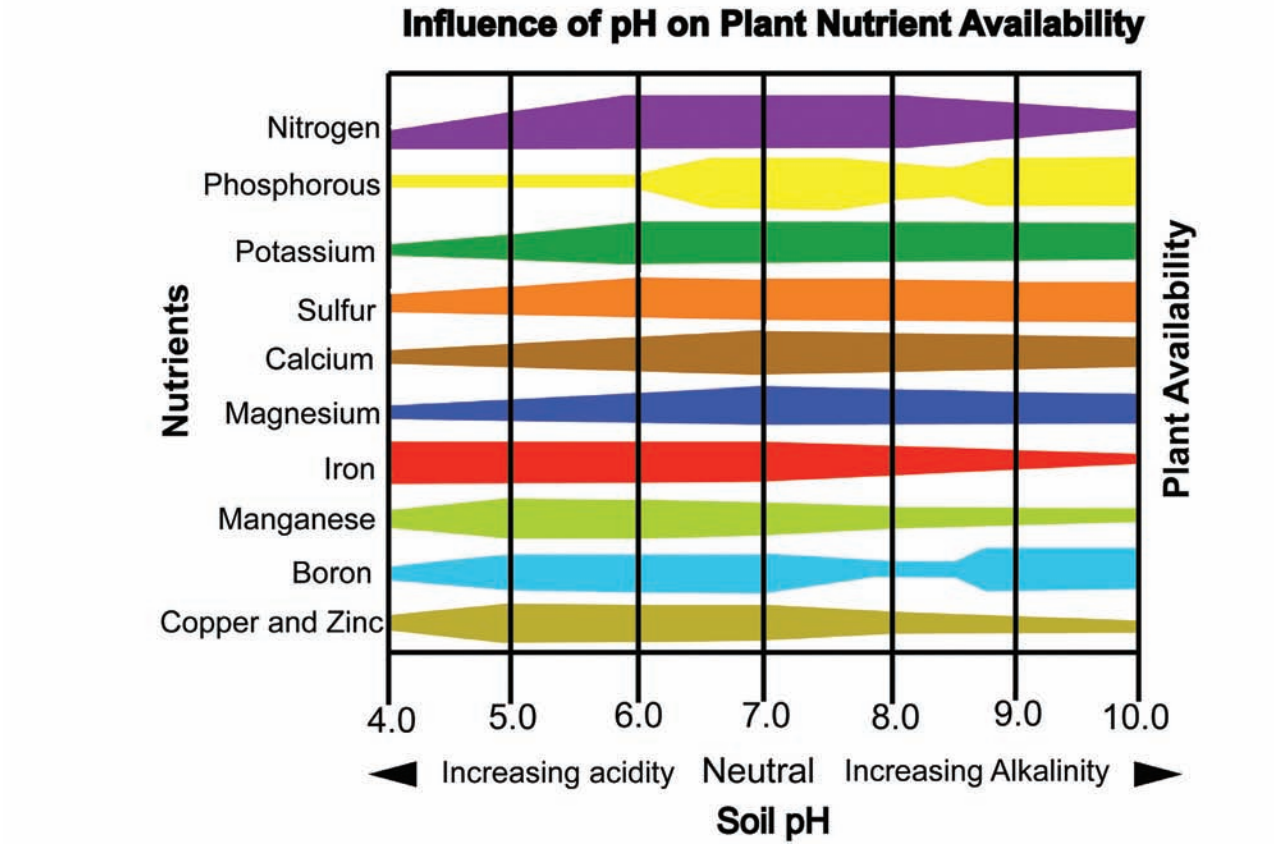
Plants are a major source of minerals for the goat, requiring all minerals that goats require except iodine. However, plant requirements for minerals, such as cobalt and selenium, may be much lower than the level required for animals. Some soils are inherently deficient in some minerals such as iodine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

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 the mineral from rain and keep the supplement clean. Replenish minerals frequently to keep them fresh.

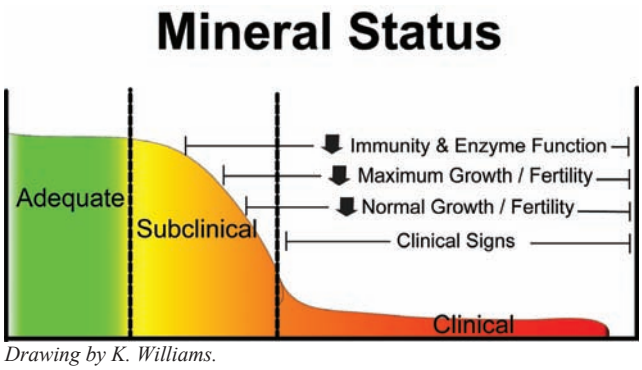
Current approximate wholesale costs for supplying 100% of mineral needs of a 150 lb goat for various minerals in 1 year are as follows:

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 total 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, selenium, zinc, 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 , cobalt, manganese, selenium, zinc, 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. Do not provide salt or other salt containing minerals as salt is used to control mineral intake.
3. Monitor intake of the mineral to make sure the animals are eating an appropriate amount.
4. Avoid excessive feeding of any supplementation.

Body Condition Scoring

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

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

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

Using the Langston Interactive Nutrient Calculator

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

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

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

Getting started

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

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

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

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

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

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

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

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

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

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

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

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

Providing needed nutrients

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

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

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

Feeding Different Classes of Goats

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

Feeding bucks

Mature bucks can obtain most of their nutrients from pasture. However, yearling and 2 year old bucks have greater nutrient requirements since they are still growing. Bucks need to be in good body condition (BCS greater than 3) before the breeding season because feed intake may be relatively low during that time, resulting in 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 more 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-body-weight 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 development 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 bucks can be 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, if necessary). Most bucks do not let a lack of body weight interfere with breeding assuming that they reach puberty, 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. 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 based on the composition of fall bermudagrass; 50% TDN and 9% CP) 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. 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 digestive problems from occurring. Feeding a dairy ration and hay to a doe during late gestation and the lactating period will cost approximately $40 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

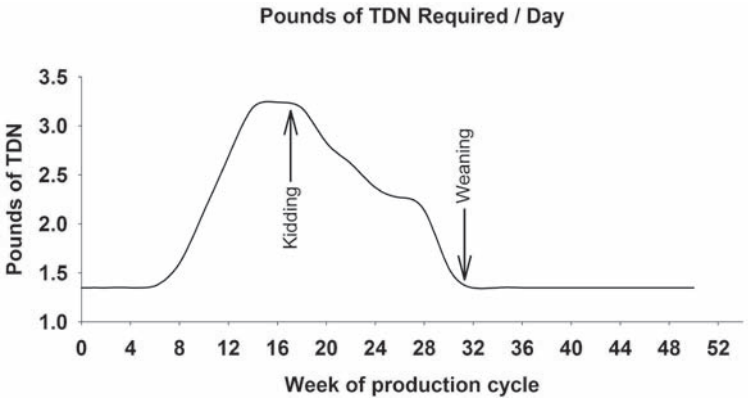
Creep feeding is a method of providing feed for the kids only. This is accomplished by fencing around a feeder and using a creep gate that has holes about 5 inch wide by 1 ft high. These holes are small enough so that kids can enter the feeder, but adults are excluded because they are too big to go through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

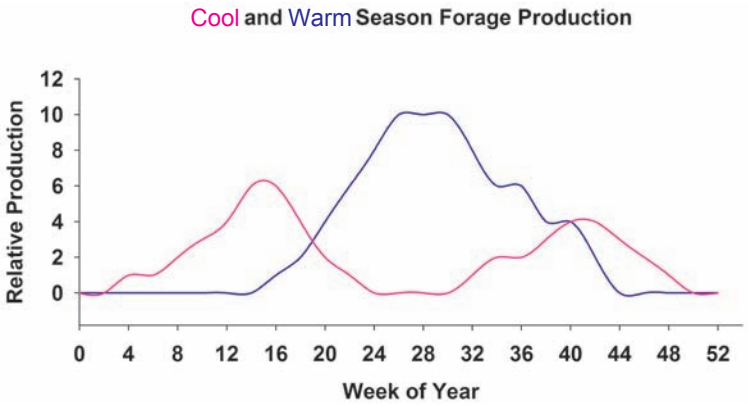
An alternative to grain-based creep feeds that is used in the beef cattle industry is to creep graze calves, using a creep gate that allows calves access to ungrazed high quality pasture. This may have application for goats using high quality pastures (crabgrass or sudangrass that is planted for the 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 24 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 1-3%, to reduce incidence of urinary calculi.

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

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

Feeding Systems

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

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

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

Nutritional Disorders

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

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

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

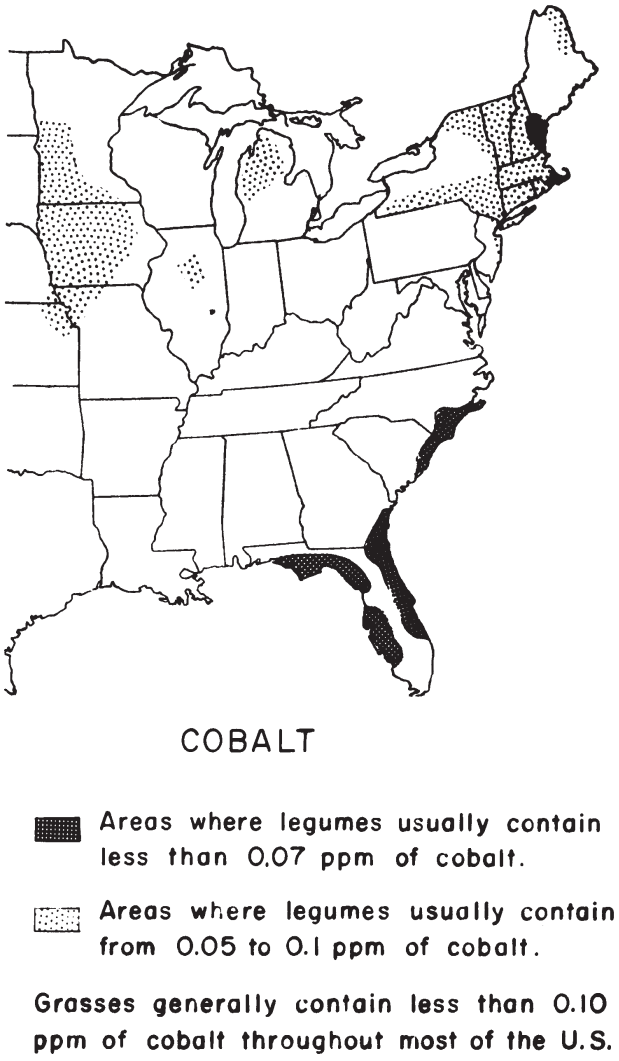
Enterotoxemia is caused by bacteria in the intestine that grow rapidly and produce an endotoxin in response to high levels of starch (grain) in the diet. Animals are in extreme pain from the effect of the endotoxin and often die quickly. Vaccination will help prevent this disease.

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

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

Soil-Related Nutritional Problem Areas for Grazing Animals

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



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

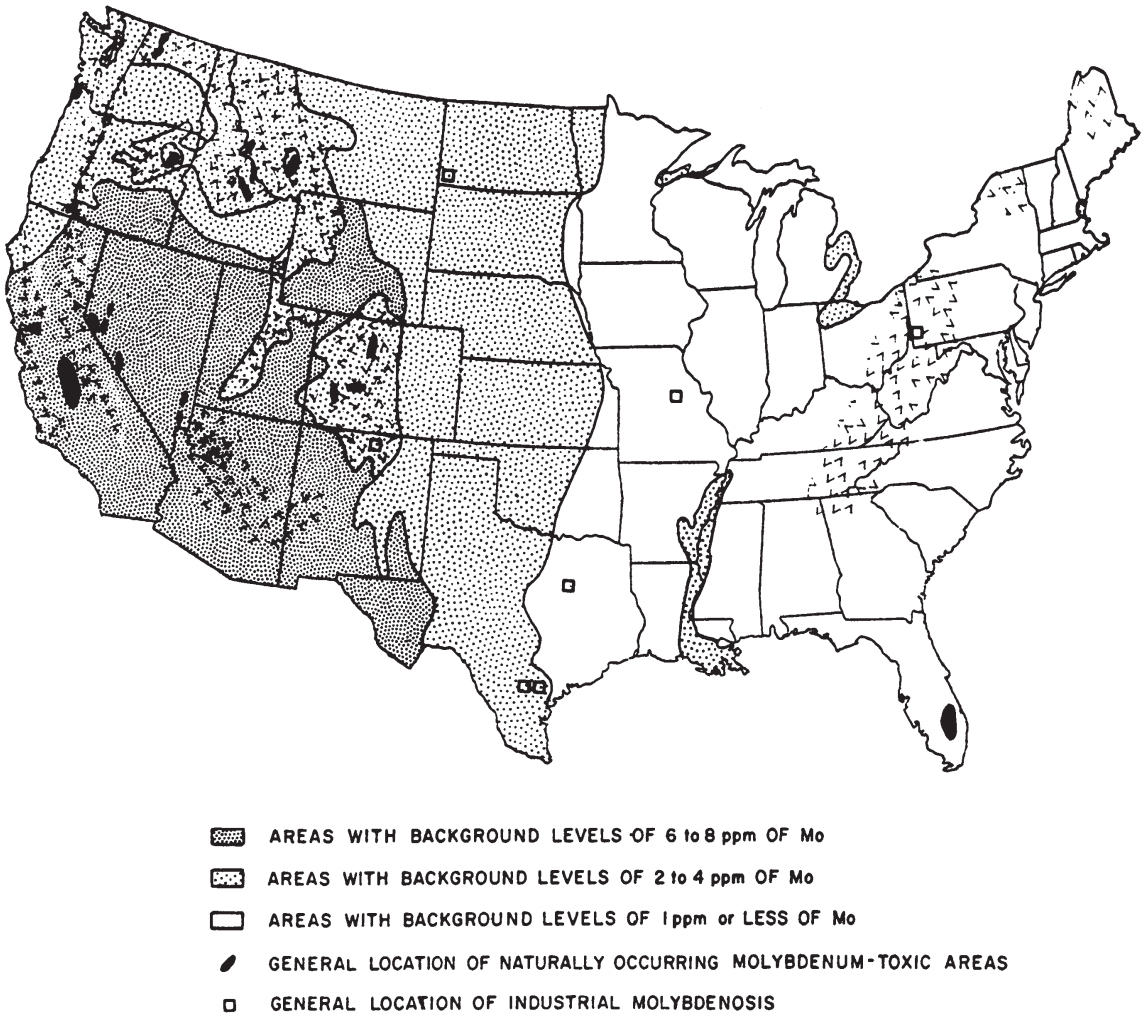


Figure 6. Generalized regional pattern of molybdenum concentration in legumes of the United States (ppm = 1 $\mu g/ g^{-1}$). From Kubota, 1977, by courtesy Marcel Dekker, Inc.

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

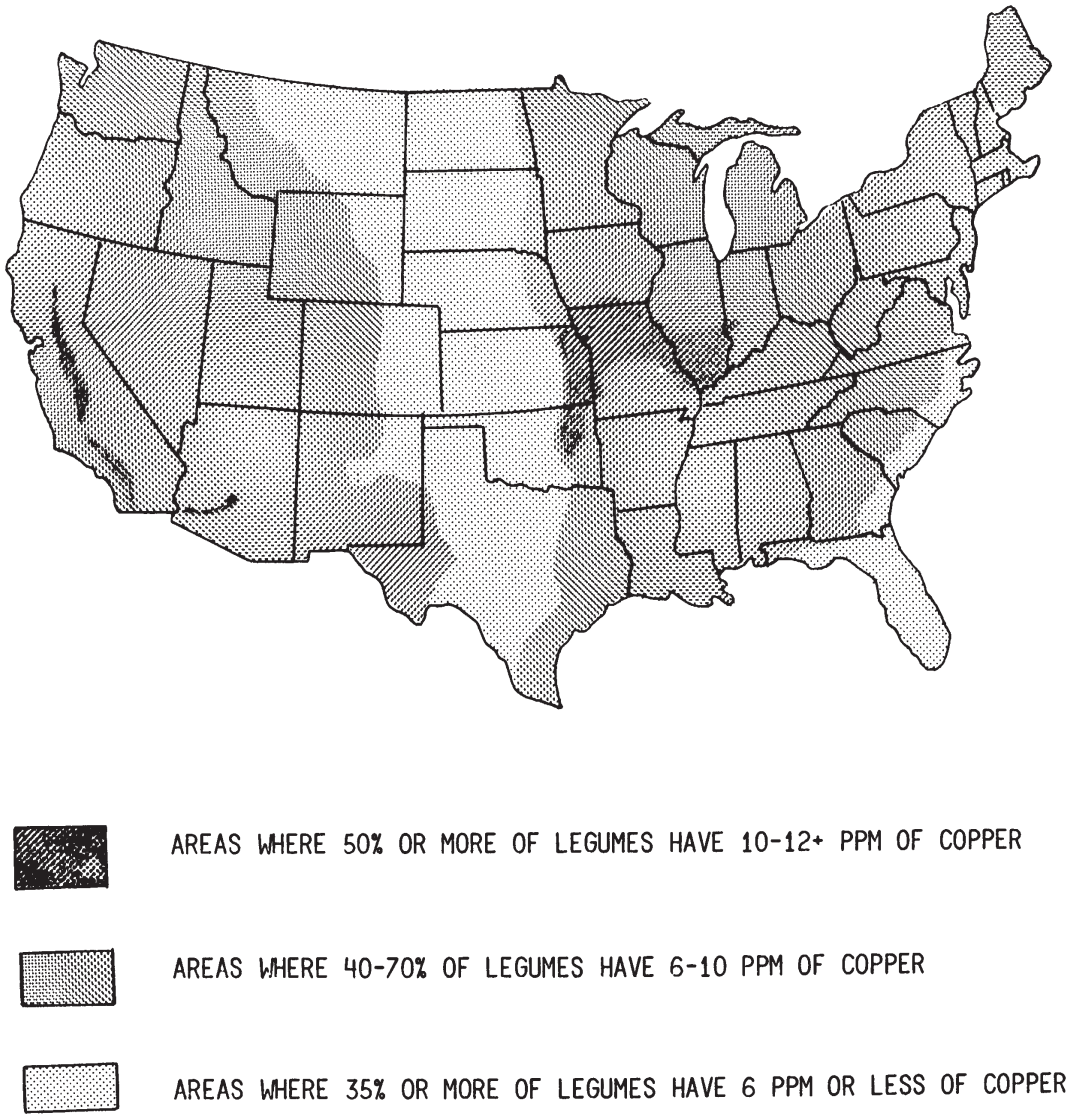


Figure 7. Generalized distribution of copper concentration in legumes of the United States (ppm = 1 μg/ g^{-1}). From Kubota, 1983a, by permission Amer. Society of Agronomy.

