WELCOME

The mission of the E (Kika) de la Garza Institute for Goat Research is to develop and transfer enhanced goat production system technologies through the generation and dissemination of technical information. Thus, our goal is to assist goat owners in management decisions for the optimization of inputs and increased profitability by providing technical information. We are continually generating information on dairy, meat, and fiber-producing goats that helps maintain the goat industry viable and competitive.

There were numerous major accomplishments of the Institute in the 1998-1999 fiscal year, among which are a successful collaborative demonstration on the use of goats to control Sericea lespedeza in Kansas, the "Kid in the Classroom" project, a large number of goat farm tours, the Boer buck test, operation of the Goat DHIA Laboratory, conduct of numerous experiments, publication of many scientific manuscripts, and the obtaining of extramural funding to maintain and expand the national and international activities in our research and extension program. The Goat Newsletter has been improved, and there are plans to update and enhance the Institute's website. Such achievements are attributable to the hard work, inspiration, and dedication of the research and extension faculty and staff of the Institute. The Institute continues to have strong working relationships with scientific organizations in many countries including Ethiopia, South Africa, Morocco, Egypt, Jordan, Israel, Philippines, China, Bulgaria, Mexico, and Brazil. Funds have been obtained from both the USDA and USAID for exchange visits to South Africa, Ethiopia, and China.

Market conditions are currently favorable for the meat goat industry, and the future appears quite bright as well with the introduction of Boer genetics. However, there is not presently an adequate information base from which to design optimal feeding and management strategies for Boer purebreds or crossbreds. To this end the Institute is aggressively carrying out research to generate such information, with dissemination by a variety of means to the scientific community, producers, and producer groups.

The schedule of topics and speakers for this 1999 field day was derived from producer suggestions, with a mini-theme of herd health. Terry Gipson has done an excellent job in organizing the event. This year's field day includes: *"Goats: Condominiums for Parasites: What Should a Producer Do?"* (Thomas Craig); *"Herd Health Management Practices for Goat Production"* (Seyedmehdi Mobini); *"Demand for Goat Meat: Implications for the Future of the Industry"* (Terry Gipson); *"Making Goat Milk Feta Cheese"* (Steve Zeng); *"Highlights of Nutritional Concepts for Goats"* (Art Goetsch); *"Measuring Financial Performance"* (Chris Petermann) and *"Goat Farm Budgeting"* (Roger Sahs); *"The Basics of Tanning Goat Hides"* (Roger Merkel); *"Goat DHIA Lab Training"* (Irene Brown-Crowder); *"Pregnancy Diagnosis in Goats"* and *"Goating for Newbies"* (Lionel Dawson); and *"Somatic Cell Counts and Drug Residue Update"* (Nelson Escobar). The first three topics will be presented for the entire group, and participants can attend two of the afternoon sessions. Please let us know your wishes for the 2000 field day, and we will do our best to again provide a quality program with requested and timely topics. On behalf of the staff of E (Kika) de la Garza Institute for Goat Research, I thank you for your continuing interest and support.

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GOATS: CONDOMINIUMS FOR PARASITES: WHAT SHOULD A PRODUCER DO?

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Introduction

Parasites of goats are often shared with sheep even though the two species are different in their dietary selection and ability to extract nutrients from forages. There is no one answer as to how to control parasites of goats. However, there are several approaches that may be taken when one has an idea of when and where parasites are being acquired and how parasites survive in the environment.

Losses caused by parasitic disease varies considerably from death to that of a minor annoyance. The differences may be due to geographic, genetic, or husbandry variability. Genetic differences between breeds and among individuals within breeds may greatly determine the effect the parasites have on their hosts. More important is the system of management which will lead to a greater or lesser exposure to potentially damaging parasites. The management of rearing young varies depending on whether the animals are being raised for production of meat, milk or fiber and therefore disease is reflected by these differences.

Not all worms that are equally virulent and until one understands that there are regional and some local differences in the epidemiology and magnitude of the worm burden, rational control programs cannot be developed. However, without a doubt Haemonchus contortus, the barber pole worm, is the most important parasite of small ruminants in the southern United States. Locally, the bankrupt or blackscours worm, Trichostrongylus colubriformis can be devastating and coccidiosis in recently weaned kids can be a major impediment to production.

