PROCEEDINGS OF THE 34th ANNUAL

GOAT and HAIR SHEEP FIELD DAY

April 27, 2019

Agricultural Research and Extension Program
Langston University
Langston, Oklahoma 73050

WELCOME

We deeply appreciate your attendance at this 34th Annual Goat Field Day of the E (Kika) de la Garza American Institute for Goat Research of Langston University. Recently, Langston University added a small research flock of Dorper, Katahdin, and St. Croix hair sheep and this year we will incorporate topics of interest to hair sheep producers. The Goat and Hair Sheep Field Day is one of the most important things we do each year. The primary purpose of Field Day is for education and extension in areas of greatest interest to stakeholders of the Institute. In addition to extension and education, Field Day provides an excellent opportunity for the staff of the Institute to meet other people who work with small ruminants. Such interaction helps make our program the most appropriate it can be for the people it serves. The proceedings of Field Day is a very useful tool for the Institute beyond impact realized from the program today. First, there are reports on Field Day presentations. After this information, there are highlights of research, extension, and international activities of the Institute in the past year. This section is an aid to assess our recent progress, display current activities, and contemplate future directions to be followed. This year's general theme for Goat and Hair Sheep Field Day is "***Holistic Approach***."

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

The morning program consists of:

- **Holistic Approach: Producer's Viewpoint** — *Ms. Gianaclis Caldwell*
- **Holistic Approach: Veterinarian's Viewpoint** — *Dr. Ann Wells*

The afternoon workshops are:

- **Holistic Strategies for Worms in Sheep and Goats** — *Dr. Ann Wells*
- **It's what's on the Inside that Counts:**
  - **Exploring the Anatomy and Physiology of the Goat (Part I)** — *Ms. Gianaclis Caldwell*
  - **Exploring the Anatomy and Physiology of the Goat (Part II)** — *Ms. Gianaclis Caldwell*
  - **Exploring the Anatomy and Physiology of the Goat (Part III)** — *Ms. Gianaclis Caldwell*
- **Basic Herd Management** — *Mr. Jerry Hayes*
- **What Processors Want** — *Mr. Bert Buitenhuis*
- **Nutrition for Health and Production** — *Dr. Steve Hart*
- **DHI Training** — *Ms. Eva Vasquez*
- **USDA Government Programs**
  - **USDA/NRCS: Conservation Programs** — *Mr. Nick Jones*
  - **USDA/FSA: Farm Loans** — *Mr. Phil Estes*
  - **USDA/WS: Wildlife Programs** — *Mr. Kevin Grant*
- **Fitting and Showing for Youth and Adults** — *LU Farm Staff*

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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Holistic Goat Care

Ms. Gianaclis Caldwell

Introduction

The holistic approach to goat care reaches back in time and seeks to understand the innate nature of the goat and then translate that into modern management in a way that produces the most productive and healthy herds possible. This benefits everyone. Healthy, productive herds are more profitable for the farmer as well as being emotionally satisfying, and of course, better for the goat.

Many goat farmers already do many of the things that a holistic approach embraces, without even knowing it! Taking it to the next level, however, often requires some paradigm shifts that initially take you out of the comfort zone – one defined by our inundation for decades of practices believed to be the best: for example, routine deworming and dry period antibiotic treatment.

Always go Back to the Beginning

It's always best to start at the beginning, and in this case, we'll start with the first goats that humans interacted with and turned into the first farm animals. In fact, we all still work with those goats today! Goats are one of the most highly capable domesticated animals when it comes to returning to a feral status, this mean that their initial nature is still intact.

Goats developed in arid, scrubby conditions requiring a lot of climbing and moving about the land. They thrived on deep-rooted shrubs, brush, and other forages. These feed and land conditions, as well as natural selection, created healthy, hardy animals. If we can keep everything about their natural conditions in mind, we can attempt to meet these needs, if not the exact condition, through management.

Let's look at the core aspects of management and think about applying the goat's nature to the solutions.

Psychology

- Herd dynamics
- Peer Groups
- Stocking rates
- Environmental enrichment

All of the above considerations are especially important to consider when you are first establishing your herd or introducing new animals. In nature, herds develop over time and establish some sort of equilibrium of hierarchy (albeit a shifting one). On most farms, groups are separated at times (weaning, dry period, etc) or new groups are introduced. This will be a time of stress for all of the goats. We can try to accommodate for that stress by providing for the best environment (we'll talk about that in a moment), but we should also make it a time of extra observation on our part to be ready to intervene (not socially but to identify an individual whose health might be compromised by the stress).

Peer groups, individuals who are reared together, are the easiest to introduce to a new herd or to reintroduce. They have their own small social order and bonds. When introduced to a new group or the more mature herd, there will be stress, but it is greatly reduced. Also, the established herd seems to be somewhat confounded by so many new goats and doesn't have just one or two new ones to single out or challenge.

New bucks should not be introduced to the male herd during breeding season/rut. A nice trick, however, when introducing a single female to the herd, is to rub a buck "rag" on her first, it seems to confuse the does a bit and make the new doe more appealing, even if it isn't breeding season!

Environment

- Housing
- Flooring
- Fencing
- Feeders and waterers

Goats like to be dry! Housing should offer shelter from wet and windy weather above all else. Rather than make a snug, closed in barn, however, it should have excellent ventilation. It is rare to need to provide heat for goats, unless perhaps they are kidding in extreme cold conditions, then the kids might be at risk of frost bit ears.

Bedding and flooring for goats is a challenge, given that in nature, they would be on the move and choose dry, clean areas. My favorite flooring for goats, in almost all climates, is raised slatted floors. These can be built in sections to retrofit a shelter or used where being closer to the ground helps with heat in the winter. (my blog has instructions for building them www.gianacliscaldwell.com) Raised floors reduce bedding in the areas used to zero (saving you money). Although a separate bedded, available if the goat desires, is a good idea in really cold weather. To increase floor space for lounging, shelves and bunks built at a slight slope (to allow pellets to roll off or be easier to sweep off) are invaluable. They can be made of plywood or covered with horse stall mat type coverings.

Fencing is as much to keep goats OUT of places as in! It should reflect the level of wear and tear it will receive (goats will use it as a scratching wall and rest their front feet on it as well). Fencing closer to their housing will need to be the sturdiest. Younger goats might try to jump fencing that mature animals won't, so keeping that in mind is important also. If you have horned goats, fencing can be a hazard and must be chosen in consideration of horns.

When it comes to feeders and water/mineral stations, there must be first of all, enough to encourage all goats to eat, drink, and supplement when they need to – not wait for an opportunity (this applies especially to the lower ranking goats). After that consideration, they will ideally keep feed waste to a minimum and keep it clean (or the goats won't eat or drink as much as they should). Water and mineral stations should ideally be where it is easy for YOU to inspect them without having to think about it (I like to place them outside of the pen with head holes for the goats to access them)

Nutrition

- Pasture/browse and graze
- Dry forage
- Minerals
- Buffers

Goats are browsers and intermediate grazers. They prefer shrubs, forbs, and other feeds that are at eye level. They also have a broad, but picky, menu! Their muzzles are designed to select leaves and nibbles in tight spaces (like through branches) and aren't built for grazing smooth, flat planes of short grasses. Indeed, it is short grasses where they will encounter parasite larvae! When natural browsing isn't present, pastures can be seeded with forbs and different perennials that will help them meet their need (much higher in mineral content than other domestic livestock). Even then, though, with their distaste for wet weather and the risk of parasites, ALL grazing/browsing should take place on tall "pasture" over 6 inches and ideally dry.

Dry forages, hays, etc., are used by almost all goat farmers to supplement their animal's diets. These should be high quality in respect to dust and molds and of nutritional content to meet the need of the goats – for example lactating vs dry or meat goats. There is a lot that should go into designing this part of their diet! Goats, being picky, will be selective and easily waste a lot of feed if given the opportunity.

Mineral supplementation is the keystone, in my opinion, to making up the gap between the goat's natural diet and that of semi-confinement. Always remember that mineral mixes for goats are produced to meet the needs of a broad geographical area! Your own area will have different balances of minerals and goats will have different needs throughout their year and productive lives. I am a huge fan of offering both a pre-mixed mixed mineral with salt AND a free-choice, individually focused mineral station. This should be followed up with at least yearly liver biopsies and mineral panels to confirm your program. More on that in the afternoon session.

The goat's rumen pH needs to be kept closer to neutral, but how does that happen with all of that acid producing fermentation going on? The answer is in the goat's saliva and in rumination. Buffers (which absorb and neutralize acid) coat each wad of cud and return to the rumen to balance the pH. Anything that limits rumination time (it should be about 8 hours a day) such as stress from other goats, kidding, illness, etc., puts the goat at risk of acidosis. Grains, which ferment quickly and produce more acid, are a problem if fed in too much quantity and/or the wrong time. Having a free-choice buffer (usually baking soda) available is an inexpensive way to help the goat during these times.

Health Intercession

- Triage
- Parasites
- Tools – remedies, veterinary relationship

This is a very in depth section that deserves more space than this time will permit! But basically, I want everyone to become their own herds triage nurse: You should be able to walk through the herd and assess their systems – everything from nervous, respiratory, digestive, and so on – based on how they look, behave, body condition, as well as vital signs. Then you should have the tools to support any signs of decreased homeostasis. AND your best tool is creating a good relationship with a veterinarian!

Genetics

- Choosing --
- Culling and Developing

We owe it to our herds to "cull" as nature would – but over time and with great thought as to the reasons for culling. You should begin your herd with more gentle criteria and then increase the standards over time. But always with an eye toward productivity, longevity, parasite resistance and resilience, ease of kidding and good mothering skills, etc. If you can choose your first goats from a breeder who has already done this, then you will be ahead of the curve!

Summary

Give yourself many years to come to the management plan that works the best for your own situation. Each farm will have different assets and challenges. It's an ongoing process. But always look back to how the natural goat would thrive – and seek to mimic that.

Holistic Approach to Animal Health and Well-Being

Dr. Ann Wells
Springpond Holistic Animal Health
Prairie Grove AR
annw@pgtc.com

Introduction

Animal disease prevention or animal wellness promotion? What do these phrases bring to mind? The first seems to focus on diseases, while the latter focuses on the well-being and health of the animal. The latter is what livestock producers need to think about in order to be most profitable with optimal production.

Animals don't have to get sick. Looking at the whole farm, instead of just the animals, gives the opportunity to observe the interactions between soil, plants, animals, weather and recognizing the changes that occur when any of one of those components changes. Diseases are more than just infectious, but include anything that adversely affects the health of an animal.

I never expect my livestock to get sick. I look at the whole farming system, using the animals as my gauge to how well I'm managing the whole system. I also know the problems I have to be aware of with the system. This can be things like running out of pasture because of drought conditions, calving problems if a bull throws too large of calves, parasites in sheep and goats.

So first start out by walking the whole farm. Yes, that's right, walk the whole farm. Look at everything, including the livestock. What does it look like as a single entity? Are the livestock contented and performing to the producers' satisfaction? What do the grasses and other pasture plants look like? Are they desirable plants? Are they strong looking or yellowed and weak? Are there bare spots in pastures or is there good ground cover? Are some pastures in better shape than others or are they all uniform? Are they overgrazed or undergrazed? What color is the soil? Grab a handful and smell it. Does it have a good earthy smell? Understand what is going on with your farm.

At this point, the producer needs to focus more in on the livestock, looking at individual ones to see how healthy they look. As the producer walks closer to livestock, their behavior should change, depending on how used they are to being approached. They should all start to look at the person walking towards them and many will go ahead and stand up. In fact, animal behavior is something that every livestock producer should spend time learning. Walking amongst the herd or flock on a daily basis teaches what normal behavior is. Remembering that these are prey animals and how important the herding instinct along with group behavior is.

Notice how bright and alert they seem, how slick the hair coat looks, how full the rumen is. The latter is really important as it tells how well the animal is eating. This lets the producer know how well he/she is doing providing adequate pasture or other feeds as well as how well the animal is doing. A full rumen means a healthy ruminant. Quickly look at body condition of animals.

Then, and only then, look for animals with problems. First check for animals that are not showing the normal behavior of herd mates. Which ones aren't looking at you? Are some lagging behind or off by themselves? These should be checked out carefully. If the herd is standing, check those that are still lying down. As livestock are observed more frequently, they become calmer and more relaxed. Those lying down may have nothing wrong with them, but walking over to them and checking is important.

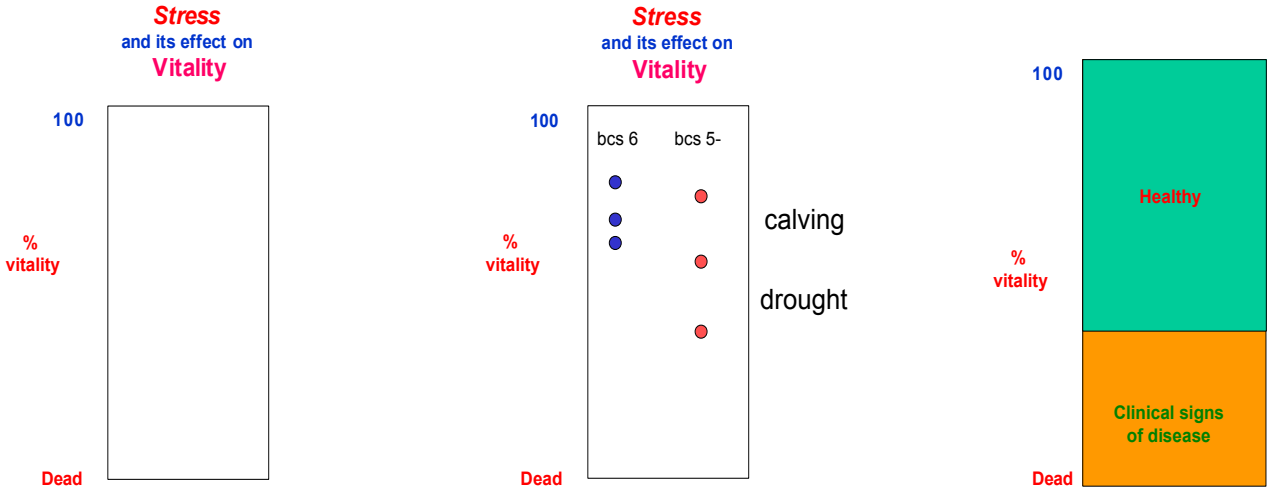
By walking the farm and through the livestock, the producer learns what is normal and healthy. This gives producers an important tool in determining what changes need to be made in the whole farm to ensure continued good health and wellness. Health and wellness occur through good nutrition and low stress. Attention to nutrition, especially through controlled grazing, along with reduction of stress provides the best preventative strategies. As producers become more skilled in the management of their farms, they see the health of the whole system improve.

Controlled grazing is the best way for livestock to get the nutrients necessary to keep them healthy. The challenge in controlled grazing is to provide a high availability of quality forage to animals at all times. The resulting high nutritional status helps prevent many diseases that might necessitate the need for antibiotics. Controlled grazing also satisfies the natural behavior of the cattle, thus reducing stress.

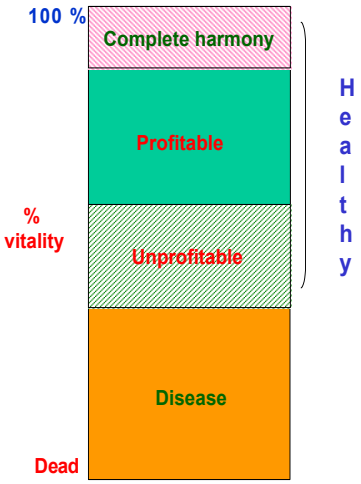
When stress is minimized, then animals remain healthier. This improves the profitability of the farm, by reducing the need for disease treatment. This makes it especially important to observe animals closely, and to provide them with the best nutrition possible through high availability of quality pasture.

Stress is the effect of change on an animal. It increases the susceptibility to disease and decreases the vitality or life force of the animal. There are two ways of looking at the effect of stress on an animal. Stress acts upon the body setting up an imbalance**.** The body produces a reaction that may give rise to symptoms in its attempt to regain equilibrium. This means that the producer needs to look for that first symptom, or change in the animal's behavior, to prevent the animal from progressing into a full blown disease process. These symptoms may be subtle, and if the stress is mild, may be corrected by another change in the animal's behavior.

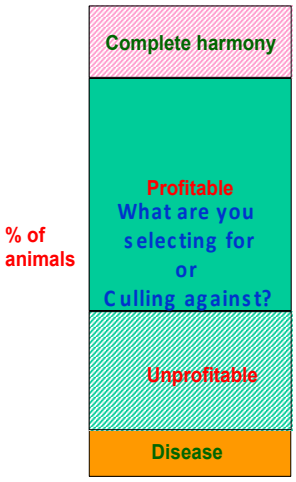
The second way to look at the effect of stress on the animal is to view the physiological changes. These changes are different depending on whether or not the animal is undergoing an acute, short term stress, or a chronic stress. Chronic stresses can be constant or intermittent. Intermittent chronic stress is much harder on the animal, as the animal just begins to recover when the same or different stress occurs. Acute stress causes the flight or fright syndrome to occur. Adrenaline is released, along with a small amount of corticosteroids. This kind of reaction indicates the animal is in control and can be seen as a good thing. Chronic stress causes release of corticosteroids which take a long time to clear from the animal's body and indicate that animal has no control over its situation. Rumination and digestion stop, which also stops growth and reproduction. The white blood cells decrease in number and the lymph tissues shrink in size. As a result the animal is less able to fight off disease and its vital force goes down.



No one living has 100% vitality. There are too many external forces that affect it at least a little. If you have 0% vitality, you are dead. At some point on the vitality scale, there is a point that clinical signs of disease start showing up. Above that point, we think of the animal as having some degree of health--the mind and body being in harmony with its environment. Any stress lowers that level of vitality and weakens the harmony, until, for that animal the vitality reaches a low enough point that disease shows up. Every animal will be affected by different stresses differently. Nutrition, feeds, exposure to bacteria or other disease causing agents, reproductive status, age all have an effect, but not an equal effect on all animals. This is why one animal will get sick and not another one.



When we treat the disease, and cause the signs to disappear, but don't take care of the underlying stress, we will have a less vital animal. In this case, the animal appears healthy, but isn't. So then, let's divide health into profitable health and unprofitable health. The animal's vitality has to be brought up to a level that achieves profitable health.



You can see that treating sick or otherwise unhealthy animals, even successfully makes no money for the farmer. It is a salvage operation. We need to start thinking of what stresses on in our herds and how we can avoid as many of them as possible. Any stress will increase the susceptibility to disease. But certain things will help the animal counteract stress better. Nutrition is the most important thing, followed by the animal's environment. It is also most economic to work on animals that are unprofitable but not "sick". And remember that any treatment may help, but the degree to which it helps depends on where the animal is on the line of % vitality. If they aren't fed well, too crowded, dirty place to sleep, too pulled down from calving, or weathers too stressful, then they won't be profitable.

Animals that are getting an abundance of protein, without adequate fiber or energy to use that protein will not be as vital. Metabolic changes will occur, in the body's attempt to provide the energy, which will be a stress on the body. This stress will allow other conditions, usually internal parasites, to show up, that the animal's immune system would otherwise be keeping under control if its nutritional status were better.

Nutrition and environmental stresses are easier to control than some other. Psychological and other behavioral stresses are harder to measure and determine. Low-stress weaning and handling techniques affect behavior in a positive way which minimizes problems. This includes treatment of sick animals. Research shows us the interaction between the animal and the treatment; how that treatment actually impacts the disease for which it is being used. It leaves out the animal-human part of that equation that also is a big factor in the health of that animal. Our thoughts and our actions affect the way our animals respond to any kind of stress and treatment. Farmers who use controlled grazing management, and thus are moving their animals frequently will have calmer animals in any handling situation.

The immune system's function is to ward off disease causing agents. Because of the destruction to it whenever the animal is under stress, this impairs its ability to fight and kill them. This is especially true when there are too many acute stresses or continuous, low-level, chronic stresses.

Stress alters the rumen microbes, which slows or stops rumination. This reduces dry matter intake, which means the animal has to use its body reserves to meet its energy requirements. If the stress is short-term, the animal will be able to overcome these affects on its own, with no apparent problems appearing. If the stress is longer lasting or chronic, returns in a short period of time or there are multiple stresses on the animal, this may throw the animal below that threshold between health and disease. For example, a first calf heifer is not only undergoing the stresses of pregnancy, calving and lactation, but also is still growing herself. These are all physiological states for which she evolved. However, if there is inadequate or poor quality forage or feed available, rough handling or weather extremes occurring, these additional stresses may be too much for her body to compensate.

The animal's response to any new stress can decrease or disappear depending on how it is dealt with. If weather extremes occur gradually, for instance, the animal is able to adapt to the change in temperature and will not be as adversely affected. How handling, hauling or other new situations happens the first time will determine how well the animal reacts subsequently to those things.

Keep in mind that, in the winter, wind chill is more of a factor than the cold. Windbreaks are crucial to keep the stress level down, to provide for more animal comfort and thus, prevent respiratory disease outbreaks. During hot weather, shade can be a factor to consider. The number of days of a heat index over 75 degrees should be known in order to determine how big a factor shade will be for the animals. Once again, if that heat index is reached gradually, the animals will be able to adapt to a certain extent. Feed intake and reproductive failure are the two big problems with heat stress. Even extreme heat and cold, if they occur gradually enough, will not cause the same amount of stress as sudden changes in cold or heat. The animal is able to adjust to the temperature change, even though some decrease in feed intake will still occur.

Other stresses to keep in mind and develop ways of minimizing them are livestock handling, introduction of new animals, chronic disease, weaning, parasites and even antibiotics. Most of these can be managed quite easily. Antibiotics kill the beneficial bacteria along with the disease causing bacteria. These beneficial bacteria take time to replenish following a course of antibiotics, which is a stress on the animal. This is just one good reason to keep antibiotic usage to a minimum. Keeping animals healthy makes antibiotic usage rare. Weaning stress can be composed of nutritional stress, environmental stress and respiratory stress, all of which can be alleviated through pasture weaning. Parasite stress can be alleviated through integrated parasite management involving the animal, soils, pasture and weather. For example, evidence now points to grazing plants high in bypass protein decrease the impact of internal parasites. Pasture management strategies can also be used as IPM. When grazing management improves, the health of the soils and pastures improve but also the health of the animal.

When an animal gets sick, get in the habit of thinking back over the last 2 weeks to determine what stress has occurred. Some will be possible to remedy. Others, such as weather, have to be lived with. There are some diseases or conditions that will totally overwhelm the animal's defenses for which there is little the farmer can do or prepare for. Once again, having the animal at a peak nutritive level is the best defense in this case.

By focusing on animal wellness promotion, we can keep our livestock healthy. We are better prepared for problems when they do occur. The problems are also usually small. We can spend our time and money improving the system instead of dealing with disasters. This results in a healthy profitable farm, producing healthy food for people everywhere.

Anatomy and Physiology – DIY Field Necropsy for Goat Producers

Ms. Gianaclis Caldwell

Nothing quite replaces studying the internal workings of the goat for helping understand how they function and keys to their overall health. By exploring the anatomy and physiology you will be able to envision how their organs function and why things such as body condition and rumen function are so critical. In addition, you will learn what is normal and eventually be able to diagnosis some causes of death – should budget or opportunity prevent a full necropsy by professionals.

A field, or gross, necropsy can be as simple as a quick look for things such as internal abscesses (caseous lymphadentitis), haemonchus contortus (barber pole worm), liver flukes or fatty liver disease, coccidiosis, blockages in the stomachs, or to extract a liver sample for mineral testing.

Please note: A full necropsy, done at a qualified facility with lab work also performed, should be considered first; especially when multiple deaths have occurred in the herd and/or infectious disease is of concern.

Great choices for your first necropsy are:

- Young kid that has died after doing well
- Old goat whose death is timely, but unusual
- A healthy goat you have butchered

What You'll Need

- Gloves – nitrile or latex
- Work surface
- Good lighting
- Tarp
- Muck bucket
- Skinning and/or de-boning knife or scalpel
- Knife sharpener
- Large pruning shears
- Camera
- Hose with sprayer
- Zip-lock bags
- Glasses if you need them or magnifying glass

Liver sample only procedure:

1. Lay the animal on its left side.
2. Locate the rib cage and make a 4-8 inch (10-20 cm) incision about halfway between the spine and the belly. You will cut through several layers – skin, fascia, and muscle.
3. The liver and likely the bile duct should be easily exposed.
4. Reach in and pull a section of the liver (a lobe) out and portion off a good sized chunk.
5. Place the sample in a labeled bag and freeze or send it immediately to the chosen lab.

Necropsy Procedure:

1. Position the animal on their right side.
2. Carefully use your knife to cut through the skin and abdominal wall. You must be careful to not puncture the rumen or intestines. It is likely that there will be bloating of the rumen simply from the continuing work of the rumen microbes even after the animal's death.
3. Open a flap of skin from the sternum to the mammary then up to the spine front (following the rib cage) and back, peeling the skin back as you go – use your knife to help separate the skin from the muscles. Note if any fluid has accumulated in the abdominal cavity (ascites).
4. Take a good look at everything, without disturbing any organs.
   a. Note if they are positioned where they should be.
   b. Note the color of the organs.
   c. Note any distention or lack of proper contents.
   d. Look for lesions: abscesses, tumors, trauma
5. The liver will be easily found if the animal is on their right side, this is the time to take a sample. As you cut the sample out, observe the tissue for signs of fat, parasites, or lesions.
6. Now start with the digestive system and inspect all organs, feel them and their contents. Open each hollow organ and carefully inspect the contents and the lining of the organ. Samples of the digestive tract contents may be taken for fecal analysis. Also observe for visible adult parasites. (Note, when you open the rumen there will be some pretty powerful methane gas and a very unpleasant odor, be prepared for that).
7. Work your way down the digestive system.
8. The kidneys and lymph nodes should be cut in half and examined for lesions.
9. Now take your knife and puncture the diaphragm, listening for leaking air that would indicate a pneumothorax.
10. Next cut the rib cage open and open the diaphragm so that you can observe the chest organs, lungs and heart.
11. Now cut sections of the lungs to observe them – note any differences from the lower to the upper lobes.

Here's a partial list of what you might be able so suspect based on sudden death and field necropsy observations:

- Heart is round instead of heart shaped—cardiac deformity
- Stomachs contain feed, but no contents in intestines— possible blockage
- Kid too young to ruminate, but rumen has foul-smelling contents—overfeeding and milk overflow to rumen
- Blood in the chest cavity—ruptured aneurysm
- Pregnant doe with kids in uterus and fatty liver—pregnancy toxemia

- Rumen contents are milky in color and the pH is below 5.5—acidosis
- A clog of feed in the esophagus—choking
- Black or bright-red section of intestines without signs of coccidiosis—colic
- Bright-red section of intestines with small white nodules—coccidiosis
- Visible *Haemonchus contortus* worms in abomasum—parasites leading to severe anemia
- Liver shows damage and bleeding—liver flukes
- Lung lobes are firm and bright red (not light pink)—pneumonia

If the animal was healthy and your investigation was relatively quick (less than an hour), you can harvest the meat if that feels appropriate (even when I necropsy a healthy goat, sometimes I'm too emotionally involved to make this more pragmatic choice). If the animal is to be buried or composted, include all of the removed organs. The fact that the body cavity has been opened will speed the breakdown of the carcass. I typically put the innards into a large muck bucket as I work. I then slide the tarp and carcass into a cart or bucket of our tractor and then bury or compost it.