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

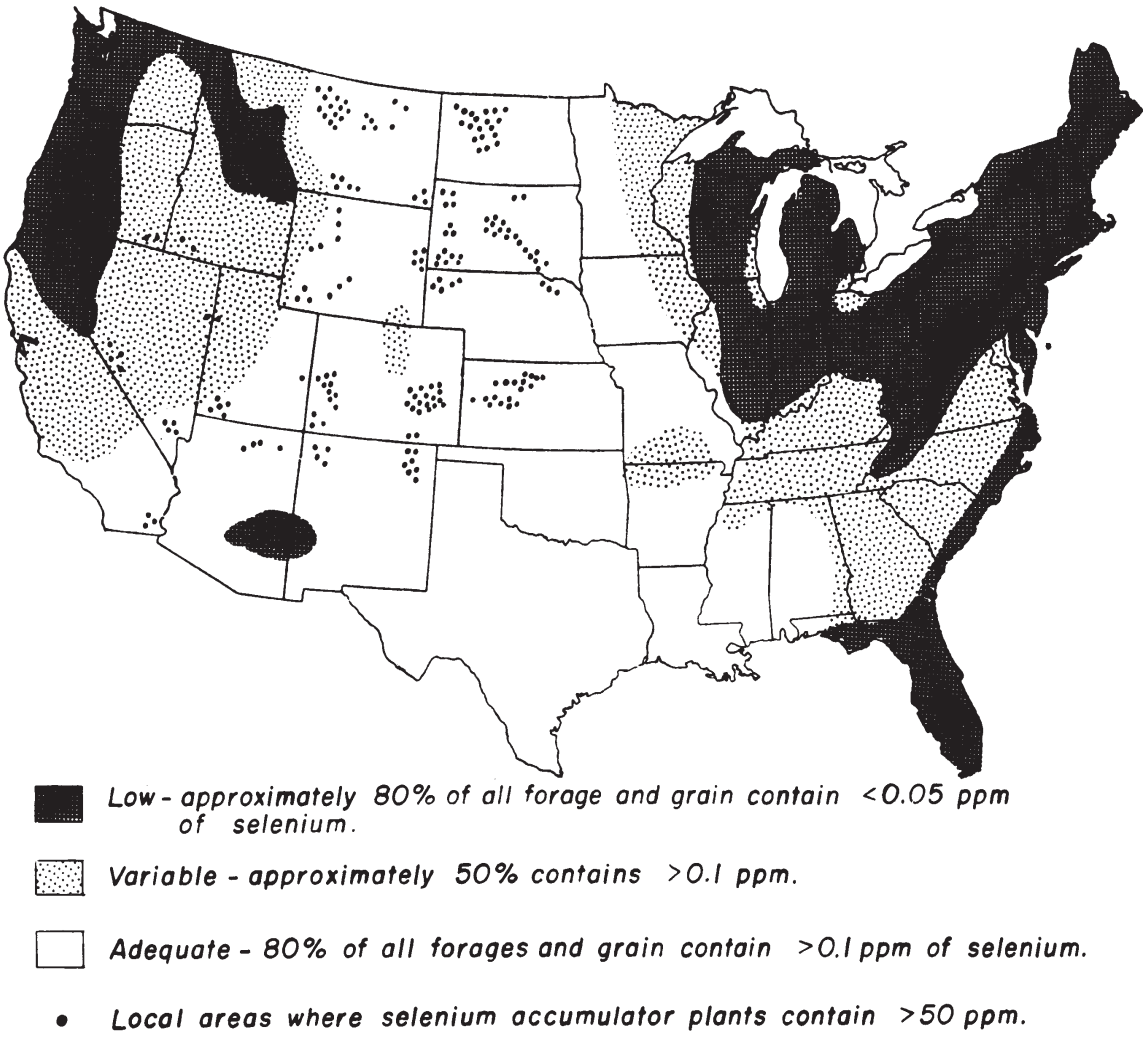


Figure 8. Geographical distribution of low-, variable-, and adequate-Se areas in the United States (ppm = 1 μg/g). From Kubota and Allaway, 1972, by permission Soil Science Society of America.

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

Definitions useful for this section

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Vitamins - Specific organic substances required for various metabolic functions.

FAMACHA for Parasite Control

Dr. Steve Hart
Langston University

There are several sources for information on parasite control and FAMACHA. The best single source is http://www.SCSRPC.org. You can also find information on Langston's web site at http://www2.luresext.edu.

Internal parasites (worms) are the number one health problem of goats in the Southern United States and kill more animals than the total of the next three diseases. Worms function in nature's ecology by preventing populations of animals from overrunning an area when production conditions are good and reduce populations when food is limited.

The most common worm is the Barberpole worm (Haemonchus contortus) which feeds on blood in the abomasum (true stomach) and if there are too many, they cause anemia, poor performance and ultimately death of the animal. The Barberpole worm is responsible for the death of 85% of the animals that die of worms and therefore a very important worm. The red stripe of the Barberpole worm is his gut full of your goat's blood and the white stripe being the worm's uterus full of eggs-essentially a blood-sucking egg-laying machine. The Barberpole worm is about an inch long and as big around as a paperclip wire, so it is easy to see him in the stomach of a freshly dead goat-most are attached sucking blood (looks like a hairy stomach), but a few will be swimming around. Since it is a tropical worm, it is a greater problem during the summer.

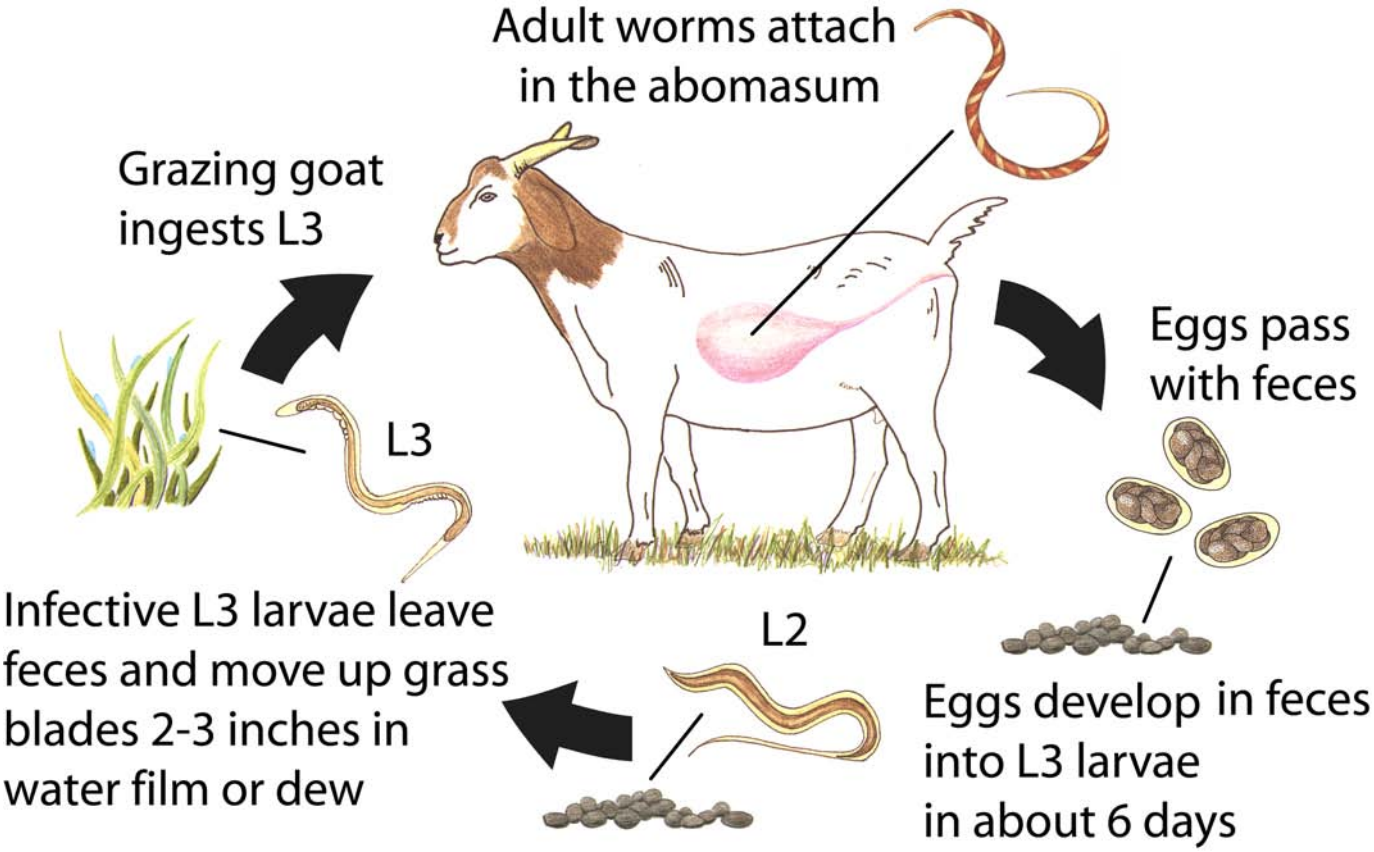
There are two other worms of secondary importance, one is the Black Scour worm (*Trichostrongylus colubriformis*) which feeds on mucous in the small intestine and causes diarrhea, reduced appetite and poor performance. The other worm is the Brown Stomach worm (*Teledorsagia circumcincta*, formerly Ostertagia) which feeds on the secretory cells of the abomasum and causes loss of blood plasma, diarrhea, reduced appetite and poor performance. None of these two worms cause anemia, you only see diarrhea and a poor doing animal. These worms are very small-the size of an eyelash. They are difficult to see, but you can see them wiggling if you put a little digesta on a white card. These worms are temperate species and cause more problems in the spring and fall rather than the summer.

The life cycle of the worm is very important to understand so we know some management steps that we can take to reduce the infection of goats. Worm eggs are in the feces and will hatch when it is over 50ºF, but hatch best at 85°F. This is why worms are less of a problem in the winter. It takes 1-6 days for the eggs to hatch, but they have to go through several developmental stages before they can infect animals. They hatch to the first stage larvae, abbreviated l-1. The l-1 eats bacteria in the feces, grows and molts (sheds skin like a snake) and becomes an l-2. Both the l-1 and l-2 can be killed by drying out when the weather is dry. When we have a dry July and August we have much fewer worm problems because of this.

The l-2 eats bacteria in the fecal pellet and grows and molts to an l-3, but this is an incomplete molt. The old skin slides up and he grows a new skin underneath which is a good news/bad news proposition. He is more resistant to drying out since he has two layers of skin, but also when he partially shed his skin, it covers his mouth so that he can no longer eat and must live off his stored fat. This means that he must get into your goat before he runs out of fat. How long can he live? Since he is cold blooded, his metabolism goes slow when he is cool and he may live 120-240 days. However, when the weather is hot like 95ºF, his metabolism really speeds up and he may only live 35-40 days before he runs out of fat. It takes about 6-14 days for an egg to develop to an l-3, the infective stage of the larvae, depending on how warm temperatures are.

Since goats don't go around eating fecal pellets, the larvae has to escape the fecal pellet and get on grass so that the goat can eat him. Since the outside of the fecal pellet dried into a hard shell and he can't penetrate it, he needs some rain or heavy dews to soften or break the crust so that he can escape. It takes about 2" of rain in a month's time to crack a pellet open. If he runs out of fat before there is enough rain or dew to release him, he dies. Once the pellet is softened or cracked open, the larvae is like a canoe, going wherever the water takes him, hopefully up a leaf of grass so that your goat will eat it along with the 3rd stage infective larvae. The larvae is unable to swim or crawl. Infective larvae are very small, slightly longer than the period at the end of the sentence and about as big around as spider web.

If the larvae is lucky enough to get into your goat, he immediately moults to an l-4. The l-4 has a decision to make-he can decide to grow into an l-5 and go to adulthood and lay eggs or he can decide to enter a state of suspended animation called hypobiosis or arrested form. He nestles down in the stomach gland and the immune system does not know that he is there. He is also harder to kill with the Benzamidole class of drugs. This is a survival mechanism for overwintering since he would die in the cold temperatures over the winter. It may also be used to keep worms alive during a prolonged drought when they would die outside the animal. The hypobiotic worm can be triggered to awaken and develop to an l-5 and onto adulthood by several mechanisms. The act of kidding, the goat eating green grass, kidding, lactating, increasing daylength all may trigger him to awaken and develop to an egg-laying adult.



Life Cycle of Haemonchus contortus, the barber pole worm

The immune system is the first line of defense against worms. Good nutrition supports the immune system in its fight against worms. Some animals have a genetically stronger immune system and goats can be selected for low fecal egg counts. Other diseases which depress the immune system such as coccidiosis, or pneumonia may make an animal more susceptible to worms. When goats are lactating, the immune system is suppressed and does not fight parasites as well. Also, those arrested l-4 larvae that overwintered awaken with kidding in the spring to feed on your goat. This is the reason for the general recommendation to deworm your goats around kidding time.

The Barberpole worm as we said likes a warm climate and it reproduces rapidly, laying as many as 6,000 eggs per day. This enables one resistant worm to produce many resistant worms. An adult Barberpole worm consumes 1-5 drops of blood per day. A thousand worms will consume nearly a pint of blood in a week. This causes your goat to have a low red blood cell number (anemia), low blood protein (hypoprotenemia) which causes edema or bottle jaw and ultimately death when there is not enough blood to sustain your goat's life. Coccidiosis, liver flukes and lice can all cause anemia also and need to be ruled out. Anemia can be determined by looking at the color of the mucous membranes. These are tissues under the lower eyelid, gums and inside the vulva. A normal amount of red blood cells gives them a healthy pink color. A reduced amount of red blood cells makes them more pale (white). You can use a FAMACHA card to determine the degree of anemia (FAMACHA score) and need for deworming.

Our biggest problem with dewormers is that some worms have become resistant to our dewormer. When an animal is dewormed with an effective dewormer, it will kill 100% of the worms. When the dewormer only kills less than 95% of the worms, we can be sure that we have significant dewormer resistance which will increase within a year or two so that the dewormer only kills 40% of the worms and is worthless as a dewormer. Dewormer resistance is measured by taking a fecal egg count, deworming and taking another fecal egg count 7-14 days later. The percent reduction in fecal egg count is called fecal egg count reduction. Figure 2 shows that there is a high level of dewormer resistance to Ivomectrin, Valbazen works on some farms and not others and Levasole was highly effective on all farms. Cydectin was highly effective in 2001, but less so now. When an animal is dewormed and any worms survive in an individual or flock, it is because they are resistant to the dewormer and if the worm(s) mates with another resistant worm, 100% of the eggs will hatch out resistant worms. However, if there are a number of susceptible worms for that worm to mate with, we can reduce the worm's chance of mating with a resistant worm. This is the concept of refugia. Animals that have not been dewormed provide a source of worm eggs (ultimately adult worms) that are genetically susceptible to the dewormer to dilute the eggs of worms that survived deworming (resistant worms) and slow the rate of dewormer development. We increase refugia by only deworming only the animals that need to be dewormed as determined by FAMACHA color score of the eyes. This is different from our old strategy of trying to kill every worm which has gotten us to where dewormer resistance is a bigger problem than having a few worms around. It must be remembered that a few worms are OK and even desirable because they keep the immune system alert against worms. Excessive worms that cause us problems.

Table 1. Oklahoma Farm FECR %

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

Worms are like wealth, not equally distributed to all. 20-30% of the animals produce 70-80% of the eggs. These are predominantly the animals that will need dewormed. Most of the other animals will not need dewormed-they can cope with the worms that they have and the level of eggs in their feces does not cause a high level of pasture contamination. If we get rid of animals that consistently have high fecal egg counts, there will be fewer infective larvae on the pasture for all the other animals.

The Barberpole worm causes anemia and therefore the degree of anemia tells us how much difficulty the worms are causing the animal. The Brown Stomach worm and Black Scour worm do not cause anemia and we have to depend on diarrhea and loss of body condition to detect them. We measure anemia with the FAMACHA card by rolling the lower eyelid down and comparing the color of the inside of the eyelid where it was touching the eyeball to the color chips on the card. A healthy pink color will match chips #1 or 2 whereas a very pale color, white as a sheet will match # 5. If the color match is in between two chips, score it the higher number (more pale) color. Do not hold the eye open for more than a few seconds because the color will change. Check the other eye if necessary. One should remember that pink eye can affect the color of the eye. Also, one should remember that there are other causes of anemia such as coccidiosis, lice and liver flukes and if animals do not respond to deworming, these may need to be investigated as well as determining if the dewormer is working.

Treat all animals with a FAMACHA score of 4 or 5 with an effective dewormer and check again two weeks later if it is during the summer worm season. At deworming, many producers give the animal a blood building supplement such as Red Cell to support producing replacement red blood cells. If >10% of the animals have FAMACHA scores of 4 or 5, then consider deworming animals that score 3, especially ewes around lambing/kidding or nursing kids, young animals, does nursing kids and thin, poorly conditioned animals. Try to rotate animals to another pasture. Be sure to check animals which lag behind the herd. Also if an animal gets "bottle jaw", deworm them regardless of their FAMACHA score. Score animals using the card, not from memory and replace the card every 12 months because the colors fade. Record animal numbers as they are dewormed. If you add up the number of times that animals are dewormed across the summer, those requiring the most deworming are also those producing the most eggs and causing pasture contamination for others. Their offspring are also likely to be like them, so those animals that were dewormed the most are good candidates for culling.

FAMACHA is not a parasite control program, but a tool in a parasite control program. Your parasite management program should include monitoring of fecal egg counts periodically as well as FAMACHA eye scores. When you have a parasite problem, determine why and change the parts of management that

you can. Only use a dewormer when necessary to reduce the rate of development of dewormer resistance. Cull wormy animals because they cause worm problems for everyone else and it is often passed onto their offspring. Deworm new animals coming onto your place with at least two classes of dewormer and check a week later to make sure their feces are free of eggs to prevent importing resistant worms. Notice animals with pale color around the eyes when you check animals and deworm them promptly. Good nutrition (not only protein and energy, but also vitamins and minerals) is necessary to fuel the immune system in its fight against worms.

Some management steps that you can use to reduce parasite problems are grazing cattle or horses with goats. Avoid forcing goats to graze close to the ground since most infective larvae are within 3 inches of the ground. Making hay or tilling the ground can clean parasites off of a pasture. If you can rest a pasture 6 weeks, especially during warm weather, it will reduce contamination level greatly. If animals are browsing or eating high off the ground, they pick up much fewer infective larvae. As stocking rate increases above two head per acre, parasite problems also increase. There are certain conditions that increase the risk for worms such as: warm weather, two or more inches of rain in a month, grazing pastures close to the ground (such as during a drought), high stocking rates, long residence time on pastures, thin animals or animals nursing young. The more risk factors that you have, the greater the parasite challenge and the more attention to parasite management will be needed.

Dewormers are classified into action families. All members of an action family use the same mode of action to kill worms, but some members of that family may be more potent than others. The benzamidoles are one of the first marketed class of dewormers and because of that there is more dewormer resistance to

this class. The Benzamidoles not only kill worms, but also worm eggs, lungworms and tapeworms. They are especially useful for these latter two worms. Members of this group include fenbendazole (Panacur, Safeguard), oxfenbendazole (Synanthic) and albendazole (Valbazen), the most potent member of the family which also kills liver flukes. The cell depolarizers includes levamisole (Tramisole, Levasole and Prohibit) are basically only effective against roundworms and is generally the dewormer used after worms develop resistance to Cydectin. Morantel or Pyrantel tartrate (Rumatel or Positive Pellet Dewormer) is a form of the dewormer that is in the feed. It is not as potent as Levasole. The Avermectin/Milbermyucin class has been very effective in the past, but there is an accumulation of dewormer resistance to this class. It includes ivermectin (Ivomec), dormectrin (Dectomax), eprinomectin (Eprinex) and moxydextin (Cydectin) which is the most potent member of this class, but has a long withdrawal time.

Selection of a dewormer depends on what works in your herd as well as the withdrawal time. If you are milking animals or animals are going to market, you want a drug that has a shorter withdrawal, but also works. Every year, you should check to make sure your dewormer is working by taking some stool samples collected from animals that were dewormed 7-14 days previously to your vet (or do it yourself) to make sure that they have no fecal eggs in them. When you develop resistance to a dewormer, you may be able to use it at a higher dose, but generally it is better to use another drug. When you have resistance to all common dewormers, you will have to resort to combinations of dewormers or alternative dewormers such as copper oxide wire capsules or sericea lespedeza. With good parasite management, we can reduce the development of dewormer resistance, but it involves the use of FAMACHA, pasture rotation and having a good parasite management program in place. In conclusion, if you fail to manage your parasites, they will manage to put you out of the goat business.

Meat Goat Herd Health Procedures and Prevention

Dr. Lionel Dawson
Oklahoma State University

Introduction

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

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

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

Common Herd Health Procedures

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

Taking temperature – rectally

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

Pulse or heart rate

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

Respiration

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

Rumen movements

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

Checking mucous membranes

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

Drenching and dosing

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

Tubing an animal

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

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

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

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

Bolus administration - "Balling"

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

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

Paste administration

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

Giving injections

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

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

Needle selection

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

Proper injection sites

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

Common injection methods

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

Subcutaneous injections

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

Intramuscular

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

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

Intravenous

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

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

Minor Surgical Procedures

Castration

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

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

Dehorning

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

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

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

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

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

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

Lancing abscesses

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

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

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

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

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

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

Normal Range for Goat Physiological Parameters

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

Extra-Label Drug Use

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

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

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

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

Three conditions of extra-label drug use:

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

FDA criteria for Using Pharmaceuticals Extra-Label

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

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

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

Ten Drug Use Tips

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

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

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

Medications Commonly Used in Goats and Approximate Withdrawal Times

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

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

Herd Health at Different Production Stages

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

Pre-breeding

Breeding does

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

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

Breeding bucks

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

Breeding Season

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

Gestation

Pre-parturition

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

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

Parturition (kidding)

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

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

Problems in parturition

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

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

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

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

Kid management at birth

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

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

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

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

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

Artificial raising of kids

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

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

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

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

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

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

Feeding schedule and amount for bottle fed kids.