Gastrointestinal nematodes have the same basic life cycle. Eggs are passed in the feces. A larva develops within the egg which then hatches. Larva feed on fecal bacteria and molts to the infective stage. The infective larvae leave the fecal pellet only when the feces are moist; as they only can move on to the forage in a film of moisture, such as dew. The larvae then become available to the grazing host. Within the host larvae molt, and become egg producing adults, approximately three weeks following ingestion.

Desiccation, or extremes of heat or cold are detrimental to the development and survival of eggs and larvae in the environment. The egg and the first two larval stages are especially vulnerable to desiccation and will not develop or survive if the fecal pellet dries too quickly. The infective larva is much more resistant to drying. The infective larva cannot feed and must utilize energy obtained while

feeding on fecal bacteria, it will live only as long as it has energy reserves. Energy is depleted in direct relationship to ambient temperature, so survival of the infective stage is short during the summer (30 to 60 days) and prolonged during the winter (4 to 8 months). Cold does not kill worms, as infective larvae survive the winter but will not live long once the temperature has increased in the spring. However, Haemonchus larvae are inactive during cool conditions and are not available on vegetation for transmission. In arid areas, drying of the fecal pellet will prevent infective larvae from leaving so the pellet becomes a repository for larvae which will be released when later moistened .

In moist environments larvae are picked up from pasture daily. In drier areas rains following periods of drought result in tremendous numbers of larvae being acquired in a short time. The numbers of larvae thus acquired is also increased because the animals are grazing closer to fecal pats and the ground.

A goat must be exposed to large numbers of larvae to suffer from parasitic disease, but not all parasites are able to establish. Factors which determine if a larval nematode is able to survive within the host are both host and worm related. It appears that there are several host factors which limit the numbers of parasites able to establish in the individual host. The mechanism(s) of natural resistance are unknown but appear to be heritable. Most hosts will also develop acquired immunity. The level of immunity is also heritable and requires exposure to worms before it functions. It is usually impossible to differentiate natural and acquired immunity, and both may be functioning at the same time. The immune system may prevent the establishment of worms, or cause the expulsion of worm already established within a host.

Hypobiosis, cessation of development of the worm within the host. Larvae in the early parasitic stages cease development; they do not feed but remain within the host in an inactive state until more favorable conditions occur for their development. The stimuli which induce hypobiosis are not well defined. Kids which have been infected by a species of worm may have hypobiotic larvae, whereas in naive kids the parasites develop at the normal rate.

Larvae in a state of hypobiosis evade unfavorable environmental conditions, and the host's immunological surveillance system by being metabolically inert. When environmental conditions are more favorable for larval transmission, hypobiotic larvae resume development. This usually coincides with rapid pasture growth, although larvae may resume development even when the host is not on pasture. Larval development from hypobiosis often occurs near parturition. Thus, the worm has an adaptive mechanism to ensure there are sufficient numbers of its offspring to infect the next generation of hosts.

Resistance to infection is abrogated at the time of parturition and during early lactation. This periparturient relaxation of resistance results in the dams' inability to expel adult worms. As a result, there is a rise in fecal egg counts which leads to serious pasture contamination. The use of an anthelmintic at or near the time of parturition has proven to be of value in neutralizing the periparturient rise. If an anthelmintic which has an effect against arrested larvae is used during the winter before they resume development, pasture contamination will be lowered.

Control Programs

Prevention, rather than cure, is the philosophy used in developing control programs against gastrointestinal nematodes. It must be assumed that worms cannot be eradicated but may be limited to the extent that they will not cause serious economic loss to the producer. A combination of treatment and management are necessary to achieve control. Several approaches to the use of anthelmintics are considered.

Strategic

The strategic approach is the use of an anthelmintic at a time when most of the total worm population is within the host and not on the pasture. This approach can be used when goats are moved from a contaminated pasture to a nearly parasite free pasture. Pastures become parasite safe when they have been tilled, given prolonged rest at a suitable time of year, or have been grazed by animals which are not satisfactory hosts for the target parasite species. Pastures grazed by adult cattle or used for hay production during the previous year may be nearly parasite free, as are small grain pastures and the gleanings of harvested crops.

Strategic treatments aimed at hypobiotic larvae are effective in aiding in the control of worm burdens during the subsequent transmission season. In dry climates; West Texas in most years, a single deworming may be sufficient to keep the level of parasitism below the economic threshold for the entire season. Treating in the winter, before parturition, will not only kill larvae that would emerge later but circumvents the effects of the periparturient rise of nematode egg production. However, strategic treatments select for anthelmintic resistance as the offspring of surviving worms will have only other survivors to mate with. Treatment before parturition and again at weaning, and moving to a clean pasture, along with yearly anthelmintic rotation, will serve the rancher well. Treating meat kids as they are weaned and moving them to clean pastures is a strategic approach.