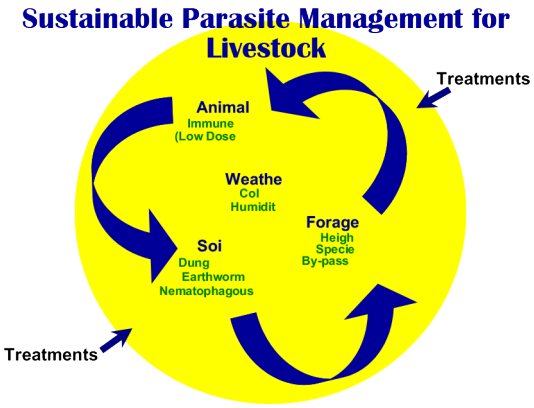
Summary

With each exploration of the animal you will learn more, so remember that there is little to be lost by attempting this exploration, and often much to be gained!

Holistic Strategies for Worms in Sheep and Goats

Dr. Ann Wells
Springpond Holistic Animal Health
Prairie Grove AR
annw@pgtc.com

Introduction



Internal parasites are considered by some to be one of the most economically important constraints in raising livestock. Confinement and pasture-based animals are almost certain to be exposed to worms at some point in their life. This is certainly true for goats.

Most producers are aware of the problems that worms cause, which range from decreased productivity of their animals to death. Animals have traditionally been routinely dewormed with different commercial chemicals, by owners using a variety of deworming schedules. ALL dewormers on the market have some resistance built up to it by the internal parasites that infest livestock. This resistance means that not all the worms are killed during deworming. The surviving worms pass that genetic resistance on to its offspring. In most cases, all worms have some level of resistance to Safeguard, which is the brand name for Fenbendazole.

The seriousness of the issue cannot be stressed enough, especially with goats. More and more goat herds are finding they have no chemical dewormers left to use. The worms are resistant to every one of them. This has changed the strategy of dealing with internal parasites. *We are no longer as interested in killing all the worms, as we are in preserving the susceptible worms.* This is such a different way of thinking; it takes a while to adjust the way a producer must deal with worms in their herd. But it will become ever more important if we are to retain any chemical dewormers for emergency use.

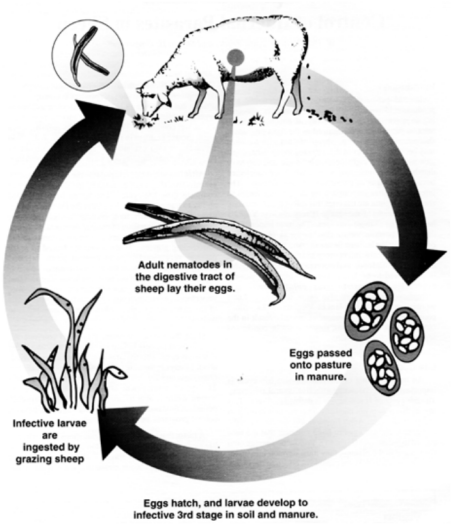
As a result, this problem has caused people to look for alternatives. Much attention both in the research community and on the farm is being devoted to discovering ways to prevent and treat internal parasites without relying on heavy doses of chemical dewormers. Many people claim this treatment or that control measure works, but there are more questions than answers. There is **no** simple alternative way of preventing or treating worms, nor will there be. By looking at the whole farm as an interrelated system, it becomes apparent that there are parts of the system that can be managed to decrease internal parasites and their effects. These management adjustments not only postpone the day when chemical controls no longer work, but they also may decrease costs and increase the overall health of the animal.

The American Consortium for Small Ruminant Parasite Control is the organization in the US that has brought the FAMACHA test to this country. It is one of the best resources for learning about everything related to internal parasites in sheep and goats. Made up of veterinary parasitologists, animal science researchers, extension educators, other veterinarians and educators, this organization is constantly working with producers and writing fact sheets to help sheep and goat producers manage their herds and flocks to keep parasite disease to a minimum. The website is www.wormx.info and all sheep and goat producers should check this website on a regular basis for more information.

Parasite Life Cycle

Goats and sheep are infested by the same species of worms. Cattle are mainly infested by other species. The barber pole worm, *Haemonchus contortus*, is a stomach worm that can severely affect goats and sheep. It is a bloodsucking worm, which can cause severe anemia and death. The cattle parasite of most concern is *Ostertagia ostertagi*, the brown stomach worm.

Both of these parasites have a simple life cycle, as illustrated here.



http://www.ext.vt.edu/pubs/sheep/410-027/figure1.html

Nutrition

Nutrition plays a major role in how well animals are able to overcome the detrimental effects of internal parasites. In fact, the signs of parasitism can often be used as a symptom of some other problem, usually poor nutrition. In an article in the Journal of the American Veterinary Medical Association in 1943, researchers showed that sheep placed on a high plane of nutrition were able to reduce their worm burden significantly and many of the sheep were even able to cure themselves (1).

By-pass Protein

Researchers in New Zealand have been studying the effects of by-pass protein on parasitized sheep (2). They have found that by increasing the amount of protein that is not degraded or broken down in the rumen, animals lose less weight than those animals that were not fed the increased level of by-pass protein. These researchers used fish meal as their source of by-pass protein. However, there are forages that also have an increased level of by-pass protein because they contain tannins. These include birdsfoot trefoil and lespedeza. The protein in native warm season grasses also has a higher level of by-pass protein.

This research is now extending into the U.S. The research done by Langston browsing goats on sericea has been breakthrough research (3). It showed that fecal egg counts went down to zero while the goats were browsing the sericea. The egg counts rebound when the goats are removed. More on sericea below.

FAMACHA testing

The FAMACHA test is a system of testing sheep and goats for the level of anemia due to Haemonchus infestation, imported from South Africa. The eyelids are each pulled down to expose the conjunctiva or pink part of the eyelid which is then compared to an eye color chart. Goats which have a score of 3, 4 or 5

are at risk of dying from Haemonchus and should be dewormed. Those with a score of 1 or 2 should not be dewormed. Research has shown that is very effective in identifying those animals at highest risk from dying due to parasites (4). The research has also shown that about 20% of a herd will have 80% of the worm problems. It's important to identify those 20%, and cull them and their offspring from the herd.

This test should be used so that animals that show no signs of parasites are not dewormed. This keeps a level of refugia, those worms still susceptible to chemical dewormers, out on pastures, barnyards and in animals. It is also useful to help determine how well the strategies outlined in the rest of this article are working for the producer.

Trainings on the use of this system are being offered around the country. Wormx.info keeps an updated list of trainings posted.

Pasture Management

Management of animals, pastures and any loafing areas is the key to reducing the amount of internal parasite problems in livestock. An understanding of the life cycles of the different parasites within the whole soil-plant-animal system will help show the interrelationships between these three components. Managing internal parasites is just like managing fleas in dogs and cats. The major part of the parasite life cycle is outside of the animal. This point will help the producer to choose management strategies that reduce parasite levels on his or her farm and decrease the usage of chemical dewormers. The same principle is used in integrated pest management for vegetables and other crops.

Many farmers closely monitor their animals but pay little attention to the plants and soil. Pasture contamination by infective larvae is the primary factor to deal with. If you start with an understanding of the interrelationship between the animal, the plants it eats and the soil on which those plants grow, then it becomes clearer how parasites infect the animal and how they can be managed so as not to cause as many problems. Everything a farmer does to his or her animals, including the grazing management, has an impact on the numbers of internal parasites their animals will have.

By looking at the whole farm as an interrelated system, it becomes apparent that there are parts of the system that can be managed to decrease internal parasites and their effects. For example, animals that continuously graze a pasture eat the grass into the ground, while contaminating the soil with so many parasites that nothing outside of regular deworming with chemicals will control them. This can especially be disastrous for goats, as they quit grazing when the pasture forage mass falls to a level of three to five inches. By using controlled grazing methods that allow pastures to rest and soil life to function well, contamination can be reduced. This reduction occurs because soil organisms, including earthworms, dung beetles, and nematophagous fungi will destroy or keep a lot of the parasite eggs and larvae from developing. Keeping the grass in a more vegetative stage, and tall enough to provide the animal with adequate forage, will provide better nutrition to keep the animal healthier, strengthening the immune system to prevent the adult worms from producing eggs. Parasites do not cause as much harm to a healthy, well nourished animal. The parasites that are present will not deplete the host as much as in an animal that is malnourished. Parasite loads affecting wildlife generally do not cause the death of the host, because the parasites need the host to survive. The same principle applies to livestock.

Pasture contamination can be reduced through management. Livestock will avoid manure piles and the grass surrounding them. This behavior also helps them avoid eating larvae. The height of the pasture sward can affect parasites. The majority of worm larvae crawl only one inch from the ground onto plants, so not allowing animals to graze below that point will cut down on a lot of infestation. This is one reason sheep tend to have more problems with internal parasites. They eat much lower to the ground than cattle do, picking up higher numbers of larvae. Therefore, it is important to monitor grazing sheep closely so they don't graze

too low. Larvae migrate from the manure no more than 12 inches from the manure pile. If livestock are not forced to eat close to their own manure, they will eat fewer larvae. This holds true even for goats and sheep which scatter the manure "berries" as they walk.

With sheep and goats, the most important time to control pasture contamination is during the periparturient rise, which is the sudden release of infective larvae and eggs within the ewe's intestinal tract. This occurs right after kidding, and is due to the doe's immune system becoming temporarily less effective. By treating animals at this time, the exposure to newborn and young lambs (those most susceptible to parasites) is minimized.

Good grazing management includes the use of clean pasture to minimize re-infection. Clean pasture is pasture that has not been grazed by the host animal (in this case, goats) for 12 months, and therefore is not contaminated with worm larvae. It may be new pasture, pasture grazed by livestock such as cattle or horses which do not share parasites with sheep (goats do share parasites with sheep), or pasture that has been hayed, renovated, or rotated with row crops. There is some killing of parasites on pasture during the winter due to freezing and thawing; however, snow cover insulates the larvae. Summer is the time in the Southern states when most larval kill will occur on pastures. Sunlight will kill them, and this occurrence can be used to determine which pastures can be used in the fall and into the winter. Grazing down to 2-4 inches from the ground allows more sunlight to get to those larvae and increases their chances of drying out and being killed.

Warmth, oxygen and moisture are the three most important things that increase the chances that larvae will survive on pasture (5). Knowing when your pastures are apt to be driest and hottest will help you manage them better for parasite control.

Good sanitation is a defense against parasites. Feed troughs and water sources located where they can be contaminated with feces will increase the chances of livestock infestation. This is only one reason not to water directly from ponds, or to allow animals continuous access to water sources. Feeders should be cleaned and elevated. Kidding areas, as well as other holding areas, should be clean and dry. Prevent the transmission of infestations from new arrivals to the herd or flock by deworming them before arrival and again three weeks later.

Immunity

While it is usually neither possible nor advisable to completely eliminate internal parasites in sheep or other livestock, reduction of parasite load can be achieved. Many people have found, and research has shown, that adult animals rarely need to be wormed (5). Most animals develop immunity against internal parasites, though not to the level that is developed against viruses and bacteria. This immunity keeps the parasites from reproducing but rarely kills them.

It is the young animal whose immune system is not fully mature and the animal whose immune system is compromised by disease, inadequate nutrition, or other stress, which is most adversely affected by worms. Animals brought from western rangelands, for example, where the arid conditions keep parasites from surviving, have no immunity and are even more easily overwhelmed by worms.

Every farm is different. The parasite load of the animal depends on many variables − such as stocking density, time of year, the reproductive state of the animal, etc. Good nutrition plays a big part in how well the animal's immune system mounts the proper defenses, and in the animal's overall ability to tolerate the presence of some worms. Healthy and well-nourished animals will be able to develop resistance and resilience to worms and other parasites much better than thin animals that do not have good availability of quality feed (5). Resistance is the ability of an animal to prevent the establishment and maintenance of a parasite population within the gastrointestinal tract. Some individuals and some breeds show more resistance to parasitic infection than others. Research to identify characteristics in such individuals is a hot area. Culling

susceptible animals can take advantage of this. Resilience is the ability of an animal to reduce production loss during a parasite infestation. Both of these traits are being looked at as ways of selecting animals that will be less susceptible to parasite effects. Animals that possess some genetic resistance or resilience can still be infected with worms. Therefore, you must keep in mind that this is just one more measure that will help control worm problems, not a cure by itself.

In my experience, goats will need to be dewormed, whereas sheep will not, under the same conditions. Goats develop less immunity than sheep and cattle. Selection of goats who develop resilience will go far to strengthening a producer's herd.

Soil Organisms

There are several soil organisms that can have an impact on parasites. Managing pastures to favor populations of beneficial soil organisms will decrease parasite levels on pastures.

Oxygen is the primary requirement for worm eggs and larvae to survive and develop. Earthworms have been shown to ingest worm eggs and larvae, either killing them or carrying them far enough below ground to keep them from maturing. Dung beetles ingest and disperse manure, taking it to their burrows, thus keeping eggs and larvae from developing. There are also nematophagous fungi that produce "traps" that engulf and kill parasitic larvae. More on a new commercial product below.

The amount of time that feces remain on the pasture has an effect on the number of parasite larvae that survive and mature. Anything that hastens the breakdown of the feces will lessen the number of larvae. This can include the soil organisms mentioned above, mechanical dragging of pastures, poultry or other animal disturbance and the consistency of the feces themselves.

Effect of Ivermectin on Dung Beetles

Resistance development by worms is not the only problem with ivermectin. There is concern today about the effects of ivermectin on soil organisms, especially dung beetles. Research has shown that the use of ivermectin kills dung beetle larvae for up to 45 days through residue in the manure (6, 7). Manure from livestock treated with ivermectin does not break down as fast, either. Other dewormers, including cydectin, don't appear to have the same effect.

Strategic Deworming

There will be times when chemical dewormers are the best treatment. The situation, time of year and location will help determine which chemical dewormer to use. These dewormings should be strategically carried out in order to reduce the number of times needed. There are three main classes of wormers—the benzimidazoles, such as fenbendazole or Safeguard (white); the imidazothiazoles, such as levamisole (yellow); and the avermectins, of which ivermectin or cydectin (clear) is a member. The recommendation now is to use a dewormer until it is no longer effective. Since many of the dewormers have no effectiveness, then using more than one class is now needed.

Effectiveness is defined as killing 90-95% of the adult worms in an animal. Even those dewormers who do not kill at this level, usually kill some of the worms and weaken others. Using a less effective dewormer can be used when the life of the animal is not at stake, along with other strategies, such as increased nutrition, rotating to a cleaner pasture and improving the animal's overall condition and immune system.

In many instances the only dewormer still effective is levamisol (Prohibit). Therefore, do not use that dewormer at all if another dewormer is still effective on your farm. Levamisol is also the least safe of all the dewormers, so knowing the weight of the treated animals is crucial.

It does little good to deworm livestock and return them to the same infected pasture. Do not deworm and immediately move animals to a clean pasture. All the dead worms, with very viable eggs in them, will be passed to contaminate the pasture. Instead, deworm, hold animals in their same location for 12-24 hours, and then move them to a clean pasture.

Appropriate management minimizes re-infection. There are several ways to utilize multiple animal species to control the worm population. Many producers raise goats and cattle. One technique that appears to work well is dividing your farm in half, with cattle on one half and goats on the other half. Midway through the grazing season, switch halves of the farm. Having one species of livestock follow another one will have a benefit. Letting the goats browse where they want to, but keeping the cattle rotating through pastures with just one strand of electric fence is yet another way of using cattle and goats together. The different livestock species will break up manure of other species and will not avoid those areas of pastures. This will break the life cycles of the parasites because their natural host will not be present.

Make sure that your dewormer is effective. Fecal Egg Counts and the Fecal Egg Count Reduction Test are important tools in determining this. If you are concerned that it isn't, have a veterinarian check the egg count in the feces of about 15 animals before treatment. After 10 days, check the egg count again. There should be at least an 90-95 percent kill. You may need to consult your veterinarian about the most effective dewormers for your area. If parasites become resistant to a particular family of dewormers, then you will have to switch families. Alternating families of wormers is a good way of slowing resistance to the dewormer. Many people alternate every time they worm. Research does not recommend this. Instead, use the same dewormer until it is no longer effective.

To implement any type of integrated parasite control program it is essential to know when loads will be highest, such as at kidding; where the young animals stay at those highest egg production times; how pastures can be divided and how long they can be rested in order to let eggs and larvae die. In addition, grazing height for goats is crucial. Goats will quit grazing when pastures fall below 3-5 inches in height. This lowers their nutritional status and if they have many worms in them, will shows of signs of worms even more quickly. This means the producer must have plenty of forage available for the goats, or else be supplementing with some other kind of feed. It is also essential to fully identify those animals having the most clinical signs through the use of the FAMACHA test and fecal egg counts.

If the producer has some idea of how much parasite infestation exists, this will also help in determining whether, and how often, chemical deworming should be given. Some scientists and producers say that rotationally grazed pastures do not aid in parasite control, because the rest period is usually not long enough to break the life cycles of parasites. Most pastures are rested between 21-30 days during the growing season, which is also the length of time it takes for infective stage larvae to develop. The goal is to lower the number of infective larvae that are ingested by the animal. The less time that animals are on a particular pasture, the less the pasture is contaminated with manure. If even one thing can be done to lower these parasite numbers, it will help reduce the need for chemical dewormers. Managing the length of time animals remain on a pasture is also important to remember. Tohis is just one other item that has to be figured in when doing pasture planning for a season. Don't let those pastures be grazed too short!

Alternative Dewormers

There are a few non-chemical alternatives. Copper Oxide Wire Particles (COWP), sericea lespedeza, Bioworma.

COWP, sold as either Copasure or UltraCruz Copper Bolus is effective against the current parasite infestation in the gut of the animal (11). It is not effective for incoming 3rd and 4th stage larvae. Copper Oxide is not absorbed well from the gut so there is less chance of copper toxicity in sheep. But it is a copper supple-

ment and so in addition to its deworming capability, it also does provide some copper that is essential for a healthy immune system.

Sericea lespedeza prevents worms from laying eggs and also weakens the adult worms. This effect only lasts while the sheep or goat is eating the sericea. Goats will eat sericea at all stages of growth and makes sericea infested pastures very attractive for goat producers. Sheep tend to eat sericea only at a young stage, before the plant gets woody.

Sericea hay and pelleted feed is available and can be effective, but must be fed at least at 25% of the diet to get the best effect. While sericea is a legume and has a good level of protein, some animals won't eat it well and it can impact growth. So, it still must be used in conjunction with other management strategies.

Bioworma is the product that all of us working with small ruminants have been waiting for. This product is the spores of a nematode-trapping fungus, *Duddingtonia flagrans.* The spores are fed daily to sheep and goats, passing through the animal intact in the manure. The spores then germinate and grow, developing trapping appendages that engulf the larval stages of any nematode, including the barberpole worm and the others affecting the sheep and goats. The research has shown almost complete control of the larvae in the pastures.

Bioworma must be fed in feed every day during the "worm" season, so between April and October in this part of the country. It is not cheap, costing somewhere between 50 cents and $1 per head per day. It also must be fed every year, during the worm season. This is because the fungi die when there are no longer any nematodes in the soil.

This product came into this country in February. It is available in a feed supplement at this time from Premier1 Supplies, called Livamol with Bioworma. Bioworma, which is just the spores product will only be available from veterinarians and a distribution center is still be worked on at this time in April 2019. Research will be started to develop a mineral mix that would be available at all times without having to be fed daily.

Even with the cost and the need to ensure goats and sheep get a daily dose of the spores, this product could be one of the best answers for producers who have no chemical dewormers that are effective or who really need to clear their pastures of worm larvae.

There are other plants, such as chicory, dock and black locust, that have shown some deworming capabilities. Like sericea, they need to be grazed or browsed daily or fed daily. They will help if in pastures but will not have any real impact if not a large part of the daily diet.

Most other alternative dewormers have not been shown by scientific research to have any effect on numbers of worms. Diatomaceous earth (DE) has been promoted by some for controlling internal and external parasites in livestock. Almost pure silica, DE is the finely ground fossilized remains of diatoms, tiny sea organisms that accumulate on the sea floor and can be mined from deposits. The diatom remains have microscopic cutting edges that are said to pierce the outer protective layer of parasitic worms and insects, causing dehydration and death. There is little scientific data on the effectiveness of DE for internal parasites, but researchers have seen a decrease in flies on animals when using DE. I have enclosed a report from The Leopold Center about a project that showed no statistical difference between the use of DE and the control group. I have talked to Dan Morrical, Sheep Extension Specialist at Iowa State, who told me that they had a hard time even getting the lambs infested with worms, which was necessary to test to the effectiveness of DE. I bring up this point to make you aware that farmers must know if their animals even have worms in order to know whether control measures are needed, are effective, or how to effectively change them.

Many producers have claimed that they have had good results with DE, but their management is usually very good. They may be giving credit to the DE when they should be giving it to themselves. Although I have nothing to back me up, I've often wondered if it isn't the minerals in the DE that provide the benefit. Worm egg count also naturally falls at the end of summer and the beginning of fall. People who are doing

fecal egg counts (FEC) may be thinking the DE is lowering the egg counts, instead of realizing that it is the natural cycle. I haven't talked to any producer who uses DE without significantly changing and then watching their management. Using DE is not just a simple substitute for a chemical dewormer. This is another problem with the scientific research that has been done on DE. Researchers have simply substituted DE for their conventional wormer and done everything else exactly the same. This is component research, whereas to really prove that DE has an effect, systems research needs to be done, using the same or similar management techniques that producers use. This type of research is much more difficult to do. If you still want to use DE, one dosage that I've seen used is ten to twenty pounds per ton of mineral supplement. Every animal must be fed a dose every day to be effective.

Deworming alternatives exist in herbal and folk medicine used for centuries in other cultures. Herbs such as garlic work not by killing the worms, but by making the intestinal tract healthier. Since worms and other intestinal parasites have evolved to thrive in the unhealthy digestive tract, anything that will make that environment healthier will be detrimental to their survival. Dr. Susan Wynn (9), writing in the Journal of American Holistic Veterinary Medical Association, discusses alternative dewormers in great detail and points out that much more research needs to be done to determine the effectiveness of herbs and other natural substances traditionally used as dewormers. Her article also states that many herbs can be toxic to animals, so great care should be taken in giving them. There are veterinarians who use herbs as part of a parasite control program. The AHVMA (10) has a list of veterinarians practicing complementary and alternative medicine in every state.

Herbal dewormers are being used more and more by goat producers. Some of these producers get complacent. Others are in parts of the country where worms are not as much of a problem. Still others have low numbers of goats on a large enough area of land, which is low stock density. These animals are unlikely to be exposed to enough worm eggs and larvae to have a problem. Human herbalists tell me that in order for herbs to be useful in ridding people of parasite infestations, they need to be in very large quantities. Usually this is as a tea. The small amounts that the commercial herb products suggest being fed will most likely do little to help with worm loads in most sheep and goats.

Conditions with Signs Similar to Parasitism

Keep in mind that there are other conditions that can mimic the signs of parasites. It is easy to assume that any unthrifty or thin animal with a rough hair coat or diarrhea is wormy. Internal parasites may be present, but the clinical signs are secondary or a symptom of some other, more insidious disease or condition. Any stressful condition, such as a weather extreme, can cause borderline clinical parasitism to become severe. If animals do not have enough forage or other feed in the fall so that they go into winter in good condition, this lack of condition will cause additional stress on the animal in other ways. This animal will be more apt to show extreme clinical signs of parasitism, including blood loss and death, than an animal which might have some internal parasites but is in good physical condition and is on a high plane of nutrition. In this case, poor nutrition is the cause of the animal's disease and worms are the symptom.

My Parasite Management Plan

I consciously think about parasites and management daily

Note weather—especially rain events and droughty times

Use only rams who NEVER need to be dewormed

Cattle are grazed after sheep

Cull ewes that need to be treated OR who have lambs that need treatment

Sheep aren't allowed to overgraze

I feed Ragland Trace Mineral Salt—contains 300 ppm copper to sheep

Analyzed livers—all within normal parameters

Purina Wind and Rain 7.5 with 2500 ppm copper and 27 ppm of selenium to goats

Sheep eat some of this

Watering areas are watched closely

I don't wean during weather extremes—keep stress to a minimum

Always keep an eye on the last 10% that go through a gate

Utilize plants that have deworming effects—sericea, black locust, chicory, dock

Do a FAMACHA check any time I am holding a sheep

I consciously think about parasites and management daily—when will lambs be affected, not if

Conclusion

There is no one thing that can be given or done to replace chemical dewormers. It will take a combination of extremely good management techniques and possibly some alternative therapies. Do not think you can just stop deworming your animals with chemical dewormers. It is something you will need to change gradually, observing and testing animals and soil, in order to monitor your progress. Alternative parasite control is an area that is receiving a lot of interest and attention. Programs and research will continue in the pursuit of parasite control, using alternative and more management-intensive methods.

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Cheesemaking

Dr. Steve Zeng

Langston University

Introduction

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

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

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

Goat Milk Soft Cheese

Step-by-Step Procedure

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

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

Cheddar Cheese Make Procedure

(100 gallons of milk)

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

Manufacturing Procedure of Colby Cheese

(10 gallons of milk)

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

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

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

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

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

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

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

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

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

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

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

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

Feta Cheese Make Procedure (10 gallons milk)

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

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

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

Goat Herd Health and Management

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

Introduction

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

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

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

Ageing Goats

Number and arrangement of teeth

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

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

Telling the age of goats

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

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

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

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

Animal Identification

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

Tattooing

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

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

Ear tags

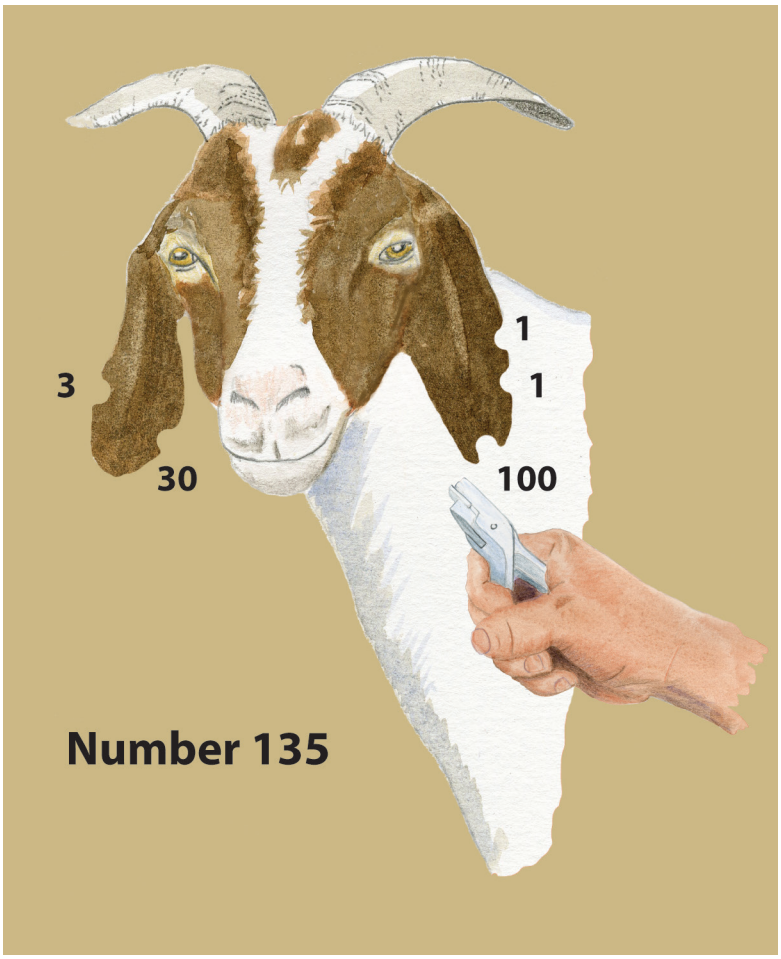
Ear tags are an easy way to identify each goat in the herd. Unlike tattoos, they can be read without actually having to catch the goat. Unfortunately, unlike tattoos, they can break or be ripped out of the goat's ear. Some producers use two ear tags because of this problem. Goats that are shipped are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

Microchip

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

Ear notching

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



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

Hoof Trimming

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

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

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

Common Herd Health Procedures

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

Taking temperature – rectally

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

Pulse or heart rate

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

Respiration

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

Rumen movements

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

Checking mucous membranes

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

Drenching and dosing

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

Tubing an animal

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

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

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

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

Bolus administration - "Balling"

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

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

Paste administration

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

Giving injections

Administering drugs via injection is a common herd health procedure routinely practiced by almost all producers. Following proper guidelines for each type of injection and using proper equipment will ensure that injections are done correctly and inflict minimum stress on an animal. Proper sanitation will ensure that you don't inject bacteria into your goat and cause an infection. Dirty needles and syringes should never be used. Using needles and syringes on multiple animals can transmit disease. After making six to ten injections with a needle it will be dull and should be changed and disposed of properly.