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

Dam raised kids

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

Medications Commonly Used in Goats and Approximate Withdrawal Times

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

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

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

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

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

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

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

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

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

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

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

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

Weaning

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

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

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

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

Vaccination Schedule for Meat Goats

Other disease preventive measures

Dam – 1 month prior to kidding

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

Kid – birth to first week

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

Kid – 3 weeks – begin coccidiosis prevention

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

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

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

Herd Health Calendar

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

Planning Calendar for Meat Goat Herd Health

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

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

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

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

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

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

Footnotes:

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

NOTE for Guideline for Anthelmintic Dosages in Goats

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

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

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

Basic Goat Husbandry

Mr. Jerry Hayes
Langston University

Introduction

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

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

Ageing Goats

Number and arrangement of teeth

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

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

Telling the age of goats

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

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

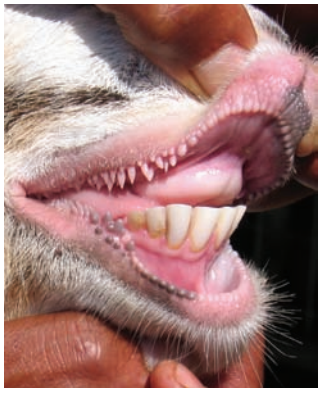
Ageing goats over 4 years of age is more difficult. Over time, the gums recede and teeth appear elongated. Teeth may also become broken or worn down from grazing and foraging. Animals that have broken or lost teeth are often referred to as "broken mouthed." "Undershot" is a condition in which the lower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

Animal Identification

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

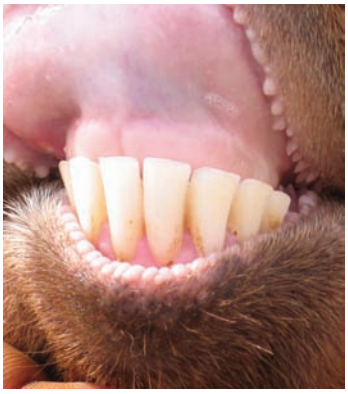
Kid (< 1 year old).

1 year old.

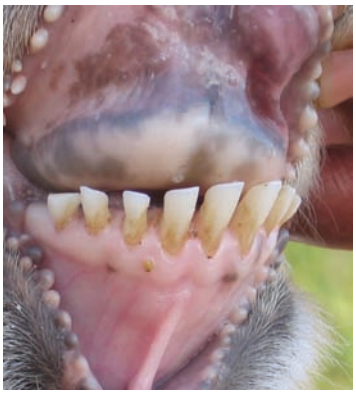


2 year old.

3 year old.



4 year old.



8½ year old.

Broken mouth.

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 is permanent identification.

Tattooing

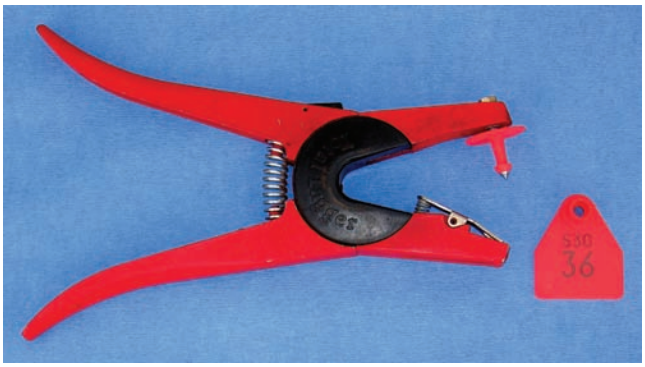
Tattooing is one method of identification that is permanent if properly done. However, it is not easily viewed and may require another complementary method of identification, such as an ear tag, that is visible from short distances. Tattooing involves making needlelike projections in the goat's skin.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

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

Tattoo pliers and ink.

Ear tags

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



Ear tag pliers and plastic ear tag.

Microchip

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

Ear notching

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

Ear notching pliers.

Example of ear notching.

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

Hoof Trimming

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

Overgrown hoof.

Proper hoof trimming technique.

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

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

Castration

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

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

Elastrator with rubber bands.

Elastrator

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

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

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

Body Condition Score

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

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

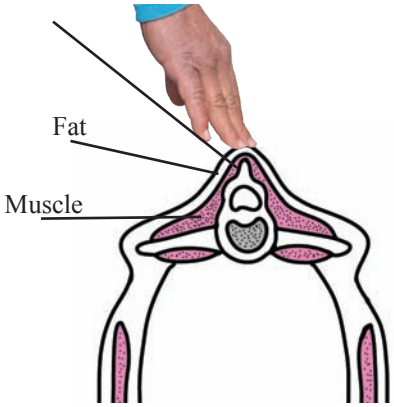
Scoring is performed in goats using a BCS ranging from 1.0 to 5.0, with 0.5 increments. Examples of BCS of 1.0, 2.0, 3.0, 4.0, and 5.0 are given using photographs and written descriptions. Assigning the 0.5 score increment is done when the animal being evaluated is intermediate to the BCS described.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

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

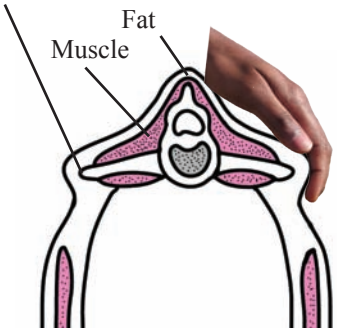
With practice, evaluating the BCS of an animal will only take about 10-15 seconds. By adding BCS as a regular part of your management program, you can more effectively monitor your feeding and herd health program for a healthy and productive herd.

Lumbar Region

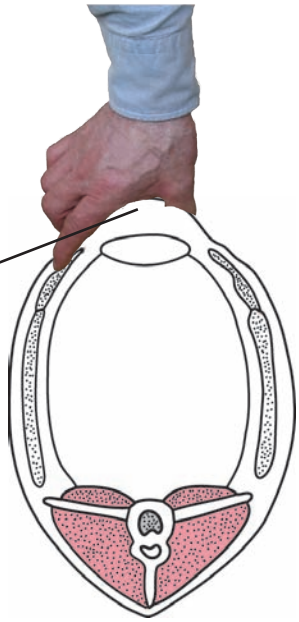
Spinous process



Transverse process



Sternum



BCS 1.0

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

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

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

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

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

BCS 2.0

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

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

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

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

BCS 3.0

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

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

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

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

BCS 4.0

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

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

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

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

BCS 5.0

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

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

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

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

Small Stock Mortality Composting

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

Why Compost Sheep and Goat Mortality?

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

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

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

Mortality Composting Basics

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

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

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

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

Site Selection

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

Mortality Composting Bins

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

Permanent bins

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

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

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

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

Low-cost alternatives

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

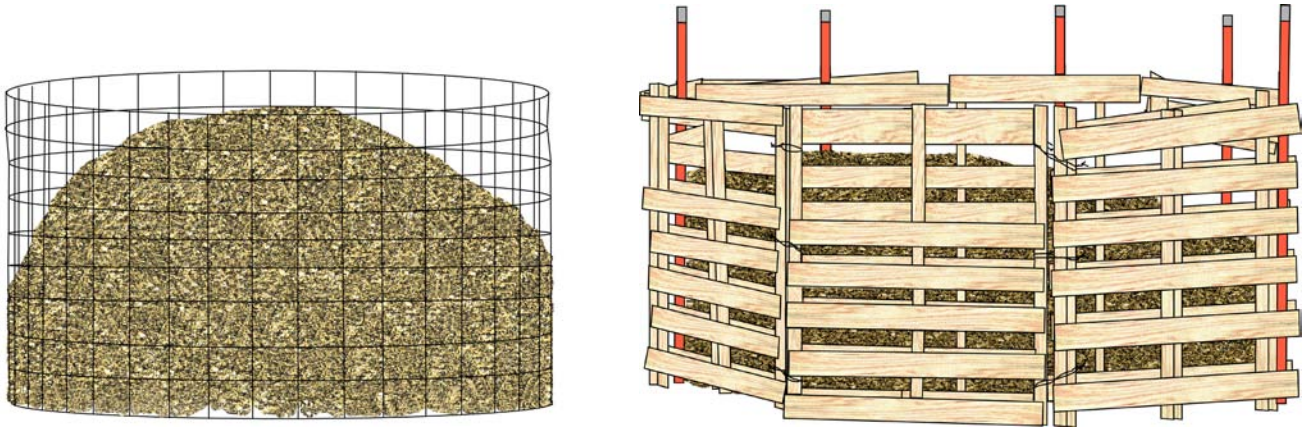


Figure 2. Bins can be made from wire panels or wooden pallets at minimal cost (All illustrations by K. Williams, Langston University).

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

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

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

Windrow systems

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

Mortality Composting Process

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

Building the pile:

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

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

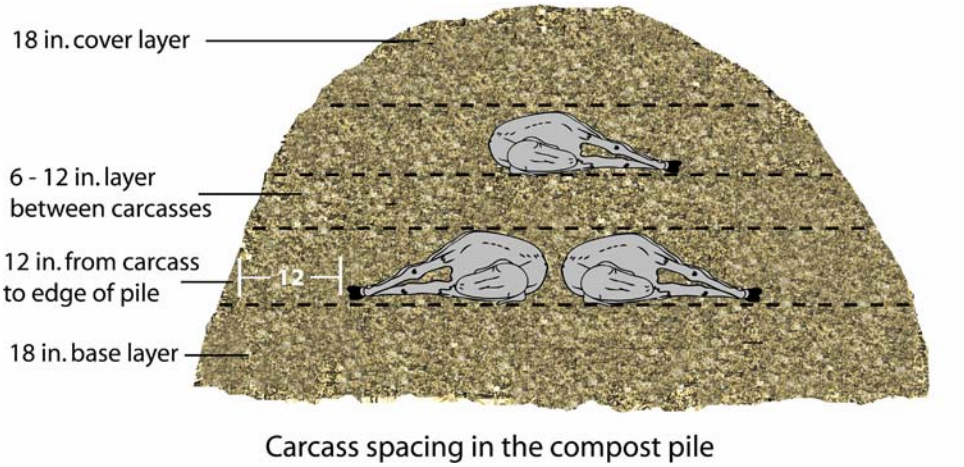


Figure 3. Use these minimum depth recommendations to ensure proper spacing and thickness of carbon source layers when layering carcasses.

Pile Temperature

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

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

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

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

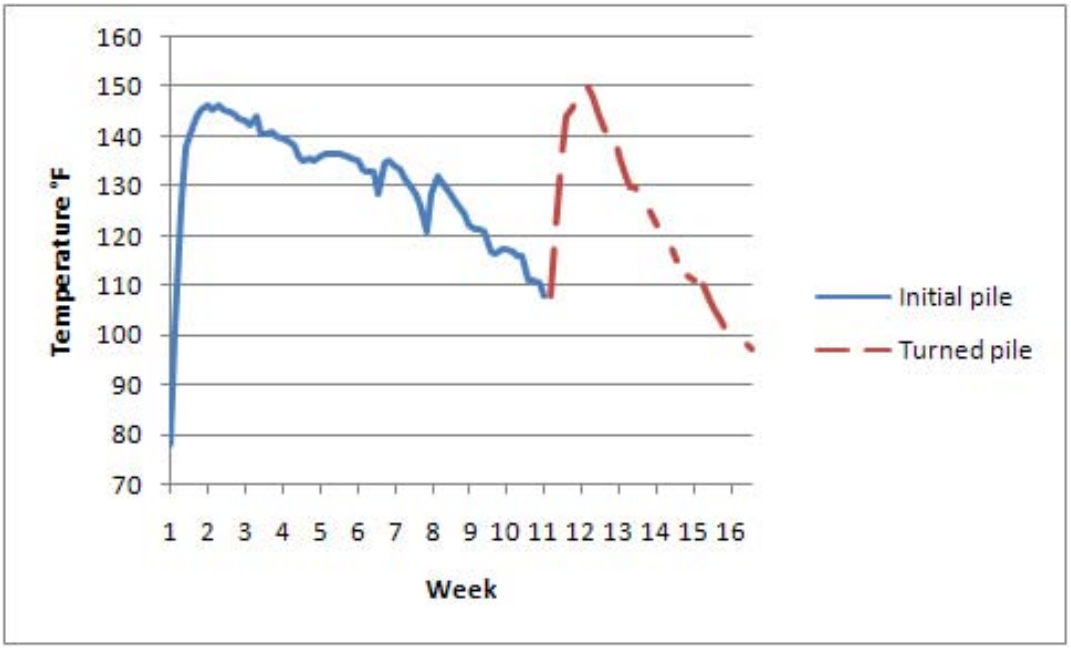


Figure 6. Temperature of a goat carcass compost pile made with a mixture of horse bedding and wood shavings.

Turning Compost Piles

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

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

Troubleshooting Mortality Compost

Low temperature

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

Pile odor

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

Failure to decompose

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

Insect/fly larvae

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

Compost Use

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

Summary

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

Acknowledgment

The authors wish to acknowledge the Sustainable Agriculture Research & Education (SARE) Program supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture for providing funding for this project.

References

Auvermann, B., S. Mukhtar and K. Heflin. 2006. Composting Large Animal Carcasses. Publication E-422. Texas Cooperative Extension. http://tammi.tamu.edu/largecarcassE-422.pdf.

Bonhotal, J., L. Telega and J. Petzen. 2002. Natural Rendering: Composting Livestock Mortality and Butcher Waste. Cornell Waste Management Institute. Cornell Cooperative Extension. http://compost.css.cornell.edu/naturalrenderingFS.pdf.

EPA. 1994. A Plain English Guide to the EPA Part 503 Biosolids Rule. U.S. Environmental Protection Agency. Office of Wastewater Management. Washingtion, D.C. http://www.epa.gov/owm/mtb/biosolids/503pe/index.htm.

Estienne, M.J. n.d. Disposing of Dead Goats. Maryland Cooperative Extension. http://www.sheepandgoat.com/articles/compost.html.

Higgins, S., S. Guinn and A.A. Guinee. 2008. On-Farm Composting of Animal Mortalities. Publication ID-166. Univ. Kentucky Cooperative Extension Service. http://www.ca.uky.edu/agc/pubs/id/id166/id166.pdf.

Looper, M. 2002. Whole Animal Composting of Dairy Cattle. Guide D-108. New Mexico State Univ. Cooperative Extension Service. http://aces.nmsu.edu/pubs/_d/D-108.pdf.

Payne, J. 2009. Proper Disposal of Routine and Catastrophic Livestock and Poultry Mortality. BAE – 1748. Oklahoma State Univ. Cooperative Extension Service. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-6301/BAE1748web.pdf.

Cheesemaking Overview – Goat Milk Cheese

Mr. Neville McNaughton
Cheezsorce, L.L.C.

Discussion Topics

- Market Place
- Manufacture
- Milk Composition
- Milk Quality
- Milk Production

Simple Economics

Ave. Price for Goat Milk - $30.00 to $38.00/100

Assume Retail Price at Farmers Market $15.00/lb

Assume 10 goats milking 365 days

Assume 6# of milk per goat per day is 60# of milk or $22.80 value as milk for manufacturing

Assume a 15% yield as fresh Chevre is 9# of cheese per day or $135.00/day

p.a. $8.344.00 gross value of milk from #10 goats when used for cheese.

p.a. $49,275.00 gross value when manufactured into cheese

Thanks to the Engineer in Session One for pointing this out.

I will not develop this any further today due to the many variable when setting up an operation to make cheese, particularly the issue of scale.

The Market place

It is strong and has remained do during this period of economic downturn. While growth may have leveled off there is no measurable decline.

Goat cheese buyers purchase for the following reasons, goat milk and by extension the cheese made from goat milk is of higher quality, is better for you and less about price.

In the recovering economy we will see a resumption of strong growth.

Cheese Sectors

Soft cheese will remain strong, while the market place doesn't need another Chevre all regional producers must include Chevre in their product mix.

There is a growing appreciation of traditional products with a wide and varied range of surface growth treatments using yeasts and molds.

There is also a willingness to try all non traditional surface treatments as well such as dipping in annatto, grape juice etc. to stain the surface, raise the pH and then grow moulds on the surface, coat surfaces with rustic mixed herb blends.

Hard Cheese

Noticeable by their absence are high quality table cheese. This is a major opportunity.

Sales Opportunities

Farmers markets are the opportunity for regional Cheesemakers in all geographic areas of the country.

Consumers particularly in the cities are joining the producers on this journey back to the production of better food. They are tolerant of producers efforts during development periods and promoters of your product to others when you get it right.

Groups

Slow Food and other similar value based organizations who believe in eating well, eat local and sustainability are the producer advocates, producers should reciprocate and support these organizations at every opportunity

Distributors

In all major population centers we have specialty distributors who want your product, seek them out. If you are producing product far from your point of sale be prepared to spend time travelling to the metropolitan areas and promote your product. Distributors full fill the important function of distribution but they really get behind products that have producer support

Manufacture

Large manufacturers are growing fast, there is strength in companies like Mont Chevre, Bongrain, Vermont Butter and Cheese, Red Wood Hill, Cypress Grove and others. They are becoming more sophisticated as manufacturers, more efficient which enables them to be competitive on the national scene.

Smaller producers have the advantage of producing products that do not look mass produced, focus on:

Quality

Variety

Natural finishes

Look for efficiencies in your operation that will help keep you costs down

Milk Composition

This Cheesemaker's View

We need more protein

We need higher solids

We do not need higher fat

We do not need more volume

Why are producers not breeding for protein????

I suspect greater than 95% of goat milk in the USA is used for Cheese

Goats breed for fat and volume do not recognize the needs of Cheesemakers

When we increase the fat content of milk we get only a small increase in yield because we need to decrease the moisture content of the cheese or it will become too soft

When we increase protein we capture additional fat and moisture and make substantially more cheese

High solids milk lowers production cost. Cheesemakers are in the process of concentration, removal of moisture (whey), increasing the protein content of milk by 20% reduces overheads by 20% approx.

It takes the same energy and labor to process low solids milk as high solids milk. Use DHI protein data to select for protein and cheese yield.

Focus on a better protein to fat ratio and higher solids.

Milk Quality

As a Cheesemaker you're my definition of quality may be different than the producers.

A producers definition is a low Total Plate Count (TPC) and low Somatic Cell Count (SCC)

As a Cheesemaker my quality problems in cheese come from Anaerobic, thermophilic organisms.

Many pass through the pasteurization process.

Lactobacilli, Propioni, Leuconostoc, Mesophilic spores.

We do not routinely check for these bacteria

Checking for LPC – Laboratory Pasteurization Count

Lactobacilli

Mesophilic spores

Many of these organisms are in the milk as a result of:

Animal management practices

Milking Parlor Cleaning Practices – Most farmers do not know essential information about how to wash the milking parlor, the presence of non 3A components that cannot be washed with CIP is a problem.

Note: Current Milking Parlor Washing Practices are:

Wasteful of chemical, it could all be reused reducing chemical cost by up to 90%

Wasteful of energy, if the recovered solution were stored in an insulated container less heat would be required for each wash

Because farm wash systems are set up to wash at sub optimal temperatures the chemicals used are much stronger and more toxic to the environment than would be the case if we used higher temperatures. The use of high levels of phosphates in farm cleaning is unfortunate as this is the major cause of algal bloom in waterways.