Tactical

When weather conditions have been favorable for the transmission of parasites (Haemonchus requires 2 inches of rainfall in a month with a mean temperature of 60EF or higher), eliminating worms from the gastrointestinal tract before they have the opportunity to reproduce and further contaminate the environment is a tactical approach. The timing of tactical deworming may be based on recent rain or it may be based on increasing fecal egg counts. There is a, more or less, linear relationship between the number of important adult nematodes and fecal worm egg counts in small ruminants. If the mean egg count of 10-12 animals in a flock is above 1000 to 2000 eggs per gram of feces, the flock should be dewormed even though there are no signs of disease. Treatment, especially when accompanied by movement to pastures with few parasites, or at the onset of dry weather may prevent an outbreak of disease. The time of year and species of parasite are important in determining when the egg count is critical. With Haemonchus a count of >1000 in May or June in lactating dams would be reason to treat, however, in September or October >2000 would be the cut off point in dry animals.

Opportunistic

Treatment may also be given when livestock are gathered for reasons such as shearing, or as a part of the flushing process. This treatment may be strategic or tactical but is usually just opportunistic. These treatments give the host a temporary reprieve from the deleterious effects of parasites and this may be sufficient to protect from disease. However, opportunistic treatment seldom affects the population of parasites in the environment so the effects are usually short lived and give the owner a false sense of security.

Individual

Treatment of wormy individuals may prove to be a worthwhile endeavor especially where resistance to anthelmintics is widespread. Individuals in a flock will have a higher egg excretion count than the average. This over-distribution of the parasite population can be lessened by the selective treatment of wormy individuals or by the removal of these individuals from the flock. This is a very time consuming approach and requires individual evaluation so it is probably not economical except in very small flocks. This approach does not put any selection pressure against the anthelmintic(s) used as many of the larvae ingested will come from untreated hosts. Conversely, identifying animals with low egg counts may be a way of identifying resistant animals in a flock. With the failure of many anthelmintics in small ruminants, this may become an important selection criterion.

Suppressive

Suppressive anthelmintic treatments are given at regular intervals. To be completely effective, this must be done before the worms which are acquired since the last deworming become reproducing adults themselves. This interval is approximately 3 weeks. However, this method of parasite control is expensive and fails to utilize the host's defences where they are applicable. Suppressive deworming is probably the most effective means of keeping parasite numbers lowered for a short period of time. However, this method will invariably lead to anthelmintic resistance by the parasite faster than when other approaches are utilized. Where large numbers of animals are confined to limited grazing, and either pasture rest, alternate grazing by other species, or tillage is impossible, suppressive deworming may have to be used.

Salvage

Salvage (treatment to save lives, not control parasites) is why anthelmintics are frequently used in small ruminants. This is treatment in the face of disease; the animals are frequently anemic, have bottle jaw or diarrhea due to the effects of worms. Whatever the case, animals may be in desperate straits and even if they have the genetic ability to resist worms, they will be overwhelmed. Although anthelmintics may remove thousands of worms from each of the treated animals, the pastures from which they came have billions of larvae awaiting ingestion. Under these circumstances, treatments at 2 to 3 week intervals may have to be practiced until weather conditions are no longer favorable for transmission.

Pasture Rotation

Over the years there have been advocates of pasture rotation schemes to aid in the control of parasitic disease. For the most part, pasture rotation schemes on improved pastures allow increased stocking density and increased populations of parasites. The improved nutritional status of the host on these pastures may overcome the deleterious effects of greater parasite exposure, but this is unlikely where Haemonchus is the primary parasite.

Pasture rotation may decrease parasite numbers in deferred grazing systems where a pasture is rested for at least 6 months during the cool or 3 months during the warm part of the year. Anything less than this is unlikely to effectively reduce larval populations in temperate climates. However, if the pasture were tilled and replanted, by the time regrowth had occurred, most of the infective larvae will have succumbed to the effects of solar radiation and desiccation. Studies comparing various deferred grazing systems in west Texas range lands have not shown significant differences among various management systems in the levels of most parasites acquired by lambs. The exception is Nematodirus, which was found in increased numbers in lambs grazing high-density low-frequency grazing systems at stocking rates higher than those in other management schemes. These studies were done during the "typical" dry summers which are the norm in west Texas. In wet tropics, due to the rapid depletion of energy reserves by infective larvae, short pasture rest periods (as few as 60 days) appear to be adequate to control internal parasites in goats but looses the advantage of improved pasture nutrition as the vegetation has over matured.