Needle selection

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

Proper injection sites

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

Common injection methods

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

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

Subcutaneous injections

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

Intramuscular

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

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

Intravenous

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

When you are injecting drugs IV, it is important to ensure that all of the drug enters the vein. Give the drug slowly. The jugular vein will take the administered drug straight to the heart and at high concentrations

many drugs can cause problems with the heart. IV drugs given around the vein instead of in the vein can cause an irritation or inflammation of the vein.

Minor Surgical Procedures

Castration

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

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

Dehorning

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

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

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

The disbudding equipment most commonly used is an electric-heated metal rod with a hollowed-out end. Newer cordless, butane gas powered dehorners are available. Some disbudding irons have problems in maintaining a constant temperature, and it is extremely important to match temperature and time. Underburning of the horn bud will result in scurs while over-burning will lead to brain damage or death. The horn buds can generally be felt in young kids to ensure proper location to burn. After the disbudding iron is hot, apply it firmly over the horn area and rock it around slowly for 3.5 to 4 seconds. Remove the iron and repeat if necessary and do the other side. Evaluate the success of the procedure by its appearance. The goal is to have the area look like "tanned leather." Black color represents burned hair and is indicative of inadequate

burning. Clipping the site prior to burning will eliminate the problem of burned hair. Scent glands are located near the base of the horn and descenting could be done at the same time if desired. Inject the kids with 150 IU tetanus antitoxin. Although the risk of tetanus after disbudding is not great, it is a good practice to administer tetanus antitoxin.

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

Lancing abscesses

Goats get a variety of swellings or "knots" at various locations on their bodies. Some of these are cysts (fluid filled structures) and some of these are abscesses (puss filled structures). There is a disease of goats called caseous lymphadenitis (CL) that causes abscesses in the lymph nodes of goats.

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

Since pus is infectious to other animals and humans, wear gloves when performing this procedure. Remove any remaining hair from the region. Scrub the area with disinfectant soap (Betadine Scrub®) and restrain the goat. If this is done correctly it is not a painful procedure for the goat. Take a pinch of skin in the center of the abscess with your gloved hand or a surgical tool (such as a towel clamp) and stab a scalpel or sharp, sterilized knife blade deeply into the abscess and cut out a circle of skin. Just slashing the abscess may allow the cut to seal over before the abscess has healed from the inside out. There will be some white, or greenish white, odorless puss come out of hole created in the abscess. Catch it in a disposable bag and dispose of it where other goats can't get into it. Caseous lymphadenitis is a contagious disease. It is also a zoonotic disease, meaning it can be transmitted to humans, so wear gloves and sanitize your hands and equipment used after this procedure.

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

Normal Range for Goat Physiological Parameters

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

Extra-Label Drug Use

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

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

Most goat producers are unaware that they do NOT have "extra-label" drug use privileges. Only veterinarians who have established a VCPR with a particular client may prescribe or use drugs in an extra-label manner on that client's animals if the animal health is threatened and suffering or death may result from failure to treat. To establish a VCPR, the veterinarian should have visited the farm, and have a thorough knowledge of the management of these animals, or has recently seen the animal to be treated. Once a VCPR has been established, the veterinarian may use drugs in an extra-label manner provided that the client has agreed to follow his or her recommendations.

Three conditions of extra-label drug use:

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

FDA criteria for Using Pharmaceuticals Extra-Label

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

1. The veterinarian must first examine the animal and assumes responsibility for making clinical decisions regarding the health and treatment of the animal within the guidelines of a VCPR. Often a goat owner will not have the animal examined by a veterinarian, but will telephone a veterinarian, who may never have visited the farm, with a list of symptoms and ask for a recommended treatment. This does not qualify as VCPR!
2. The second criterion requires that the veterinarian determine there is no marketed drug specifically labeled to treat the diagnosed condition, or that the recommended dosage on the label for that product is clinically ineffective. Since there are few drugs labeled for use in goats, it is not difficult to determine whether or not there is a legally licensed product available.
3. The third criterion requires that the individual animals to be treated are clearly identified, and that accurate records be maintained regarding the treatment of those specific individuals. If there is no permanent identification such as an ear tag, notch, or tattoo, the owner must make some effort to identify the treated animals with a visible temporary mark by using temporary tags or paint. If

possible, these animals should be isolated. Records on animals and treatment must be kept for future reference to avoid any drug residues in the meat or milk.

4. The fourth criterion requires that a significantly extended time period be assigned for drug withdrawal prior to marketing meat or milk from treated animals. The owner must keep accurate records of the treatment, namely the person treating this animal, date, route of administration, product used and a proper withdrawal period. Proper withdrawal period can be obtained from your veterinarian. Veterinarians can access drug information at the Food Animal Residue Avoidance Databank, http://www.farad/org.
5. Many goat owners casually treat their animals and do not keep proper records of animals treated, drugs used, or proper withdrawal period for that product. If no information is available to establish a withdrawal time, then the treated animal or animal products such as milk and meat are permanently barred from the human food chain. This is to prevent illegal drug residues in products for human consumption. Although there are no drug residue test kits marketed specifically for goat meat, owners should be aware that drug residue testing is conducted on milk and meat produced for human consumption.
6. The last criterion details the information that must be listed on the drug dispensed for extra-label use. The label should include the name and address of the veterinarian, the established name of the drug(s), and the specific directions for use including: dosage, routes of administration, frequency of treatment, duration of therapy, cautionary statements, and the withdrawal time for any food that might be derived from the treated animal.

Ten Drug Use Tips

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

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

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

Medications Commonly Used in Goats and Approximate Withdrawal Times

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

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

Herd Health at Different Production Stages

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

Pre-breeding

Breeding does

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

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

Breeding bucks

Bucks are too often neglected and omitted from herd health management practices. Some of the common conditions seen in bucks are urinary calculi (stones), lameness, urine scalding around the prepuce, and front leg injury due to a dominant buck in the pen. In the case of urinary scald, wash the affected area. Application of petroleum jelly can help protect the affected areas. Maintain a 2:1 ratio of dietary calcium to phosphorous and provide a high level of salt (up to 4%) and 1 to 2% ammonium chloride in the diet to prevent urinary

calculi. Bucks should be vaccinated at the same time as the does and for the same diseases. Body condition and breeding soundness should be evaluated at least 4 weeks before the breeding season and adjustments made to prevent bucks from becoming overly thin or obese. As breeding season approaches, extremely aggressive and dominant bucks may need to be penned separated to prevent injury. Monitor fecal egg counts in bucks or FAMACHA score and deworm as needed.

Breeding Season

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

Gestation

Pre-parturition

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

Feeding schedule and amount for bottle fed kids.

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

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

Parturition (kidding)

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

Medications Commonly Used in Goats and Approximate Withdrawal Times

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

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

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

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

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

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

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

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

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

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

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

problems are always a possibility. First-freshening does should be closely watched, especially if bred to bucks known to sire large kids.

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

Problems in parturition

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

When assisting birth, it is important to clean the area around the vulva with disinfectant soap and warm water and to have clean hands. Wear gloves. There are certain diseases that can be transmitted to humans during this time period. Pregnant women should not assist with the kidding process. Lubricate the hand prior to entering the vagina. Feel and identify the parts of the kid. Try to ensure that all body parts felt belong to the same kid and not to two separate bodies. If you feel only one leg or no legs at all, reach further and try to determine the exact position of the fetus. Arrange the legs and/or head gently in a proper position for birth. The fetus may have to be pushed forward towards the doe's head until a leg can be grasped and repositioned. Once the limbs are in a proper position, the kid should be gently pulled out and downwards using only your hands. Clear the mouth and nasal passages of the kid with straw or a towel and ensure it is breathing. Rubbing the body with a piece of cloth can sometimes stimulate breathing. Never pull on any presentation other than a normal presentation of two front legs and a head or a presentation of two hind legs and a tail. Pulling on any other arrangement of limbs and body parts will only make the problem worse.

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

Kid management at birth

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

Another critical practice is the feeding of colostrum as soon after birth as possible. The colostrum, or first milk, contains antibodies, which the doe does not pass to the fetal kid in the womb. Consumption of colostrum must occur as early as possible, ideally within 2-4 hours of birth. At 24 hours after birth there is a rapid reduction in the permeability of the intestinal wall to colostral antibodies. If a newborn kid does not or cannot nurse, the colostrum should be bottle-fed or the kid should be tube fed to insure adequate

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

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

consumption. Excess colostrum can be frozen for use in orphan or bonus kids. Recent research indicates that disease organisms, especially caprine arthritis encephalitis (CAE), may pass from doe to kid through milk and transmission might be avoided through the use of extra colostrum frozen from does tested and shown to be CAE-free or by feeding pasteurized colostrum. CAE is not considered to be a problem on most meat goat farms.

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

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

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

Artificial raising of kids

Milk is the principal component of the diet of the pre-weaning kid. Most meat goat kids will nurse their dam until weaning. However, for orphaned kids or for kids of does that have lactation problems it may be necessary to use a milk replacer. Goat milk replacers are commercially available. If necessary, a lamb milk replacer may be used as a substitute for goat milk. Typical lamb milk replacers contain 22 to 24 % protein and 28 to 30% fat (on a dry matter basis). If no other milk replacer is available whole cows milk or calf milk replacers can be used. Maintaining milk replacer quality after mixing is particularly important when kids are fed ad libitum (all they can consume).

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

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

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

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

Dam raised kids

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

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

Weaning

In raising goat kids, increases in size and weight are not the only measure of success. A well-formed skeleton and proper development of internal organs are often neglected when the emphasis is on rapid gains.

Dry feed consumption is important in developing body capacity. By increasing body capacity, feed intake and digestion increase.

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

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

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

Vaccination Schedule for Meat Goats

Other disease preventive measures

Dam – 1 month prior to kidding

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

Kid – birth to first week

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

Kid – 3 weeks – begin coccidiosis prevention

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

Herd Health Calendar

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

Planning Calendar for Meat Goat Herd Health

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

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

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

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

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

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

Footnotes:

1. **Valbazen** Suspension (11.36 % or 113.6 mg/ml): ***Do NOT use in pregnant does in the first trimester of pregnancy.*** Meat withdrawal time is 9 days and 7 days for milk (FARAD).
2. **Safe-Guard/ Panacur** Suspension (10% or 100 mg/ml): Approved in goats at 5 mg/kg with meat withdrawal time of 6 days and no withdrawal period for milk. Although the label dose in goats is 5 mg/kg, it is generally recognized that 10 mg/kg dosage is required for good efficacy. At 10 mg/kg dosage, meat withdrawal is 16 days and 4 days for milk (FARAD).
3. **Ivomec Sheep Drench** (0.08% or 0.8 mg/ml): Protect from light. Coughing may occur during and following drenching. Meat withdrawal time is 14 days (FARAD).
4. **Levasole Soluble Drench Powder (Sheep)**: Oral solution ONLY. To prepare use 1 packet (13 gm/11.7 gm active ingredient) dissolved in 262 ml [8.9 oz.] water (44.7 mg/ml) {or 52 gram packet dissolved in 1048 ml water [35.4 oz.].} NOTE: This is different dilution from the label directions for administration. Meat withdrawal time is 4 days (FARAD).
5. **Cydectin Pour-on for cattle** (0.5% or 5 mg/ml): Meat withdrawal time is 23 days. ***Not for use in lactating dairy goats.***
6. **Cydectin Drench for sheep** (0.1% or 1 mg/ml): Meat withdrawal time is 14 days. ***Not for use in lactating dairy goats***.
7. **Cydectin Injectable for cattle** (1% or 10 mg/ml): GIVE SQ. Meat withdrawal time is 30 days. ***Not for use in lactating dairy goats.***

NOTE for Guideline for Anthelmintic Dosages in Goats

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

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

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

Goat Nutrition

Dr. Steve Hart
Langston University

Introduction

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

The ruminant stomach

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

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

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

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

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

Nutrients

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

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

Water

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

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

Carbohydrates

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

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

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

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

Fats

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

Protein

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

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

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

Vitamins

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

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

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

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

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

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

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

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

Minerals

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

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

Macrominerals

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

Calcium (Ca) 0.3 - 0.8%

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

Phosphorus (P) 0.25 - 0.4%

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

Sodium (Na) 0.2%

Potassium (K) 0.8 - 2.0%

Chloride (Cl) 0.2%

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

Sulfur (S) 0.2 - 0.32%

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

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

Magnesium (Mg) 0.18 - 0.4%

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

Micro or trace elements

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

Iron (Fe) 35 - 500 ppm

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

Copper (Cu) 10 - 50 ppm

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

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

Cobalt (Co) 0.11 - 25 ppm

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

Zinc (Zn) 40 - 500 ppm

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

Manganese (Mn) 40 - 1000 ppm

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

Selenium (Se) 0.1 - 20 ppm

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

Molybdenum (Mo) 0.1 - 5 ppm

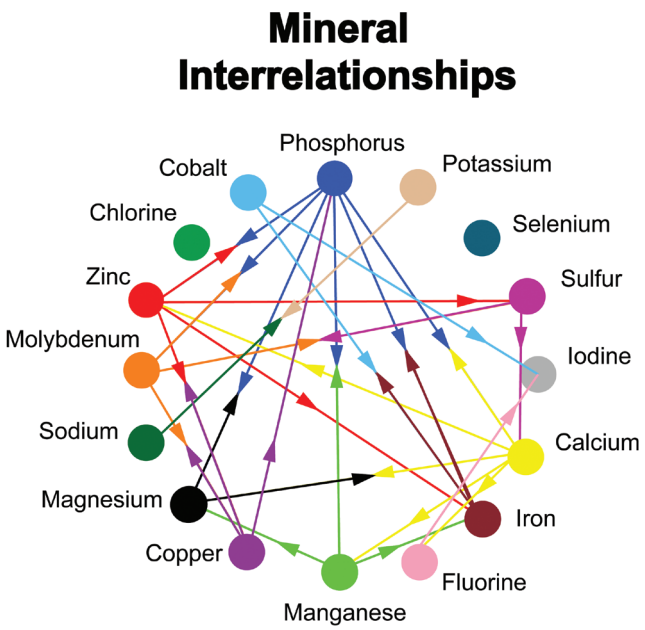
Molybdenum deficiencies are very rare. Toxicity occurs above 3 ppm due to reduced copper absorption, resulting in a copper deficiency. The copper level must be six times the molybdenum level to overcome this effect. High dietary levels of molybdenum are usually related to soil content. Molybdenum (as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

Iodine (I) 0.5 - 50 ppm

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

Mineral nutrition considerations

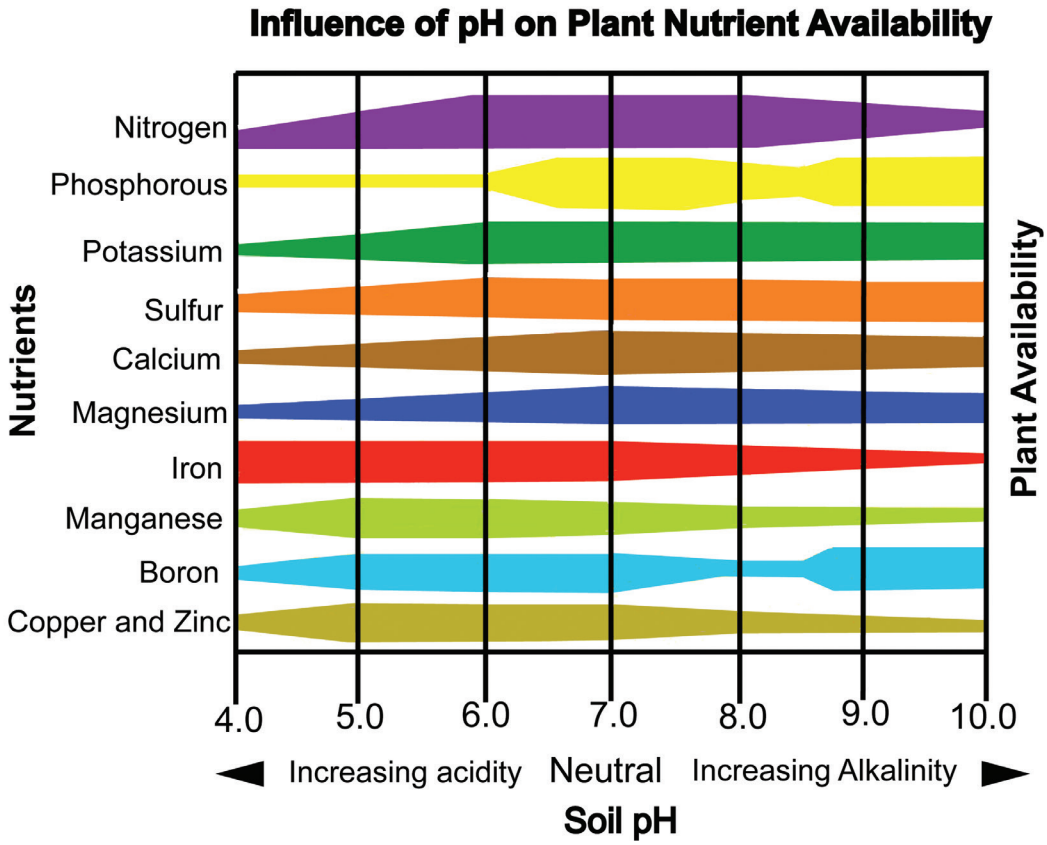
Plants are a major source of minerals for the goat, requiring all minerals that goats require except iodine. However, plant requirements for minerals, such as cobalt and selenium, may be much lower than the level required for animals. Some soils are inherently deficient in some minerals such as iodine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



Drawing by K. Williams.

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

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



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

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

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

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

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

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

Choosing a mineral supplement

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

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

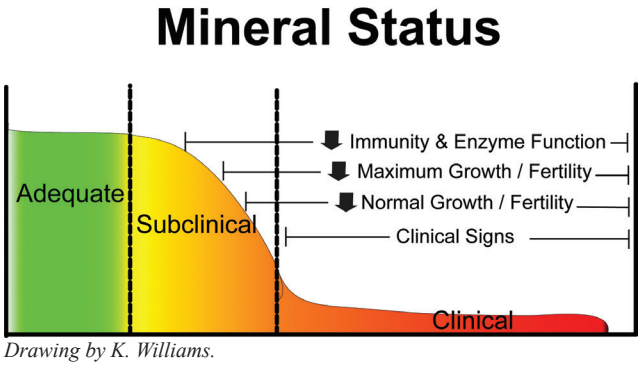
Current approximate wholesale costs for supplying 100% of mineral needs of a 150 lb goat for various minerals in 1 year are as follows:

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

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

Diagnosing mineral deficiencies or toxicities

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



Drawing by K. Williams.

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

Take home lessons on mineral nutrition

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

Body Condition Scoring

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

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

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

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

Using the Langston Interactive Nutrient Calculator

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

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

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

Getting started

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

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

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

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

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

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

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

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

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

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

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

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

Providing needed nutrients

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

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

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

Feeding Different Classes of Goats

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

Feeding bucks

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

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

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

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

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

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

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

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

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

Feeding replacement bucks and does

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

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

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

Feeding does throughout their life cycle

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

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

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

Flushing meat goats

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

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

Winter feeding of does

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

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

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

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

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

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

Feeding does in late gestation

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

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

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

Feeding the lactating doe

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

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

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

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

Creep feeding

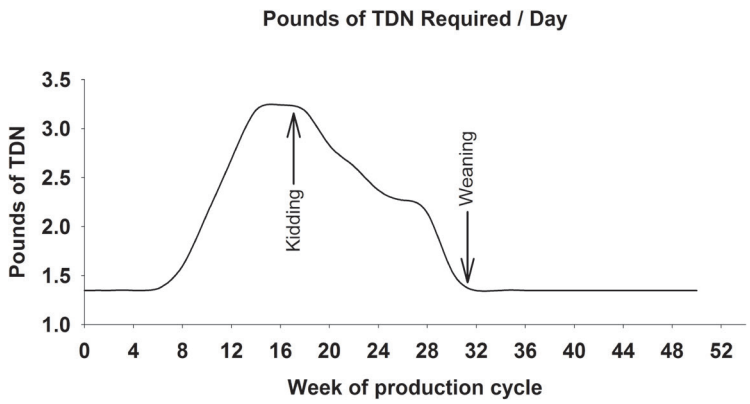
Creep feeding is a method of providing feed for the kids only. This is accomplished by fencing around a feeder and using a creep gate that has holes about 5 inch wide by 1 ft high. These holes are small enough so that kids can enter the feeder, but adults are excluded because they are too big to go through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

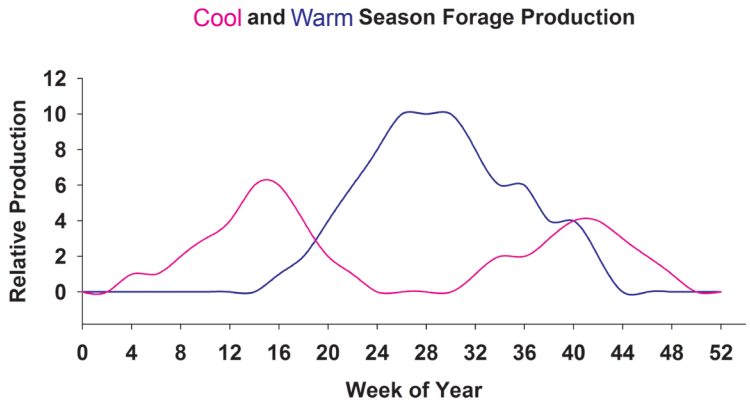
An alternative to grain-based creep feeds that is used in the beef cattle industry is to creep graze calves, using a creep gate that allows calves access to ungrazed high quality pasture. This may have application for goats using high quality pastures (crabgrass or sudangrass that is planted for the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

Effect of Kidding Season on Nutrient Requirements

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

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





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

Artificial Raising of Kids

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

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

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

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

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

Considerations in Ration Formulation

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

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

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

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

Feeding Systems

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

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

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

Nutritional Disorders

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

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

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

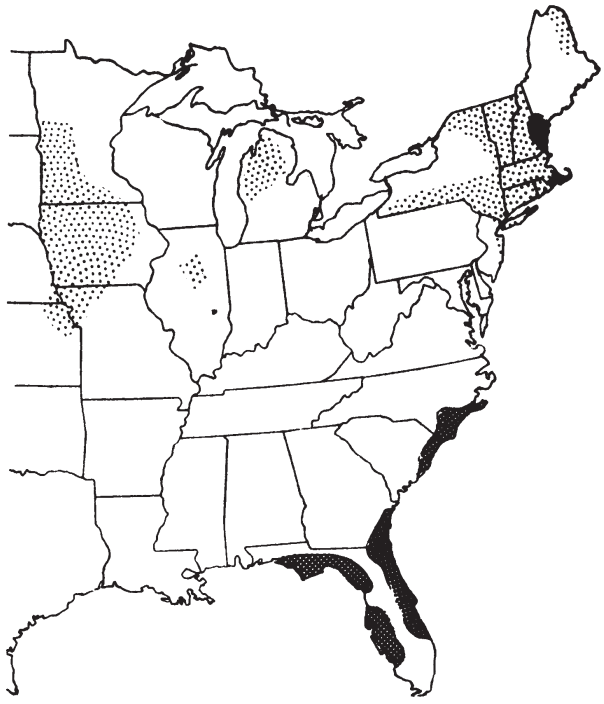
Enterotoxemia is caused by bacteria in the intestine that grow rapidly and produce an endotoxin in response to high levels of starch (grain) in the diet. Animals are in extreme pain from the effect of the endotoxin and often die quickly. Vaccination will help prevent this disease.

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

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

Soil-Related Nutritional Problem Areas for Grazing Animals

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



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

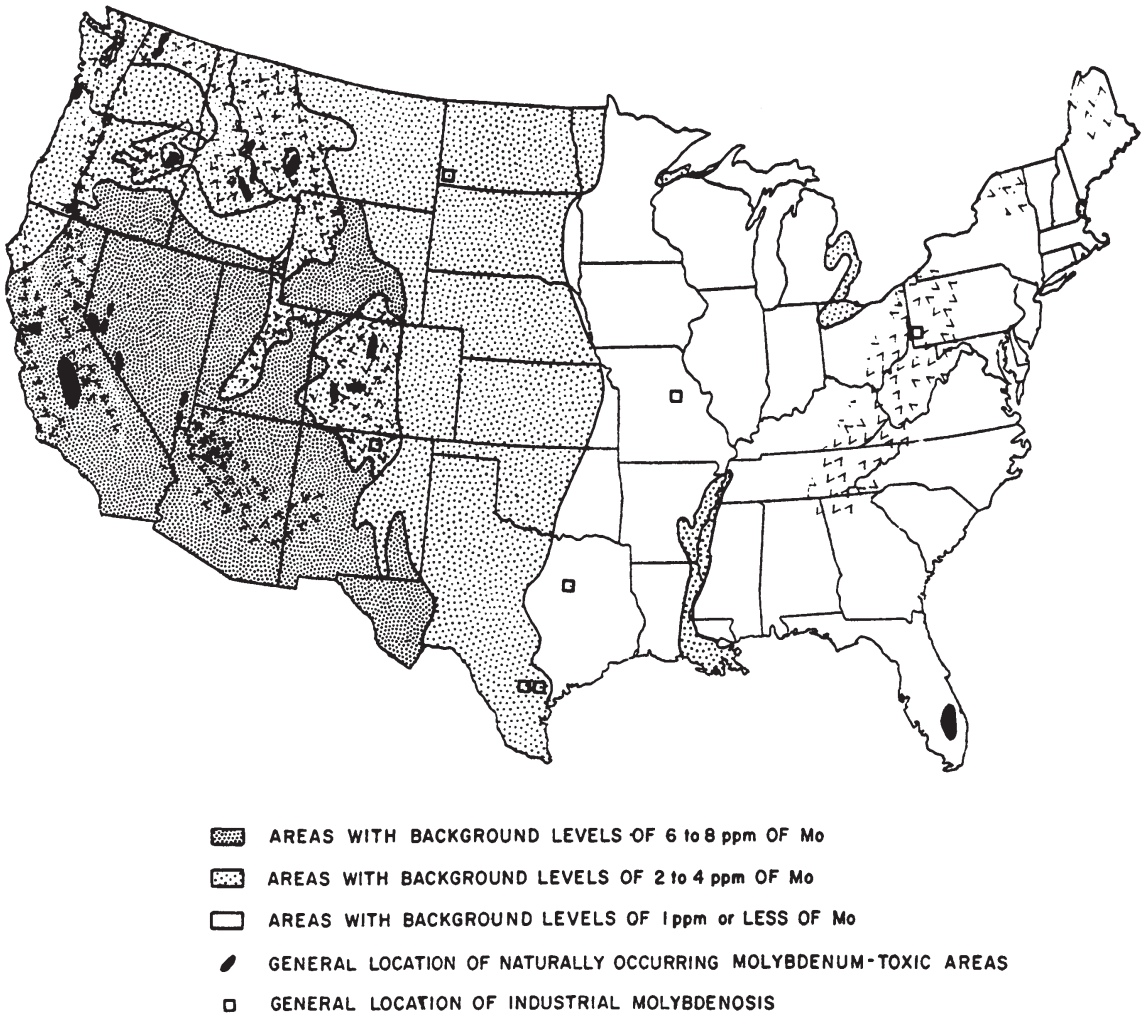


Figure 6. Generalized regional pattern of molybdenum concentration in legumes of the United States (ppm = 1 μg/ g^{-1}). From Kubota, 1977, by courtesy Marcel Dekker, Inc.