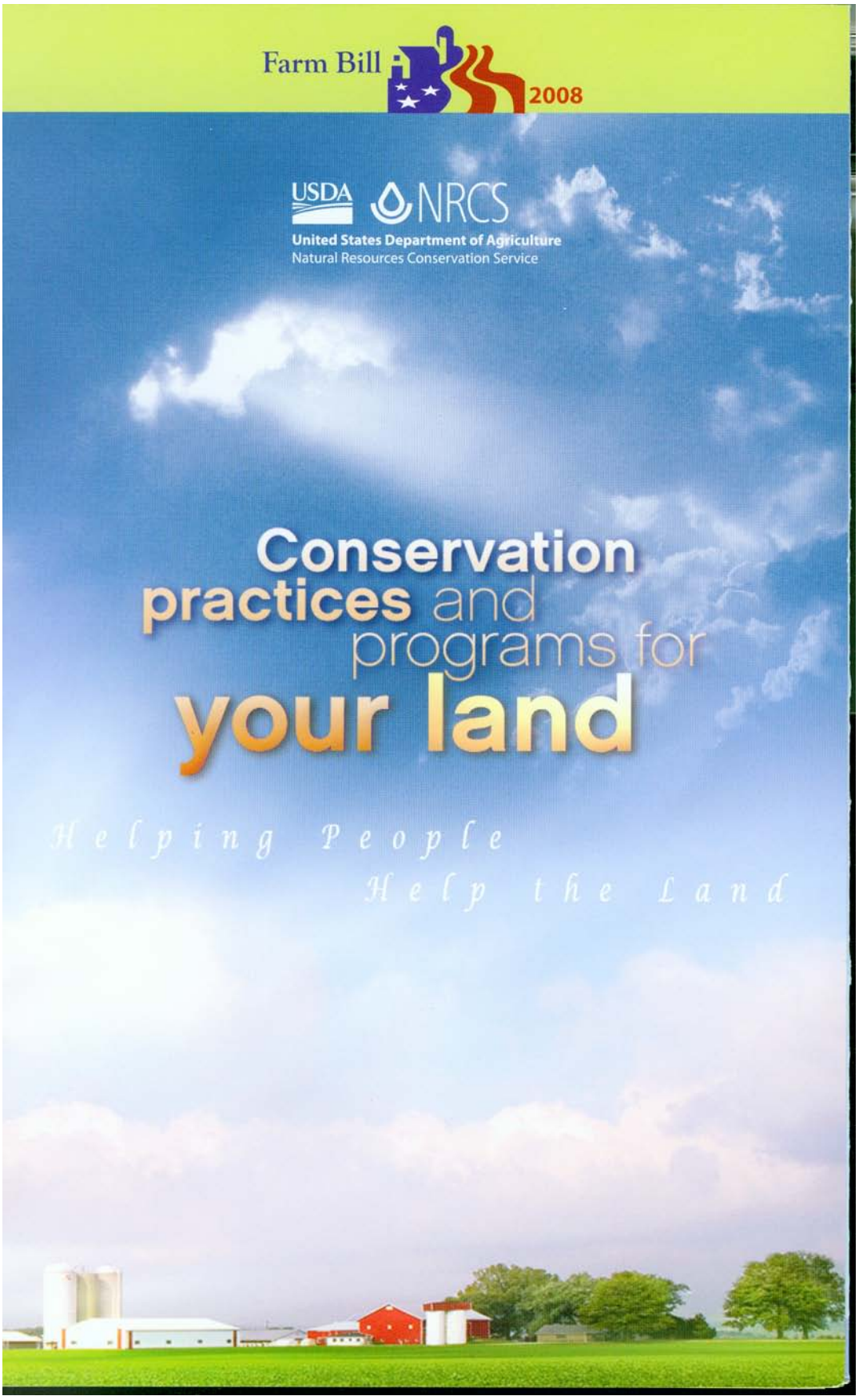
Closing Note:

The Goal is!

Better Quality Milk for Cheese
More Cost Effective Milk for Cheese
Resulting in Better Cheese
A More Profitable Future

Benefits of USDA Programs

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


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

FAQ

frequentlyasked**questions**

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

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

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

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

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

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

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

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

PA - 2037 November 2009

What USDA Offers

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

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

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

Conservation practices & programs for your land

What's in it for you?

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

What's New?

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

Financial & Economic Incentives

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

Technical Assistance

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

Partnerships Enhance Assistance to NRCS Private Land Programs

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

For More Information

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

Water Erosion

Curbing water erosion

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

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

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

Wind Erosion

Curbing wind damage

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

- Residue management
- Shelterbelts
- Windbreaks
- Field stripcropping

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

Soil

Conserving soil and water resources

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

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

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

Waterways

Protecting waterways from erosion and degradation

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

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

Manure

Managing manure

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

Begin with a look at these programs:
EQIP, CBWI

Grasslands

Managing grasslands

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

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

Wildlife

Establishing wildlife habitat

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

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

Forest Lands

Managing forest lands

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

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

Air, Energy & Climate Change

Improving air quality, conserving energy, and mitigating climate change

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

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

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Farm Bill 2008

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

January 2012

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

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

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

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

Applicants must:

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

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

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

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

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

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

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

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

Payment Limitations

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

More Information

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

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Farm Bill 2008

Fact Sheet: Environmental Quality Incentives Program Seasonal High Tunnel Initiative

January 2012

Overview

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

Seasonal High Tunnel Initiative

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

Eligibility

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

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

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

How EQIP Works

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

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

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

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

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

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

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

Payment Limitations

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

More Information

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

Pack Goats

Mr. Dwite and Mrs. Mary Sharp
Paradise Ranch

Introduction to Dwite and Mary Sharp

Dwite and Mary Sharp have raised and trained pack goats for over 13 years. They own and operate Paradise Ranch in the Flint Hills near the historical town of Council Grove, Kansas. Their family has lived in Morris County for eight generations. Although they grew up in southern California they have returned to the Flint Hills several times to live. The last time they moved to the Flint Hills was in 1997 when they moved from Charlotte, North Carolina; this time to stay.

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

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

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

Introduction to Goat Packing

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

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

John was on his own and at first he used horses to carry his equipment and supplies. The horses didn't work very well, they did a good job getting to base camp, but they couldn't get near the terrain where the

sheep lived. There wasn't enough grass in that country to leave them picketed out for more than a day. He would have to come back once a day to move and water them. This was not going to work.

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

He was at a high level of desperation, after a particularly difficult day in the mountains, he imagined a goat packed up like a horse. At first he laughed at the idea, but he was desperate. Several days later he returned home for a few days off. He had several goats, he liked goat milk. One was an eleven year old wether named Wethervane that he harnessed and used to haul water on a travois from a creek to a cabin. He knew Wethervane could haul a couple hundred pounds on a travois using an old upside down horse halter for a harness. He had no idea how he would react to carrying a load on his back. He started slowly using a saddle bag, adding a little weight at a time, leading him around. Wethervane acted as though he was carrying nothing. So John got some bigger bags and loaded them with his gear. He slung them over Wethervane's back, using a horse saddle pad for padding. It worked, this was becoming exciting. After a day of walking Wethervane around and increasing the weight, it became evident that with a few refinements he could probably take Wethervane back to the mountains with him. He made the first pack goat saddle out of some 1"x6" boards and cross bucks from a sawed up shovel handle. It became clear that with the saddle to help distribute the load more evenly, Wethervane could easily carry even more weight.

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

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

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

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

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

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

Facts about Goats

1. Goats are quite picky about what they eat.
2. Goat's eyesight is seven times better than a human.
3. Goats can smell with their mouth (called the Flehman response), using an organ in the roof of their mouth called the Jacobsens organ. When they curl up their upper lip with their mouth slightly open, they are smelling.
4. Goats can be very social animals making them wonderful companions.
5. Goats will follow with out being led.
6. Goats are the most surefooted animal on the planet.

7. Goats are one of the most intelligent creatures on the planet.
8. Goats are thought to have been domesticated more than 10.000 years ago. 5,000 years before the horse and probably the first wild animal to be domesticated.
9. Goat's primary diet consists of weeds and brush.
10. Goats are browsers not grazers.
11. Goats can go 3 or 4 days without water. The only animal better is a camel.
12. While in the desert a large wether can carry enough water for you and itself to last a week.
13. Goats can adjust their metabolism as the need arises.
14. An exercising goat has up to 12% heat loss through their horns. (They are like radiators)
15. Generally there is no need to carry feed for goats on a pack trip.
16. Goats are herd animals and should be kept with at least one other goat.
17. Goats have the ability to regain all their natural instincts when taken into the wilderness.
18. Goats have the widest variety of food preferences.
19. When danger approaches pack goats will surround you and face the danger. They will not flee.
20. Horned goats are capable of killing predators, and will if forced to do so.
21. Wildlife has been known to follow and get extremely close to pack goats in the wild. This makes for great photo opportunities.
22. When given a large selection of plants in a pasture a goat is capable of eating the correct amount of the right plants to be at optimum health. A nutritionist can not compete with this ability.

Preparing the Facilities for Pack Goats

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

Their needs are:

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

2. Pens and Pastures; the goat house should have a pen or corral on the side or sides that are open, so you can contain the goats as needed. I recommend using 2"x4" woven wire or even 2"x4" horse panels. These two are five feet tall. My reasoning for this is to protect the goats inside the pens from predators. The 2"x4" openings will not allow the small kids to get their heads through the fence and be grabbed by something on the other side. This is a very common way for goats to be killed. We have had very bad luck using cattle panels and woven field wire (sometimes called hog wire) which have 6"x6" openings. Newborns have been known to crawl through these fences and as they get older and have horns they get their heads stuck in the fence and then they are at the mercy of what ever is on the outside. The wire with the 6"x6" opening is cheaper but don't take the chance! Spend the money at the beginning before you loose something precious to you! Also don't use welded wire. The welds will eventually break loose and your fence will come apart. We use T posts everywhere we use panels. With the woven wire you must have braced, hedge corner posts. The reason for this is because the wire must be stretched and if they are not cemented and braced the tension of the wire will pull the posts over. We use 4'-12' round tubular gates and cover the side the goats are on with 4' chain link. You could also use chain link gates. All the materials can be bought at a farm and ranch

store. Remember to put the fence on the side of the post that will be pushed on most. For example, if you have cows on one side and goats on the other, then the fence should be on the side the cows are on. If you have nothing on the other side the fence should be on the goat side. Let the post support the fence not the wire that is holding the fence to the post. When putting the T posts in the ground do not forget to face the T post the correct way for the side the fence will be on.

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

My experience with goat fencing is vast. I've made every mistake I think I could have. I think I finally have it under control. Goats are brilliant escape artists and eating machines. These two attributes make them tough to fence. You might think you've beat them but you'll only know for sure when the eating looks better on the other side of the fence. That is why they will show you your deficiencies in fence building. I have had way more Boer goats over the years than pack goats but it seems to be the trained pack goats that instigate the major break outs. These very large goats have escaped through the places I would not have believed if I had not seen it with my own eyes. They have shorted out electric fences and led one hundred goats into the neighbor's bean field. They have done this more than once.

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

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

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

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

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

a 100 mile low impedance Zareba fence charger. Orschlins and Tractor Supply sell them. My pastures are only about 25 acres total.

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

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

Choosing Your Pack Goats

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

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

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

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

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

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

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

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

Training

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

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

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

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

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

1st Hour

1. "All Wether Marching Band" arrives.
2. Paradise Ranch introduction.
3. Introduction to the "Boys".
4. How goatpacking began.
5. Packgoat confirmation.
6. Horns: yes or no?

2nd Hour

1. Choosing a Packgoat.

2. Packgoat facilities, housing, fencing, and pens.
3. Training.
4. How to tie goats out safely.
5. Vaccinations.
6. Parasite.

3rd Hour

1. Hoof trimming.
2. Nutrition and wavy teeth.
3. Saddles, pannier bags, and how to pack them.
4. Questions and answers.

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

Alpine	Boer	LaMancha	Nubian	Oberhasli	Saanen	Toggenburg
Louis	Brock	Levi	Jake	Mudslide	Avalanche	Poncho
Cochese	Dynamite	Garrett	Chief	Satchel 2	Glacier	Lefty
Forrest	Valentino	Axel	Cole	Cargo	Rockslide 2	Moses
Ukon		Snow		Satchel 1	Whitewater 2	Sampson
Denali					Clifford	
Stuart					Rockslide 1	
Geronimo					Whitewater 1	

Sabor (Saanen/Boer)	Nubor (Nubian/Boer)	Bopine (Boer/Alpine)	Oberpine (Oberhasli/Alpine)	Bobopine (Boer/Boer/Alpine)
Clark	Micah	Mucury	Ridge	Zeek
Luke	Rio	Wethervane	Thorne	
Noah				
Gabriel				
Tarzan				

Books

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

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

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

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

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

Magazine

"Goat Tracks Journal of the Working Goat"
owned and published by Larry Robinson
13 Norwood Place
Boise, ID 83716-3283

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

Reproduction and the Bottom Line

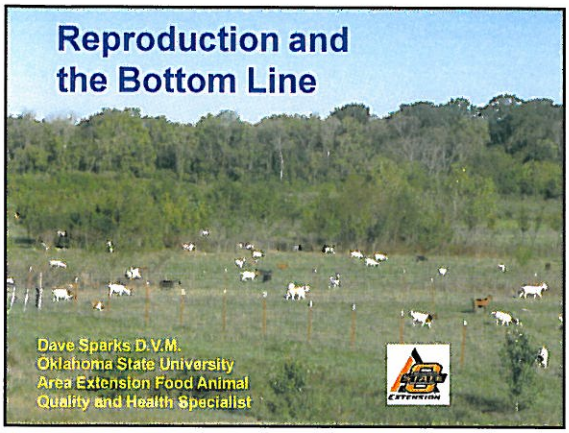
Dr. Dave Sparks
Oklahoma State University

Introduction

Reproductive efficiency probably affects the profitability of meat goat operations more than any other factor. It seems like reproduction should be the simple part of the goat management plan. After all we only have to let nature take its course, right? Remember that in nature all that is required is to reproduce efficiently enough to maintain the population, not show a profit. A better understanding of the reproductive physiology and some simple management tips can help producers manage to have more product to offset the expenses, and maybe even have a little black ink left over.

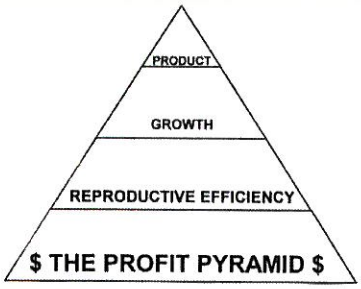
As I give talks on meat goat health and productivity I find that most of us are in this industry because we enjoy working with our goats. Most of the folks I visit with, however, tell me that they would enjoy it a lot more if they were taking some profits to the bank. Many producers don't realize that although carcass quality and growth rate are important, it is reproduction performance that spells the difference between profit and loss. Today in Oklahoma, there is about a $5/cwt difference in the sale price of a number 1 or number 2 kid. On a 60 Ib. kid, this translates to about $3.00 per goat. Obviously kids that reach market weight faster are more profitable. If however, your doe can wean twice as many kids, then the income is doubled, while the expense of maintaining the does is unchanged. This is important for commercial producers, but it is even more important for purebred breeders who are depreciating large investments for their breeding herd. The easiest and fastest way to increase profits is simply to have more kids to hop in the trailer when it is time to go!

Reproduction and the Bottom Line



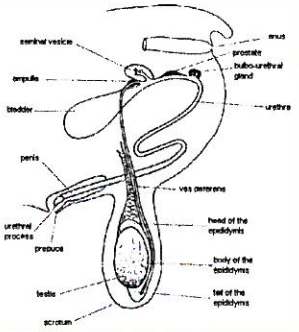
Dave Sparks D.V.M.
Oklahoma State University
Area Extension Food Animal
Quality and Health Specialist

Relative Economic Value of Traits



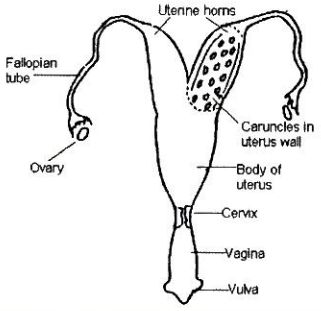
Male Reproductive System

The male continues to manufacture haploid cells, the sperm, throughout his life.



Female Reproductive Tract

The female is born with a predetermined number of haploid cells, the ova or egg cells, in her ovary and will never make any more.



Goat Estrous Cycle

- Anestrous
  - The time between breeding seasons when the doe is not coming into heat
- Estrus
  - The time the doe is "in heat"
- Metestrus
  - The time between heat periods when the doe is trying to become pregnant

Anestrus

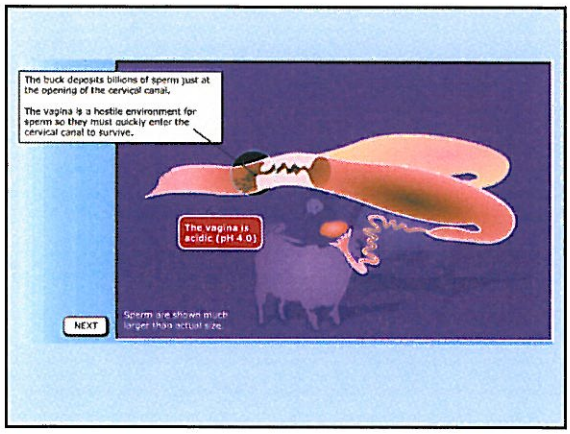
- Goats are seasonal breeders. Anestrous is the part of the year when does are not cycling.
- All reproductive hormone levels are low.
- The onset and decline of the breeding season are controlled by day length and buck activities.
- Poorly influenced by drugs, but can be influenced by artificial lights and teaser bucks.

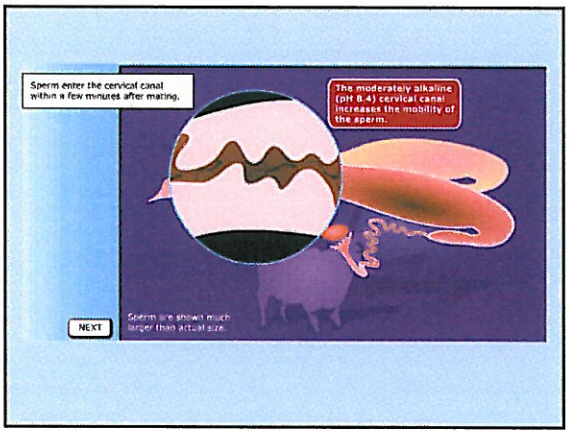
Estrus

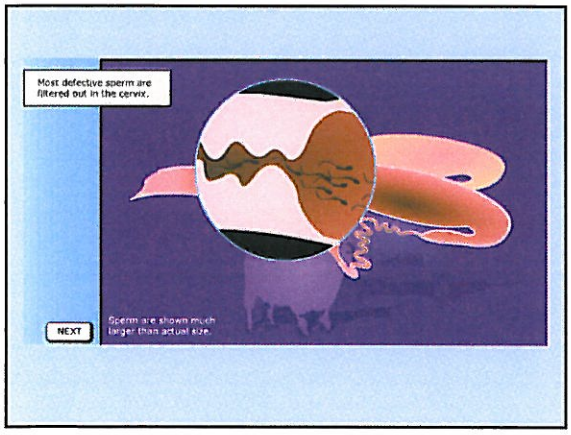
- This is the period just before, during and just after the egg is released in the ovary.
- The dominant structure on the ovary is the follicle which releases estrogen as the dominant hormone in the system.
- The estrogen causes the doe to be receptive to the male.

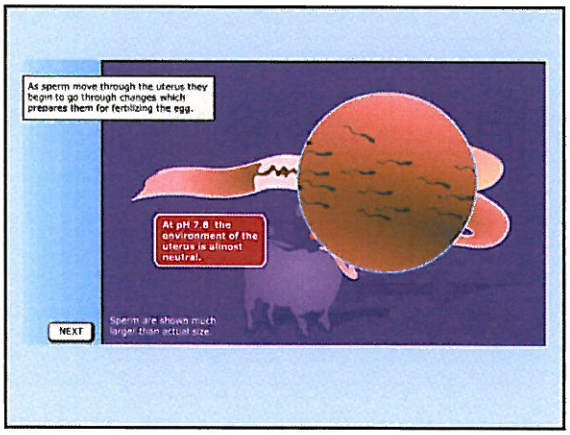
Metestrus

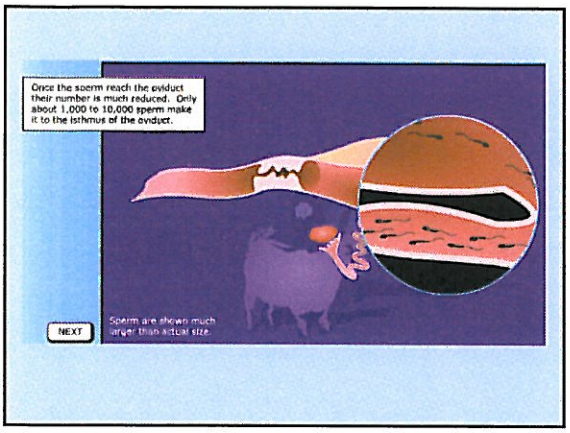
- The part of the cycle between heat periods.
- The dominant structure on the ovary is the Corpus Luteum and the dominant hormone is progesterone.
- Under the influence of progesterone the doe rejects the buck and the reproductive tract undergoes changes to allow for attachment of the embryo and support of the pregnancy.

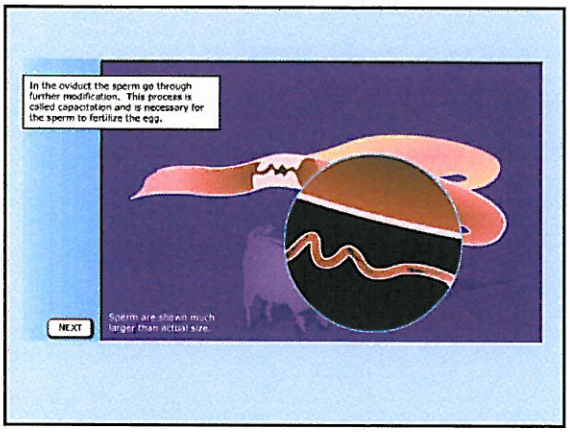


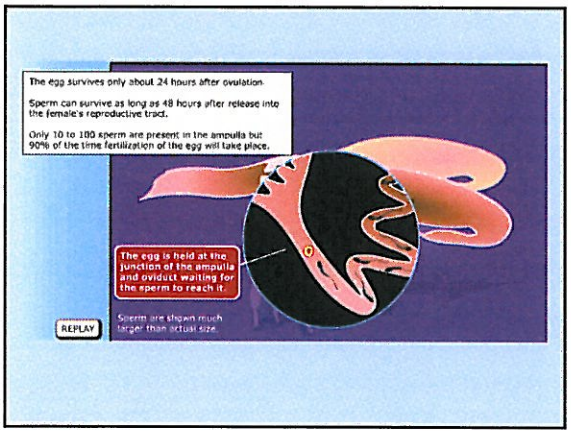












How Big is Big Enough?