Alternate grazing of different species of ruminants may be of value in controlling some species of parasites. When the range is shared by several foraging species, the competition for nutrition is usually intraspecific. Interspecific competition for preferred forage is of lesser importance because of feeding behavior. When sheep and goats are cohabiting brushy country such as in the Edwards Plateau of Texas or forested areas in the Southeast, sheep tend to graze and goats browse bushy herbage. In these circumstances, sheep may suffer from severe parasitic disease while the goats are relatively unscathed. On the other hand, when goats are forced to graze the same pastures as sheep and have little opportunity to browse, the same parasites devastate the goat population while the sheep are minimally affected.

Anthelmintic Resistance

When maximum small ruminant production is desired, parasitic disease is an important limiting factor. The judicious use of anthelmintics is essential, although drought, good nutrition, tilling soil, alternative species grazing, dung destroying insects etc. may all contribute to the demise of parasites. Because of the lack of effective approved anthelmintics in the United States, producers are by necessity going to have to evaluate drugs which are approved in other countries for use in small ruminants. The effectiveness of these drugs is going to be variable and may differ from farm to farm. Populations of Haemonchus resistant to thiabendazole were reported within a few years of its introduction in the United States in the early 1960's and these populations are still resistant to thiabendazole as well as to other benzimdazoles (white drenches).

Anthelmintics which may be effective against benzimidazole resistant Haemonchus include levamisole which appears to be effective on approximately 60% of ranches evaluated in Texas. However, resistance to this compound is increasing. Ivermectin resistance has been documented in the United States and there is evidence that the resistance may be widespread, however, it is still less common than benzimidazole or levamisole resistance.

Anthelmintics with different activity than those to which the worms have become resistant should be used when resistance is encountered. Because of anthelmintic resistance, it is imperative that anthelmintics are evaluated to determine if they are truly effective on a specific farm. The simplest method to measure efficacy is to determine fecal egg counts before and after (7 to 10 days) the use of an anthelmintic. If possible, some animals should remain as untreated controls to determine if other factors may be contributing to parasite loss. Evaluation of anthelmintics should be done yearly on goat farms.

A larval development assay has been developed in which worm eggs are placed in varying concentrations of anthelmintics. The concentrations of drug required to prevent the hatching of the eggs and/or development to the infective stage is correlated with the results seen in fecal egg reduction tests. The larval development assay determines which species of parasites are resistant or susceptible at a farm and evaluates benzimidazoles, levamisole, combinations, and macrolides in a single test. This test is more sensitive than the fecal egg resistance in determining if a resistant subpopulation is present. When compared to the fecal egg reduction test it may also indicate if underdosing or the failure of individual animals to metabolize or present the drug to the worm is present.

There are differences as to how anthelmintics are metabolized among host species. With presently available anthelmintics, a rule of thumb should be to dose a goat at a level 1.5 to 2 times higher than a sheep unless a goat dosage has been established for the product. Levamisole at 12 mg/kg (1.5 ×) is approaching the toxicity level for goats. None of the cattle injectable anthelmintics should be injected into sheep or goats. It is very likely that the use of subcutaneously administered ivermectin significantly increased the selection of resistant worms. In Great Britain, New Zealand and Texas anthelmintic resistance was first noted in goats and, if they were grazed with sheep, the resistant worms then infected the sheep.

Holding animals without feed overnight before drenching and then administering in a low volume dose over the tongue will increase the efficacy of benzimadazole anthelmintics. Dividing the dose of benzimidazoles by administering two or three drenches at 12 hour intervals will increase efficacy. Using two anthelmintics of different drug families concurrently such as fenbendazole and levamisole has been effective in controlling worms even when each of the drugs used separately are ineffective.

The selection for resistant worms is accomplished by removing susceptible worms. There is a direct relationship between the number of treatments and the onset of anthelmintic resistance. Owners buy resistant worms, then select for them. By not effectively treating and quarantining infected animals, they allow the establishment of resistance on their property. They further select by deworming too

often. If they are not 100% effective in controlling parasites, the surviving worms have only other survivors with which to mate with and a small resistant population can increase rapidly as each female Haemonchus produces 5,000 to 6,000 eggs per day. Fewer dewormings means that some susceptible worms will be present to mate with and the advent of observable resistance takes longer. Another factor that will speed up the onset of resistance is underdosing by administering anthelmintics to the flock with the dose based on mean weights rather than on the heaviest animals in the flock. Underdosing per se will not select for resistance when a single, dominant gene is responsible for resistance but it may where several genes are involved or where heterozygote worms have a level of resistance that is dose dependent. With the safety margins of available anthelmintics, adequate dosage is essential in preventing the onset of resistance.