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

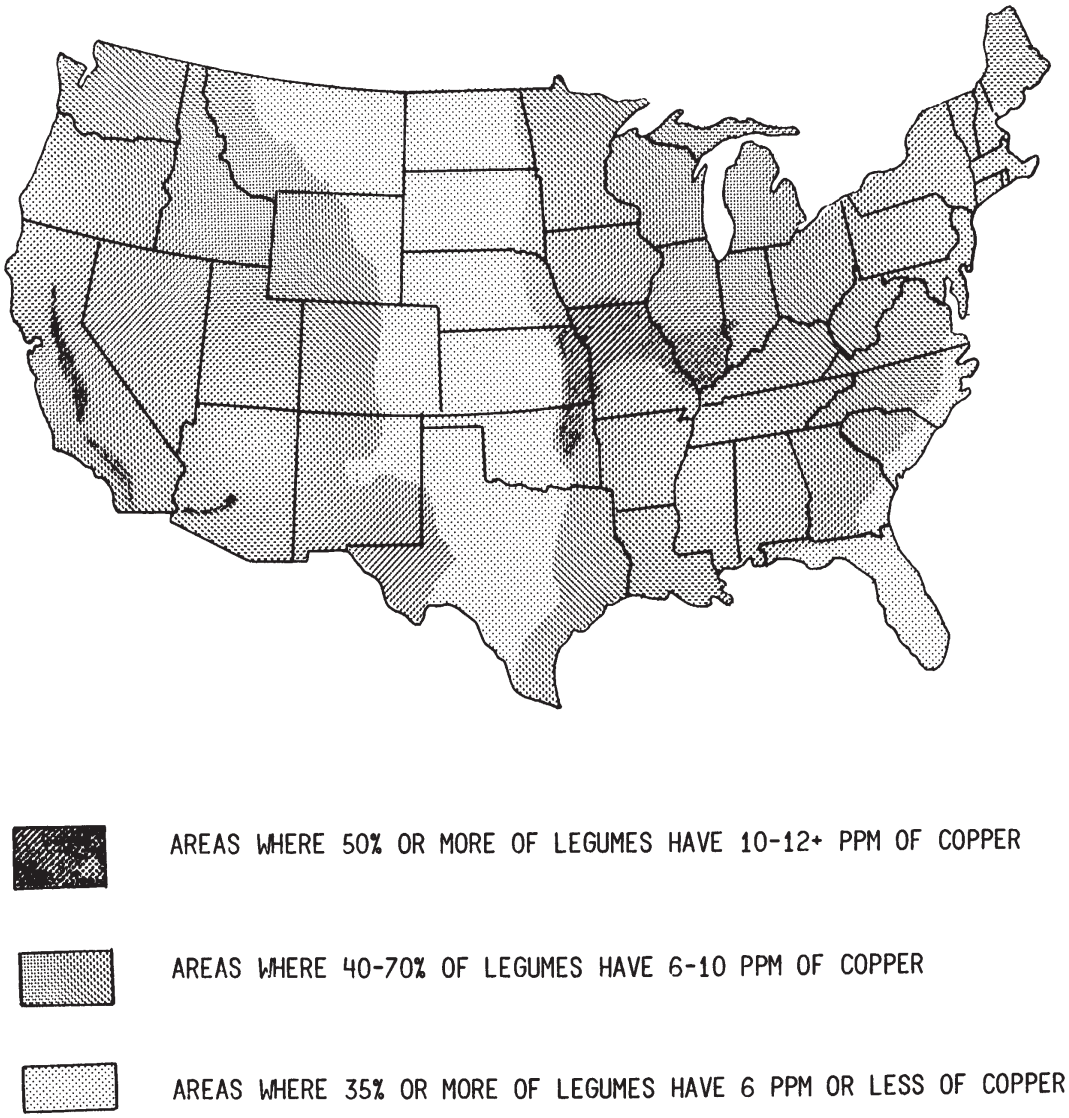


Figure 7. Generalized distribution of copper concentration in legumes of the United States (ppm = 1 $\mu g/ g^{-1}$). From Kubota, 1983a, by permission Amer. Society of Agronomy.

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

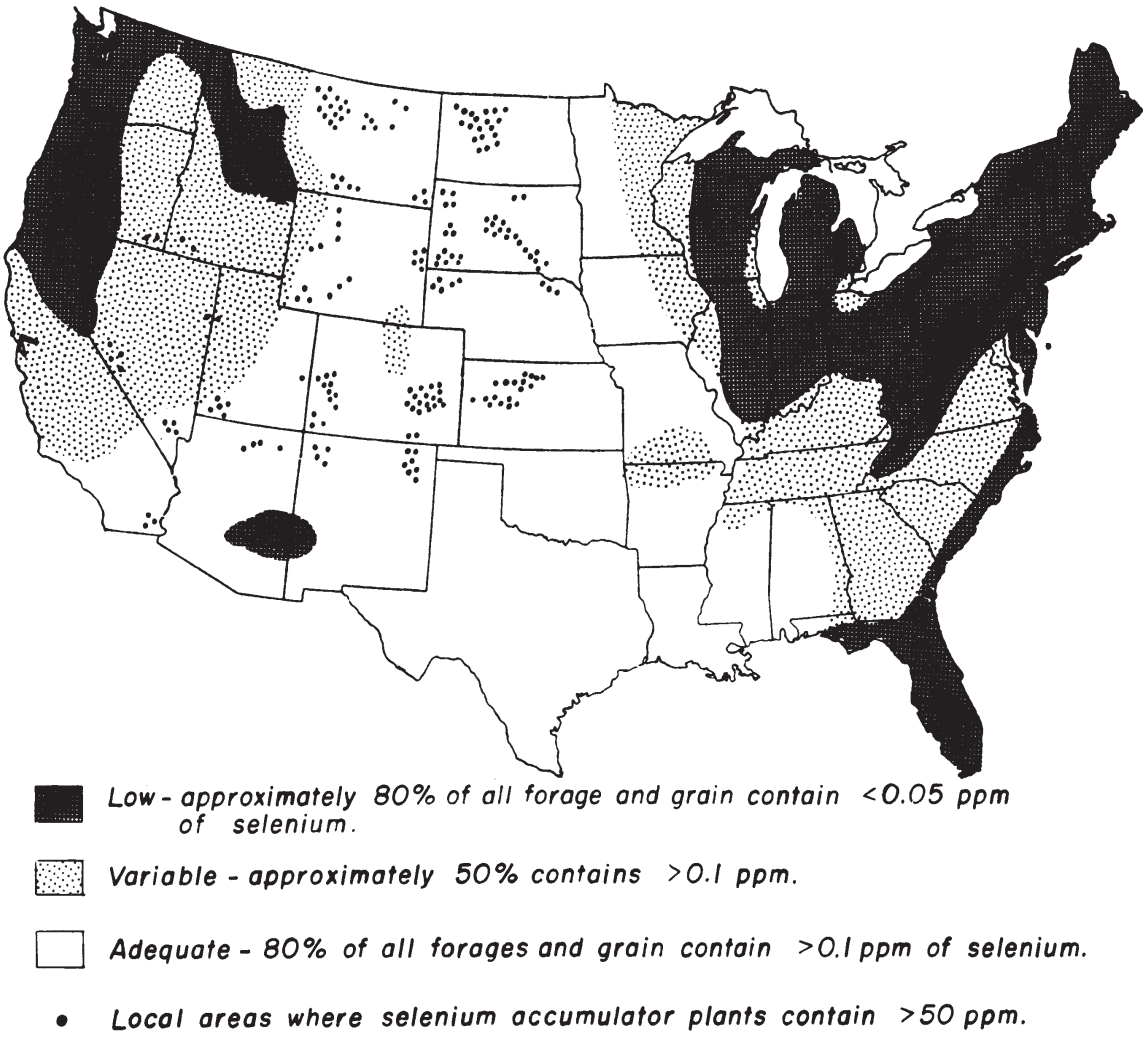


Figure 8. Geographical distribution of low-, variable-, and adequate-Se areas in the United States (ppm = 1 μg/g). From Kubota and Allaway, 1972, by permission Soil Science Society of America.

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

Definitions useful for this section

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Vitamins - Specific organic substances required for various metabolic functions.

DHI Training

Ms. Eva Vasquez
Langston University

In 1996, the Langston DHI program launched under the umbrella of the Texas DHIA. That partnership was not mutually beneficial and Langston Goat Dairy DHI elected to operate independently. In addition, the dairy records processing software that had been initially acquired from Texas DHIA had reached well beyond it capabilities and could not be modernized. Thus, Langston Goat Dairy DHI has partnered with Dairy Records Management System (DRMS) of Raleigh, NC to conduct the record processing. The Langston DHI program became the first DHI program to introduce forms and reports in goat terminology to dairy goat producers in the United States. A national Dairy Herd Improvement Association (DHIA) has been in existence for a number of years. However, until 1996 DHIA catered only to cow dairies. The Langston DHI program has been very popular with dairy goat producers and has grown significantly since its establishment in 1996.

NATIONAL DAIRY HERD IMPROVEMENT PROGRAM
UNIFORM OPERATING PROCEDURES

Effective June 1, 2014

CODE OF ETHICS

PURPOSE

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

UNETHICAL PRACTICES

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

REMEDY

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

UNIFORM DATA COLLECTION PROCEDURES

PURPOSE

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

The uniform records and data thus provided are used for:

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

AUTHORITY

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

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

RESPONSIBILITY

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

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

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

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

DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

DATA COLLECTION PROCEDURES

1. COLLECTION OF MILK WEIGHTS AND SAMPLES

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

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

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

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

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

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

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

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

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

2. STANDARD EQUIPMENT

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

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

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

B. **PRODUCER OWNED EQUIPMENT**

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

3. RECORDING PROGRAMS

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

4. METHODS FOR CALCULATING LACTATION RECORDS:

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

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

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

5. COWS TO BE TESTED

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

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

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

6. IDENTIFICATION

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

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

7. MILK SHIPPED MEASUREMENTS

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

8. COWS IN MILK

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

9. DRY COWS

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

10. COWS LEAVING THE HERD

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

11. COWS ENTERING THE HERD

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

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

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

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

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

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

13. COWS ABORTING OR CALVING PREMATURELY

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

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

14. COWS CALVING WITHOUT GOING DRY

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

15. PREPARTUM MILK

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

16. COWS MILKED MORE THAN TWICE PER DAY

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

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

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

17. MISSING MILK WEIGHTS AND/OR SAMPLES

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

A. First Test Day Weights or Samples Missed

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

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

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

C. New Cows Entering The Herd

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

18. STANDARD CALCULATIONS

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

H. Calculation of Ages of Cows (Truncation Method)

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

I. Adjusting Records to 24 Hours

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

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

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

J. Adjusting Milk Weights to a Verifiable Source

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

19. VERIFICATION TESTING

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

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

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

20. RETESTING AT THE DAIRY PRODUCER'S REQUEST

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

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

21. PRODUCTION REPORTS

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

22. YEARLY AVERAGES

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

23. TRANSFER OF HERD DATA

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

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

24. TRANSFER OF INDIVIDUAL COW DATA

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

25. AUTOMATIC MILKING SYSTEM (ROBOTIC) PROCEDURES

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

26. DATA COLLECTION RATING

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

Herd Data For Next Test

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

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

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

HERD CODE ____-____-_____

TRANSFER DOES

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

BREED CODES FOR NEW AND TRANSFER DOES

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

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

NEW DOES ENTERING THE HERD OR IDENTITY CORRECTION

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

SUPERVISOR'S BARN SHEET

DHI-201

Supervisor's Signature

Herd Code _____ - _____ - _____

Test Date		
Mo	Day	Yr

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

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

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

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

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

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

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

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

Calf Sex
F. Female
M. Male
7. Unknown

Date_____ 2019 Langston DHI Supervisor Test
Must return by Mar. 1, 2019 if you want a certificate

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

Name:_____

Address:_____

City:_____State:_____ Zip:_____

Telephone: _____

Who do you test for:_____E-mail: _____

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

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

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

   True False

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

   True False

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

   True False

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

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

   True False

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

   A: Three months

   B: Six months

   C: Eight months

   D: One year

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

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

    True False

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

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

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

IF YOU HAVE ANY QUESTIONS, PLEASE ASK THEM HERE:

Langston DHIA
Invoice

Herd Code # _____

Herd Owner _____

Verification Test YES NO

Service Affiliate Fee
DMS 201 _____x $.08 _____

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

Milk Analysis Fee
Total Samples _____ x $1.15 _____

Accounting Fee ……..$2.00

No Cash. Check or Money Order Only Please

Total _____

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

Number of Does dried this month _____

Number of Does freshened this month _____

Does Dried:

INDEX # DRY DATE

Does Freshened:

INDEX # FRESH DATE

(COPY THIS SHEET IF MORE SPACE IS NEEDED)

Langston University Goat DHIA
Agriculture Research & Cooperative Extension

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

Acknowledgement of Membership Agreement
in the Langston University Goat DHIA

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

Should my membership be accepted, I agree:

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

_____ _____
Date Signature of Applicant

Applicant name:

Name: _____

Address: _____

City State Zip: _____

Phone: _____ Email: _____

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

_____
Langston University Goat DHIA Representative

Getting Your Goat

Ms. Patricia Moore

Introduction by Terry Gipson

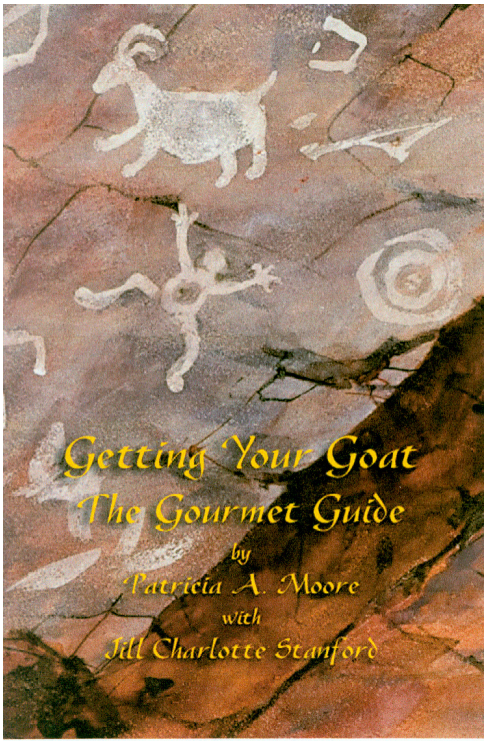
Often, we receive calls about goat cookery and the best way to prepare goat meat. Many of the recipes that one can find, either in print publications or on the Internet, has been about barbecued goat. Indeed, our barbecued chopped goat is always a popular lunch item for our annual Goat Field Days. Recently, I came across a new goat cookbook, *Getting Your Goat: The Gourmet Guide* (Evertype 2009) by Patricia A. Moore and Jill Charlotte Stanford. This cookbook covers a wide array of dishes and I think that the section headers reveals the breadth of the cookbook. They include 1) appetizers, 2) roasts, 3) shanks and chops, 4) soups, stews, and casseroles, 4) ground goat, 5) on the side, 6) desserts, and 7) miscellaneous. I recently contacted Patricia Moore and asked her if she would please share her favorite recipes from the cookbook with our Goat Field Day participants. She recommended Chevon Osso Buco (page 34 of the cookbook), Chevon Moroccan (page 51 of the cookbook), African Goat Soup (page 52 of the cookbook), and Pat's Goat-Loaf Muffins (page 85 of the cookbook) and those four recipes have been included in the proceedings. For those of you seeking new ways to prepare goat, I highly recommend this cookbook. I don't think that you will be disappointed.

About the authors:

Patricia A. Moore spent 25 years in horticulture, running a landscape maintenance business in the San Francisco Bay area before moving to Central Oregon in 1988. She raises Boer goats, serves on the State Board of the Oregon Meat Goat Producers and is involved with her local chapter of the OMGP. Cooking is Patricia's passion. This book contains many wonderful recipes from her own kitchen, as well as recipes from other goat gourmets.

Jill Charlotte Stanford has been a writer, editor, and author since 1978. She is the author of Lamb Country Cooking (Culinary Arts 1994), The Cowgirl's Cookbook (Globe Pequot 2008), and Going It Alone (Evertype 2008). As a Restaurant Reviewer as well as a Lamb Cook-Off Judge, she has a highly developed sense of good food. Jill lives and writes in Sisters, Oregon, with her faithful Australian Shepherd Elsa.

Susan Koch (illustrator) studied life drawing and watercolor at the American Academy of Art in Chicago, Illinois. Over the past thirty-five years her paintings have won many awards, including "Best of Show" and "Peoples' Choice" several years running in the Watercolor Society of Oregon annual shows.



Getting Your Goat: The Gourmet Guide is also available at Amazon.com

Chevon Osso Buco

4 servings

Osso Buco is a northern Italian tradition. The slow cooker is the ideal way to cook this dish flavored with rosemary. Try spooning the sauce over mashed potatoes or polenta.

- 4 goat shanks
- 2 tablespoons (30 ml) flour
- ¾ teaspoon (3.75 ml) black pepper
- 1 tablespoon (15 ml) olive oil
- 1 cup (240 ml) chopped carrot
- 1 cup (240 ml) chopped celery
- 1 cup (240 ml) chopped white onion
- 1 large garlic clove, minced
- ½ cup (120 ml) red wine
- One 14.5 oz (430 ml) can diced tomatoes, drained
- 1 tablespoon (15 ml) chopped rosemary
- ½ teaspoon (2.5 ml) salt
- 1 bay leaf

Combine the flour and pepper in a shallow pan. Wash and dredge the shanks in the flour, coating them evenly.

Heat the oil in a large skillet. Add the goat shanks and braise for 2 minutes each side or until evenly browned. Place the shanks in a slow cooker.

Put all the vegetables in the pan and sauté for 5 minutes. Add the wine. Scrape the pan to loosen any browned bits. Cook over medium low heat for 1 minute.

Pour the vegetable mix over the shanks in the cooker. Add the tomatoes, rosemary, salt and bay leaf. Stir well.

Cover and cook on Low 8-9 hours.

Discard the bay leaf before serving.

African Goat Soup

6 servings

Goats are a symbol of a family's wealth in Africa. The more goats they have, the wealthier they are. Too many goats? They serve them up in this tasty soup which is more like a stew. Serve it with a good loaf of crusty bread and a bottle of hearty red wine.

- 2 lbs (900 g) lean goat meat, cut into 1" (2.5 cm) cubes
- ¼ cup (60 ml) of flour
- 3 tablespoons (45 ml) olive oil
- 1 large yellow onion, sliced
- 1 cup (240 ml) celery/ cut into pieces
- 1½ cups (360 ml) carrots, cut into pieces
- 2 cups (480 ml) sweet potatoes (or yams) washed, skinned, and cubed
- 3 cups (710 ml) vegetable broth
- 1 cup (240 ml) water
- ¼ cup (60 ml) white wine (optional) salt and pepper to taste
- 1 clove garlic, mashed
- 1 teaspoon (5 ml) cinnamon
- 1 tablespoon (15 ml) cumin

Trim any excess fat from the meat. Dredge the meat in the flour that has the salt and pepper added to it. Coat it well.

In a heavy skillet, put 1 tablespoon of the olive oil and sauté the meat until browned on all sides. Remove from the pan.

Add the remaining olive oil and sauté the vegetables until the onions are clear.

Put the meat back into the pan and add the vegetable broth, white wine, water and spices.

You may also put everything into a Slow Cooker. Simmer, covered, for 5 or 6 hours on Low, stirring occasionally.

Chevon Moroccan

6 servings

Cat Addison is a go-get 'em kind of gal. She loves new adventures and especially new recipes. She says, "Chevon Moroccan was my first taste of goat meat. It is now one of my favorite dishes and I have prepared it for others to get them to see how wonderful goat meat is too."

- 3 tablespoons (45 ml) olive oil
- 2 lb (900 g) goat meat, cubed in 1" (2.5 cm) pieces
- ½ lb (225 kg) fresh, sliced mushrooms
- ½ onions/ chopped
- 1 garlic clove, minced
- 1 lb (450 g) fresh tomatoes, peeled and quartered
- ½ cup (120 ml) raisins
- ½ cup (120 ml) toasted almond slices
- 2 tablespoons (30 ml) sugar
- 1 teaspoon (5 ml) cinnamon
- 1 teaspoon (5 ml) salt
- ¼ teaspoon (1.25 ml) allspice
- ¼ cup (60 ml) chicken broth

Heat the oil in a large skillet. Add the goat meat and sauté until browned. Add the mushrooms, onions and garlic. Sauté for 2 more minutes.

Add the tomatoes, raisins, almonds, sugar, cinnamon, salt and allspice.

Add the broth and simmer for one hour, stirring occasionally, until the meat is tender. Add more broth if needed as it simmers.

Serve the stew over couscous for a truly authentic dish.

Pat's Goat-Loaf Muffins

6 servings

A simple and fast way to cook and serve "diner-style" meat loaf.

- 1 teaspoon (5 ml) olive oil
- 1 cup (240 ml) sweet onion, chopped very fine
- ½ cup (120 ml) carrot, chopped fine
- 1 teaspoon (5 ml) oregano
- 2 cloves of garlic, minced
- 1 cup (240 ml) tomato ketchup, divided
- 1½ lb (680 g) ground goat
- 1 cup (240 ml) (about 20) saltine crackers, crushed very fine
- 2 tablespoons (30 ml) prepared yellow mustard
- 1 teaspoon (5 ml) Worcestershire sauce
- ¼ teaspoon (1.25 ml) black pepper
- 2 large eggs

Preheat the oven to 350°F/180°C/Gas 4

Grease 12 muffin cups (you can use cooking spray).

Heat the olive oil in a large skillet. Add the vegetables and herbs and spices. Sauté for about 2 minutes and then allow to cool.

In a large bowl, combine the vegetable mixture with half the ketchup and the remaining ingredients. Mix well.

Spoon the mixture into the muffin cups and top each with 2 teaspoons of the remaining ketchup.

Bake at 350°F/180°C/Gas 4 for 25 minutes, or until the tops are browned.

Let them stand for 5 minutes before removing.

Goat Cuisine

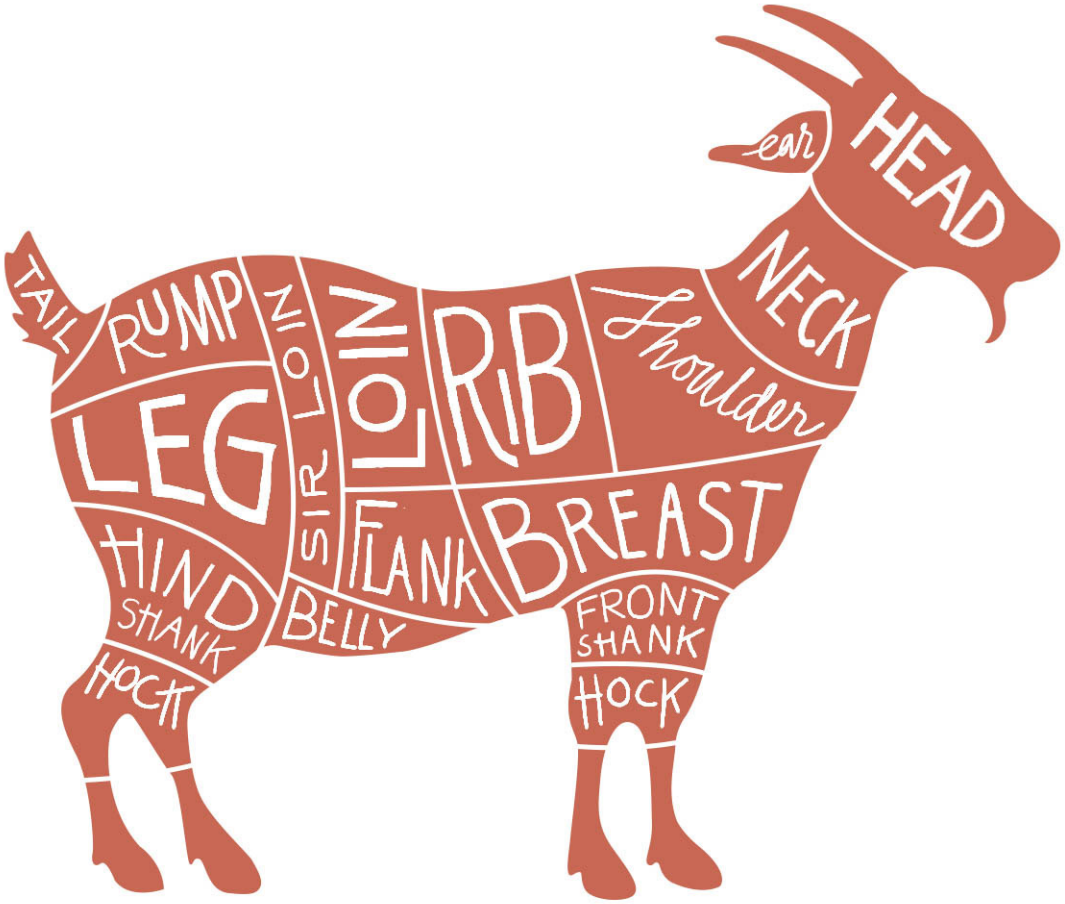
Ms. Suzanne Stemme

Introduction by Terry Gipson

Suzanne Stemme is the Cuisine Columnist for the Goat Rancher and offers mouth-watering recipes in every edition.

> *Goat meat is a tasty alternative to beef, pork and poultry — one that hasn't quite caught on here in the United States. Although preferred by many ethnic groups, goat meat is an unfamiliar delicacy for most Americans. Our Cuisine columnist, Suzanne Stemme, each month acquaints our readers with a new and delicious goat meat cooking experience. Suzanne and her husband, Dr. Kraig Stemme, DVM, raise Kiko breeding stock at Lake Fork Kikos in Alba, Texas.*
>
> *https://goatrancher.com/aboutus.php*

Suzanne shares two of her recipes with us.



LAKE FORK KIKOS

Provencal Goat Stew

Serves 6-8

3 lbs. trimmed boneless goat, cut into 1 ½ inch pieces
Olive oil
6 T. anchovy paste
10 cloves garlic, chopped
4 cups red wine
4 T. chopped basil
1 package instant brown gravy
Salt and freshly ground pepper to taste
1 package frozen pearl onions
2 T. minced rosemary (fresh is best)
2 lbs. baby red potatoes, halved
1 cup oil-cured pitted black olives
2 cups beef broth
2 T. Kitchen Bouquet seasoning

In a heavy pot, heat olive oil and brown goat; remove and drain on paper towels. If necessary, add more olive oil and sauté onions and garlic until softened. Add potatoes and rosemary and brown, approximately 2-5 minutes. Add goat, olives, wine, beef broth, gravy mix, chopped basil, anchovy paste, and Kitchen Bouquet. Bake, covered, in a slow oven (300 degrees) for 4-5 hours. Stir once an hour. The oil-cured olives tend to be salty, so taste before adding additional salt.