Kid doe body weight at mating (lb)	First kidding%	Average lifetime kidding%
Below 40	2	48
40 – 44	21	70
44 – 51	32	72
51 – 55	55	79
55 – 60	78	82
60 – 70	81	86
Above 70	88	89

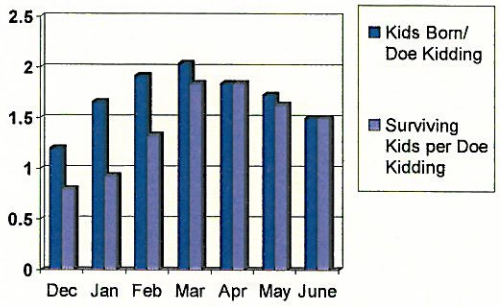
Weaning Traits of Boer Does (3 Matings)

Dam ID	Litter Size, n	Litter Wt, lbs
220	2.33	100.27
217	2.00	90.93
Herd Avg	*1.48*	*58.00*
Boer Avg	*1.19*	*47.57*
247	1.00	35.48
207	1.00	34.20

You Can't Afford Singles

- The average meat goat doe eats about 1 ton of "something" per year!!
- First time does have a higher percentage of singles.
- Second pregnancies tend to be singles if first time was twins.
- Higher percentage of singles in mature does following triplets in prior year.
- Does above the age of 6 years have a higher percentage of singles.

Does Bred Early or Late Have More Singles



Teaser Bucks Can Help!

- Teasers are intact vasectomized males used to stimulate the does.
- Teasers stimulate does to cycle but cannot cause a pregnancy.
- When herd sires are introduced the doe is more fertile than on her first cycle of the season.
- Quality or size is not a concern but teasers should be tough, vigorous and trouble free.

Nutrition and Reproduction

- **Flushing – Increasing nutritional plane by adding .5 lbs of corn or protein supplement for 2 weeks before and 2 weeks after breeding increases pregnancy rate and litter size at birth.**
- **Does in good body condition at breeding deliver more kids and have better kid survival rates.**
- **Pregnancy toxemia**

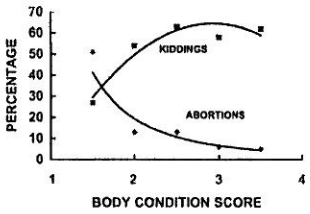


Fig. 1. Relationship between body condition score of goats at mating and abortion and kidding rates.

Pregnancy Toxemia

- **Inadequate carbohydrates in diet in last trimester causes mother to metabolize her body fat.**
- **By product is ketones which build up to toxic levels.**
- **Doe carrying twins, carbo requirement increases to 180%, with triplets 240%.**
- **Doe should gain ½ lb. day last trimester.**

Pregnancy Diagnosis

- **Can reduce costs, increase income, and maximize returns on available inputs.**
- **Several possibilities, each with advantages and disadvantages.**
  - Doppler Ultrasound
  - "A Mode" Ultrasound
  - Blood Hormone Assay

Doppler Ultrasound

- Expensive to purchase.
- Delicate and only somewhat portable.
- Requires extensive training and practice to use accurately.
- Accurate and early results.
- Use with multiple species and multiple functions.
- May show number of fetuses.
- Slower to operate accurately.

Ultrasound of 55 day Pregnancy

"A Mode" Ultrasound

- Inexpensive to purchase and operate
- Purchase preset for one type of animal.
- Quickly operate successfully.
- Accurate at 30 to 40 days.
- Audio tones. Can not tell how many kids are present.
- Tough and easily portable.

Blood Chemical Assay

- BioPRYN – Measures the amount of a very specific protein, released from the plancenta, present in the maternal blood.
- Accurate at 26 days
- 95% accurate
- Samples received in lab by Wednesday are reported Friday
- Cost is $7.50/test + supplies and shipping

- www.biotracking.com
- 208-882-9736

Assisted Reproduction

- **Artificial Insemination**
- **Embryo Transfer**

Valuable tools for increasing the impact of outstanding genetics, but also require increased management, cost, and risk.

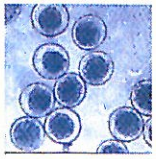
Artificial Insemination

- **Bucks are collected via;**
  - **Artificial Vagina and estrus doe**
  - **Electro-ejaculator**
- **Semen is examined, extended, and frozen.**

- **Semen is placed inside the cervix by means of a glass speculum and pipette.**
- **Typical conception rates are 30-50% for one insemination or 60-80% with 2 or three inseminations.**
  - **May get 2 or 3 straws with one certificate.**
- **Laparoscopic AI increases the success rate but also the danger to doe and the cost.**

Embryo Transfer

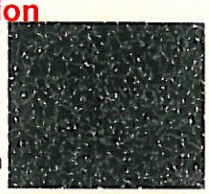
High value doe is synchronized with lower value does, super-ovulated, and bred to high value buck. At about 1 week of pregnancy the fertile embryos are flushed from the donor doe and introduced surgically into heat synchronized recipient does.



- Typically harvest from 0 to 20 fertile embryos from donor.
- Very expensive and management intensive, must have strong market for high value kids.
- Difficult to do legally in goats due to restrictions on drugs used in the procedure.

Buck Breeding Soundness Examination

- Not so much to identify sterile males as to identify marginally fertile males.
- Late kidding, low conception rates and small litter sizes cost big dollars. (Especially since goats are seasonal breeders and goat markets are seasonal)



Breeding Soundness Exam

- Evaluation of semen sample
  - Semen volume and concentration
  - Correct morphology
  - Motility
- Physical examination for ability to breed
  - Reproductive system
  - Musculoskeletal system
- Libido determination must be made from observations over time.

Your local veterinarian can help you identify problems before they are problems.

Oklahoma Veterinary Medical Association
www.okvma.org

American Association of Small Ruminant Practitioners
www.aasrp.org

DHI Training

Ms. Eva Vasquez
Langston University

STANDARD OPERATING PROCEDURES FOR DAIRY GOAT PRODUCTION TESTING

Effective January 1, 2004

CONTENTS

STANDARD OPERATING PROCEDURES

1.0 SCOPE & APPLICATION

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

2.0 SUMMARY OF PROGRAM

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

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

3.0 AUTHORITY

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

4.0 RESPONSIBILITY

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

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

5.0 DEFINITIONS

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

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

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

6.0 PERSONNEL QUALIFICATIONS

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

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

7.0 MINIMUM PERSONNEL TRAINING REQUIREMENTS

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

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

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

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

8.0 EQUIPMENT AND SUPPLIES

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

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

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

9.0 SAMPLE COLLECTION – PREPARATION

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

9.2 Obtain necessary sampling and/or weighing equipment.

9.3 Coordinate with herdowner and partner agencies, if appropriate.

10.0 SAMPLE COLLECTION - METHOD OPTIONS

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

GOAT METERS

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

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

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

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

10.4 Scales should be identified with a unique identification number.

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

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

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

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

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

11.0 SAMPLE HANDLING AND PRESERVATION

11.1 Use pre-preserved sample vials.

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

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

11.4 Record all pertinent data on a field data sheet.

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

12.0 DATA COLLECTION AND RECORDS MANAGEMENT

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

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

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

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

12.5 Minimum Suggested Record Retention

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

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

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

14.0 REFERENCES

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

Fitting and Grooming for Youth Market Doe Shows in Oklahoma

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

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

Fitting and Grooming for Youth Market Wether Shows in Oklahoma

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

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

CURRENT PROGRAM SUMMARY

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

- **EXTENSION OVERVIEW**
- **INTERNATIONAL OVERVIEW**
- **RESEARCH OVERVIEW**
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Research Overview

Dr. Arthur Goetsch
Goat Research Leader

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

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

To provide an idea about our research program since the last Field Day, listed below are research projects and experiments we have been involved with in 2011, abstracts for 2012, and summaries of scientific articles that were published in 2011 or currently are "in press."

Standard Abbreviations Used

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

Current Research Projects

Title:	Enhanced Goat Production and Products in the South-Central U.S.
Type:	CSREES project
Project Number:	OKLX-SAHLU
Period:	2006-2012
Investigators:	T. Sahlu, A. L. Goetsch, R. Puchala, R. C. Merkel, T. A. Gipson, S. P. Hart, S. Zeng, and Z. Wang
Institution:	Langston University
Objective:	Study goat feeding and management, relevant health issues, and milk product technologies in order to increase the level and efficiency of goat productivity for increased profitability from goat production and lower costs to consumers of goat products.

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

Title:	Boer Goat Selection for Residual Feed Intake
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2008-38814-02661
Period:	2008-2012
Investigators:	T. A. Gipson[1], A. L. Goetsch[1], R. Puchala[1], T. Sahlu1, and C. Ferrell[2]
Institutions:	[1]Langston University, and [2]USDA ARS Meat Animal Research Center, Nutrition Research Unit
Objective:	1) Determine and demonstrate efficacy of use of residual feed intake to achieve genetic progress in improving efficiency of feed. utilization without elevating mature size or body fatness compared with selection based on growth rate.; and 2) Characterize relationships between residual feed intake and animal activities, feeding and social behaviors, and energy expenditure, and assess potential means of prediction of residual feed intake at an early age.

Title:	Establishing a Pilot Tannery and Capability for Goat Leather Research at Langston University
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	2008-38814-02520
Period:	2008-2011
Investigators:	R. C. Merkel[1] and C. K. Liu[2]
Institutions:	[1]Langston University and [2]USDA ARS Eastern Regional Research Center
Objective:	1) Establish a pilot tannery and capability for goat leather research at the LU campus; 2) Determine the effects of goat breed, diet and age upon skin chemical composition and the mechanical properties of resulting leather; and 3) Evaluate environmentally friendly tanning methods on U.S. goat skins

Title:	Enhanced Safety and Product Quality from On-Farm Thermization/Pasteurization of Goat Milk in the Middle East
Type:	United States - Israel Binational Agricultural Research and Development Fund
Project Number:	FG-9503-09R
Period:	2010-2011
Investigators:	T. Sahlu[1], A. L. Goetsch[1], S. Zeng[1], Z. Abdeen[2], M. Fanum[2], K. Azmi[2], N. Silanikove[3], G. Leitner[3], K. Ereifej[4], L. Alrousan[4], and K. Al-Qudah[4]
Institutions:	[1]Langston University; [2]Al-Quds University, East Jerusalem, Palestine; [3]Agricultural Research Organization, Bet Dagen, Israel; [4]Jordan University of Science and Technology, Irbid, Jordan
Objectives:	Develop specifications of an inexpensive thermization/pasteurization equipment system suitable for use on small goat farms in the Middle East, conduct preliminary evaluations of the prototype for possible refinement, and determine procedures for an associated MERC grant proposal to be developed.

Title:	Effects of Selected Nutritional Components on Immunity to Haemonchus in Goats
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	OKLXWANG10
Period:	2010-2013
Investigators:	Z. Wang[1], A. L. Goetsch[1], S. P. Hart[1], T. Sahlu[1], and G. Chen[2]
Institutions:	[1]Langston University, and [2]Oklahoma State University
Objectives:	Investigate immune regulation by H. contortus and reversing this regulation by nutritional components in small ruminants.

Title:	Establishing a Langston University Testing Center for Electric Fence Modifications of Cattle Barb Wire Fence for Goat Containment
Type:	USDA 1890 Institution Research Capacity Building
Project Number:	OKLXGOETSCH10
Period:	2010-2013
Investigators:	A. L. Goetsch[1], T. A. Gipson[1], T. Sahlu[1], and J. Burke[2]
Institutions:	[1]Langston University, and [2]USDA ARS Dale Bumpers Small Farms Research Center
Objectives:	Develop a repeatable method of testing effectiveness of the various means of cattle fence modifications with electric fence for goat containment.

Experiments Active in 2011/2012

Title:	Effects of (-)-Epigallocatechin-3-Gallate (EGCG) on viability of H. contortus and immune responses of white blood cells of goats in vitro
Experiment Number:	RZ-11-03
Project Number:	OKLXWANG10
Investigators:	R. Zhong, Z. Wang, A. L. Goetsch, and T. Sahlu
Objectives:	1) Determine whether EGCG exerts a direct inhibitory effect on the viability of third-stage larvae of H. contortus and whether such effect shows a dose-dependent manner in in vitro conditions using larval viability inhibitory assay (LVIA); 2) Detect cytokine production by white blood cells stimulated by EGCG; and 3) Observe whether changes in cytokine expression affect viability of third-stage larvae of H. contortus

Title:	Boer goat selection for residual feed intake: Phase II, Year 2
Experiment Number:	AM-11-04
Project Number:	OKLXGIPSON08
Investigators:	A. Manley, A. L. Goetsch, T. A. Gipson, R. Puchala, and T. Sahlu
Objectives:	1) Determine and demonstrate efficacy of use of residual feed intake to achieve genetic progress in improving efficiency of feed utilization without elevating mature size or body fatness compared with selection based on growth rate; and 2) Characterize relationships between residual feed intake and animal activities, feeding and social behaviors, and energy expenditure, and assess potential means of prediction of residual feed intake at an early age

Title:	Investigation of CNS bacteria related to subclinical mastitis: changes in goat milk composition, casein fractions, and the plasmin system
Experiment Number:	LPW-11-05
Project Number:	2007-38814-18474
Investigators:	L. Wang, S. Zeng, L. J. Spicer, and C. DeWitt
Objectives:	Investigate the effect of subclinical mastitis caused by major types of CNS bacteria species (S. Epidermidis, S. Simulans, S. Caprae, and S. Chromogenes) on the plasmin system, casein fractions, the mechanism by which CNS affects caseinolysis, and gene profiles in Alpine and Nubian dairy goats

Title:	Investigation of CNS bacteria related to subclinical mastitis changes: changes in Colby cheese yield, quality, and microstructure
Experiment Number:	LPW-11-06
Project Number:	2007-38814-18474
Investigators:	L. Wang, S. Zeng, L. J. Spicer, and C. DeWitt
Objectives:	Assess effects of subclinical mastitis in dairy goats on milk production, composition, and caseinolysis, milk coagulation properties, and curd yield and microstructure profiles

Title:	Effects of CNS bacteria induced subclinical mastitis on gene profile of dairy goats and casein fractions and plasmin system of goat milk
Experiment Number:	LPW-11-07
Project Number:	2007-38814-18474
Investigators:	L. Wang, S. Zeng, L. J. Spicer, and C. DeWitt
Objectives:	Investigate the effect of subclinical mastitis caused by major types of CNS bacteria species causing IMI (S. epidermidis, S. simulans, S. caprae, and S chromogenes) on plasmin system, casein graction, the mechanism by which CNS affects caseinolysis, and gene profiles in dairy goats of one research Alpine herd during a year-found lactation

Title:	Effects of level of ginger and rumen undegraded protein supplementation on intake, metabolism, and ruminal conditions in yearling meat goat doelings
Experiment Number:	IR6-11-08
Project Number:	OKLX-SALHU
Investigators:	A. Nauman, T. A. Shujaa, A. Mohammed, R. C. Merkel, R. Puchala, T. A. Gipson, T. Sahlu, and A. L. Goetsch
Objectives:	Determine effects of dietary level of ginger and potential interactions with supplemental concentrate levels of rumen degraded and undegraded protein on intake, metabolism, and ruminal conditions in yearling meat goat doelings

Title:	Effects of levels of rumen degraded and undegraded protein on intake, digestion, energy expenditure, and performance of yearling Spanish wethers
Experiment Number:	IR3-11-09
Project Number:	OKLX-SALHU
Investigators:	A. Mohammed, T. A. Shujaa, A. Nauman, R. C. Merkel, R. Puchala, T. A. Gipson, T. Sahlu, and A. L. Goetsch
Objectives:	Determine effects of dietary level of rumen degraded and undegraded protein on intake, metabolism, and performance of yearling Spanish wethers

Title:	Effects of arginine, glutamine, and cysteine on cytokine genes expression in peripheral blood mononuclear cells stimulated with third-stage H. contortus antigen
Experiment Number:	RZ-11-10
Project Number:	OKLXWANG10
Investigators:	R. Zhong, Z. Wang, A. L. Goetsch, T. Sahlu
Objectives:	Characterize the profile of cytokine gene expression in peripheral blood mononuclear cells (PBMC) stimulated by H. contortus antigens, and demonstrate the effects of garlic on expressions of these genes

Title:	Evaluation of the efficacy of colostrum replacer in dairy kids
Experiment Number:	SH-11-12
Project Number:	OKLX-SALHU
Investigators:	S. Hart and L. J. Dawson
Objectives:	Determine the efficacy of a commercially available bovine colostrum replacement product (Land O Lakes Colostrum Replacement manufactured by The Saskatoon Colostrum Co, Ltd, Saskatoon Canada) in neonatal goat kids

Title:	Development of a model to evaluate methods of modifying cattle barb wire fence for goat containment – preliminary adaptation, experimental design, and Latin square washout (study number 3)
Experiment Number:	AG-11-13
Project Number:	OKLXGOETSCH10
Investigators:	A. L. Goetsch, T. Tsukahara, G. D. Detweiler, T. A. Gipson, and T. Sahlu
Objectives:	Determine appropriateness of conditions preliminary adaptation procedures, experimental design [i.e., completely randomized design, Latin square, and repeated measures with a completely randomized design], and Latin square washout procedures) in a method to be developed for evaluating efficacy of electric fence additions to cattle barb wire fence for goat containment

Title:	Use of mimosa as a protein bank for lactating meat goats
Experiment Number:	AG-11-14
Project Number:	OKLXGOETSCH10
Investigators:	A. L. Goetsch, G. D. Detweiler, Z. Wang, L. J. Dawson, R. Puchala, T. A. Gipson, and T. Sahlu
Objectives:	Determine effects of once or twice weekly 'protein bank' grazing of pastures with mimosa trees on performance of meat goat does and suckling twin kids

Title:	Effects of arginine, glutamine, and cysteine on cytokine genes expression in peripheral blood mononuclear cells stimulated with third-stage H. contortus antigen
Experiment Number:	RZ-11-15
Project Number:	OKLXWANG10
Investigators:	R. Zhong, Z. Wang, A. L. Goetsch, E. Loetz, and T. Sahlu
Objectives:	1) Determine which mitogen (ConA, PHA, or LPS) is similar to H. contortus antigen in term of cytokine gene expression in peripheral blood mononuclear cells (PBMC) from neonatal and adult Alpine goats; and 2) Investigate effects of arginine, glutamine, and cysteine on cytokine genes expression in PBMC stimulated by H. contortus antigen

Title:	Investigation of anthelmintic properties of medicinal herbs in goats infected with nematode parasites
Experiment Number:	RZ-11-16
Project Number:	OKLXWANG10
Investigators:	R. Zhong, Z. Wang, D. Zhou, A. L. Goetsch, and T. Sahlu
Objectives:	Determine the anthelmintic efficacy of three medicinal herbs, Rheum palmatum L. (Da huang), Meliae cortex (ku lian pi), and Quisqualis indica L. (shi jun zi), in goats infected with Haemonchus contortus (estimated by FEC)

Title:	Influence of trace mineral supplementation on goat reproductive performance following estrus/ovulation synchronization and different sites of semen placement
Experiment Number:	EL-11-17
Project Number:	OKLX-SAHLU
Investigators:	E. Loetz, L. Dawson, A. L. Goetsch, S. Hart, D. Arrocha, I. Portugal, J. Hayes, and T. Sahlu
Objectives:	Evaluate the influence of two levels of a commercially available trace mineral supplement (Multimin-90) on rates of fertilization, ovulation, conception, and pregnancy following natural service or traditional transcervical AI or RamGo-aided intracervical

Title:	Optimum goat breeding time based on vaginal/cervical electrical resistance changes
Experiment Number:	EL-11-18
Project Number:	OKLX-SAHLU
Investigators:	E. Loetz, L. Dawson, D. Arrocha, I. Portugal, and J. Hayes
Objectives:	1) Establish if vaginal/cervical impedance changes during goat per-estrus are associated with changes in LH levels and ultrasound imaging detection of ovulation; and 2) Determine if vaginal/cervical impedance changes during goat peri-estrus can be used to predict time of ovulation