LAKE FORK
KIKOS

Goat Pot Pie

Makes 6 generous portions

1 to 2 lbs. of goat meat cut into 1 inch cubes
½ lb. sliced mushrooms
1 shallot or small, sweet onion chopped fine
1/2 lb. package of baby carrots
1 cup beef broth
Pie dough for top and bottom of 9 or 10 inch pie pan
Seasoned flour to coat goat cubes
1 clove garlic, chopped fine
6 red potatoes, cut in half
1 cup frozen peas (optional)
1 bottle of stout or Guinness (12 oz.)

In a deep skillet, lightly brown floured goat cubes in 1-2 tablespoons of olive or canola oil. When browned, remove goat and set aside. Add garlic, onion, and mushrooms to the pan and cook over low heat until softened, approximately 6-8 minutes. (Add more oil to the pan if necessary to keep mixture from sticking.) Return meat to the pan and add remaining vegetables, beef broth, and stout. Simmer for 30 minutes until all vegetables are cooked. Correct seasonings as necessary. Roll out pie crust and place bottom crust in pan; pour in filling and top with remaining crust. Make 3 or 4 slits in the pie to allow steam to escape while cooking. (You can cover the pie pan with foil and freeze for later use; thaw before baking.) Bake at 375 degrees until top crust is golden brown. .

CURRENT PROGRAM SUMMARY

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

- **EXTENSION OVERVIEW**
- **RESEARCH OVERVIEW**
- **INTERNATIONAL 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. 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 unique aspect of the Institute's research program is that a large proportion is made possible by grants, many of which are through various USDA programs. Hence, although the broad or general direction of the research program is known, specific topics of investigation in 2- to 4-year periods partially depend on the faculty's ability to obtain grant funds for novel and unique ideas. Researchers are strongly encouraged to seek extramural support funds, but there is care taken to ensure that proposed activities fit with the general direction of the program. An example of this exists in grant projects involving hair sheep. The competitiveness of proposals submitted for funding consideration has been increased by giving attention to sheep rather than study only with goats.

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 2018 and 2019, some of the abstracts that will be presented at meetings in 2019, and summaries of scientific articles that were published in 2018 or 2019 or that are in various stages of progress.

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

2018 and Current Research Projects

Title:	Management Practices for Production of Goats in the South-Central U.S.
Type:	USDA NIFA Evans Allen
Project Number:	OKLXSAHLU2017
Period:	2017-2022
Investigators:	T. Sahlu, A. L. Goetsch, R. Puchala, R. C. Merkel, T. A. Gipson, S. P. Hart, S. Zeng, Z. Wang, L. J. Dawson, and E. Loetz
Institution:	Langston University
Objective:	Study goat management practices and product technologies to increase the level and efficiency of goat productivity for increased profitability from goat production and lower costs to consumers of goat products.

Title:	Relationships Between the Microbiome and Internal Parasitism in Goats
Type:	USDA NIFA Evans Allen
Project Number:	OKLUTILAHUN2018
Period:	2018-2023
Investigators:	Y. Tilahun[1], Z. Wang[1], T. A. Gipson[1,] A. L. Goetsch[1], L. J. Dawson[1,2,] and P. R. Hoyt[2]
Institution:	[1]Langston University and [2]Oklahoma State University
Objectives:	1) Characterize relationships among the microbiome (all microorganisms present) at different sites in goats 2) Determine how relationships among the microbiome at different sites of goats are affected by internal parasitism, primarily infection with *Haemonchus contortus* 3) Elucidate how the microbiome of goats in production settings varies with resistance to internal parasites and other environmental conditions

Title:	Genomics of Resilience in Sheep to Climatic Stressors
Type:	USDA 1890 Institution Capacity Building – Research and Teaching
Project Number:	OKLXGOETSCH13
Period:	2013-2018
Investigators:	A. L. Goetsch[1], T. A. Gipson[1], R. Mateescu[2], S. Zeng[1], R. Puchala[1], M. Rolf[3], T. Sahlu[1], P. Oltenacu[2], and B. K. Wilson[4]
Institutions:	[1]Langston University, [2]University of Florida, [3]Kansas State University, and [4]Oklahoma State University
Objectives:	Evaluate responses of different breeds of hair sheep (Dorper, Katahdin, and St. Croix) from four regions of the USA varying in environmental conditions (i.e., Midwest, Northwest, Central Texas, and Southeast) to stress factors expected to increase in importance with climate change (i.e., high temperature and humidity, limited availability of drinking water, and restricted feed availability), and determine relationships between these resilience properties and genetic characteristics.

Title:	Comparison of Biological Control of Red Cedar with Goats to Conventional Methods of Control
Type:	USDA 1890 Institution Capacity Building – Research and Extension
Project Number:	OKLXHART14
Period:	2014-2018
Investigators:	S. P. Hart[1], T. A. Gipson[1], R. C. Merkel[1], J. Pennington[2], C. Clifford-Rathert[2], and C. Williams[1]
Institutions:	[1]Langston University, and [2]Lincoln University
Objectives:	1) Learn more about factors affecting red cedar consumption by goats so that they can be more effectively for control red cedar 2) Compare the degree of control and cost of use of goats versus alternative methods of clipping, burning, and herbicide

Title:	Enhancing Wellbeing and Productivity of Dairy Goats Using Smart Technology
Type:	USDA 1890 Institution Capacity Building - Research
Project Number:	OKLXGIPSON14
Period:	2014-2018
Investigators:	T. A. Gipson[1], S. P. Hart[1], R. Puchala[1], E. Loetz[1], and L. J. Dawson[1,2]
Institutions:	[1]Langston University and [2]Oklahoma State University
Objective:	Evaluate measures of behavior, such as pattern of rumination and lying versus standing as assessed by accelerometer systems, to characterize physiological conditions like mastitis and estrus and production setting

Title:	Sustainable Control of Greenhouse Gas Emission by Ruminant Livestock
Type:	USDA 1890 Institution Capacity Building - Research
Project Number:	OKLXGOETSCH14
Period:	2014-2019
Investigators:	A. L. Goetsch[1], R. Puchala[1], T. Sahlu[1], M. Flythe[2], and G. E. Aiken[2]
Institutions:	[1]Langston University and [2]USDA ARS Forage-Animal Production Research Unit
Objective:	Characterize long-term effects of lespedeza condensed tannins in combination with other substances to reduce ruminal methane emission by sheep and goats

Title:	Combating Anthelmintic Resistant Parasitic Nematodes in the Small Ruminant Industry
Type:	USDA 1890 Institution Capacity Building - Research
Accession Number:	1012072
Proposal Number:	2016-06596
Period:	2017-2020
Investigators:	Z. Wang[1], J. Zhao[2], A. L. Goetsch[1], S. P. Hart[1], T. Sahlu[1], and W. C. Davis[3]
Institutions:	[1]Langston University, [2]AZ Nature Art LLC, and [3]Washington State University
Objective:	Develop alternative approaches to lessen use of chemical anthelmintics that parasites of small ruminants have developed resistance to

Title:	A Respiration Calorimetry System for Study of Energy Use and Methane Emission by Small Ruminants in Production Settings
Type:	USDA AFRI Foundational Equipment Grant
Accession Number:	1014848
Project Number:	OKLUGOETSCH2018
Period:	2018-2019
Investigators:	A. L. Goetsch, R. Puchala, T. A. Gipson, and T. Sahlu
Institution:	Langston University
Objectives:	Acquire and set up a calorimetry system (for measurement of the expenditure of energy from the uptake of oxygen and output of carbon dioxide and emission of the greenhouse gas methane) that can be used with groups of animals in natural settings such as on pasture, and conduct research to determine how best to use the system (e.g., number and times of daily measures and number of animals)

Title:	Sky Wrangler: Smart Application of Precision Livestock Farming for Grazing Animals and Pasture Management
Type:	USDA 1890 Institution Capacity Building - Research
Accession Number:	1018964
Project Number:	OKLU-GIPSON-SKY-2018
Period:	2018-2021
Investigators:	T. A. Gipson, M. White, and R. Puchala
Institution:	Langston University
Objectives:	Overall goal: Develop a smart but inexpensive unmanned aerial vehicle (UAV, or drone) that provides useable and concise feedback for livestock producers to manage their pastures and animals Specific objectives: 1) Assess pasture biomass and nutritive status (Normalized Difference Vegetation Index, or NDVI) 2) Determine effects of presence (distance and duration) on animal stress and behavior 3) Inventory grazing animals

Title:	LINC 2.0 – Enhanced Goat Management and Education Tool
Type:	USDA 1890 Institution Capacity Building – Integrated (Research, Extension, and Teaching)
Accession Number:	1018078
Project Number:	OKLUPUCHALA2018
Period:	2019-2022
Investigators:	R. Puchala[1], T. A. Gipson[1], A. L. Goetsch[1], R. C. Merkel[1], S. Zeng[1], C. Williams[1], and M. L. Galyean[2]
Institution:	[1]Langston University and [2]Texas Tech University
Objectives:	1) Develop accurate means of predicting positive and negative feedstuff associative effects in goats 2) Upgrade LINC to LINC 2.0 by improving accuracy of adjustments for associative effects in supplemental concentrate and total mixed ration calculators and updating with findings of other research conducted since LINC was created 3) Increase usage of LINC 2.0 through an array of outreach activities

Title:	Sustainable Use of Saline Water by Ruminant Livestock Species
Type:	USDA 1890 Institution Capacity Building – Research
Accession Number:	1018179
Project Number:	OKLUGOETSCH2019
Period:	2019-2022
Investigators:	A. L. Goetsch[1], D. L. Lalman[2], R. Puchala[1], T. A. Gipson[1], L. J. Dawson[1,2], T. Sahlu[1], and S. Zeng[1]
Institution:	[1]Langston University and [2]Oklahoma State University
Objectives:	1) Determine responses of goats, sheep, and cattle to different levels of total dissolved salts (i.e., TDS) in drinking water as varying with water source and NaCl (sodium chloride, or salt) additions 2) Identify factors affected by drinking water high in TDS that may affect performance of ruminant livestock 3) Determine water intake by and requirements of goats, sheep, and cattle and how they vary with water TDS characteristics

2018/2019 Experiments

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

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

Title:	Characterization of immunity to *Haemonchus contortus* in goats
Project Number:	OKLUSAHLU2017
Experiment Number:	QY18-05
Investigators:	Q. Yang, Z. Wang, Y. Tilahun, R. C. Merkel, A. L. Goetsch, T. Sahlu, L. J. Dawson, and W. Davis
Objectives:	The proposed work will investigate the time course of immune responses after infection with *H. contortus* in goats. The underlying hypotheses are that *H. contortus* down-regulates their host's protective immunity and this parasitic regulation can be reversed by certain immune modulators. Zoledronic acid will be applied to goats that will be inoculated with L3 *H. contortus*. The effects of these treatments will be estimated by changes in fecal egg count, worm burden, ratios of lymphocyte subpopulations in lymph nodes and abomasal mucosa, and gene expression of cytokines (IL-2, -4, -5, -6, -8, -10, -13, -17a, and -23, TNF-α, TGF-β, and IFN- γ) in peripheral blood, abomasal mucosa, and lymph nodes.

Title:	Effects of the nutritional plane before breeding on performance of hair sheep
Project Number:	OKLUSAHLU2017
Experiment Number:	RV-18-06
Investigators:	R. V. Lourencon, R. Puchala, T. Sahlu, L. J. Dawson, E. Loetz, T. A. Gipson, L. P. S. Ribeiro, I. Portugal, A. C. Scronce, M.A. Rojas, and A. L. Goetsch
Objectives:	Determine effects of a limited nutritional plane before breeding on reproductive performance (conception, embryo mortality, litter size and birth weight) of different hair sheep breeds (Dorper, Katahdin, and St. Croix), and compare various means of assessing the nutritional plane of hair sheep and evaluate their relationships with reproductive performance

Title:	Reproductive performance of Spanish goats time-bred with frozen/thawed semen using transcervical, intrauterine, or hysteroscopic deep uterine procedures
Project Number:	OKLUSAHLU2017
Experiment Number:	EL-18-07
Investigators:	E. Loetz, R. M. Calle, Tyapa Tiovo, M. Rojas, L. J. Dawson, and T. A. Gipson
Objectives:	1) Determine the effect of three breeding procedures (i.e., transcervical, laparoscopically-aided intrauterine semen deposition technique, and hysteroscopic deep uterine procedures on reproductive performance of timed inseminated Spanish goats of different parity during the early transitional breeding phase 2) Establish the time investment to artificially inseminate Spanish doelings and does using each of three breeding techniques 3) Evaluate embryonic viability at 32 and 45 days of Spanish doelings and does in reference to pregnancy at 22 days for all breeding techniques

Title:	Interactions of high levels of salinity of drinking water salinity and protein supplementation on intake, body weight, digestion, and metabolism of yearling Boer and Spanish wethers
Project Number:	OKLUSAHLU2017 and Fulbright Fellowship
Experiment Number:	AK/CM-18-08
Investigators:	A. Keli, C. Merera Erge, R. Puchala, L. J. Dawson, L. Ribeiro, A. C. Scronce, I. Portugal, T. Sahlu, and A. L. Goetsch
Objectives:	Determine effects of moderate to high levels of salinity in drinking water on feed intake, digestion, concentration of constituents in ruminal fluid and blood, daily body weight gain, gain efficiency, and efficiency of energy utilization by yearling Boer and Spanish goat wethers consuming low-quality forage (i.e., wheat straw) with different levels of dietary crude protein

Title:	Effects of dietary level of lespedeza condensed tannins on ruminal methane emission, feed intake, feeding behavior, digestion, energy metabolism, and growth performance by growing Alpine doelings and Katahdin ewe lambs
Project Number:	OKLUAGOETSCH2014
Experiment Number:	WW-18-09
Investigators:	W. Wang, R. Puchala, L. Ribeiro, I. Portugal, T. A. Gipson, and A. L. Goetsch
Objectives:	Determine effects of the dietary level of condensed tannins from Sericia lespedeza on feed intake, feeding behavior, digestion, ruminal methane emission, energy metabolism, and growth performance by Alpine doelings and Katahdin ewe lambs over a relatively long period of time

Title:	I. Assessment of estrus onset and ovarian response in cycling Alpine nulliparous or multiparous goats estrus/ovulation synchronized using GnRH or PGF2α II. Reproductive performance of estrus/ovulation synchronized Alpine goats following laparoscopically-aided intrauterine insemination at 40, 48, or 56 hours using 120 or 240 million sperm per mL
Project Number:	OKLUSAHLU2017
Experiment Number:	EL-18-10
Investigators:	E. Loetz, J. Farris, R. M. Calle, M. Rojas, L. Dawson, and A. Manley
Objectives:	1) Determine the effect of using GnRH or PGF2α at the beginning of a 10-day progestogen E/OS protocol on the time to standing estrus onset and ovulation at 48 hours 2) Establish the influence of laparoscope-aided insemination procedure at one of three fixed-time inseminations (40, 48, or 56 h post P4 exposure) on reproductive performance traits 3) Determine the influence of bi-cornuate deposition of 2.4 × 108 frozen-thawed sperm/mL by means of laparoscope-aided insemination procedure at one of three fixed-time inseminations (40, 48, or 56 h post P4 exposure) on reproductive performance traits

Title:	Efficacy of an experimental anthelmintic in goats
Project Number:	OKLUSAHLU2017 and Oklahoma State University College of Veterinary Medicine
Experiment Number:	MJ-18-11
Investigators:	M. Jones, M. Socha, K. Ritz, and L. J. Dawson
Objectives:	Determine the efficacy of an experimental anthelmintic product being developed in controlling helminths in meat goat wethers

Title:	Reproductive performance of Spanish goats time-bred with frozen/thawed semen using transcervical, intrauterine, or hysteroscopic deep uterine procedures
Project Number:	OKLUSAHLU2017
Experiment Number:	EL-18-12
Investigators:	E. Loetz, R. M. Calle, Tyapa Tiovo, M. Rojas, L. J. Dawson, and T. A. Gipson
Objectives:	1) Determine the effect of three breeding procedures (i.e., transcervical, laparoscopically-aided intrauterine semen deposition technique, and hysteroscopic deep uterine procedures on reproductive performance of timed inseminated Spanish goats of different parity during the early transitional breeding phase 2) Establish the time investment to artificially inseminate Spanish doelings and does using each of three breeding techniques 3) Evaluate embryonic viability at 32 and 45 days of Spanish doelings and does in reference to pregnancy at 22 days for all breeding techniques

Title:	Effects of the level and nature of total dissolved salts in drinking water on feed intake, digestion, and physiological conditions in yearling goat doelings and hair sheep ewe lambs
Project Number:	OKLUGOETSCH2019
Experiment Number:	LR-19-01
Investigators:	L. P. S. Ribeiro, A. Moehlenpah, R. Puchala, C. Merera Erge, T. A. Gipson, I. Portugal, L. J. Dawson, D. L. Lalman, and A. L. Goetsch
Objectives:	Determine how variables such as feed intake, ruminal conditions, digestion, blood constituent levels, and energy metabolism in yearling females of different breeds of goats and hair sheep are influenced by differences in total dissolved salt level of drinking water due to level of minerals in a brackish/saline water source compared with added NaCl

Title:	Effects of the level and quality of dietary forage on milk yield and composition of Alpine goats
Project Number:	OKLUSAHLU2017
Experiment Number:	RL-19-02
Investigators:	R. V. Lourencon, R. Puchala, T. A. Gipson, L. P. S. Ribeiro, W. Wang, T. Sahlu, I. Portugal, A. Manley, E. Loetz, L. J. Dawson, and A. L. Goetsch
Objectives:	Determine effects of the level and quality of dietary forage on feed intake, digestion, metabolism, behavior, and milk yield and composition of Alpine dairy goats

Abstracts

2019 Meeting of the Southern Section of the American Society of Animal Science in Oklahoma City and National Meeting of the American Society of Animal Science in Austin Texas. (The American Society of Animal Science has copyright ownership and the Journal of Animal Science is the source of this information.)

Effects of High Heat Load Conditions on Dorper, Katahdin, and St. Croix Sheep from Different Regions of the USA

D. Tadesse[1,2], R. Puchala[1], T. A. Gipson[1], and A. L. Goetsch[1]

[1]American Institute for Goat Research, Langston University, Langston, Oklahoma
[2]College of Agriculture, Debre Berhan University, Debre Berhan, Ethiopia

Forty-six Dorper, 46 Katahdin, and 43 St. Croix female sheep (initial BW of 58, 59, and 46 kg, respectively, SEM = 1.75; 3.3 ± 0.18 yr of age, 2.6 – 3.7) from 45 commercial farms in four regions of the USA (Midwest, Northwest, Southeast, and central Texas) were used to evaluate responses to high heat load index (HLI) conditions in a central facility. The four trials entailed sequential 2-wk periods with target HLI during day/nighttime of 70/70 (thermoneutral zone conditions during the day and night), 85/70, 90/77, and 95/81, with weekly measures at 0700 (before increased daytime HLI), 1300, and 1700 h (preceding lower nighttime HLI). Rectal temperature (ºC) in period 3 (38.64, 38.66, and 38.48 at 0700 h, 39.08, 39.23, and 38.84 at 1300 h, and 39.20, 39.15, and 38.99 at 1700 h) and period 4 (38.71, 38.90, and 38.51 at 0700 h, 39.18, 39.12, and 38.83 at 1300 h, and 39.45, 39.34, and 39.07 at 1700 h for Dorper, Katahdin, and St. Croix, respectively) (SEM = 0.054, 0.037, and 0.038 at 0700, 1300, and 1700 h, respectively) ranked St. Croix < Katahdin < Dorper. Nonetheless, there were corresponding differences in respiration rate (breaths/min) in period 3 (63.1, 56.8, and 49.6 at 0700 h, 133.8, 125.8, and 115.7 at 1300 h, and 125.5, 114.7, and 106.8 at 1700 h) and period 4 (81.6, 72.2, and 54.5 at 0700 h, 149.2, 143.6, and 137.3 at 1300 h, and 147.0, 141.4, and 134.2 at 1700 h for Dorper, Katahdin, and St. Croix, respectively) (SEM = 3.12, 4.11, and 3.62 at 0700, 1300, and 1700 h, respectively). In conclusion, based on rectal temperature and respiration rate the overall impact of region was minimal and resilience to high HLI was greatest for St. Croix and lowest for Dorper sheep.

Terpenes as Antinutritive Chemicals in Red Cedar

R. V. Lourencon[1], S. P. Hart[1], T. A. Gipson[1], B. Adams[2], and G. D. Rassi[3]

[1]American Institute for Goat Research, Langston University, Langston, Oklahoma
[2]Biology Department, Baylor University, Waco, Texas
[3]Food and Agricultural Products Center, Oklahoma State University, Stillwater, Oklahoma

At some research sites goats aggressively consumed red cedar(Juniperus virginiana) throughout the year while at other sites goats consumed little cedar, although they consumed more cedar in winter. It was hypothesized that differences in red cedar intake may be caused by terpenes. The purpose of this study was to measure terpenes in cedar needles at different locations and times of the year. Ninety-one samples of red cedar needles were obtained from four locations (Langston, OK; Midwest City, OK; Mannford, OK; Neosho, MO) at monthly intervals over a 2-yr period. Needles were manually stripped from branches at approximately 1.5 M high from at least 25 plants at each location. Sixty grams of cedar needles were extracted by steam distillation for 2 h. Some samples were exhaustively extracted for a further 6 h to calculate recovery (45.7%). Two mL of diethyl ether were added, containing 1 mg/mL of methyl decanoate (internal standard), samples were vortexed and the ether was dried with a stream of nitrogen. Samples were subjected to gas chromatography for terpenes. The total amount of terpenes (mg/g DM) was calculated as the sum of peak areas/peak area of the internal standard x 2 mg internal standard/ 0.457/dried weight of cedar needles. Months were categorized as season. Data were analyzed using the SAS GLM procedure with factors of season, year, and location. Neither season (P>0.8) nor location (P>0.25) nor the interaction (P>.9) were significant factors determining total terpene content of red cedar. Concentration of total terpenes for Langston was 20.8, Mannford 18.4, Neosho 15.2 and OKC 18.6 mg/g DM. Concentration by season was Fall 17.1, Spring 18.6, Summer 17.5, and Winter 19.7 mg/g DM. Total terpene concentration does not seem to be a factor affecting red cedar consumption by goats since it did not follow the pattern of cedar consumption.

Tannins as Antinutritive Chemicals in Red Cedar

R. C. Lourencon[1], S. P. Hart[1], T. A. Gipson[1], and J. P. Muir[2]

[1]American Institute for Goat Research, Langston University, Langston, Oklahoma
[2]Texas AgriLife Research, Stephenville, Texas

In studies using goats to control red cedar (Juniperus virginiana) it has been observed that in some locations goats readily consume red cedar while in other locations, they consume relatively little, but consume more during the winter months. It was hypothesized that differences in red cedar intake may be caused by tannins acting as an antinutritive chemical. The purpose of this study was to characterize the levels and types of tannins in red cedar from different locations and season of the year. Thirty-seven samples of red cedar needles were obtained from four locations (LOC; Langston, OK, Midwest City, OK Mannford, OK and Neosho, MO) at monthly intervals over a one-year period. Samples were obtained by manually stripping the needles from branches at approximately 1.5 M high from at least 25 plants at each location. Samples were refrigerated until analyzed for extractable condensed tannin (ECT), protein bound tannin (PBT) fiber bound tannin (FBT) and total tannin (TOT; sum of the three) by procedure of Terrill et al., 1992. Data was analyzed by SAS GLM with main effects of LOC and SEA. FBT averaged less than .1% and PBT averaged 1.3% and both were not significantly affected by LOC or SEA. ECT was significantly lower for Neosho (1.53%) than for Mannford (2.69%), OKC (2.79%) and Langston (2.37%) which were similar. ECT was lowest for summer (1.76%), similar to Fall (1.85%) and both were significantly lower than for winter (3.32%) and spring (2.39%) which were similar. TOT followed a similar pattern being highly correlated to ECT (R=.955; P<0.001) and was significantly lower for Neosho (2.61%) than for Langston (3.79%), Mannford (3.81%) or OKC (4.15%) which were similar. Total tannins were significantly higher in the winter (4.71%) than for the other seasons Spring (3.64%, Fall, 3.18% and Summer 2.87%. Tannins were lowest for Neosho where goats browsed red cedar most aggressively, killing >85% of the trees whereas goats killed <10% cedars at other locations which had greater levels of tannins. Tannins may be a significant antinutritive factor in red cedar, affecting consumption and degree of control.

Effects of Nutritional Plane Before Breeding on Performance of Hair Sheep

R. V. Lourencon, L. J. Dawson, R. Puchala, L. P. S. Ribeiro, T. A. Gipson, E. Loetz, M. A. Rojas, M. Calle, A. S. Scronce and A. L. Goetsch

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

The objective of the study was to determine effects of the nutritional plane before breeding on performance of different hair sheep breeds. Twenty-five Dorper, 27 Katahdin, and 32 St. Croix ewes with initial BW of 65.6, 65.7, and 54.3 kg (SEM=1.95) and body condition score (BCS; 1-5) of 3.35, 3.29, and 3.09, respectively, consumed wheat straw ad libitum for 11 wk before breeding. Ewes of each breed were divided into four groups, with two groups per nutritional plane (NP). Ewes on a low NP (Low-NP) were supplemented with 0.16% BW (DM) of soybean meal (SBM) and ewes on the high NP (High-NP) received 0.8% BW (DM basis) of 0.25% soybean meal and 0.75% ground corn. Ewes were divided into two groups for estrus synchronization. Four rams of each breed were used, two for the first 17 d of breeding and the other two from d 17 to 34. Conception and embryo mortality were determined by ultrasound imaging at 25 and approximately 40 d post-breeding. Average daily gain and BCS change were similar among breeds, but both were greater for High-NP vs. Low-NP (ADG: 57 vs. -4 g, SEM=8.1; BCS change: 0.22 vs. -0.02, SEM=0.041). Wheat straw DMI was greater (P=0.01) for Low-NP than for High-NP (2.02 and 1.58% BW, respectively; SEM=0.042) and for St. Croix than for Dorper and Katahdin (P=0.04; 1.96, 1.68, and 1.74% BW, respectively, SEM=0.060). There were no differences in the number of services or conception (P>0.05), and no embryo mortality was noted. In conclusion, NP did not influence reproductive performance assessed early after breeding despite differences in ADG and BCS change. This may be due to the initial moderate BCS and increased straw intake by Low-NP ewes.

Burning for Redcedar Control in Oklahoma

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

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

In a research study using goats to control redcedar (Juniperus virgiana), burning was used as a comparison. The objective of the study was to measure the degree of control of redcedar provided by burning in Oklahoma. There were three research locations in Oklahoma, Langston, Mannford, and Midwest City. All plots were 0.81 hectares. The redcedar population was inventoried, quantified as to height, width, and GPS coordinates during the summer of 2016. An adjacent area was cleared by clipping cedars and the dry cedars (fuel) were stacked on the border of sites to be burned. A fire plan was made and burns were conducted in October 26 at Langston, November 11 at Midwest City, and December 6 of 2016 at Mannford. Percentage green canopy of the cedars was scored 3 months after burning. Percentage green canopy of the trees according to size (short; ≤ 1.83m or tall; > 1.83m) and presence of fuel were analyzed using Chi-Square statistics. The results indicated that burning was more effective in Langston with 33% of green canopy (P<.001), while Mannford and Midwest City averaged 64% of green canopy. In all locations the presence of fuel around the trees potentiated the fire and reduced green canopy to 28% as compared with the trees not surrounded by fuel with 79% of green canopy (P<0.001). In Midwest City, taller trees were better controlled by fire and averaged 60% of green canopy, while the shorter trees averaged 69% (P = 0.021) with no significant differences due to height of tree in Langston and Mannford or when data of all three locations were analyzed together. The presence of fuel around the trees can potentiate the fire and give a better control of recedar. However, burning was not a very effective method to control redcedar.

Effects of Hair Sheep Breed and Region of Origin on Feed Dry Matter Required for Maintenance Without and With a Marked Feed Restriction

D. Tadesse[1,2], R. Puchala[1], and A. L. Goetsch[1]

[1]American Institute for Goat Research, Langston University, Langston, Oklahoma
[2]College of Agriculture, Debre Berhan University, Debre Berhan, Ethiopia

Effects of hair sheep breed and region of origin on feed required for maintenance without and with a substantial restriction were determined with 46 Dorper, 47 Katahdin, and 41 St. Croix females (initial BW of 62, 62, and 51 kg, respectively, SEM=1.43; 3.8±0.18 yr of age, 1.2–11.7) from 45 commercial farms in Midwest, Northwest, Southeast, and central Texas regions of the USA. A 50% concentrate pelleted diet was fed, with the amount varied in the first 4 wk for stable BW and average DM intake in wk 3-4 relative to $BW^{0.75}$ considered DM required for maintenance without restriction (DMm-m). Feed offered in wk 6-10 was 55% of DMm-m, with DM intake relative to $BW^{0.75}$ in wk 9-10 considered the requirement with feed restriction (DMm-r). Region had little effect on any measure. The DMm-m was slightly greater (P<0.05) for St. Croix than for Dorper and Katahdin (49.4, 48.9, and 50.9 g/kg $BW^{0.75}$ for Dorper, Katahdin, and St. Croix, respectively; SEM=0.48). The decline in BW during the restriction phase was relatively small and similar among breeds (wk 9-10 vs. 3-4: 3.6, 3.2, and 2.9 kg for Dorper, Katahdin, and St. Croix, respectively; SEM=0.21). The DMm-r averaged 43% less than DMm-m, again being greater (P≤0.056) for St. Croix than for Dorper and Katahdin (28.3, 27.9, and 29.1 g/kg $BW^{0.75}$ for Dorper, Katahdin, and St. Croix, respectively; SEM=0.28). The DMm-m and DMm-r were highly related, indicating that animals would rank similarly at both levels of intake, and variation was similar among breeds. In conclusion, the amount of feed required for BW maintenance was greatest for St. Croix regardless of feed restriction, but differences were minor. The hair sheep exhibited considerable capacity for decreasing the feed requirement for maintenance when offered feed was markedly restricted.

Ruminating and Lying Behavior of Dairy Goats in Confinement or Grazing

L. Ribeiro, S. Ishii, R.C. Merkel, S. LeShure, and T.A. Gipson

American Institute for goat research, Langston University, Langston, Oklahoma

Behavior is a key indicator of animal welfare and wellbeing. The objective of this study was to examine the effect of management system (confinement (C) or grazing (G)) on the behaviors of rumination time (RT) and lying/standing (L/S) in dairy goats. Forty Alpine goats (57.7±5.7 kg) in late lactation were randomly assigned to one of four groups. A replicated switch-back design was used with Groups A and C the Confinement-Grazing-Confinement (CGC) sequence and Groups B and D the Grazing-Confinement-Grazing (GCG) sequence. Each group spent 1 wk in each management system. A 40% forage diet was offered free-choice in both systems, with some growing forage available for goats in G as well. Goats were fitted with two tri-axial accelerometers, one in an elastic, nose-band halter and the other attached to the hind leg. Data from tri-axial accelerometers were processed using SAS with prediction equations for RT and L/S. A mixed model analysis was conducted with RT or L/S as the dependent variable, and replicate (1, 2), sequence (CGC, GCG), management system (confinement, grazing), and interactions as independent variables, and animal as random. Rumination time and L/S were not affected (P>0.10) by sequence or replicate. Goats in G had greater (P<0.01) RT than those in C (12.7 vs 10.2 min/h; SEM=0.509). Regardless of management system, goats had lower RT in the second week than in the first or third week of the experiment (12.2, 10.2, and 11.9 min/h in wk 1, 2, and 3, respectively; SEM=0.574). Daily L/S behavior was not affected (P>0.10) by management. Lying time was 726 min/d in C and 699 min/d in G (SEM=16.7). Standing time was 714 min/d in C and 741 min/d in G (SEM=16.7). These results indicate that management system affects rumination time but not lying/standing behavior in dairy goats.

Relationships Among Body Condition Score, Linear Measures, Body Mass Index, and Growth Performance of Yearling Alpine Doelings

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

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

Alpine doelings (54; initial BW and age of 31.7±0.38 kg and 306±1.9 days, respectively) were used to evaluate relationships among body condition score (BCS), linear measures and associated body mass indices (BMI), and growth performance. Doelings were allocated to treatments with ad libitum intake of diets of 75% alfalfa or Sericea lespedeza. The experiment was 12 wk with two 6-wk periods. Linear measures included height at the withers (Wither), length from the point of the shoulder to hook bone (Hook) and pin bone (Pin), and circumference from heart girth (Heart). There were 13 BMI, including BMI1–Wither (BW/Wither), BMI2–Hook (BW/Hook), BMI3–Pin (BW/Pin), BMI4-Heart (BW/Heart), BMI6-Wither×Hook (BW/(Wither×Hook)), BMI7-Wither×Pin (BW/(Wither×Pin)), BMI8-Heart×Hook (BW/(Heart×Hook)), and BMI9-Heart×Pin (BW/(Heart×Pin)), all in g/cm2. Correlation coefficients between BCS and Wither, Hook, Pin, and Heart were 0.14 (P=0.155), 0.29 (P=0.002), 0.21 (P=0.030), and 0.38 (P<0.001), respectively. Correlation coefficients of BCS were 0.39 (P<0.001), 0.21 (P=0.023), 0.32 (P=0.001), 0.18 (P=0.064), and 0.23 (P=0.018) for BW, ADG, and DM intake in g/d, % BW, and g/kg $BW^{0.75}$, respectively, with nonsignificant r for residual feed intake and ADG:DM intake. Higher r were observed between BMI and performance measures. Correlation coefficients were 0.71, 0.58, 0.66, 0.69, 0.78, 0.67, and 0.812 between BMI1-Wither, BMI3-Pin, BMI4-Heart, BMI6-Wither×Hook, BMI7-Wither×Pin, BMI8-Heart×Hook, and BMI9-Heart×Pin and BW; 0.36, 0.45, 0.42, 0.34, and 0.42 for BMI2-Hook, BMI3-Pin, BMI6-Wither×Hook, BMI7-Wither×Pin, BMI8-Heart×Hook, and BMI9-Heart×Pin and ADG; and 0.49, 0.56, 0.47, 0.63, and 0.58 for BMI1-Wither, BMI3-Pin, BMI6-Wither×Hook, BMI7-Wither×Pin, and BMI9-Heart×Pin and DM intake, in g/d, respectively. The BMI were not related to residual feed intake, and there were some BMI with weak relationships to ADG:DM intake. In conclusion, due to stronger relationships between measures of performance of yearling Alpine doelings consuming a forage-based diet and BMI compared with BCS, future research should address other physiological states and productions conditions.

Summaries of Recent Journal Articles
(2018, 2019, and in progress)

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

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

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

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

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

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

Small Ruminant Research. 164:70-81. 2018.

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

Effects of Ovar-DNA and Ovar-DRB1 genotypes in small ruminants with haemonchosis

Z. M. Estrada-Reyes, Y. Tsukahara, A. L. Goetsch, T. A. Gipson, T. Sahlu, R. Puchala, Z. Wang, S. P. Hart, and R. M. Mateescu

Parasite Immunology 40:e12534.https://doi.org/10.1111/pim.12534. 2018

The effect of Ovar-DRA and Ovar-DRB1 genotypes on faecal egg count (FEC) was determined in sheep and goats infected with *Haemonchus contortus*. One hundred and forty-three sheep from 3 different breeds (St. Croix, Katahdin and Dorper) and 150 goats from three different breeds (Spanish, Boer and Kiko) were used. Parasitological (FEC), haematological (packed cell volume) and immunological (IgA, IgG and IgM) parameters were measured. Sheep populations showed a higher FEC and humoural response than goat breeds. Genotypes were determined by high-resolution melting assays and by conventional PCR. For Ovar-DRA, sheep and goats carrying the AA genotype showed significant lower FEC than AG and GG genotypes. The additive effect was found to be 115.35 less eggs per gram of faeces for the A allele for goats. For Ovar-DRB1, only in sheep, the GC genotype was associated with low FEC. The additive effect was 316.48 less eggs per gram of faeces for the G allele, and the dominance effect was 538.70 less eggs per gram of faeces. The results indicate that single nucleotide polymorphisms within Ovar-DRA and Ovar-DRB1 could be potential markers to be used in selection programmes for improving resistance to *Haemonchus contortus* infection.

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

R. Puchala, S. LeShure, T. A. Gipson, K. Tesfai, M. Flythe, and A. L. Goetsch

Journal of Applied Animal Research 46:1127=1136. 2018

Mature Boer goat wethers were supplemented with 0.5% BW rolled corn and consumed pelleted alfalfa (CON), pelleted Sericea lespedeza (HSL; 6.4% condensed tannins), a 1:1 mixture of alfalfa and lespedeza (MSL), or alfalfa with monensin (ION; 22 mg/kg), coconut oil (CCO; 4%), or soybean oil (SBO; 4%). Total DM intake in the 20-wk study (3.86, 3.75, 3.52, 3.69, and 3.64% BW) and total tract OM digestibility determined every 5 wk (72.8, 69.5, 70.3, 72.0, and 71.1%) were not affected by treatment, although there were differences in nitrogen digestion (77.5, 70.7, 67.0, 77.0, 75.7, and 73.6% for CON, MSL, HSL, ION, CCO, and SBO, respectively; SEM = 1.76). Ruminal methane emission was not influenced by period and was lowest among treatments for CON expressed as percentages of gross (10.3, 6.8, 6.3, 7.2, 6.5, and 6.5%; SEM = 0.35) and digestible energy (14.8, 10.2, 9.3, 10.6, 9.8, and 10.1% for CON, MSL, HSL, ION, CCO, and SBO, respectively; SEM = 0.62). In conclusion, both levels of lespedeza elicited similar depressions in ruminal methane emission, with a magnitude of change similar to that of an ionophore and coconut and soybean oils, and effects did not vary with week of the study.

Recent research of feeding practices and the nutrition of lactating dairy goats

A. L. Goetsch

Journal of Applied Animal Research 47:103-114. 2019

Dairy goats can mobilize considerable body fat for support of milk production, but this can necessitate a high nutritional plane later for replenishment. Tissue mobilization during gestation should be controlled so as not to impair lactational performance. Dairy goats can markedly vary feeding behavior in response to factors such as restricted periods of access; however, further studies are needed to address efficiency of production. With some tolerance of goats to plant secondary metabolites and voluntary consumption of a wide array of materials, regionally available byproducts and other nonconventional feedstuffs can be used to minimize production costs. Dairy goats are resilient to moderately harsh environmental conditions, but more extreme ones should be addressed with anticipated future climate change. Some differences in effects of dietary inclusion of fats and oils between dairy goats and cattle may relate to ruminal microbial conditions as well as susceptibility of mammary gland enzymes to bioactive conjugated linoleic acid isomers. Much research is being conducted to improve the fatty acid composition of fat in goat milk in regard to effects on human health through use of fats and oils as well as plant secondary metabolites, and effects on antioxidant status are increasingly being considered as well.

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

H. Liu, R. Puchala, S. LeShure, T. A. Gipson, M. D. Flythe, and A. L. Goetsch

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Fifty-four Alpine doelings (initial body weight and age of 31.7 ± 0.38 kg and 306 ± 1.9 d, respectively) were allocated to nine treatments individually fed for ad libitum intake of 25% concentrate and 75% forage diets (dry matter basis). Alfalfa was the forage in the Control diet. Other diets contained Sericea lespedeza as the forage, with 1.25% dry matter of quebracho extract included in the concentrate fraction for a dietary condensed tannin level of 8.4%. Lespedeza treatments were no additive (L) and inclusion of monensin (I) at 22 mg/kg dry matter (L-I), soybean oil at 3% (L-S), coconut oil at 3% (L-N), I and 3% soybean oil (L-I-S), I and 3% coconut oil (L-I-N), 1.5% soybean oil and 1.5% coconut oil (L-S-N), and I, 1.5% soybean oil, and 1.5% coconut oil (L-I-S-N). The experiment was 12 wk with two 6-wk periods. Gas exchange was determined in wk 6 and 12, and other measures occurred in wk 5 and 11. The Control diet offered averaged 2.67% nitrogen, 43.8% neutral detergent fiber, and 8.8% acid detergent lignin, and the L diet offered averaged 2.03% nitrogen, 42.8% neutral detergent fiber, and 13.2% acid detergent lignin. There were no treatment × period interactions for digestibilities ($P \geq 0.770$) or methane emission ($P \geq 0.324$). There were differences ($P < 0.001$) between the Control treatment and diets with lespedeza in intake of dry matter (1.46, 1.23, 1.30, 1.18, 1.32, 1.10, 1.02, 1.20, and 1.01 kg/d; SEM = 0.059), digestibility of organic matter (57.4, 50.9, 51.8, 52.7, 50.3, 52.1, 52.1, 51.9, and 49.8%; SEM = 1.42), and digestibility of nitrogen (59.1, 31.2, 32.5, 37.1, 31.6, 38.3, 30.4, 38.4, and 34.1% for Control, L, L-I, L-S, L-N, L-I-S, L-I-N, L-S-N, and L-I-S-N, respectively; SEM = 2.21). Ruminal methane emission was less ($P < 0.001$) for diets with lespedeza than for the Control in MJ/d (1.36, 0.76, 0.84, 0.71, 0.71, 0.66, 0.65, 0.68, and 0.68; SEM = 0.048) and relative to intake of gross energy (5.92, 3.27, 3.49, 3.19, 2.84, 2.91, 3.20, 3.20, and 3.27%; SEM = 0.165) and digestible energy (11.19, 6.98, 7.40, 6.38, 5.90, 5.69, 6.37, 6.38, and 6.70% for Control, L, L-I, L-S, L-N, L-I-S, L-I-N, L-S-N, and L-I-S-N, respectively; SEM = 0.400). In conclusion, the magnitude of effect of condensed tannins from lespedeza and quebracho extract on ruminal methane emission by Alpine doelings did not diminish over time and was not markedly influenced by dietary inclusion of monensin, soybean oil, or coconut oil.

Effects of level of intake of a 50% concentrate pelleted diet on metabolizability by mature Katahdin wethers

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

Small Ruminant Research 174:7-12. 2019

Ten adult Katahdin sheep wethers (74.3 ± 2.03 kg initial BW), approximately 3 yr of age, were used in a crossover experiment to study effects of a restricted feeding regime on digestibility, metabolizability, and heat energy. A 50% concentrate pelleted diet was fed near the ME requirement for maintenance (Control; DM intake = 44.4 g/kg $BW^{0.75}$) and at 55% of this level (Restricted; DM intake = 24.4 g/kg $BW^{0.75}$). Periods were 4 wk in length, with 3 wk for adaptation, measures in the final week when animals were situated in metabolism cages, and 2 days for gas exchange quantification via a head-box respiration calorimetry system. Apparent total tract digestibilities of DM (68.9 and 76.1%; SEM = 1.08), OM (78.3 and 83.3%; SEM = 1.57), CP (74.6 and 80.7%; SEM = 1.68), NDF (50.9 and 61.9%; SEM = 3.23), and gross energy (77.9 and 83.0%; SEM = 1.59) were greater ($P < 0.05$) for Restricted than for Control. Expressed in MJ/day, energy in urine (1.03 and 0.67; SEM = 0.294) and ruminally emitted methane (1.03 and 0.77; SEM = 0.076) were greater for Control vs. Restricted ($P < 0.05$), but as a percentage of gross energy were at least numerically greater for Restricted (urine: 5.63 and 6.48%, SEM = 2.218 and P = 0.594; methane: 5.46 and 7.16% for Control and Restricted, respectively, SEM = 0.579 and P = 0.030). As a consequence, ME intake as a percentage of gross energy intake did not differ (P = 0.354) between treatments (66.8 and 69.4% for Control and Restricted, respectively; SEM = 2.89). The treatment difference in heat energy (11.05 and 9.29 MJ/day; SEM = 0.563) was less than in ME intake (12.67 and 7.30 MJ/day for Control and Restricted, respectively; SEM = 0.508); thus, recovered energy differed from 0 ($P < 0.05$) and was greater for Control vs. Restricted (1.62 and -1.99 MJ/day; SEM = 0.661). In conclusion, restricted feed intake had marked influence on digestibility, although energy losses in urine and methane energy compensated so that metabolizability did not differ between treatments. With a diet of this nature a similar ME concentration could be assumed for studies with hair sheep fed near the standard maintenance requirement and restricted in intake.

Relationships among body condition score, linear measures, body mass index, and growth performance of yearling Alpine doelings

H. Liu, T. A. Gipson, R. Puchala, and A. L. Goetsch

Small Ruminant Research. Accepted with revision. 2019

Fifty-four Alpine doelings (initial BW and age of 31.7 ± 0.38 kg and 306 ± 1.9 days, respectively) were used to evaluate relationships among body condition score (BCS), linear measures and associated body mass indices (BMI), and growth performance. Doelings were allocated to nine treatments with ad libitum intake of 25% concentrate and 75% forage diets. Alfalfa was the forage in the control diet and others consisted of Sericea lespedeza with 1.25% DM of quebracho extract in concentrate. Lespedeza treatments were no additive and inclusion of monensin (I) at 22 mg/kg DM, soybean oil (SBO) at 3% DM, coconut oil (CCO) at 3% DM, I and 3% SBO, I and 3% CCO, 1.5% DM SBO and 1.5% DM CCO, and I, 1.5% DM SBO, and 1.5% DM CCO. The control diet averaged 16.7% CP, 43.8% NDF, and 8.8% ADL, and lespedeza diets averaged 12.7% CP, 42.8% NDF, 13.2% ADL, and 8.4% condensed tannins. The experiment was 12 wk with two 6-wk periods. Linear measures were height at the withers (Wither), length from the point of the shoulder to hook bone (Hook) and pin bone (Pin), circumference from heart girth (Heart), and width at the hook bones (Rump). There were 13 BMI, including BMI 1–Wither (BW/Wither), BMI 2–Hook (BW/Hook), BMI 3–Pin (BW/Pin), BMI 4-Heart (BW/Heart), BMI 6-Wither×Hook (BW/(Wither × Hook)), BMI 7-Wither×Pin (BW/(Wither × Pin)), BMI 8-Heart×Hook (BW/(Heart × Hook)), and BMI 9-Heart×Pin (BW / (Heart × Pin)), all with the unit of g/cm2. There were no treatment effects on BCS, linear measures, or BMI. Correlation coefficients between BCS and Wither, Hook, Pin, Heart, and Rump were 0.14 (P = 0.155), 0.29 (P = 0.002), 0.21 (P = 0.030), 0.38 ($P < 0.001$), and 0.30 (P = 0.002), respectively. Correlation coefficients of BCS were 0.39 ($P < 0.001$), 0.21 (P = 0.023), 0.32 ($P = 0.001$), 0.18 (P = 0.064), and 0.23 (P = 0.018) for BW, ADG, and DM intake in g/day, % BW, and g/kg $BW^{0.75}$, respectively, with nonsignificant r for residual feed intake, ADG:DM intake, and the Kleiber ratio. Higher r were observed between BMI and performance measures. Correlation coefficients were 0.71, 0.58, 0.66, 0.69, 0.78, 0.67, and 0.812 between BMI 1-Wither, BMI 3-Pin, BMI 4-Heart, BMI 6-Wither×Hook, BMI 7-Wither×Pin, BMI 8-Heart×Hook, and BMI 9-Heart×Pin and BW; 0.36, 0.45, 0.42, 0.34, and 0.42 for BMI 2-Hook, BMI 3-Pin, BMI 6-Wither×Hook, BMI 7-Wither×Pin, BMI 8-Heart×Hook, and BMI 9-Heart×Pin and ADG; and 0.49, 0.56, 0.47, 0.63, and 0.58 for BMI 1-Wither, BMI 3-Pin, BMI 6-Wither×Hook, BMI

7-Wither×Pin, and BMI 9-Heart×Pin and DM intake, in g/day, respectively. BMI were not related to residual feed intake, and there were some BMI with weak relationships to ADG:DM intake and the Kleiber ratio. In conclusion, due to stronger relationships between measures of performance of yearling Alpine doelings consuming a forage-based diet and BMI compared with BCS, future research should address other physiological states and productions conditions as well as different mathematical expressions of linear measures.

Recent advances in the feeding and nutrition of dairy goats

A. L. Goetsch

Asian-Australasian Journal of Animal Science. Accepted with revision. 2019

There have been recent advances concerning research of the feeding and nutrition of dairy goats in a wide array of areas. Ruminally emitted methane and supplementary feedstuffs to a lesser extent make appreciable contributions to the carbon footprint of dairy goats, with the former affected by type of production system and associated dietary characteristics. Unique behavior of goats necessitates careful consideration of the nature of confinement facilities to achieve optimal production by animals differing in social hierarchy. Physiological conditions such as nutritional needs and perhaps health status may influence diet selection by goats in both grazing and confinement settings. Some research suggests that low concentrations of protein and fat in milk of high-yielding dairy goat breeds could involve the type and nature of dietary ingredients as influencing endproducts of ruminal fermentation. With the relationship between milk urea nitrogen concentration and efficiency of dietary protein utilization, through future research the measure may be a useful tool for diet formulation as in dairy cattle. Effects of dietary inclusion of sources of fats and oils vary considerably depending on their nature, as is also true for byproduct feedstuffs and conventional ones being substituted for. Supplementation of dairy goats with sources of polyunsaturated fatty acids can affect oxidative stress and various feedstuffs influence antioxidant status; however, research addressing the significance of such changes under practical production settings would be beneficial.

Across and within breed differences in the relationship between packed cell volume and fecal egg count in growing meat goat and hair sheep males naturally and artificially infected with gastrointestinal namatodes

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

Veterinary Parasitology: Regional Studies and Reports. Accepted with revision. 2019

The relationship between packed cell volume (PCV) and fecal egg count (FEC) in different breeds of meat goats and hair sheep infected with gastrointestinal nematodes, including *Haemonchus contortus*, was characterized. Growing males from eight commercial and two research farms (one Kiko, Spanish, Dorper, and St. Croix; three Boer; four Katahdin) in the southcentral United States were evaluated in a central performance test with ad libitum intake of a 50% concentrate pelleted diet. There were 84 Boer, 55 Kiko, and 57 Spanish goats and 52 Dorper, 129 Katahdin, and 49 St. Croix sheep. During adaptation, animals were dewormed then dosed with 10,000 infective *H. contortus* larvae. PCV and FEC were determined before deworming (i.e., natural infection potentially with multiple internal parasites) and 21, 28, 35, 42, and 49 days after artificial infection. Effects of species, breed, and year were analyzed with mixed effects models including day of sampling post dosing as a repeated measure and FEC and FEC×breed as covariates. Moreover, differences in correlation coefficients between PCV and logarithmic FEC (lnFEC) among species, breed, year, and day of sampling were evaluated. Breed affected ($P \leq 0.001$) PCV in goats (24.8, 27.2, and 26.0% for Boer, Kiko, and Spanish, respectively; SEM=0.42) and sheep (29.8, 26.7, and 31.0% for Dorper, Katahdin, and St. Croix, respectively; SEM=0.28). There were effects of FEC×breed ($P \leq 0.029$) on PCV for Boer, Kiko, Dorper, Katahdin, and St. Croix (-0.31, -0.33, -0.46, -0.46, and -0.49% per 1000 eggs, respectively) but not for Spanish goats ($P = 0.451$). With all data, PCV and lnFEC with natural infection were highly correlated ($P < 0.001$) for Boer and Kiko goats and Dorper and Katahdin sheep ($r = -0.59, -0.67, -0.77$, and -0.84, respectively) but not for Spanish goats or St. Croix sheep ($P \geq 0.323$). Correlation coefficients for artificial infection with *H. contortus* were significant ($P \leq 0.002$) except for Spanish goats, although values were lower (-0.40, -0.21, -0.23, -0.47, and -0.28 for Boer, Kiko, Dorper, Katahdin, and St. Croix, respectively) compared with natural infection. In conclusion, PCV was not related to FEC in Spanish goats infected either naturally or artificially, and the nature of the relationship varied among breeds of goats and sheep. Based on the magnitude of the FEC×breed coefficient, sheep incurred a relatively greater reduction in PCV as FEC increased, and correlations indicate stronger relationships with natural than artificial infection.

Effects of high heat load conditions on body weight, feed intake, rectal and skin temperature, respiration rate, and panting score of Dorper, Katahdin, and St. Croix sheep from different regions of the USA

D. Tadesse, R. Puchala, T. A. Gipson, and A. L. Goetsch

Journal of Animal Science. In review. 2019

Forty-six Dorper (DOR), 46 Katahdin (KAT), and 43 St. Croix (STC) female sheep [initial body weight (BW) 58, 59, and 46 kg, respectively, SEM = 1.75; 3.3 ± 0.18 yr, 2.6 – 3.7] derived from 45 commercial farms in four regions of the USA (Midwest, Northwest, Southeast, and central Texas) were used to evaluate responses to high heat load index (HLI) conditions. The four trials entailed sequential 2-wk periods with target HLI during day/nighttime of 70/70 (thermoneutral zone conditions), 85/70, 90/77, and 95/81. Rectal temperature (RT) and respiration rate (RR) were measured at 0700 (before increased daytime HLI), 1300, and 1700 h (preceding lower nighttime HLI). Region had only a few and minor effects. Intake of DM intake in g/d and g/kg $BW^{0.75}$ was not influenced by period ($P > 0.05$). Body weight was affected by a period × week interaction ($P < 0.001$), with small increases as time advanced presumably because of increasing water consumption. Rectal temperature was considerably less for STC than for DOR and KAT at each time, with differences increasing as period advanced. Similarly, RR in periods 2, 3, and 4 was least for STC, particularly at 0700 h in period 4. Moreover, RT was slightly less for KAT vs. DOR in period 4 at 1300 and 1700 h, although the opposite difference occurred at 0700 h. However, RR was less for KAT than for DOR at each time in periods 3 and 4. For example, RT (ºC) in period 4 was 38.71, 38.90, and 38.51 at 0700 h, 39.18, 39.12, and 38.83 at 1300 h, and 39.45, 39.34, and 39.07 at 1700 h for DOR, KAT, and STC, respectively (SEM = 0.054, 0.037, and 0.038, respectively). Furthermore, RR (breaths/min) in period 4 was 82, 72, and 55 at 0700 h, 149, 144, and 137 at 1300 h, and 147, 141, and 134 at 1700 h for DOR, KAT, and STC, respectively (SEM = 3.1, 4.1, and 3.6, respectively). Variance in RT in periods 3 and 4 at each time differed among breeds, with SD ranking STC < DOR < KAT (e.g., period 4 values of 0.33, 0.411, and 0.212 at 0700 h, 0.308, 0.357, and 0.184 at 1300 h, and 0.416, 0.473, and 0.300 at 1700 h for DOR, KAT, and STC,

respectively). In conclusion based on RT and RR, resilience to high HLI conditions ranked STC > KAT > DOR, with lowest variability among individuals for STC and greatest for KAT. Efficiency of energy use for respiration to dissipate heat appeared greatest for STC, and the opportunity for improvement in resilience through selection may be greatest for KAT.