Title:	Effects of an enzyme additive on hay intake and fiber digestion
Experiment Number:	SH-11-19
Project Number:	OKLX-SALHU
Investigators:	S. Hart
Objectives:	Test effects of an enzyme additive on fiber digestion and intake in weaned Boer cross wethers

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

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

Abstracts

2012 National Meetings of the American Society of Animal Science (Journal of Animal Science, Volume 89 ESupplement 2; the American Society of Animal Science has copyright ownership and the Journal of Animal Science is the source of this information)

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

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

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

Spanish (S; 28 - 40 wk of age) and Boer (B; 33 - 46 wk) wethers were used to determine effects of level (SL) and length of supplementation on BW and harvest characteristics. The experiment started in January, with wethers residing in 4 pastures primarily with warm season grasses. Alfalfa hay was given free-choice, and a pelleted diet (16% CP and 60% TDN) was supplemented at 0.5 or 1.5% BW (DM basis; L and H, respectively). Five S and 6 B were harvested initially, and 12 per breed (BR) and SL were harvested after 110 and 218 d (PR 1 and 2, respectively). Data were analyzed by GLM procedures. There were BR differences ($P \leq 0.06$) in initial BW (33.3 and 23.7 kg), carcass weight (15.4 and 10.9 kg), and mass of noncarcass components (NCC; 11.7 and 9.2 kg for B and S, respectively) but not in mass of NCC relative to empty BW (EBW). The ADG was greatest ($P < 0.05$) among PR-BR treatments for PR 1-B (139, 74, 63, and 56 g for PR 1-B, PR 1-S, PR 2-B, and PR 2-S, respectively; SEM = 5.23). The BW was affected ($P < 0.05$) by SL (48.2 and 43.1 kg for H and L), BR (53.1 and 38.2 kg for B and S), and PR (41.8 and 49.3 kg in 1 and 2, respectively). There were corresponding differences ($P < 0.05$) in weight of the carcass (23.6 and 20.4 kg for H and L; 25.5 and 18.5 kg for B and S; 20.3 and 23.8 kg for PR 1 and 2, respectively) and NCC (16.9 and 15.0 kg for H and L; 18.4 and 13.5 kg for B and S; 15.1 and 16.8 kg for PR 1 and 2, respectively). Digestive tract mass was similar between BR and lowest ($P < 0.05$) among SL-PR treatments for PR 2-H (7.21, 7.19, 6.31, and 7.51% EBW for PR 1-H, PR 1-L, PR 2-H, and PR 2-L, respectively). Liver mass was similar between BR and less ($P < 0.05$) for H than for L (2.15 and 2.30% EBW) and for PR 2 vs. 1 (2.11 and 2.34% EBW). Mass of internal fat was greatest ($P < 0.05$) among SL-PR treatments for PR 2-H (6.72, 6.36, 8.61, and 5.95% EBW for PR 1-H, PR 1-L, PR 2-H, and PR 2-L, respectively). In summary, advantages of B in BW and carcass weight were similar after PR 1 and 2, BR had little effect on NCC mass relative to EBW, and H increased mass of internal fat after PR 2 but not PR 1.

Efficacy of a bovine colostrum replacement product for goat kids

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

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

When adequate doe colostrum is not available for neonatal goat kids an alternative source of colostrum is necessary to support the health of the neonate. The objective of this study was to determine the efficacy of a commercially available bovine colostrum replacement product (Land O'Lakes Colostrum Replacement manufactured by The Saskatoon Colostrum Co, Ltd., Saskatoon, Canada) in neonatal goat kids. Goat kids were removed from the doe at birth and a jugular blood sample taken for analysis of serum IgG. The colostrum replacement containing 100 g IgG/470 g of powder was reconstituted with water using 76 ml of warm water to 40 g of colostrum powder and mixed using a plastic jar with a spring similar to those used to mix protein drinks for athletes. Kids were fed reconstituted colostrum replacement at 10% of their bodyweight divided into 3 feedings over a 16-hour period. Six hours after the last feeding another blood sample was collected for determination of serum IgG. Kids were observed for 10 minutes after each feeding for any adverse reactions. After the 3 feedings of colostrum kids were fed a milk replacer, 470 ml/feeding, two feedings per day and offered a starter feed. Health and weight gains were compared to other kid cohorts (fed heat-treated goat colostrum) up to three weeks of age. Prefeeding levels of IgG were about .2 mg/dl and were significantly increased ($P < 0.01$) to 18.9 mg/dl (SD = 4.9) post-feeding. There were no cases of scours or off-feed in test animals or cohorts. Weight gains were similar for kids fed the bovine colostrum replacement or pasteurized doe colostrum (138g/day vs 121 g/day; $P > 0.10$). In conclusion, the bovine colostrum substitute resulted in satisfactory blood levels of IgG and kids that were equally healthy to cohorts and gained similarly.

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

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

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

Lactating meat goats grazing 0.4-ha grass/forb pastures were used to determine effects on performance of different supplement treatments. Boer does (32) with 1 or 2 kids were used in a study with 4 4-wk periods (PR) starting 22 ± 2.0 d after birth. Two groups were subjected to treatments of no supplementation (CO), access to a 20% CP supplement block (SB), and placement in a supplement pasture with mimosa (Albizia julibrissin) trees for 6 h 1 d/wk (1X) or twice weekly for 3 h/d (2X). All groups received access to the same mineral-vitamin supplement. Available forage DM in non-supplement pastures averaged 3,477, 3,448, 3,353, 2,802, and 2,423 kg/ha initially and after PR 1, 2, 3, and 4, respectively; hand-plucked forage samples averaged 15 and 67% CP and NDF, respectively. Treatment did not affect doe ADG (-23, -42, -23, and -15 g; SE = 11.5), FAMACHA score, or fecal egg count, although kid ADG in the first 3 PR differed ($P < 0.05$) between type of supplement and frequency of supplement pasture access (121, 111, 120, and 134 g for CO, SB, 1X, and 2X, respectively; SE = 3.3). Spanish does (32) nursing 2 kids were used in a study with 3 4-wk PR starting 66 ± 0.8 d after kidding. The same CO and SB treatments were employed, but access to supplement pastures was for 24 h 1 d/wk (1X) or 2 d for 6 h/d (2X). Forage DM averaged 1,530, 842, 791, and 750 kg/ha initially and after PR 1, 2, and 3, respectively), and 0.6 kg/d (as fed) per doe of grass hay (7 and 67% CP and NDF, respectively) was fed after PR 1. Hand-plucked forage samples averaged 14 and 64% CP and NDF, respectively. Treatment did not affect doe or kid FAMACHA score. Kid ADG in PR 1 and 2 was not affected by treatment. Doe ADG was affected by supplementation ($P < 0.05$) and supplement type ($P < 0.09$) (-44, -33, -23, and -12 g; SE = 5.5), which resulted from effects ($P < 0.05$) in PR 3 after weaning (-87, -69, -16, and -2 g for CO, SB, 1X, and 2X, respectively; SE = 14.3). In conclusion, use of the SB was not beneficial, and infrequent access to supplement pastures had relatively small effects on ADG, perhaps because forage availability and nutritive value were not severely limiting.

Anthelmintic efficacy of medicinal herbs in goats infected with nematode parasites

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

[1]Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun, China

[2]American Institute for Goat Research, Langston University, Langston, OK

Thirty high-percentage Boer does (2.9 ± 0.12 yr; 48 ± 1.9 kg BW) naturally infected with Haemonchus contortus from grazing pasture of Langston University were allocated to 5 groups and moved to a barn to investigate anthelmintic efficacy of three medicinal herbs, Rheum palmatum L. (rhubarb; R), Meliae cortex (melia bark; M), and Quisqualis indica L. (rangoon creeper; Q). Does were given ad libitum access to grass hay and water, along with 200 g/d per doe of a concentrate-based pelleted supplement. Treatments were control (C), R, M, Q, and a 1:1:1 mixture of the three herbs (RMQ). The herbs in powder form were mixed with water at 20 g/100 mL just before drenching. After being acclimated for 7 d, does were drenched with 100 mL of water alone or with the respective herbs at 20 g/d for 10 d. Fecal samples were collected on d 0, 3, 6, 9, 13, and 16 after the start of drenching for worm egg count (FEC). Blood samples were taken on d 0 and 13 for measuring packed cell volume (PCV). Initial FEC was 2,208, 3,933, 3,025, 2,350, and 3,033/g for C, R, M, Q, and RMQ, respectively (SEM = 425.2; $P > 0.05$). After 10 d of treatment, none of the herbs showed anthelmintic effects. The FEC on d 16 was 1,350, 3,058, 1,525, 825, and 2,067/g for C, R, M, Q, and RMQ, respectively (SEM = 332.9, $P > 0.05$). Change in PCV was 1.8, 20.1, 9.1, 10.7, and 13.3% for C, R, M, Q, and RMQ, respectively (SEM = 1.68). Compared with C, the PCV value increased in does treated with R and RMQ ($P < 0.05$); however, the increases may have been due to scouring in response to treatment with R. In conclusion, these herbs were not effective anthelmintics for the most problematic internal parasite of goats, H. contortus, in much of the US.

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

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

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

Many goat producers divide their herd into 2 or more groups for grazing in adjacent pastures with or without other livestock species. The objective of this study was to observe the spatial patterns of two adjacent herds of goats pastured with and without cattle. A 15.8-ha pasture was stocked with 36 Spanish goats and 12 Angus cows (GC), and a 14.1-ha pasture was stocked with 36 Spanish goats without cattle (GO). Neither group of goats had been exposed to cattle before. The pastures consisted of fescue, bermudagrass, various Panicum such as switchgrass, bahiagrass, and broomsedge bluestem, but areas were reverting to woody plant species such as sapling-sized trees of pecan, elm, and honey locust. Eleven goats in GC and 10 goats in GO were fitted with GPS collars that recorded a fix every 5 min in the first 2 wk. A GIS point-in-polygon analysis using a 10 × 10 m grid was conducted for each pasture. The GO had greater ($\chi2 = 858$, $P < 0.01$) explored space (65% of 1473 grids) compared with GC (13% of 1584 grids). Of the grids explored, GO had a higher percentage with a density of 100 or more fixes than did GC (55 vs. 33%; $\chi2 = 11$, $P = 0.01$), indicating a wider area of methodical exploration or habituation. Only 21% of fixes were within 100 m of the water point. Goats in GO preferred pasture locations closer ($\chi2 = 15106$, $P < 0.01$) to the water point than did GC (200 vs. 300 m); however, GC came to the water point earlier ($P < 0.01$) than did GO (0730 vs. 1000 h). The favored location in the morning for each pasture was near the water point in the eastern intersection of the pastures. During the remainder of the day GC favored the southwestern-most corner of their pasture near a central fence line. In the afternoon, GO preferred the location near GC but also had a favorite location shaded by trees in the center of the pasture. The spatial behavior of the groups of goats appeared to be influenced by each other, and presence of cattle may have inhibited GC from fully exploring their pasture.

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

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

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

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

Ruminal methane emission by Boer and Spanish does supplemented with garlic

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

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

Twenty Boer (B; 2-7 yr of age and 48.5 ± 2.2 kg) and 20 Spanish (S; 4-6 yr of age and 39.3 ± 1.5 kg) does were used to examine effects of garlic on ruminal methane emission and heat production. Ten does of each breed were randomly allocated to control (C) and garlic (G) treatments. All does received 200 g/d (as-fed basis) of a concentrate mixture consisting of 54.4% ground corn, 26.0% soybean meal, 12.9% molasses, and 6.7% mineral and vitamin sources. The G does also received 20 g/d (as-fed basis) of garlic powder. For at least 2 mo does grazed grass/forb pastures in the summer. Thereafter, sets of 4 does consisting of 1 doe per treatment (CB, CS, GB, and GW) were sequentially placed in metabolism crates for 2 wk, continued to receive supplements, and were fed coarsely ground alfalfa hay free-choice. Gas exchange was measured on the last day for 24 h in an indirect, open circuit respiration calorimetry system with 4 metabolism cages fitted with head-boxes. There were no interactions between breed and supplement treatment ($P > 0.05$). Alfalfa hay DMI during the calorimetry measurement period was greater ($P < 0.05$) for G vs. C (781, 742, 934, and 853 g/d for CB, CS, GB, and GS, respectively; SEM = 29). Ruminal methane emission was less ($P < 0.05$) for G than for C in g/d (12.0, 10.8, 8.5, and 6.4, respectively; SEM = 0.56) and relative to intake of DM (15.2, 14.6, 9.1, and 7.6 g/kg; SEM = 0.44) and GE (4.31, 4.12, 2.58, and 2.14% for CB, CS, GB, and GS, respectively; SEM = 0.124). Treatment did not affect ($P > 0.05$) respiratory quotient (1.012, 1.004, 1.003, and 0.994), heart rate (73, 72, 72, and 70; SEM = 1.6), heat production (450, 444, 447, and 432 kJ/kg BW0.75; SEM = 10.7), or the ratio of heat production:heart rate (6.18, 6.19, 6.18, and 6.21 kJ/kg BW0.75 per heart beat for CB, CS, GB, and GS, respectively; SEM = 0.056). In conclusion, supplementation with garlic decreased ruminal methane emission and increased DMI by Boer and Spanish does consuming alfalfa hay.

Summaries of Recent Journal Articles
(2011, 2012, and In Press)

Effects of small ruminant type and restricted protein intake on metabolism

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

Small Ruminant Research 98:111-114. 2011

Boer goat (BG), Spanish goat (SG), and Rambouillet sheep (RS) wethers, ≥ 2 yr of age, were used in a crossover experiment with 28-d periods. Diets were ad lib. consumption of wheat straw alone (CON) or with a 90% soybean meal, 10% molasses supplement given at 0.22% BW (SBM). Initial BW was 35, 55, and 32 kg for BG, RS, and SG, respectively. NDF digestibility was similar among animal types and between diets. BW change was numerically least for RS (-92, -158, and -107 g/d for BG, RS, and SG, respectively; SE = 22.6). ME intake was similar among animal types (244, 230, and 259 kJ/kg BW0.75 for BG, RS, and SG, respectively; SE = 16.6) and greater (P < 0.05) for SBM vs. CON (320 vs. 168 kJ/kg BW0.75). Total energy expenditure (EE) was greater (P < 0.05) for RS than for BG (362, 415, and 402 kJ/kg BW0.75 for BG, RS, and SG, respectively) and for SBM vs. CON (413 vs. 374 kJ/kg BW0.75). EE by the portal-drained viscera (PDV) (1.34, 1.33, and 1.17 MJ/d; SE = 0.122) and liver (1.48, 1.44, and 1.32 MJ/d; SE = 0.133) was similar among animal types. Liver EE was greater (P < 0.05) for SBM vs. CON (1.60 vs. 1.22 MJ/d), but PDV EE was similar between diets. Net fluxes of ammonia N (AMN) and urea N (UN) across the PDV (AMN: 3.4, 2.4, and 3.2 g/d (SE = 0.69); UN: -5.2, -3.3, and -4.6 g/d (SE = 1.19)) and liver (AMN: -3.6, -3.2, and -4.3 g/d (SE = 0.78); UN: 7.6, 4.8, and 4.2 g/d for BG, RS, and SG, respectively (SE = 1.17)) were similar among animal types. In conclusion, the magnitude of any difference in N recycling among animal types was less than necessary to affect fiber digestibility. Nonetheless, some findings suggest a lesser ability of sheep to modify metabolic functions to cope with limited nutritional planes elicited by feeding crop residue-based diets, perhaps relating to energy use by extra-splanchnic tissues.

Factors affecting goat meat production and quality

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

Small Ruminant Research 101:173-181. 2011

Deposition of relatively less subcutaneous fat by goats than sheep adversely affects storage properties of meat, most importantly dehydration and cold-shortening. High concentrate diets increase internal and carcass fat in goats, including intramuscular fat though levels are less than in cattle or sheep. Levels of saturated and monounsaturated fatty acids are greater in goats consuming concentrate in confinement compared with rangeland grazing. Because the botanical composition of the diet selected by goats is more reflective of plant species available compared with cattle and sheep, changes in the botanical and chemical composition with high vs. low stocking rate or as forage mass declines with increasing stocking rate should be smaller compared with cattle and sheep, with greatest differences when browse plant species are available. The magnitude of effect of castration on carcass fatness varies considerably with plane of nutrition, although some gender comparisons have not considered stage of maturity. Limited nutrient intake maximizes lean tissue accretion and minimizes fat deposition regardless of gender. Pre-weaning growth rate is greater for single-kid litters compared with kids of multiple births depending on factors influencing milk production. Concentrate supplementation should increase pre-weaning growth when milk yield is low regardless of litter size but not with moderate-high milk yield when concentrate substitutes for milk. Genetic variability in performance traits is considerable and has been the target of various breed improvement and crossbreeding programs. Breed and genotype differences in carcass traits also exist; however, few improvement programs have included these traits in selection objectives.

Factors affecting goat milk production and quality
Goetsch, A. L., S. Zeng, and T. A. Gipson
Small Ruminant Research 101:55-63. 2011

Differences between production systems based on grazing and browsing vs. use of harvested feedstuffs in confinement largely depend on specific feedstuffs and plants available and being consumed. Low forage nutrient ingestion should have relatively greater impact on tissue mobilization than milk production in early than later periods of lactation, with a transition to proportionally greater change in milk production in late lactation. However, low body condition at kidding would limit tissue energy mobilization and restrict impact of level of nutrient intake to milk yield and, likewise, tissue mobilization would be less with one vs. two or three milkings per day. As lactation advances after freshening, fat and protein levels decrease with increasing milk yield, and when production declines in mid- to late lactation, fat and protein concentrations increase. Milk production generally peaks at a parity of 3 or 4, thereafter declining slowly. Elevated somatic cell count alone in dairy goats is not a valid indication of mammary infection. Extended lactations offer opportunities to minimize or avoid seasonal fluctuations in milk production and lessen production costs. If differences in performance between suckled and machine-milked dairy goats occur, they may be restricted to or of greater magnitude during the suckling period compared with post-weaning, and differences in milk yield will either be absent or less with one kid compared with greater litter sizes. The magnitude of effects of milking frequency on milk yield is less for goats of low vs. high production potential and with low vs. high diet quality. Likewise, the effect of milking frequency is greater in early and mid-lactation when yield is higher than in late lactation, along with a shorter period of peak production with one vs. two daily milkings. Physical form of the diet can affect production and composition of goat milk, although effects appear of smaller magnitude than in dairy cattle. When tissue is mobilized to support milk production in early lactation, levels of C18:0 and C18:1 cis in milk increase and levels of medium-chain fatty acids decline. Effects of elevated levels of dietary fatty acids on specific long-chain fatty acids in milk and milk products vary with the fatty acid profile of fat sources used.

Change in behavior of goat producers after on-line training in health practices
Merkel, R., and T. Gipson
Small Ruminant Research 98:31-34. 2011

In 2006, Langston University (Oklahoma, USA) unveiled an on-line training and certification program for meat goat producers (http://www2.luresext.edu/training/qa.html). The program consists of 22 learning modules, including herd health, biosecurity and internal parasite control. In March 2010, an electronic survey was sent to 160 certified producers to assess impact of the training. Fifty-four surveys were completed for a response rate of 33.7%. Prior to certification, 52.8% of respondents used selective deworming criteria. Current deworming practices and percentage of responses include: FAMACHA, 43; visual condition, 28; pasture rotation-based, 15; and calendar-based, 14 ($\chi 2=19.02$, $P<0.001$). When asked if individual animals or all animals in a pasture or pen received anthelmintic when deworming, 76% of respondents said that only animals requiring deworming received anthelmintic ($\chi 2=14.52$, $P<0.001$). The dosage of dewormer given was most often calculated based upon table guidelines given in the certification course (54%), vs. 35% who relied on veterinarian instructions and 11% who self-determined dosage amounts ($\chi 2=18.22$, $P<0.001$). Over 60% of respondents reported that prior to becoming certified they did not consult a veterinarian for use of drugs extra label. When asked how current withdrawal times for drugs not approved for goats are determined, 41% of responses reported using veterinarian instructions with an identical percentage using table guidelines from the certification course; with 19% of responses using information from the internet ($\chi 2=7.32$, $P<0.03$). Results of the survey show changes in behavior of certified goat producers when compared with previous practices in anthelmintic usage. More emphasis on the importance of veterinarian approval for lawful use of extra-label drug is needed. Changes in production practices noted imply that an on-line training course can be effective in promoting proper herd health practices for goat producers.