Effects of hair sheep breed and region of origin on feed dry matter required for maintenance without and with a marked feed restriction

D. Tadesse, D., R. Puchala, and A. L. Goetsch

Livestock Science. In review. 2019

Effects of hair sheep breed and region of origin on feed required for maintenance without and with a substantial restriction were determined with 46 Dorper, 47 Katahdin, and 41 St. Croix females (initial BW of 62, 62, and 51 kg, respectively, SEM = 1.43; 3.8 ± 0.18 yr of age, 1.2 – 11.7) from 45 commercial farms in Midwest, Northwest, Southeast, and central Texas regions of the USA. A 50% concentrate pelleted diet was fed, with the amount varied in the first 4 wk for stable BW and average DM intake in wk 3-4 relative to $BW^{0.75}$ considered DM required for maintenance without restriction (DMm-m). Feed offered in wk 6-10 was 55% of DMm-m, with DM intake relative to $BW^{0.75}$ in wk 9-10 considered the requirement with feed restriction (DMm-r). Region had little effect on any measure. DMm-m was slightly greater ($P < 0.05$) for St. Croix than for Dorper and Katahdin (49.4, 48.9, and 50.9 g/kg $BW^{0.75}$ for Dorper, Katahdin, and St. Croix, respectively; SEM = 0.48). The decline in BW during the restriction phase was relatively small and similar among breeds (wk 9-10 vs. 3-4: 3.6, 3.2, and 2.9 kg for Dorper, Katahdin, and St. Croix, respectively; SEM = 0.21). DMm-r averaged 43% less than DMm-m, again being greater ($P \leq 0.056$) for St. Croix than for Dorper and Katahdin (28.3, 27.9, and 29.1 g/kg $BW^{0.75}$ for Dorper, Katahdin, and St. Croix, respectively; SEM = 0.28). DMm-m and DMm-r were highly related, indicating that animals would rank similarly at both levels of intake, and variation was similar among breeds. In conclusion, the amount of feed required for BW maintenance was greatest for St. Croix regardless of feed restriction, but differences were minor. The hair sheep exhibited considerable capacity for decreasing the feed requirement for maintenance when offered feed was markedly restricted.

Visiting Scholars, Graduate Students, and Interns (2018 and 2019)

Dr. Raquel Lourencon
- Visiting Scholar
- Native of Brazil
- Projects: Red Cedar Control with Goats, Pre-breeding Nutritional Plane for Hair Sheep, and Optimal Diet Quality for Lactating Alpine Goats
- Experiments: SH-15-07, LR-18-06, LR-19-02

Dr. Luana P. S. Ribeiro
- Visiting Graduate Student and Visiting Scholar
- Native of Brazil
- Projects: Factors Influencing Performance of Lactating Dairy Goats, Condensed Tannins and Ruminal Methane Emission, and Utilization of Saline Drinking Water
- Experiments: LR-15-02, LR-17-14, LR-17-16, LR-18-01, LR-19-01

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

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

Mr. Miguel Angel Rojas
- Native of Bolivia
- Visiting Scholar
- Emphasis Areas: Animal management and reproduction
- Experiments: EL-17-07, EL-17-13, MR-17-18, ak-18-02, EL-17-20, EL-18-10, EL-18-12

Mr. R. Mauricio Calle
- Native of Bolivia
- Visiting Scholar
- Emphasis Areas: Animal management and reproduction
- Experiments: AK-18-02, EL-18-07, EL-18-10, EL-18-12

Dr. Qunhui Yang
- Native of China
- Visiting Scholar
- Chinese Scholarship Council support
- Project: Immunity to Internal Parasitism
- Experiment: ZW-17-17

Dr. Abdelhafid Keli
- •Native of Morocco
- •Visiting Scholar
- •Fulbright Scholarship support
- •Project: Utilization of Saline Drinking Water
- •Experiments: AK-18-02, AK/CM-18-08

Mr. Chala Merera
- •Native of Ethiopia
- •Visiting Scholar
- •Fulbright Scholarship support
- •Research Project: Utilization of Saline Drinking Water
- •Experiment: AK/CM-19-08

Dr. Wei Wang
- Native of China
- Visiting Scholar
- Chinese Scholarship Council support
- Project: Condensed Tannins and Ruminal Methane Emission
- Experiment: WW-18-09

Extension Overview

Dr. Terry A. Gipson
Goat Extension Leader

The year 2018 was a busy year for the Langston Goat Extension program. The goat extension specialists have answered innumerable producer requests for goat production and product information via the telephone, letters and e-mail, have given numerous presentations at several state, regional, national and international goat conferences for potential, novice and veteran goat producers, and have produced quarterly newsletters. They have also been busy with several major extension activities. These activities include the annual Goat Field Day, Langston Goat Dairy Herd Improvement (DHI) Program, grazing demonstrations, and various goat workshops on artificial insemination, tanning hides, and on internal parasite control.

Goat Field Day

Our annual Goat Field Day was held on Saturday, April 28, 2018 at the Langston University Goat Farm with registration beginning at 8:00 a.m. Recently, Langston University added a small research flock of Dorper, Katahdin, and St. Croix hair sheep and this year we incorporated topics of interest to hair sheep producers. Last year's theme was **Preventing Production Losses** and our featured speakers will be Mr. Matthew Branan, Dr. David Pugh, and Dr. Jim Keen. Matthew Branan earned his MS in Statistics from Colorado State University in 2015. His thesis focused on applying information criteria-based model averaging and pseudo-R2 metrics for linear mixed model evaluation. Throughout his last year at Colorado State University, he worked as a cooperator statistician for the Surveillance Design and Analysis (SDA) unit, within the Center for Epidemiology and Animal Health (CEAH). As a collaborator with SDA, Matthew helped to modify, develop, and implement Bayesian models for applications in disease freedom and prevalence estimation settings in the swine, cattle, aquaculture, and equine industries. In August 2016, he began working for the National Animal Health Monitoring System (NAHMS). He is currently involved in all stages of implementing national studies related to animal health in a variety of industries including aquaculture, swine, cattle, sheep, goat, beef cow-calf, and dairy cattle, with particular focus on the design of the studies and the analysis of study results. The focus of his statistical work currently centers on the use of survey weights in estimation and in linear and Bayesian models. David Gartrell Pugh earned both DVM and MS (Nutritional Physiology) degrees from the University of Georgia in 1981, and a MAG in Agricultural Entomology (external parasites- 2013). He received post-DVM training at Virginia Tech (Clinical Nutrition) and Texas A & M University (Theriogenology). He is a Diplomate of the American College of Theriogenology (1986), the American College of Veterinary Nutrition (1992), and the American College of Veterinary Microbiology (Parasitology 2012). He has held faculty positions at the University of Georgia and Auburn University, owned a large animal practice in Georgia, has been a consulting veterinarian for Fort Dodge Animal Health and Pfizer Animal Health, project veterinarian and Director of Farm Operations for the AU Equine Source Plasma Project (a multi million dollar research grant), and is currently Director of the Al Vet Diagnostic Lab

System. During his academic career he taught veterinary nutrition for horses, cows, and small ruminants, and was a clinician in ambulatory medicine and theriogenology. He is the author of >600 publications, >100 book chapters, 2 textbooks (Sheep and Goat Medicine, Sheep and Goat Medicine, 2nd ed), and a co-author of a publication of the NRC (NRC for Sheep, Goats, Camelids and Cervids). Pugh has received five university and five national awards for teaching, was the 2006 recipient of the UGA's AM Mills Award for contributions to Veterinary Medicine, and was the UGA's College of Vet Med's Alumni of the Year for 2017. He has served on various committees for the American Association of Small Ruminant Practitioners, the Society for Theriogenology, the College of Theriogenology, the American College of Veterinary Nutrition, and the National Research Council, Nutrient Requirement Committee and the American Academy of Veterinary Parasitologists. He and his wife of 43 years are sheep, goat, and donkey/mule owners, part-time motorcycle/trike builders and riders, and the father of two daughters, a son, 2 sons-in law, a daughter-in-law, and 4 grandchildren. Jim Keen earned a DVM and PhD (epidemiology) from the University of Illinois and is a veterinary infectious disease eco-epidemiologist and sustainable agriculture proponent with broad interests and 27 years of research and field experience in livestock health and production medicine, veterinary public health and zoonotic infections, biomedicine and animal protection. He currently is a faculty member at the University of Nebraska-Lincoln in the School of Veterinary Medicine and Biomedical Sciences. Much of Keen's research interest has focused on the diagnosis, epidemiology and control of infectious diseases of sheep and goats, especially Caprine Arthritis and Encephalitis virus, Ovine Progressive Pneumonia virus and Caseous Lymphadenitis. In addition, he kept a small (10-20 does) hobby herd of Alpine and Pygmy goats for 20 years. Keen is author or co-author of 70 peer-reviewed scientific publications and more than 100 scientific abstracts. Keen taught high school science in Togo, West Africa for two years in the 1980s. From 2007 to 2014, he was a disease surveillance consultant on dangerous veterinary pathogens (zoonoses and transboundary diseases eg brucellosis and foot and mouth disease) in Azerbaijan and Armenia for the Biological Threat Reduction Program of the US Department of Defense.

Adult Activities (afternoon session): In the afternoon session, participants were able to break into small-group workshops. There was a total of fourteen workshops; however, participants only had time to attend three. The afternoon workshops included:

- Tools in the War on Parasites with Dr. David Pugh.
- Common Diseases of Small Ruminants and Their Symptoms with Dr. James Keen.
- Where Are They Going? A Look at Past and Future NAHMS Goat and Sheep Health National Studies with Mr. Matthew Branan.
- Basic Herd Management –hoof trimming, body condition scoring, FAMACHA scoring, etc. with Mr. Jerry Hayes.
- What Processors Want – learn from a panel of meat processors concerning the type and weights of lambs and goats that they want with Oklahoma meat processors
- Goat and Sheep Farm Budgeting - basics of budgeting and financial recordkeeping with Mr. Clark Williams.
- Pack Goats - basic goat training as a pack animal and equipment needs with Mr. Dwite Sharp.
- Tanning Goat Hides - basic tanning and leather treatment of goat skins with Dr. Roger Merkel.
- The Art of Cheesemaking with Dr. Steve Zeng.
- Nutrition for Health and Production - calculation of energy, protein and feed intake requirements with Dr. Steve Hart.
- DHI Training - supervisor/tester training for dairy goat producers including scale certification with Ms. Eva Vasquez.
- USDA/APHIS: Animal ID with Dr. Michael Pruitt and USDA/WS: Wildlife programs with Mr. Kevin Grant (1:30 p.m. and 2:30 p.m. ONLY)

- USDA/NRCS: Conservation programs with Ms. D'Ann Peterson and USDA/FSA: Farm loans with Mr. Phil Estes (1:30 p.m. and 3:30 p.m. ONLY)
- USDA/NASS: Animal inventories with Mr. Wil Hundl and USDA/AMS: Market strategies with Mr. Cole Snider (2:30 p.m. and 2:30 p.m. ONLY)
- Fitting and Showing for Youth and Adults - tips and pointers on fitting and show ring etiquette with Ms. Janet and Messrs. Robbie and Coleman Sanders (this is a half-day afternoon workshop).

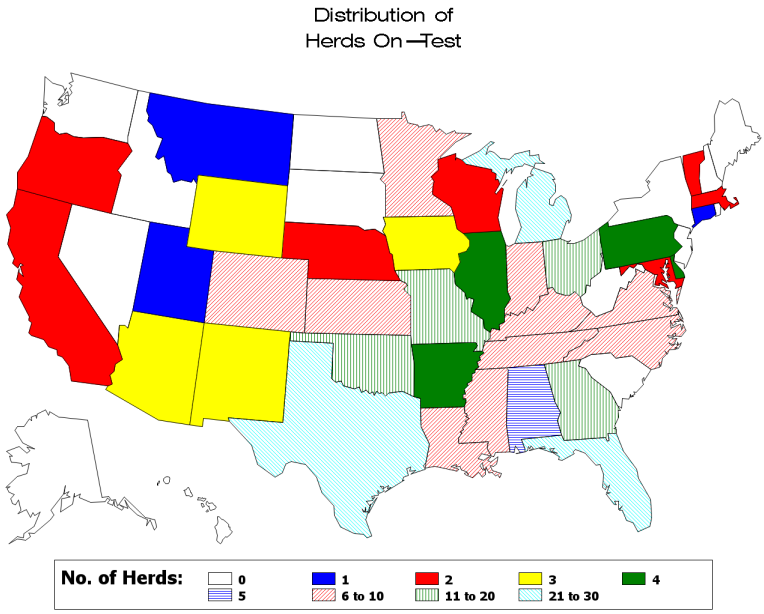
Goat Field Day Program for Kids (Old Fashioned Fun): The Goat Field Day for Kids provides the opportunity for kids to explore and enjoy "old-fashioned fun activities" while their parent(s) participate in the Goat Field Day Program. With all of today's technological gizmos from the iPod to high-end smart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

Cheese Manufacturing Workshop

Our ever-popular goat milk cheesemaking workshop was Friday April 27, 2018 (the day before our annual goat field day on April 28). Dr. Steve Zeng, Professor and Dairy Product Specialist in the American Institute for Goat Research at Langston University, was the host/instructor for this workshop. He has instructed cheese workshops in many states as well as internationally. He has also judged cheeses for the World, the United States, the American Cheese Society and the American Dairy Goat Association cheese championships/contests since 2007. He will share his rich background, personal experience and masterful skills in small-scale cheese manufacture, particularly goat milk cheeses. He plans to demonstrate basic principles and practical skills of making soft and surface mold cheeses using our own Grade "A" goat milk. Milk quality, cheesemaking facility, cheese sensory evaluation and federal safety requirements will also be discussed. This one-day hands-on workshop will be held in the pilot creamery at Langston University.

Goat DHI Laboratory

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



(DRMS) of Raleigh, NC to conduct the record processing. The Langston DHI program became the first DHI program to introduce forms and reports in goat terminology to dairy goat producers in the United States. A national Dairy Herd Improvement Association (DHIA) has been in existence for a number of years. However, until 1996 DHIA catered only to cow dairies. The Langston DHI program has been very popular with dairy goat producers and has grown significantly since its establishment in 1996. Goat producers are now able to get records for their animals that reflect accurate information with the correct language. Currently, we have 157 producer herds in 34 states enrolled in the Langston Goat Dairy DHI Program. In 2018, the DHI laboratory processed more than 12,000 samples. Langston University continues to serve the very small-scale dairy goat producer. The average herds size on test with Langston University is 10 animals. This is significantly smaller than the herd size average for the five other processing centers. For those interested in becoming a Langston goat DHI tester, training is available either in a formal classroom setting or through a 35-minute video tape (see additional information in the YouTube section). Every tester is required to attend the DHI training session or view the tape and take a test. Upon completion of the DHI training, the milk tester can start performing monthly herd tests.

Goat Newsletter

To date, the Goat Extension program published four issues of the 8-page Goat Newsletter in 2018. Interest in the newsletter has grown and we currently have over 1,600 subscribers to our free quarterly Goat Newsletter and the subscription list continues to increase every year. The Goat Newsletter is mailed to every state in the nation and to 10 countries overseas. Ninety-seven percent of the mailings go to American households. At least one newsletter is mailed to a household in every state in the nation. Fifty percent of the newsletters are mailed to Oklahoma households. An additional thirty percent of the newsletters are mailed to households to state adjacent to Oklahoma.

Artificial Insemination Workshop

The use of superior sires is imperative in improving the genetic composition of breeding stock. Artificial insemination has long been used in the dairy cattle industry and is a simple technology that goat producers can acquire. However, opportunities for goat producers to the necessary skills via formal and practical instruction are not widespread. Langston University has instituted a practical workshop for instruction in artificial insemination in goats. Producers are instructed in the anatomy and physiology of the female goat, estrus detection and handling and storage of semen. Producers participate in a hands-on insemination exercise. An understanding of the anatomy and physiology enable the producer to devise seasonal breeding plans and to troubleshoot problem breeders. An understanding of estrus detection enables the producer to effective time inseminations for favorable conditions for conception and to effectively utilize semen. An understanding of semen handling and storage enables the producer to safeguard semen supplies, which can be scarce and costly. The experience of actually inseminating a female goat enables the producer to practice the knowledge that they have gained. The acquisition of these inseminating skill will allow producers the use of genetically superior sires in their herds that they normally would not have access to. It also allows producers to save money by conducting the inseminating themselves instead of hiring an inseminator. In 2018, an AI workshops was held in October at the Langston University campus. Eleven participants were trained.

Production Handbooks

The first edition Meat Goat Production Handbook has been sold-out and the revised second edition is available. The Meat Goat Production Handbook was partially funded by USDA/FSIS/OPHS project #FSIS-C-10-2005. An illustrated and scaled-down version of the Meat Goat Production Handbook is available. Our collaborating project institutions/organizations include Kentucky State University and the University at Puerto

Rico at Mayagüez. Partial funding to develop the Meat Goat Production Basics was from USDA/NIFA grant #2010-38821-21581 (OKLX-GIPSON10). The University of Puerto Rico – Mayagüez has translated the Meat Goat Production Basics book into Spanish for the Producción de Cabros para Carne Conceptos Básicos.

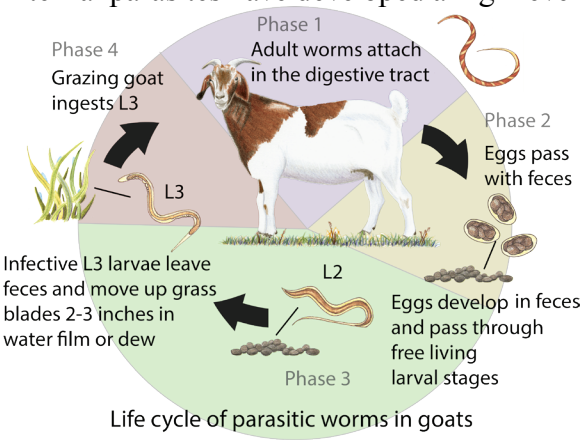
The Dairy Goat Production Handbook has 475 pages of information on all aspects of dairy goat production and could be considered as a companion book to the Institute's Meat Goat Production Handbook, 2nd Edition. Partial funding to develop the Dairy Goat Production Handbook was from USDA/NIFA grant #2011-38821-30952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

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

Controlling Internal Parasites Workshop

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

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



Life cycle of parasitic worms in goats

YouTube Channel

Created in 2005, YouTube is a video-sharing website on which users can upload, view and share videos. YouTube now has over 120 million videos, including movie clips, TV clips, and music videos, as well as amateur content such as video blogging and short original videos. The Goat Program at Langston University has created its own YouTube channel (https://www.youtube.com/user/taglu01) The following are the YouTube videos that are available and you can quickly access them on a mobile device by using the QR (2D barcode) to the right. Additional videos will be added to the channel in the future

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

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

AI Kit (length 6:28)

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

Basic Hoof Care (length 10:48)

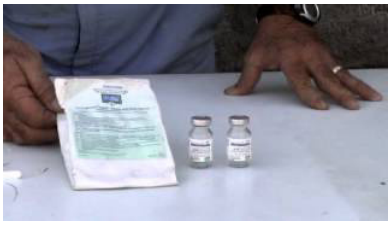
This video explains basic hoof care for goats.

Body Condition Scores in Goats (length 2:11)

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

Buck Effect (length 1:53)

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

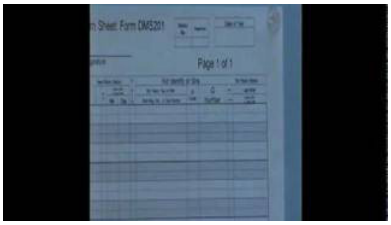


Estrous Synchronization in Goats (length 5:08)

This video explains estrous synchronization for artificial insemination in goats.

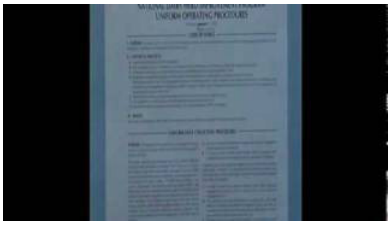
Langston DHI Tester Training - Part 1 (length 9:24)

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



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

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



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

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

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

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

Semen Tank (length 6:39)

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

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

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

Nutrient Requirements of Goats

Under a research project which developed equations for energy and protein requirements for goats, as well as prediction of feed intake, an extension sub-project developed a website calculation system for "Nutrient Requirements of Goats" (http://www2.luresext.edu/goats/research/nutreqgoats.html). Most calculators were based on studies of the project reported in a Special Issue of the journal Small Ruminant Research. For calculators with score inputs (i.e., grazing and body conditions), pictures are available to aid in determining most appropriate entries. Realistic examples are given, as well as discussion of appropriate and inappropriate usage. However, for the experienced user there is an option to hide text and examples and to view only inputs and outputs.

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

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

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

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

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

Tanning Goat Hides

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

tical knowledge of the tanning process that will help them when trying tanning skins at home. In 2018, one tanning goatskins workshop was held at Langston University in April.

Internet Website

http://goats.langston.edu

In 2014, Langston University unveiled a new web presence with new branding design. In 2015, the Office of Public Relations informed the Institute that our website must meet branding requirements and we took steps to comply with branding requirements. This was done by purchasing a new server and engaging a Drupal consultant. Capabilities of the new web site include a document library with the complete proceedings of the annual Goat Field Day and the quarterly newsletter for the past several years. Both the proceedings and newsletters are also available in portable document format (pdf), which allows for the viewing and printing of documents across platform and printer without loss of formatting.

Information, recent abstracts and scientific articles of completed and current research activities in dairy, fiber and meat production are available for online viewing and reading. Visitors will be able to take a Virtual Tour of the research farm and laboratories, complete with digital photos and narrative. Visitors will also be able to browse a digital Photo Album. Visitors will also be able to subscribe to our free quarterly newsletter online. Visitors will be able to test their knowledge of goats with the interactive goat quiz which covers nearly all aspects of dairy, fiber and meat goat production. For those questions that are lacking in the interactive quiz database, visitors will be able to submit a question to be included in the database. Visitors will be able to read about research interests of faculty and will be able to contact faculty & staff via email.

Tracking code for Google Analytics was added to the new Drupal server. Overall in 2018, there were 77,639 visits (up 13% from 2017). Visitors spent an average 1 minutes and 34 seconds, which is down slightly from 2016 (1 minutes, 44 seconds). The United States accounted for 51% of all users. The top 10 countries (users) are listed in Table 1.

Country	Users	New Users	Sessions	Bounce Rate	Pages / Session	Avg. Session Duration (sec)
United States	31485	31442	40625	70.59%	2.06	96.01
India	4195	4190	4744	79.57%	1.60	67.33
Nigeria	2874	2873	3646	69.83%	1.65	114.96
Philippines	2293	2293	2606	76.09%	1.62	93.90
Ethiopia	1821	1802	2363	77.53%	1.65	121.77
South Africa	1801	1800	2061	75.89%	1.69	90.37
Kenya	1420	1415	1773	75.07%	1.48	74.97
Canada	1295	1290	1536	76.24%	1.87	71.70
Australia	1068	1071	1240	82.50%	1.49	56.04
United Kingdom	1001	996	1114	87.97%	1.26	26.18

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

Region	Users	New Users	Sessions	Bounce Rate	Pages / Session	Avg. Session Duration (sec)
Texas	4168	4079	5151	73.68%	1.81	78.61
California	2573	2539	3094	79.35%	1.67	56.64

Oklahoma	2085	1992	3269	49.83%	3.11	179.77
New York	1585	1538	1853	72.37%	2.16	106.89
North Carolina	1335	1294	1582	76.68%	1.65	72.71
Florida	1123	1090	1370	71.90%	1.95	91.72
Missouri	1020	991	1408	68.32%	2.28	112.02
Georgia	989	962	1210	69.01%	1.96	117.76
Ohio	971	958	1173	74.60%	1.67	73.55
Tennessee	948	925	1172	72.87%	1.83	69.68

Web-based Training for Meat Goat Producers

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

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

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

Country	State	Dairy QP Number	Meat QP Number
USA	Alaska	2	0
	Alabama	2	7
	Arkansas	4	14
	Arizona	1	2
	California	3	7
	Colorado	5	3
	Connecticut	0	1
	Florida	2	28
	Georgia	3	18
	Hawaii	1	0
	Iowa	1	4
	Idaho	1	2
	Illinois	3	6
	Indiana	1	8
	Kansas	3	11
	Kentucky	0	16
	Louisiana	1	3
	Massachusetts	0	2
	Maryland	1	4
	Maine	1	0
	Michigan	8	11
	Minnesota	0	4
	Missouri	4	16
	Mississippi	1	3
	Montana	0	2
	North Carolina	0	18
	Nebraska	0	4
	New Hampshire	0	1
	New Jersey	3	2
	New Mexico	1	1
	Nevada	0	3

Country	State	Dairy QP Number	Meat QP Number
USA	New York	1	11
	Ohio	6	12
	Oklahoma	4	36
	Oregon	3	9
	Pennsylvania	5	12
	Rhode Island	2	0
	South Carolina	1	6
	South Dakota	0	2
	Tennessee	2	13
	Texas	5	45
	Utah	1	2
	Virginia	2	14
	Vermont	0	1
	Washington	1	5
	Wisconsin	1	5
	West Virginia	2	6
	Wyoming	1	5
Canada	Alberta	1	3
	British Columbia	0	4
	Manitoba	0	3
	Nova Scotia	0	1
	Ontario	0	3
Other Country	Botswana	0	1
	England	0	2
	India	0	1
	Japan	0	1
	Malaysia	0	4
	Mexico	0	2
	Pakistan	1	1
	Philippines	3	0
	Russian Federation	2	1
	Saudi Arabia	0	1
	South Africa	0	1
	Suriname	0	1
	Zimbabwe	1	2
TOTAL		***97***	***417***

Current Extension Projects

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

Title:	PastureDrone: An Innovative Tool for Grazing and Pasture Management
Type:	New Seeds Initiative - Assoc. of Research Directors
Project Number:	Langston
Period:	2019-2020
Investigators:	T.A. Gipson[1], M. White, D. Lechner[2], B. Kouakou[3], C. Ogden[3], K. Andries[4], R. Noble[5], N. Gurung[6], E. N. Escobar[7]
Institution:	[1]Langston University, [2]Letchner.com, [3]Fort Valley State University, [4]Kentucky State University, [5]North Carolina A&T University, [6]Tuskegee University, [7]University of Maryland – Eastern Shore
Objective:	1) Assess pasture biomass and nutritive status for grazing animals using the PastureDrone.

International Overview

Dr. Roger Merkel
International Program Leader

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

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

Simplified Artificial Insemination for Sheep and Goat Producers

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

and Genetics" Dr. Terry Gipson, PI, was the mentor on the former Fellowship and Dr. Erick Loetz, Co-PI, was the mentor on the latter Fellowship.

Dr. Malanda instructs trainees in the use of an artificial vagina.

In June of 2018, Dr. Terry Gipson travelled to Egerton University to implement the objectives of the project. Dr. Joab Malanda of Egerton University and Dr. Gipson worked together to establish a small semen evaluation laboratory consisting of a digital microscope and a spectrophotometer. The gold standard for determining sperm concentration is using a hemocytometer and a microscope but it is a time-consuming and tedious task. The spectrophotometer uses light traveling through a solution and measures the amount of absorption by the solution. Using both instruments, Drs. Malanda and Gipson were able to establish standard curves that will render a quick and easy determination of sperm concentration. This is important for one of the objectives of the project, which is to determine the effect of total number of sperm on non-return to estrus (NRE) and pregnancy rate (PR). Typically, a dose (straw) contains 200 to 250 million motile sperm. This project will utilize two total number of sperm in a single dose: 300 million sperm or 500 million sperm. Using the spectrophotometer, the standard curve, and the total volume of the ejaculate, Egerton technicians will be able to divide the ejaculate into the appropriate number of dose containing the desired number of sperm.