Effects of feed restriction and realimentation on mohair fiber growth and tissue gain by growing Angora goats
Puchala, R., A. K. Patra, G. Animut, T. Sahlu, and A. L. Goetsch
Livestock Science 138:180-186. 2011

Angora wethers (48), approximately 6 months of age and 15.7 kg initial BW (SEM = 0.38), were used to determine effects of level of feed intake and realimentation on mohair fiber growth and tissue gain. There were two 12-wk phases in which dehydrated alfalfa pellets (18% CP and 48% NDF, DM basis) were fed. In phase 1, feed amounts were intended to provide ME adequate for 0, 15, 30, 45, 60, and 75 g/day of tissue (non-fiber) gain and 0, 1.5, 3.0, 4.5, 6.0, and 7.5 g/day of clean mohair fiber growth, respectively (L1, L2, L3, L4, L5, and L6, respectively), although actual levels were slightly greater; intake was ad libitum in phase 2. DM intake in both phases increased linearly ($P < 0.05$) with increasing level of feed offered from 0.48 to 1.00 kg/day in phase 1 and 1.08 to 1.48 kg/day in phase 2. Tissue gain increased linearly ($P < 005$) with increasing level of feed offered in phase 1 from 15.3 to 72.1 g/day and decreased slightly in phase 2 from 105.6 to 97.0 g/day. Greasy mohair fiber growth was not affected by treatment in phase 1 (6.31, 6.18, 6.85, 7.14, 7.07, and 6.47 g/day; SEM = 0.431) or 2 (6.59, 6.67, 6.52, 7.21, 7.69, and 6.64 g/day for L1, L2, L3, L4, L5, and L6, respectively; SEM = 0.349). During the entire experiment, mohair fiber growth relative to DM intake decreased linearly ($P < 0.05$) from 8.40 to 5.37 g/kg with increasing level of feeding in phase 1. Mohair fiber diameter increased linearly ($P < 0.05$) from 22.4 to 23.8 μm in phase 1 and 25.4 to 27.1 μm in phase 2. Digestibility of DM components and energy utilization were determined once per phase. Digestibility of OM was similar among treatments in phase 1, whereas values in phase 2 increased linearly ($P < 0.05$) from 68.0 to 73.4% as level of feed offered in phase 1 increased. Assuming requirements of 37.2 and 157 kJ/g of tissue and clean mohair fiber gain, ME used for maintenance (MEm) in phase 1 was not affected by treatment. In phase 2, MEm was greater than in phase 1 (mean = 431 kJ/kg BW0.75) and increased linearly ($P < 0.05$) as level of feed offered in phase 1 increased (551, 599, 647, 765, 788, and 902 kJ/kg BW0.75 for L1, L2, L3, L4, L5, and L6, respectively; SEM = 97.5). The phase difference and unrealistically high values for some treatments may have resulted from a greater requirement than assumed for tissue gain in phase 2. This may have been because levels of fat and energy in tissue gained was greater in phase 2 than 1 and increased in phase 2 as level of feed offered in phase 1 increased. In summary, with levels of intake above maintenance, growing Angora goats partition nutrients to mohair fiber growth at the expense of tissue gain. Realimentation likewise does not affect mohair fiber growth but can increase tissue gain, the magnitude of which depends on the severity of previous intake restriction.

Effects of level of feeding on energy utilization by Angora goats
Tovar-Luna, I., R. Puchala, T. Sahlu, H. C. Freetly, and A. L. Goetsch
Journal of Animal Science 89:142-149. 2011

Twelve mature Angora does were used in a replicated 3 × 3 Latin square to determine effects of feeding level on energy utilization. Fiber growth and change in tissue (non-fiber) mass were determined in the first 4 wk of 6-wk periods, preceded by 14 or 18 d of adaptation. Determination of ME intake and gas exchange measures occurred in wk 4, followed by feeding near maintenance then fasting in wk 5 and 6 to determine the ME requirement for maintenance (MEm). A 60% concentrate diet was fed at levels to approximate 100, 125, and 150% of assumed MEm (L, M, and H, respectively). Digestibilities and diet ME/GE were not affected by treatment with different levels of offered feed and subsequent intake near MEm. Heat energy (HE) during fasting (261, 241, and 259 kJ/kg BW0.75; SEM = 8.7) and efficiency of ME use for maintenance (71.6, 69.6, and 69.2%; SEM = 2.29) were similar among treatments, although MEm differed ($P < 0.04$) between M and H (365, 344, and 377 kJ/kg BW0.75 for L, M, and H%, respectively; SEM = 10.3). Tissue gain was lower ($P < 0.01$) for L than for the mean of M and H (-0.6, 23.7, and 29.8 g/d), although clean fiber growth only tended ($P < 0.09$) to differ between L and the mean of M and H (5.60, 6.57, and 7.36 g/d for L, M, and H, respectively; SEM = 0.621). Intake of ME was greater ($P < 0.01$) for the mean of M and H than for L (6.87, 8.22, and 8.41 MJ/d for L, M, and H, respectively). Total HE was lower ($P < 0.02$) for L vs. the mean of M and H and tended ($P < 0.07$) to be greater for H than for M (6.03, 6.31, and 6.77 MJ/d); mobilized tissue energy was low but greater ($P < 0.02$) for L vs. the mean of M and H (0.16, 0.01, and 0.04 MJ/d for L, M, and H, respectively). Efficiency of ME use for fiber growth was similar among treatments (17.2, 16.3, and 17.7% for L, M, and H, respectively; SEM = 1.61). In conclusion, efficiency of ME use for fiber growth was similar to the NRC recommendation regardless of feeding level, although MEm was lower perhaps because of experimental conditions employed. Energy appeared partitioned to fiber growth, but preferential usage was not complete possibly because energy metabolism for tissue accretion reached a plateau with the highest feeding level.

Effect of proteolysis and calcium equilibrium of natural cheddar cheese during ripening and the resultant processed cheese on functional properties

Wang, F., X. Y. Zhand, J. Luo, H. Y. Guo, S. S. Zeng, and F. Z. Ren
Journal of Food Science 76:E248-253. 2011

The changes in proteolysis, calcium (Ca) equilibrium and functional properties of natural Cheddar cheeses during ripening and the resulted processed cheeses were investigated. For natural Cheddar cheeses, the majority of the changes in pH 4.6 soluble nitrogen as a percentage of total nitrogen (pH 4.6 SN/TN) and the soluble Ca content occurred in the first 90 d of ripening, and subsequently the changes were slight. During ripening, functional properties of natural Cheddar cheeses changed, i.e., , hardness decreased, meltability was improved, storage modulus at 70°C (G'T=70) decreased and the maximum tan delta (TDmax) increased. Both pH 4.6 SN/TN and the soluble Ca were correlated with changes in functional properties of natural Cheddar cheeses during ripening. Kendall's partial correlation analysis indicated that pH 4.6 SN/TN was more significantly correlated with changes in hardness and TDmax. For processed cheeses manufactured from natural Cheddar cheeses with different ripening times, the soluble Ca content did not show significant difference and the trends of changes in hardness, meltability, G'T=70 and TDmax were similar to those of natural Cheddar cheeses. Kendall's partial correlation analysis suggested that only pH 4.6 SN/TN was significantly correlated with the changes in functional properties of processed cheeses.

Sensory profile and Beijing youth preference of seven cheese varieties

Zhang, X. Y., H. Y. Guo, L. Zhao, W. F. Sun, S. S. Zeng, X. M. Lu, X. Cao, and F. Z. Ren
Food Quality and Preference 22:101-1009. 2011

The sensory characteristics that determined consumer preference for seven imported cheeses were investigated. Descriptive sensory analysis was performed by seven trained assessors who used 17 descriptors to quantitatively describe the flavors of these cheeses. In parallel, 268 Beijing teenagers expressed their preference for the cheeses on a nine-point hedonic scale. Descriptive sensory data were analyzed using principal component analysis to determine the relationships between cheeses and sensory attributes. Significant differences were found between the cheeses ($P<0.05$) on the first two principal components, accounting for 81% of the experimental variance. Hierarchical cluster analysis of the preference data identified seven consumer segments with different preferences and showed that there existed a potential market for each of the cheeses. Descriptive and consumer-preference data were related using external preference mapping and the sensory characteristics of cheeses preferred by the consumer segments were identified. Overall, most Chinese teenagers preferred cheeses with a mild flavor such as "milky", "sweet", or "soured milk", and disliked cheeses with a "salty," "nutty," "umami," "toasted," or "bitter" character.

Effects of method of processing broiler litter on feed intake and performance by meat goat doelings

Goetsch, A. L., G. D. Detweiler, and T. Sahlu
Professional Animal Scientist 27:553-560. 2011

Forty-eight Boer goat doelings, 10.4 ± 0.13 mo of age and 27.1 ± 0.98 kg BW, were used in a 9-wk experiment to compare feeding value of deep-stacked (DS) and ensiled (EN) broiler litter (BL). The BL was processed for 82 d before use. Treatments were feeding 1% BW (DM) of a 3:1 corn-soybean meal mixture and moderate to high-quality grass hay free-choice (Cont-Hay); 1% BW hay and the concentrate mixture free-choice (Cont-Conc); 1% BW hay, 1.1% BW corn, and DS or EN free-choice (DS-Low and EN-Low, respectively); and 1% BW hay and DS or EN free-choice (DS-High and EN-High, respectively). Daily samples of DS and EN averaged 70.9 and 73.3% OM (DM basis), 21.8 and 23.2% CP, and 34.0 and 37.2% NDF, respectively. Total OM intake was less for High vs. Low BL treatments ($P < 0.05$), similar between DS-Low and EN-Low, and greater ($P < 0.05$) for EN-High than for DS-High (1,025, 1,199, 829, 952, 470, and 631 g/d for Cont-Hay, Cont-Conc, DS-Low, EN-Low, DS-High, and EN-High, respectively; SE = 64.0). There were similar differences ($P < 0.05$) in ADG (126, 234, 58, 75, -46, and -8 g; SE = 10.1) and ADG:DMI (118, 188, 60, 66, -84, and -11 g/kg for Cont-Hay, Cont-Conc, DS-Low, EN-Low, DS-High, and EN-High, respectively; SE = 12.7). In conclusion, feeding value of DS and EN for yearling meat goat doelings appears similar with moderate dietary levels, but with limited consumption of other feedstuffs, feeding value of EN may be greater.

Effects of restricted feed intake on energy expenditure by different goat breeds
Helal, A., R. Puchala, G. D. Detweiler, T. A. Gipson, T. Sahlu, and A. L. Goetsch
Journal of Animal Science 89:4175-4187. 2011

Sixteen Boer (B) goat doelings, 16 Spanish (S) doelings, and 8 Angora (A) doelings and 8 wethers, 283, 316, and 330 d of age initially (SEM = 5.0), respectively, were used to evaluate effects of nutrient restriction on heat energy (HE). During the first and second 10-wk phases, 8 animals of each breed were fed a 50% concentrate pelletized diet at a level adequate for maintenance and moderate energy accretion (CONT). Other animals were fed approximately 50% of these amounts in phase 1 relative to initial BW, followed by the higher level of feeding in phase 2 based on initial or actual BW when greater (REST). Average daily gain was 43, -20, 16, -78, 8, and -48 g in phase 1 (SEM = 5.0) and 26, 44, 50, 65, 27, and 32 g in phase 2 (SEM = 3.5) for A-CONT, A-REST, B-CONT, B-REST, S-CONT, and S-REST, respectively. Total HE was greater for CONT vs. REST in both phases ($P < 0.001$), greater in phase 1 for A than for B ($P < 0.01$) and S ($P < 0.01$), and greatest ($P < 0.01$) in phase 2 among breeds for A [481, 347, 430, 356, 424, and 338 kJ/kg BW0.75 per day in phase 1 (SEM = 11.1), and 494, 479, 445, 397, 444, and 406 kJ/kg BW0.75 per day in phase 2 (SEM = 11.3) for A-CONT, A-REST, B-CONT, B-REST, S-CONT, and S-REST, respectively]. Equations describing the temporal pattern of HE (kJ/kg BW0.75 per day), expressed as a percentage of the wk-0 value and corrected for corresponding breed × week CONT means, in phase 1 were: 95.8 ± 2.43 – (8.18 ± 1.144 × wk) + (0.655 ± 0.1098 × wk2) ($R2 = 0.58$) for A, 95.3 ± 2.63 – (4.34 ± 1.237 × wk) + (0.271 ± 0.1187 × wk2) ($R2 = 0.41$) for B, and 97.4 ± 2.21 - (4.69 ± 1.068 × wk) + (0.282 ± 0.1021 × wk2) ($R2 = 0.53$) for S. Phase 2 equations were: 78.9 ± 2.22 + (8.74 ± 1.036 × wk) - (0.608 ± 0.0095 × wk2) ($R2 = 0.60$) for A, 77.5 ± 2.10 + (3.30 ± 0.978 × wk) - (0.153 ± 0.0942 × wk2) ($R2 = 0.39$) for B, and 80.6 ± 2.50 + (4.50 ± 1.165 × wk) - (0.208 ± 0.1122 × wk2) ($R2 = 0.43$) for S. These equations indicate that changes in HE in response to nutrient restriction and realimentation were more rapid and of greater magnitude in A vs. B and S. The temporal pattern of decline in HE by B and S during restriction was similar, but the subsequent rise with realimentation was slower and smaller for B. In conclusion, most appropriate methods of predicting change in the maintenance energy requirement during and after periods of limited feed intake may differ among breeds of goats.

Effects of night-locking and stage of production on forage intake, digestion, behavior, and energy utilization by meat goat does grazing grass/legume pasture
Tovar-Luna, I., R. Puchala, T. A. Gipson, G. D. Detweiler, L. J. Dawson, T. Sahlu, A. Keli, and A. L. Goetsch
Livestock Science 40:225-245. 2011

Twenty-three Boer (75%) × Spanish (25%) multiparous does, eight with ruminal cannula, grazed grass/legume pastures in different stages of production. Four cannulated and eight non-cannulated does were confined in a building at night and had pasture access from approximately 07:00 to 19:00 h (Night); other animals had continual pasture access (Past). Data collection periods 15 days in length were in late gestation (L-G; 137 ± 5.2 days), early lactation (E-L; 43 ± 2.1 days), late lactation (L-L; 97 ± 1.1 days), the dry period (Dry), and early gestation (L-G; 65 ± 5.9 days). Most does had a litter size of 2, and kids were weaned at 118 ± 1.0 days. Ingesta collected from cannulated does after rumen-evacuation averaged 19.9, 12.5, 14.7, 13.4, and 19.9% CP (SE = 0.59) and 50.8, 59.2, 63.1, 61.4, and 38.1% NDF in L-G, E-L, L-L, Dry, and E-G, respectively; SE = 1.55). Kid ADG tended ($P < 0.08$) to be greater for Past than for Night (138 vs. 118 g; SE = 7.4). Intake of ME (823 vs. 735 kJ/kg BW0.75; SE = 27.5) was greater for Night than for Past ($P < 0.05$). There were treatment differences in time spent grazing (4.5 and 5.8 h; SE = 0.28) and resting (18.5 and 16.7 h for Night and Past, respectively; SE = 0.25). Energy expenditure (EE) was greater ($P < 0.05$) for Past than for Night (754 vs. 687 kJ/kg BW0.75; SE = 14.5). Recovered energy (RE) in and EE for tissue gain were similar between treatments. RE in tissue gain was greatest among periods ($P < 0.05$) in Dry (6, 0, 11, 113, and 22 kJ/kg BW0.75 in L-G, E-L, L-L, Dry, and E-G, respectively; SE = 8.5). RE of lactation from dietary ME was greater for Past vs. Night regardless of period (244 vs. 194 kJ/kg BW0.75; SE = 16.1). However, RE of lactation derived from mobilized tissue differed between treatments ($P < 0.05$) in E-L but not L-L (54, 15, 175, and 11 kJ/kg BW0.75 in Night/E-L, Night/L-L, Past/E-L, and Past/L-L, respectively; SE = 16.0). EE associated with activity tended to be greater ($P < 0.07$) for Past than for Night (243 vs. 202 kJ/kg BW0.75; SE = 14.4) and was greatest among periods in E-G (184, 219, 193, 176, and 343 kJ/kg BW0.75 in L-G, E-L, L-L, Dry, and E-G, respectively; SE = 22.7). In conclusion, 'night-locking' decreased activity EE to an extent less than the depression in MEI. The greatest impact of Night was in E-L, with reduced RE of lactation and a tendency for lower kid ADG.

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

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

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

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

Effects of small ruminant type and level of intake on metabolism

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

Small Ruminant Research 102:186-190. 2012

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

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

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

Optimum duration of performance testing for growth, feed intake, and feed efficiency in growing Boer bucks
Hu, W., T. A. Gipson, S. P. Hart, L. J. Dawson, T. Sahlu, and A. L. Goetsch
Small Ruminant Research (In press). 2012

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

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

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

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

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

Gipson, T. A., T. Sahlu, M. Villaquiran, S. P. Hart, J. Joseph, R. C. Merkel, and A. L. Goetsch
Journal of Applied Animal Research (In press). 2012

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

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

R. Puchala, G. Animut, A. K. Patra, G. D. Detweiler, J. E. Wells, V. H. Varel, T. Sahlu, and A. L. Goetsch
Journal of Animal Science (In press). 2012

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

Methane emissions by goats consuming Sericea lespedeza at different frequencies

R. Puchala, G. Animut, A. K. Patra, G. D. Detweiler, J. E. Wells, V. H. Varel, T. Sahlu, and A. L. Goetsch
Animal Feed Science and Technology (In press). 2012

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

Visiting Scholars (2011/2012)

Dr. Liping Wu
Native of China
Research Project: Impact of Sub-Clinical Mastitis on Production and Quality of Goat Milk and Cheese (OKLXSTEVEZ-ENG2007)
Experiments: LPW-11-05, LPW-11-06, LPW-11-07

Dr. Rongzhen Zhong
Native of China
Research Project: Effects of Selected Nutritional Components on Immunity to Haemonchus in Goats
Experiments: RZ-11-03, RZ-11-15, RZ-11-16, RZ-11-20

Ms. Amanda Manley
Research Project: Boer Goat Selection for Residual Feed Intake
Experiment: AM-11-04

Dr. Taher Shujaa
Native of Iraq
Research Projects: Effects of Ginger and Rumen Undegraded Protein Supplementation on Intake, Metabolism, and Ruminal Conditions in Yearling Meat Goat Doelings and Effects of Levels of Rumen Degraded and Undegraded Protein on Intake, Digestion, Energy Expenditure, and Performance of Yearling Spanish Wethers
Experiments: IR6-11-08, IR3-11-09

Mr. Abdullah Nauman
Native of Iraq
Research Project: Effects of Ginger and Rumen Undegraded Protein Supplementation on Intake, Metabolism, and Ruminal Conditions in Yearling Meat Goat Doelings
Experiments: IR6-11-08, IR3-11-09

Mr. Ahmed Mohammed
Native of Iraq
Research Project: Effects of Levels of Rumen Degraded and Undegraded Protein on Intake, Digestion, Energy Expenditure, and Performance of Yearling Spanish Wethers
Experiments: IR6-11-08, IR3-11-09

Dr. Yoko Tsukahara
Native of Japan
Research Project: Establishing a Langston University Testing Center for Electric Fence Modifications of Cattle Barb Wire Fence for Goat Containment
Experiments: AG-11-13, YT-12-01

Extension Overview

Dr. Terry A. Gipson
Goat Extension Leader

The year 2011 was a busy year for the Langston Goat Extension program. The goat extension specialists have answered innumerable producer requests for goat production and product information via the telephone, letters and e-mail, have given numerous presentations at several state, regional, national and international goat conferences for potential, novice and veteran goat producers, and have produced a quarterly newsletter. They have also been busy with several major extension activities. These activities include the annual Goat Field Day, Langston Goat Dairy Herd Improvement (DHI) Program, grazing demonstrations, the 13th annual meat buck performance test and various goat workshops on artificial insemination and on internal parasite control.

Goat Field Day

In 2011, our annual Goat Field Day was held on Saturday, April 30 at the Langston University Goat Farm and the theme was Healthy Goats, Healthy Herds. Our featured speakers were Dr. Susan Kerr and Dr Lionel Dawson. Dr. Jacqueline Johnson of Alabama A&M University was scheduled to be a speaker; however, due to tornado damage to her home, she was not able to attend. Dr. Dawson substituted for her at the last minute. Our ever-popular goat milk cheesemaking workshop was conducted on Friday April 29, 2011 (the day before our annual goat field day 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 a cheese plant and managed the cheese operation in her unique and creative manners. She is also an excellent instructor and speaker with vast personal experiences. She shared 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 facilities and marketing strategies were also discussed. This one-day hands-on workshop was held in the pilot creamery at Langston University.