A second objective of the project is to investigate the effect of management (breed, age, parity, body condition, etc.) on success rate (NRE and PR). This project will utilize the goat herd at Egerton University and will recruit goat producers in the community surrounding Egerton University as collaborators. From previous studies, factors that have affected success rate for insemination in goats are age of female, body condition score, month of AI, and buck.

The final objective of the project is to investigate the effect of volume on success rate (NRE and PR).Typically a dose is ½ cc in the United States and ¼ cc in Europe; however, both sizes of straws generally contain 200 to 250 million sperm. Therefore, the concentration is different for the two straws. The effect of the total volume is unknown in goats; however, volume has affected semen quality in swine and in dogs. An ejaculate will be extended to total number of sperm, as defined in the

Under the watchful eye of Dr. Malanda, trainees learn proper dilution for determining sperm concentration.

first objective, per ½ cc or 1 cc of skim milk extender and stored in a labeled collection tube in a refrigerator. A summary of treatments are presented in Table 1. Extended, fresh semen can remain viable for 24 hours, if refrigerated. Therefore, a schedule will be established to collect various bucks to ensure that fresh semen is always available. A buck will be collected no more than three times per week and most buck will be collected only twice per week.

At Egerton University, farm staff will check heat daily, once early in the morning and once in late afternoon. If females are determined to be in estrus, then the appropriate insemination treatment will be deposited vaginally. The procedure will be that if a female comes into estrus in the morning, she will be inseminated that afternoon. If she comes into estrus in the afternoon, she will be inseminated the next morning. In the community surrounding Egerton University, local farmers will receive basic training on estrus detection. The simplified artificial insemination tool consists of a 3 cc syringe and an AI sheath cut to 7 inches and is used to deposit the extended semen vaginally. Langston University hopes this simplified AI technique will allow Egerton University to disseminate valuable genetics to surrounding farmers all the while maintaining vital biosecurity.

Trainees learn to determine sperm concentration.

Table 1. Treatments to be used for testing simplified AI.

Treatment	Total number of spermatozoa (million)	Total volume
A	300	½ cc
B	300	1 cc
C	500	½ cc
D	500	1 cc

Trainees with Dr. Malanda on left and Dr. Gipson on right.

LINC Training in Vietnam

From October 14-21, Dr. Arthur Goetsch traveled to Vietnam to participate in the 4th International Asian-Australasian Conference on Dairy Goats. The meeting was held at Trà Vinh University, located about a 4-hour drive south of Ho Chi Minh City. The University has an enrollment of approximately 20,000 students. The conference was Wednesday through Friday, October 17-19. Dr. Goetsch gave an invited presentation entitled "Recent areas of research emphasis in feeding practices and the nutrition of lactating dairy goats."

Dr. Goetsch (back row , right) and other presenters at the conference. Ms. Sanae Ishii (back row, center) was recently at Langston University for training.

Likewise, Dr. Goetsch participated in the 3rd conference in 2016 held at the Northwest Agriculture & Forestry University in Yangling, China. There were attendees from many countries in the region, including Vietnam, Malaysia, China, Thailand, Taiwan, Indonesia, India, Philippines, Sudan, Australia, New Zealand, USA, Japan, and Pakistan. Dr. Goetsch participated in an organizational meeting of the Asian-Australasian Dairy Goat Network in which Bangkok, Thailand was selected as the location for the next 5th conference in 2020. There was also an organizational meeting held for an upcoming Special Issue of the journal Asian-Australasian Journal of Animal Science focusing on dairy goats, in which Dr. Goetsch will have an invited review on recent advances in feeding and nutrition research of dairy goats and will be a Guest Editor.

Moreover, Dr. Steve Zeng will be coauthoring a review on dairy goat products. On the morning of Saturday, October 20, Dr. Goetsch met with administrative, research, and teaching personnel of Trà Vinh University to discuss programs of both institutions and potential for future collaboration.

Dr. Goetsch touring dairy goat facility with conference attendees.

Indonesia Training

From October 13 to 22, 2018, Dr. Roger Merkel traveled to Indonesia to present a paper entitled "Smallholder Livestock Production and Commercialization" at the International Seminar on Livestock Production and Veterinary Technology, held in Medan, North Sumatra and sponsored by the Indonesian Center for Animal Research and Development of the Indonesian Ministry of Agriculture. Attending the conference were scientists from the US, England, New Zealand, Indonesia, and two scientists from the International Center for Tropical Agriculture working in Vietnam. The workshop consisted of oral and poster sessions. Many of the papers will be published in an upcoming issue of Wartazoa, the Indonesian Bulletin of Animal and Veterinary Sciences.

Goats grazing in a field of immature oil palm trees at the Sei Putih meat goat research center.

Following the workshop, Dr. Merkel toured a meat goat research center about one hour from Medan set in the midst of rubber and oil palm plantations. Research is conducted on nutrition, management, production systems, and other areas. In the region, goats are grazed under rubber and oil palm trees. The center initially conducted research on sheep under rubber, fearing that goats could disrupt the collection of latex from the trees, but studies showed that goats do not have any negative effect on rubber production or collection and, over time, the switch was made from sheep to meat goats.

A Garut ram at the research farm of the Indonesian Center for Animal Research and Development.

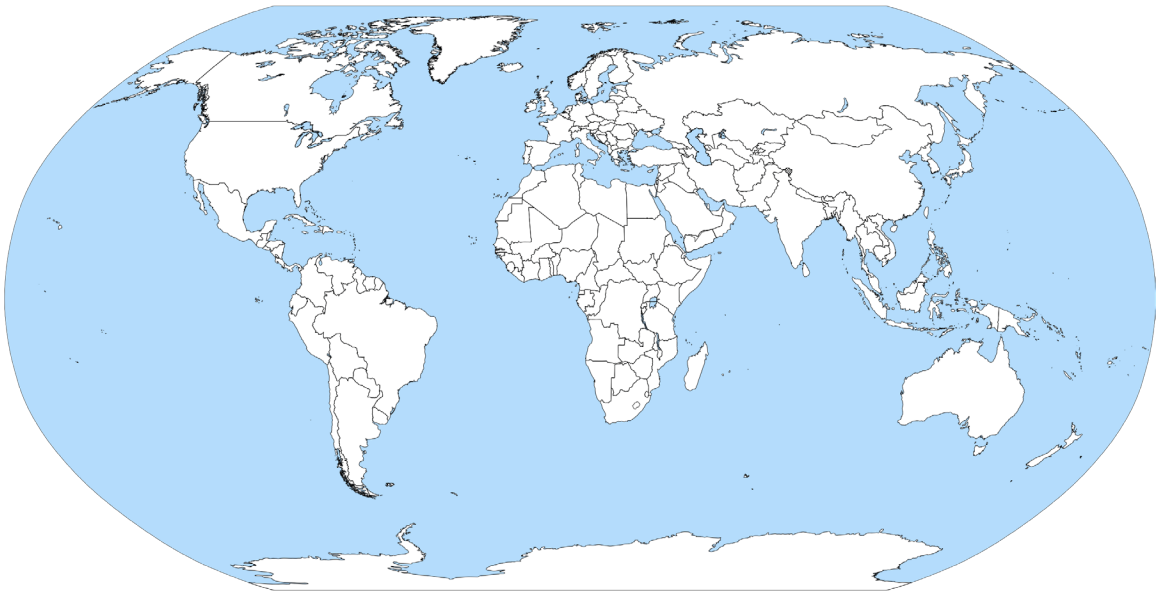
Following that visit, Dr. Merkel traveled to Parapat, North Sumatra to participate in a workshop entitled "Participatory and Community Based Breeding, Nutrition and Socio-Economic Management to Support a New Strategy for Small Ruminant Industry in Indonesia." Participants of this workshop were research scientists who had worked in the Small Ruminant Collaborative Research Support Program that operated in Indonesia. The outputs

and impact of that program were discussed as were ways to continue and expand the impact of the project's results that included a composite hair sheep breed, numerous research studies on all aspects of sheep production and economics, Indonesian staff members receiving graduate training, and a positive community impact. The large numbers of the composite sheep breed that are raised by farmers in the area as well as continued use of training materials are two examples of the lasting impact of the project.

Ewes and lambs at the research farm of the Indonesian Center for Animal Research and Development.

Finally, Dr. Merkel traveled to Bogor, West Java just south of the capital Jakarta to meet scientists from the Indonesian Center for Animal Research and Development and tour their research facilities and animal barns. The Center conducts research on all aspects of livestock production and is working to develop composite breeds of sheep and goats that are extended to village producers. During his visit, Dr. Merkel spoke with the Center Director who stated that two of their scientists are interested in coming to the American Institute for Goat Research for post-doctoral studies.

Sei Putih means "white river" in Indonesian and refers to the "river" of white latex that comes from the rubber tree plantations in the region. The latex from rubber trees is similar to the milky, white latex from milkweeds, Indian hemp, and other plants found in North America. However, the latex from the rubber tree is much higher in concentration. To collect the latex, a worker called a rubber tapper pulls dry latex from the



Left: A picture of rubber trees near the gate of the meat goat research center in Sei Putih, Indonesia. Note the cup used to collect latex from the tree.
Right: Cuts are made diagonally for the latex to run down a center channel into the collection cup.

previous collection off a tree and then uses a special knife to slice off a thin layer of bark less than 2 millimeters thick. The cut is made diagonally so that the latex runs down a channel and into a cup. The tapper begins his day early in the morning, tapping 400 hundred or more trees. Late morning, the tapper returns to collect the liquid latex from each tree, pouring it into a large pail. The latex is then weighed and processed. Rubber trees are not tapped until they are about 7 years old and can be tapped for 25 or more years.

Cheetah Conservation Fund

In July of 2018, Dr. Terry Gipson travelled to Cheetah Conservation Fund (CCF) headquarters in Otjiwarongo, Namibia to conduct a hands-on training of artificial insemination (AI) in dairy goats. At CCF, Dr. Gipson worked closely with Mr. Tyapa Toivo, CCF Small Ruminant Manager, in the instruction of buck collection, semen evaluation, and artificial insemination using fresh semen. Mr. Toivo continued his AI training with a ten-day stay at Langston University in September of 2018. Mr. Toivo performed 36 of transcervical inseminations and assisted in several laparoscopically-aided intrauterine insemination and hysteroscopic-aided deep uterine inseminations.

Impact or benefits for participants:

1. Successful training in artificial insemination in goats will allow the Cheetah Conservation Fund to remain the leader in goat production in Namibia.
2. The Cheetah Conservation Fund can better mentor goat producers in Namibia by offering artificial insemination services and providing for sale items such as frozen semen from their herd or imported from abroad.
3. Langston University has broadened its international exposure and programming to Namibia.

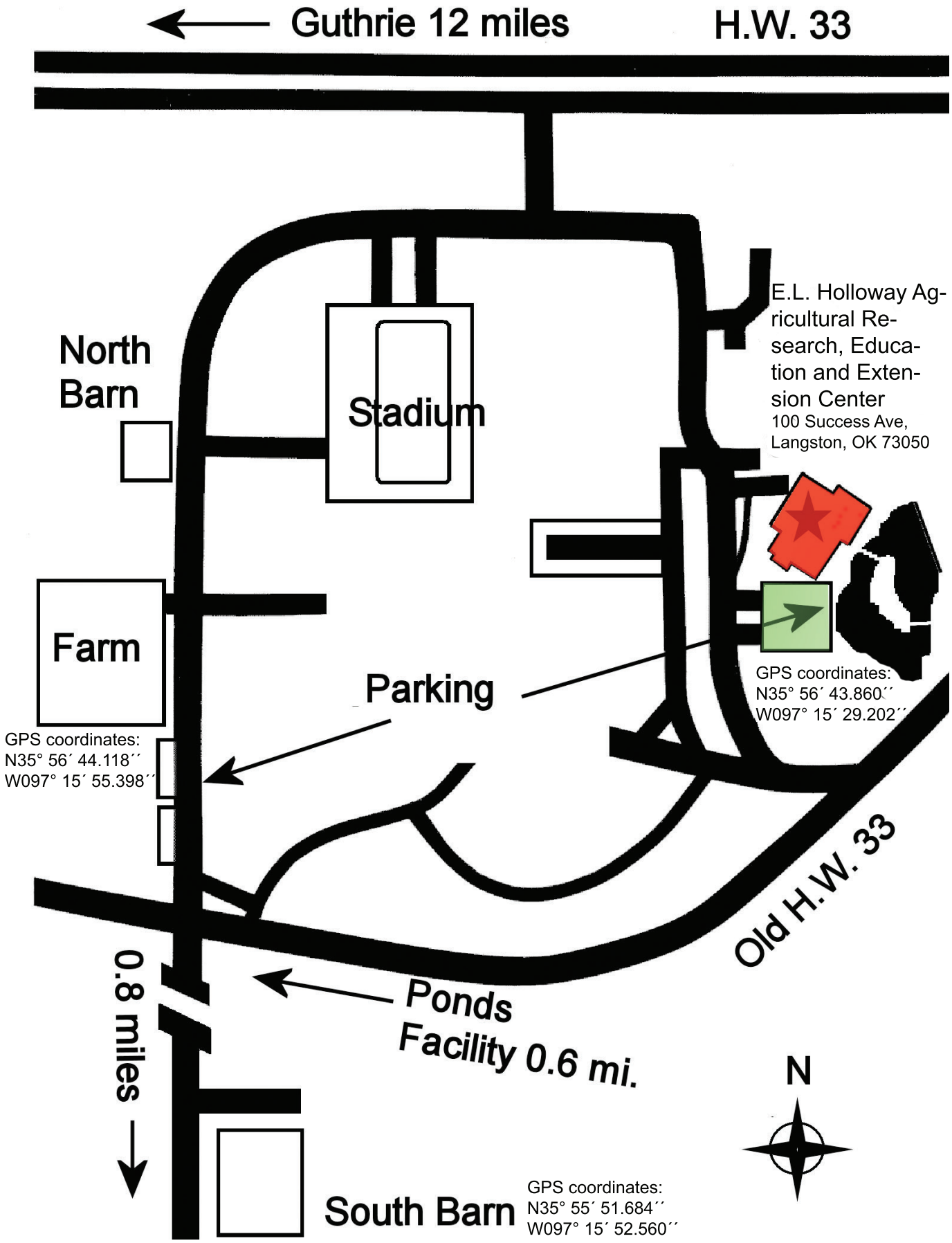
Dr. Terry Gipson and Mr. Tyapa Toivo (holding artificial vagina) demonstrate buck collection to CCF staff.

The End Result

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

Current International Project

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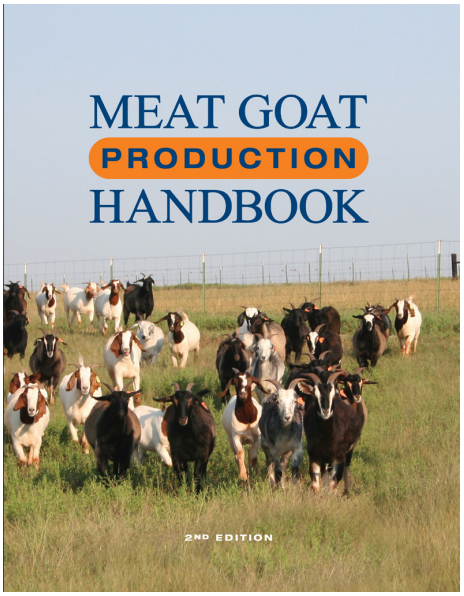

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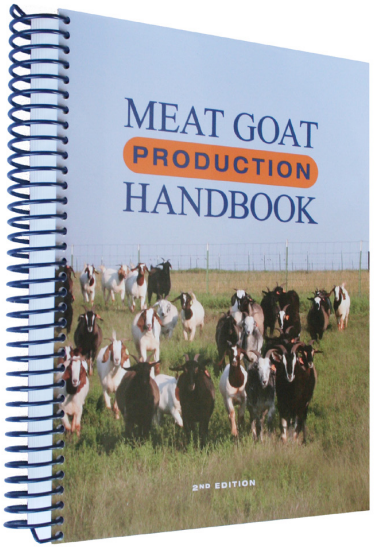

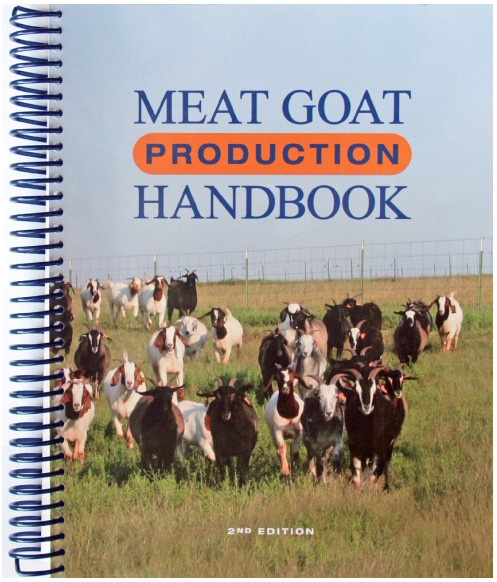

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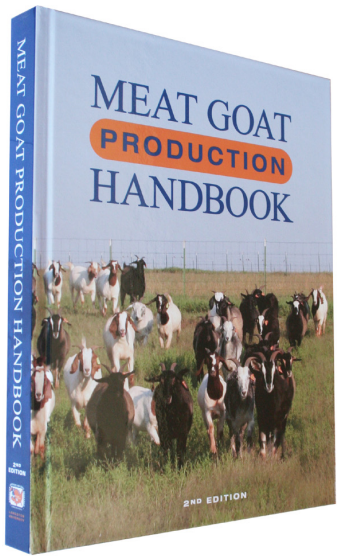

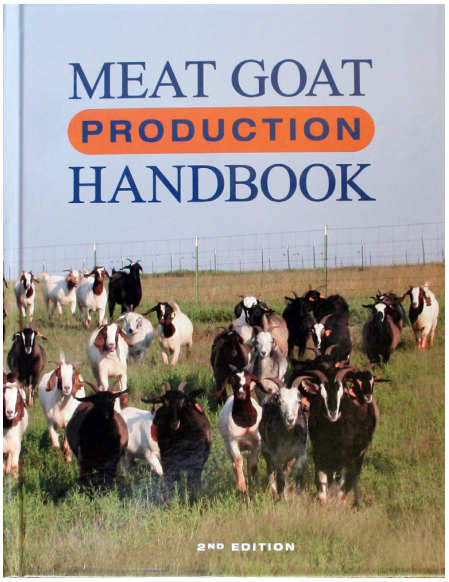

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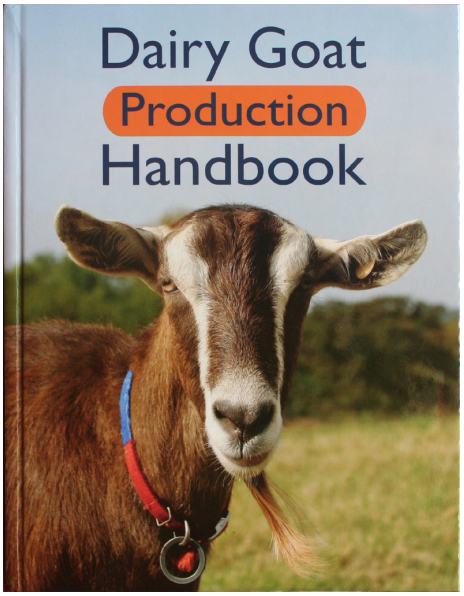

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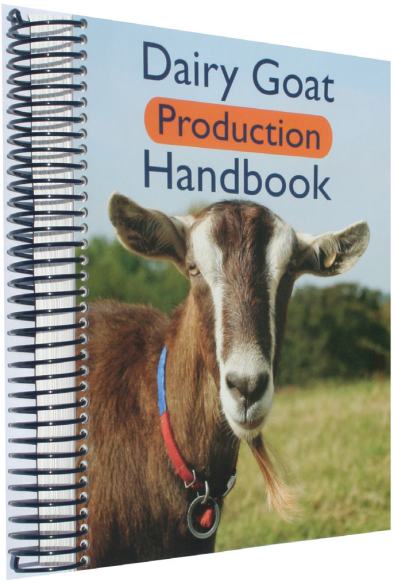

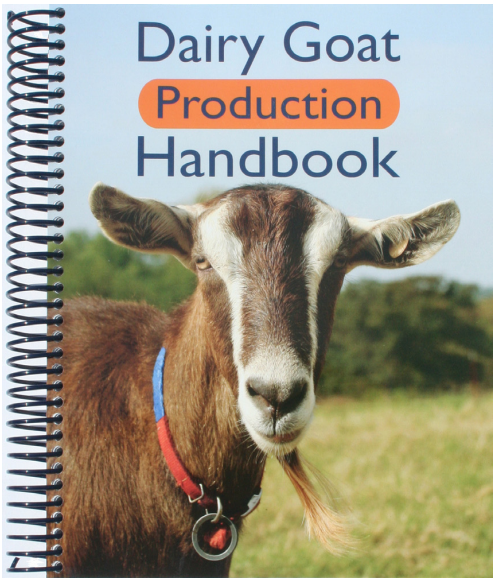

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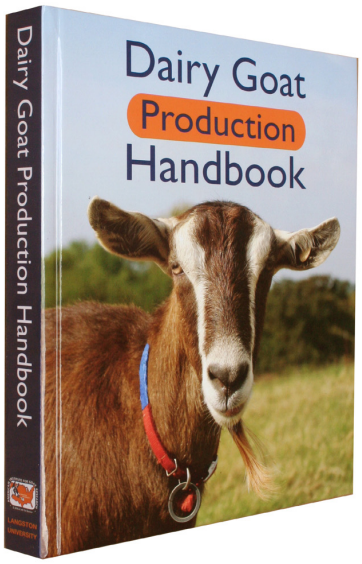

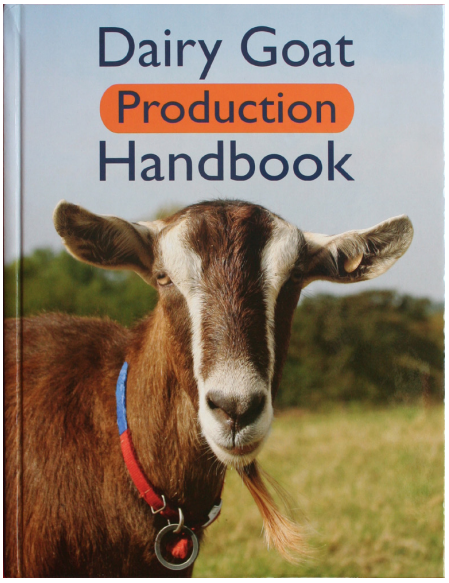

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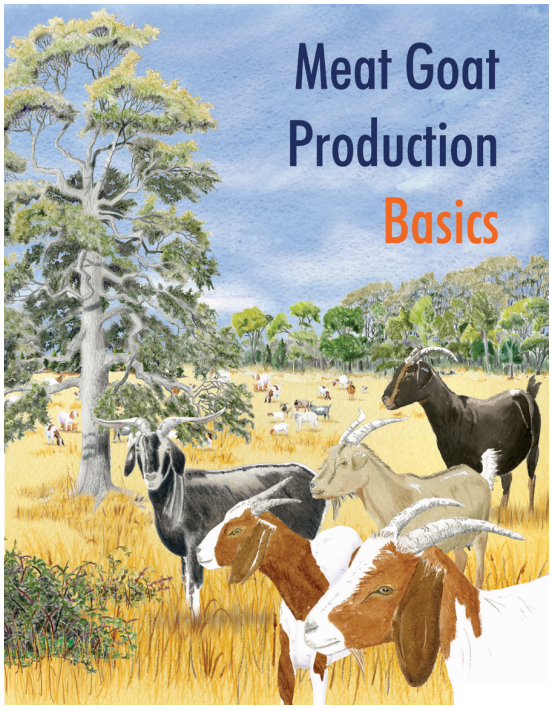

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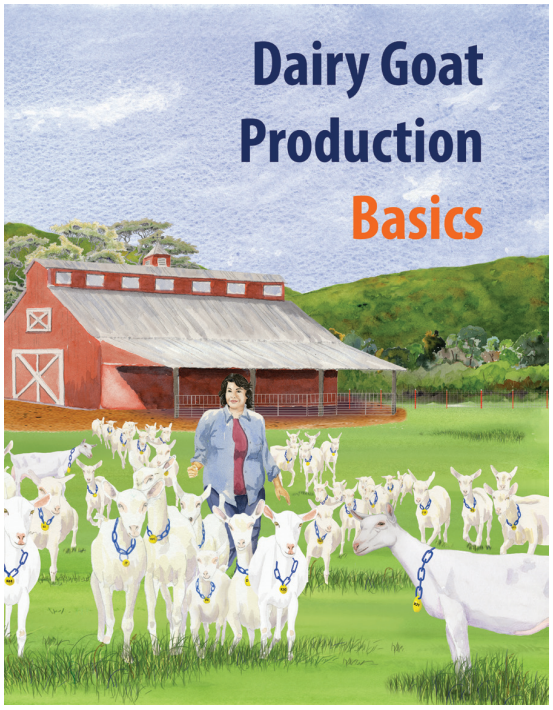

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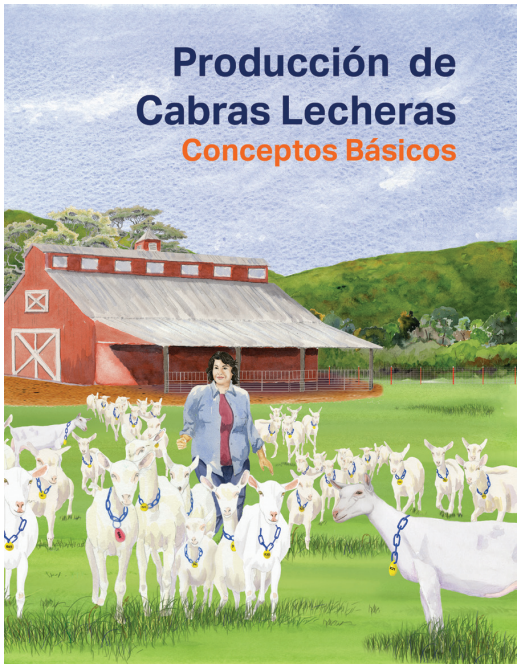

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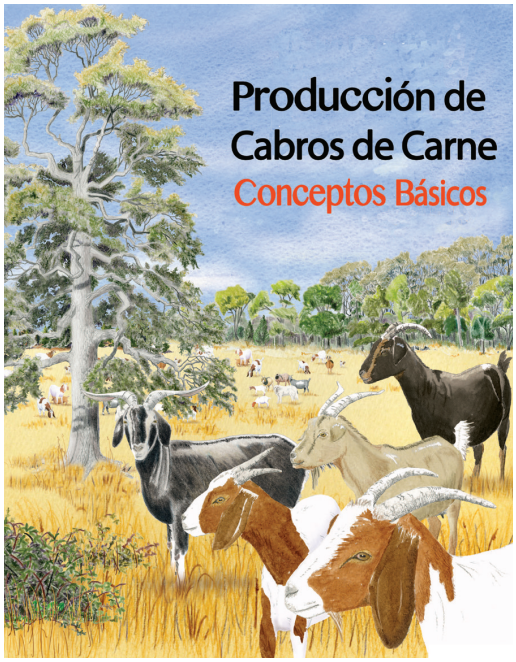

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