The afternoon workshops included:

- Goat Emergencies - learn what to do and not to do in an emergency with Dr. Susan Kerr.
- Neonatal Kid Care - feeding, passing a feeding tube, routine procedures and other treatments for the newborn kid with Dr. Susan Kerr.
- Biosecurity: It's Worth the Effort! - how to keep disease off your farm and your goats healthy with Dr. Susan Kerr.
- Internal Parasite Control - sustainable internal parasite control program with Dr. Steve Hart.
- Basic Herd Health - herd health program including vaccinations, injection sites, and approved drugs with Dr. Lionel Dawson.
- eXtension Goat Information on the Web - research-based goat production information on the Internet with Dr. David Kiesling.
- Cheesemaking Overview - basics of cheesemaking with Ms. Gianaclis Caldwell.
- Social Media - how social media can be used to link producers with Dr. Nelson Escobar.
- Nutrition for Health and Production - calculation of energy, protein and feed intake requirements with Dr. Steve Hart.
- Goat Reproduction - basics of goat reproduction and techniques and equipment for artificial insemination in goats with Dr. Dave Sparks.

- DHI Training - supervisor/tester training for dairy goat producers including scale certification with Ms. Eva Vasquez.
- USDA Government Programs - overview of USDA Natural Resource Conservation Service's work with goats and its cost-sharing program with Mr. Dwight Guy.
- Body Condition Score as a Management Tool - overview/hands-on of conducting body condition scoring for management use in goat production with Mr. Glenn Detweiler.
- Fitting and Showing for Youth and Adults - tips and pointers on fitting and show ring etiquette with Ms. Kay Garrett.
- Fun Tent Youth Activity: Ms. Sheila Stevenson hosted a full day of activities for youth ages 5-12 in the Fun Tent.

Goat DHI Laboratory

The Langston Goat Dairy Herd Improvement (DHI) Program operates under the umbrella of the Texas DHIA. In February 1998, the Langston DHI program became the first DHI program to introduce forms and reports in goat terminology to dairy goat producers in the United States. A national Dairy Herd Improvement Association (DHIA) has been in existence for a number of years. However, until 1996 DHIA catered only to cow dairies. The Langston DHI program has been very popular with dairy goat producers and has grown significantly since its establishment in 1996. Goat producers are now able to get records for their animals that reflect accurate information with the correct language. Currently we are serving a 29 state area that includes a majority of the eastern states. Currently, we have 81 producer herds in these 29 states enrolled in the Langston Goat Dairy DHI Program. In 2011, the DHI laboratory processed more than 8,000 samples. Langston University continues to serve the very small-scale dairy goat producer. The average herds size on test with Langston University is 10 animals. This is significantly smaller than the herd size average for the five other processing centers.

For those interested in becoming a Langston goat DHI tester, training is available either in a formal classroom setting or through a 35-minute video tape. 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 2011. Interest in the newsletter has grown and we currently have over 2400 subscribers to our free quarterly Goat Newsletter and the subscription list continues to increase every year. The Goat Newsletter is mailed to every state in the nation and to 10 countries overseas. Ninety-seven percent of the mailings go to American households. At least one newsletter is mailed to a household in every state in the nation. Fifty percent of the newsletters are mailed to Oklahoma households. An additional thirty percent of the newsletters are mailed to households to state adjacent to Oklahoma.

Artificial Insemination Workshop

The use of superior sires is imperative in improving the genetic composition of breeding stock. Artificial insemination has long been used in the dairy cattle industry and is a simple technology that goat producers can acquire. However, opportunities for goat producers to the necessary skills via formal and practical instruction are not widespread. Langston University has instituted a practical workshop for instruction in artificial insemination in goats. Producers are instructed in the anatomy and physiology of the female goat, estrus detection and handling and storage of semen. Producers participate in a hands-on insemination exercise. An understanding of the anatomy and physiology enable the producer to devise seasonal breeding

plans and to troubleshoot problem breeders. An understanding of estrus detection enables the producer to effective time inseminations for favorable conditions for conception and to effectively utilize semen. An understanding of semen handling and storage enables the producer to safeguard semen supplies, which can be scarce and costly. The experience of actually inseminating a female goat enables the producer to practice the knowledge that they have gained. The acquisition of these inseminating skill will allow producers the use of genetically superior sires in their herds that they normally would not have access to. It also allows producers to save money by conducting the inseminating themselves instead of hiring an inseminator. In 2011, an AI workshop was held in September at the Langston University campus.

Meat Goat Production Handbook

The first edition Meat Goat Production Handbook is sold-out and the revision of the second edition is underway. Even though Langston University has taken the lead in this revision project, this handbook is not the product of one person nor of a single university. Our collaborating project institutions/organizations, which include Alcorn State University, American Boer Goat Association, American Meat Goat Association, Florida A&M University, Fort Valley State University, Kentucky State University, Langston University, Prairie View A&M University, Southern University, Tennessee Goat Producers Association, Tennessee State University, Tuskegee University, United States Boer Goat Association, University of Arkansas Pine Bluff, and Virginia State University. Handbook contributing institutions/organizations include Allen Veterinary Clinic, American Boer Goat Association, American Meat Goat Association, BIO-Genics, Ltd., Bountiful Farm, Cornell University, Fort Valley State University, Kentucky State University, Langston University, Law Office of Wheeler and Mueller, Louisiana State University, Louisiana State University AgCenter, NCAT / ATTRA National Sustainable Agriculture Information Service, North Carolina State University, Oklahoma State University, Texas A & M University, United States Boer Goat Association, and Virginia State University.

Controlling Internal Parasites Workshop

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

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

Nutrient Requirements of Goats

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

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

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

In summary, for nutrient requirement expressions to be of value, they must be readily accessible and reasonably simple. Therefore, a web-based goat nutrient requirement system was developed based on findings of a recent project. It is hoped that this system will enjoy widespread usage and enhance feeding practices for goats.

Internet Website

http://www2.luresext.edu

The Agricultural Research and Cooperative Extension program of Langston University recently unveiled a new and improved Internet web site. The Internet address (URL) of the new web site is http://www2.luresext.edu.

Capabilities of the new web site include a document library with the complete proceedings of the annual Goat Field Day for the past three years and the quarterly newsletter for the past several years. Both the proceedings and newsletters are also available in portable document format (pdf), which allows for the viewing and printing of documents across platform and printer without loss of formatting.

Information, recent abstracts and scientific articles of completed and current research activities in dairy, fiber and meat production are available for online viewing and reading. Visitors will be able to take a Virtual Tour of the research farm and laboratories, complete with digital photos and narrative. Visitors will also be able to browse a digital Photo Album. Visitors will also be able to subscribe to our free quarterly newsletter online. Visitors will be able to test their knowledge of goats with the interactive goat quiz which covers nearly all aspects of dairy, fiber and meat goat production. For those questions that are lacking in the interactive quiz database, visitors will be able to submit a question to be included in the database. Visitors will be able to read about research interests of faculty and will be able to contact faculty & staff via email.

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

In 2011 Langston University and the City of Stillwater cooperated to establish a pilot project that relied upon goats, and not city workers, to control unwanted vegetation in controlled areas, especially in drainage easements. Stillwater's Stormwater Manager Cody Whittenburg said in a press release "I like this idea because it's eco-friendly and may prove beneficial for managing especially difficult areas. Many other cities have successfully used goats to manage vegetation in urban and residential areas. Goats are natural mowers and may be a more efficient in certain areas than machines." The pilot program was launched in October and Langston University provided a herd of goats and equipment. The goats were sequentially released in a fenced area in three places where steep or rugged terrain made it difficult to mow using traditional machinery. Stillwater's External Services Director John McClenny reported to the Stillwater City Council that "All of staff feels like this program was a success by every measure that we have." Those measures include

providing good public relations, a partnership with Langston University and an environmentally friendly solution. McClenny told councilors that he had received a number of positive comments from the public, and councilors echoed that sentiment. "I did not receive one negative comment about it," Councilor John Bartley said. Stillwater is looking to make the pilot program long term, McClenny said, and goats could be used to maintain steep rights-of-way or areas in parkland such as around the dam in Boomer Lake. "(These are) places that machinery can't get to, and this is the only thing that works," he said. Rugged terrain can create issues for both traditional machinery and city employees, which could increase the city's tort liability. .

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 1,000 producers have enrolled for certification and 157 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."

Meat Buck Performance Test

The thirteen annual meat buck performance test started June 4, 2011 with 38 bucks enrolled from 3 different breeders (2 bucks from private producers and 36 from Langston University). Geographical distribution is 37 from Oklahoma and 1 from Kansas. Breed distribution is 38 Boer. Bucks were given a physical examination, dewormed with Cydectin (moxidectin), deloused with Atroban De-Lice, given a preemptive injection of long-acting antibiotic for upper respiratory infections, and those bucks that needed booster or initial vaccinations for enterotoxemia and caseous lymphandinitis.

International Overview

Dr. Roger Merkel
International Program Leader

Goats and goat products are part of the livelihood of a majority of the world's population and are an important resource for poor farmers in many countries of the world. Part of the mission of the American Institute for Goat Research is to effect positive change in goat production throughout the world. To fulfill this aspect, the Institute has developed and maintains many strong ties with research and academic institutions around the world. In addition to collaborative work with foreign institutions, the Institute has hosted visiting scientists from over 20 foreign countries to conduct research activities. Training for foreign livestock workers and scientists as well as for U.S.-based persons who will travel and work overseas are other ways in which the Institute is active in the international arena.

International research and training, hosting foreign scientists, and training those who will teach others are internationally-focused activities that give the Institute unique opportunities to not only increase knowledge of foreign production systems and constraints, but also to positively impact agricultural development in foreign countries and help alleviate poverty and hunger. General objectives of the Institute's international program are to: 1) increase our knowledge of goat production systems worldwide and current constraints to increased production; 2) build human capacity through training foreign scientists and agricultural workers in goat production, thereby allowing them to more effectively carry out their missions of teaching, research, and extension; 3) increase Langston University and the Institute's involvement in agricultural development and impact on human welfare; and 4) enhance the Institute's knowledge of development and development issues. As recognition of the impact that the Institute has had on international development, five Langston University scientists, Drs. Terry Gipson, Arthur Goetsch, Roger Merkel, Tilahun Sahlu, and Steve Zeng, were jointly awarded the 2006 George Carver Agricultural Excellence Award of USAID for their efforts and positive impact on international agriculture.

International Research

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

Research grants with Middle Eastern Institutions

For over a decade, the Institute has collaborated with research institutions in the Middle East. This collaboration began in 2000 with the grant "Multinational Approaches to Enhance Goat Production in the Middle East" supported by the Middle East Regional Cooperation program of USAID. That grant program was completed in the fall of 2008 and entailed collaborative research, training, and extension activities among Langston University; Desert Research Center, Cairo, Egypt; Agricultural Research Organization and Kimron Veterinary Institute, Bet Dagan, Israel; Al-Quds University, East Jerusalem, Palestine; and the Jordan University of Science and Technology, Irbid, Jordan. The objective was to revitalize and develop the Middle East goat industry via research and technology transfer to increase income and improve the standard of living.

The Institute has worked diligently to continue activities with the Desert Research Center of Egypt and was awarded three grants from the U.S.- Egypt Joint Science and Technology Fund for further collaborative research. In 2005, the Institute and the Desert Research Center embarked on a research project to ascertain

the "Effects of Acclimatization on Energy Requirements of Goats." That project was completed in June of 2008. The second of these three grants, "The Grazing Activity Energy Cost of Goats," began in 2007 and ran through 2010. In 2010, the Institute and the Desert Research Center initiated a project entitled "Effects of Nutritional Plane on the Maintenance Energy Requirement of Goats" that is scheduled to run through 2011.

Research collaboration also continued with institutes in Israel through an United States – Israel Binational Agricultural Research and Development (BARD) grant in 2005 that entailed a project with the Newe Ya'ar Research Center of the Agricultural Research Organization in Israel entitled "Energy Expenditure for Activity in Free-Ranging Ruminants: A Nutritional Frontier." In 2010, the Institute was awarded a grant for a project entitled "Enhanced Safety and Product Quality from On-Farm Thermization/Pasteurization of Goat Milk in the Middle East" by the United States – Israel Binational Agricultural Research and Development Fund as a Facilitating Grant in the MARD (Multinational Agricultural Research and Development) program. Collaborators in this project are Langston University; Kimron Veterinary Institute and Agricultural Research Organization, Bet Dagan, Israel; Al-Quds University, East Jerusalem, Palestine; and the Jordan University of Science and Technology, Irbid, Jordan. Objectives of this project are to develop specifications of an inexpensive thermization/pasteurization equipment system suitable for use on small goat farms in the Middle East, conduct preliminary evaluations of the prototype for possible refinement, and determine procedures for an associated MERC grant proposal to be developed.

Education and Training

Increasing the Capacity of Higher Education in East Africa through the creation of a Consortium of African and United States Educators (CAUSE)

In 2009, the Institute entered into a partnership with Oklahoma State University, three universities in Ethiopia (Haramaya, Hawassa, and Mekelle), two universities in Kenya (Kenyatta and Moi), the International Livestock Research Institute, and the International Maize and Wheat Improvement Center to form the Consortium of African and United States Educators (CAUSE). The objective of the grant was to establish relationships among U.S. and African institutes of higher education and to develop a strategic plan to address critical societal issues by increasing human and institutional capacity of higher education in East Africa in teaching, research, and outreach. The goals of the partnership are to: 1) Enhance Academic Programs through Regional Collaboration; 2) Develop Research-Based Solutions to Address Food and Nutritional Security in East Africa; 3) Transfer Knowledge and Skills to Enhance Community Development; and 4) Provide Research Based Information to Stakeholders and Policy Makers. The partnership held meetings in Ethiopia and Kenya to gather information and develop the strategic plan that was submitted in November, 2009. While long-term funding was not awarded, all institutions involved continue to seek funding for future collaborative activities.

Institute Personnel Providing Technical Assistance Abroad

Institute scientists also travel abroad to conduct technical training activities and workshops. The most recent example of these activities are of Dr. Terry Gipson, the Institute's Extension Leader, traveled to Mali in 2009 and 2010 and Haiti in 2011 as part of the Farmer-to-Farmer Program to conduct training in goat artificial insemination.

Agricultural Development

Ethiopian Sheep and Goat Productivity Improvement Program

In 2005, the American Institute for Goat Research of Langston University and Prairie View A&M University, Prairie View, TX were awarded a $5.5 million grant from the USAID Mission in Ethiopia for

a 5-year project entitled "Ethiopia Sheep and Goat Productivity Improvement Program." The project was extended for 1 year into 2011 with an additional $750,000 of funding. The project entailed collaboration with the Ministry of Agriculture and Rural Development of the Government of Ethiopia. The overall goal of the program was to conduct research and extension activities in the areas of production and marketing to sustainably increase small ruminant productivity in Ethiopia to improve food and economic securities. The project worked in six regions of Ethiopia (Tigray, Amhara, Oromia, Southern States, Afar, and Somali), and addressed a number of factors including human and institutional capacity building, research and technology transfer, and introduction of improved animal genetics.

There were four major components of the project. The Genotype component dealt with the introduction of improved genotypes, Dorper sheep and Boer goats, nucleus and crossbreeding stations, and distribution of animals. The Animal Health component searched for means of enhancing productivity through improved health practices. A third area, termed "Production," entailed on-farm research and demonstration of useful feeding and nutrition practices. Finally, the Training component was designed to improve information delivery services and content to enhance the effectiveness of extension agents who work directly with farmers and pastoralists in small ruminant production.

For the Production component, as was true for all other areas, activities occurred in collaboration with the Ministry of Agriculture & Rural Development, regional research and extension entities, and universities and colleges. Furthermore, extension agents who work directly with farmers and pastoralists received small ruminant production training.

The great majority of ESGPIP research was on-farm, which was the desire of the donor, USAID-Ethiopia. In this regard, extension was integral in these activities, with inclusion of field days near the end. Moreover, frequently nearby farmers not directly involved in the activities adopted the new technologies without assistance.

The two general approaches in on-farm research were formation of Farmer Research Groups (FRG) and work with households on an individual basis. The most appropriate method depended on the particular setting, and each had advantages and disadvantages. A study with the former method might have entailed three to five FRG, each with perhaps ten households. Households contributed a number of animals equal to the treatments, commonly three or four. Then, all animals of a FRG were housed during the evening in different pens of a barn situated at a household of the FRG to receive the different feeding treatments. Conversely, with the individual farmer approach, a number of villages also participated, but with animals located at individual households and usually subjected to one of the treatments.

Many different topics were studied in on-farm research. One area addressed in demonstrations and field days was ammoniation of crop residues via treatment with urea. Previously, ammoniated crop residues were used with cattle but not extensively with small ruminants. This technology has been readily adopted in all areas where introduced. In fact, a number of other non-governmental organizations (NGO) have followed the ESGPIP lead and copied its methods in other areas. Byproduct feedstuffs studied included leftover khat and poultry litter, and experiments were conducted with urea-molasses multi-nutrient blocks, various supplements such as cactus, noug cake, sweet potato vines, and wheat bran, and trace mineral supplementation. Anecdotal evidence that darkening of carcasses of sheep and goats from Highland areas occurred more quickly than that of animals from Lowland areas was investigated. The performance and carcass and skin characteristics of crossbreds of Dorper sheep and Boer goats with local breeds were experimentally compared.

Field days not directly associated with on-farm research were conducted. Typically, a number of technologies were demonstrated, such as ammoniation, making and use of urea-molasses blocks, and improved forages. There was a major effort to aid in the distribution of seeds and seedlings of improved forages, in coordination with similar activities at sites of introduction of improved genotypes. And, as women typically

are responsible for care of sheep and goats in Ethiopia, the formation of women groups for sheep and goat production was promoted and technical assistance provided.

In 2007, the Genotype component worked with Ethiopian officials to import Boer goats and Dorper sheep from South Africa. The broadest genetic base possible was selected from the top stud producers in South Africa as represented in the Table below.

Breed	Province	Studs	Males	Females	Total
Boer	Eastern Cape	5	12	60	72
Boer	Northern Cape	4	8	40	48
Dorper	Free State	2	4	20	24
Dorper	Northern Cape	7	15	84	99
Total			39	204	243

These animals formed the backbone of purebred and crossbreeding programs designed to utilize the fast growth rate and larger carcass of these animals with the native adaptability and toughness of local breeds. The resulting crossbreds will be able to supply the export market with the desired frame size and carcass characteristics. The ESGPIP built a quarantine facility and nucleus and crossbreeding facilities to carry out project activities. After the quarantine period expired, the Boer goats were divided equally across studs and transported to the Adami Tulu Nucleus Breeding site and to the Hawassa Nucleus breeding site, in the central and southern region of Ethiopia, respectively. The Dorper sheep were divided equally across studs and transported to the Melkawarer Nucleus Breeding site and to the Fafen Nucleus breeding site in the central and eastern region of Ethiopia, respectively. In addition to the four nucleus breeding sites, 10 Breeding, Evaluation, and Distribution (BED) sites have been established across Ethiopia with the express intent of propagating and disseminating crossbred animals. In 2008 and 2010, Boer goat semen was purchased in South Africa, imported into Ethiopia and used in artificial insemination projects to broaden the genetic base of the purebred Boer goat nucleus flocks. Purebred Boer goats and Dorper sheep have been used to crossbreed with indigenous breeds and animals have been distributed to private farmers.

The Training component of the project aimed to enhance the knowledge and ability of village development agents to assist farmers in raising small ruminants via direct training in small ruminant productivity. Village development agents received training in sheep and goat production and management. In support of this program, the Sheep and Goat Production Handbook for Ethiopia was published in 2008. This text, written by Ethiopian scientists, is the first of its kind in Ethiopia and has over 400 pages of information that can be used by development agents. The depth of information in the book also allows its use as a classroom text by university faculty. In addition, technical bulletins of certain aspects of sheep and goat production were produced and distributed to development agents and institutions throughout the country. The technical bulletins were designed to contain material that a development agent could use directly in training village farmers. The bulletins became very popular and were translated into several different regional languages of Ethiopia to broaden their use. In 2008, the ESGPIP and Institute staff established a project website, www.ESGPIP.org, that contains the technical bulletins, handbook, and other materials and reports produced by the ESGPIP.

The Animal Health component combated the problem of external parasites downgrading the quality of Ethiopian sheep and goat skins for the important leather industry by training villagers to be providers of dipping and spraying services to control these pests. Studies on lamb and kid mortality aimed to find most common causes of mortality of young animals and design means to ameliorate this problem.

Finally, all project components worked together to enhance the ability of Ethiopian institutions and personnel to effect sustainable, positive change in small ruminant production.

The End Result

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