Repeated treatment at or near the prepatent period selects for resistance as the population is constantly culled. Suppressive deworming has been very successful in selecting for anthelmintic resistance. Suppressive deworming also may prevent the development of immunological resistance and further increase dependency on anthelmintic treatment.

Anthelmintic Rotation

A strategy intended to prevent anthelmintic resistance from occurring is by switching anthelmintics each time used. The rationale for doing this is that the worms will be exposed to a different drug than they had previously encountered and will not become resistant to the new drug. This is a very persuasive theory but unfortunately false. Researchers have demonstrated that rapid (within a grazing season) rotation of anthelmintics leads to resistance to all the compounds used in the rotation faster than if a product is used until no longer effective, then another drug is substituted. Slow rotation (use for a grazing season then switch the next year) is more likely to retard the development of resistance.

Summary

Present recommendations are to: 1) Make certain that the anthelmintic or combination used on a farm actually works (kills at least 90% of the available worms). 2) Deworm the flock during the period the worms are in hypobiosis and are being transmitted at low levels, ie the winter. 3) Utilize clean or safe pastures when possible; the aftermath of crops, annual forages, rotational or co-grazing with cattle or horses. 4) Rotate anthelmintics yearly, if effective drugs are available. 5) Deworm new animals, place them in a non-pasture environment such as a dry lot or barn after treatment and only allow them to forage after they are examined for the presence of worm eggs and none are found 7 to 14 days after treatment.

Other recommendations may be made depending on the management, climate, and forage the flock are subjected to. Selection of individuals resistant to worms, zero grazing systems or other suggestions may be ideal for some flocks but not at all practical for others. The interactions among parasites, hosts and environment are complex so there are no simple answers to everyone's problems.

Coccidiostats for use in small ruminants. Not all of the products listed are approved for use in the United States but have been used and are approved in other countries.

Chemical Name	Trade Name	Feed Dose
*Amprolium	Corid	42 g/100 gal H_20
Monensin[1]	Rumensin	15 g/ton
Lasalocid[2]	Bovatec	25 g/ton
Decoquinate	Deccox	27 g/ton
Sulfa methiazine	Sulmet	50 g/ton

The above are levels of coccidiostats for the prevention of coccidiosis during times of exposure to oocysts. Treatment times vary as will level needed for treating sick animals.

*Do not use for more than 28 days.

[1]Appears to be more effective in goats than sheep.
[2]Appears to be more effective in sheep than goats.

Suggested Readings

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HERD HEALTH MANAGEMENT PRACTICES FOR GOAT PRODUCTION

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Introduction

In any livestock production system, certain diseases and production constraints can be anticipated on the basis of accumulated experiences. Herd Health management and preventive medicine programs are designed to minimize potential adverse effects of these predictable constraints and to protect against unexpected ones. The goal of the program is to improve the goat herd's productivity through general husbandry, nutritional management, parasite control, vaccination, and environmental management. An understanding of some of these management practices and common disease problems is helpful to accomplish these goals.

In general, great emphasis would have to be placed on kid rearing techniques to reduce neonatal mortality and diseases that inhibit the rapid, efficient growth of young kids such as pneumonia, coccidiosis, and gastrointestinal parasites. A major obstacle to newborn kids survival is hypothermia/hypoglycemia and infectious diseases due to delayed or an inadequate intake of a colostrum. Failure of passive transfer of maternal antibodies to newborn kids leads to increased disease incidence and death throughout the postnatal period. The does in late pregnancy should receive their yearly vaccination booster for enterotoxemia and tetanus. The vaccine will both protect the doe and ensure high levels of antibodies in the colostrum, which will subsequently protect the newborn kid. Therefore, kidding should be a well-anticipated event, not an unexpected surprise. Being prepared for routine processing of kids at birth, such as dipping navels, colostrum feeding, and being ready to respond to emergencies will reduce neonatal mortality.

In goats surviving the neonatal period, diseases that inhibit rapid, efficient growth are pneumonia, coccidiosis, and gasterointestinal parasites. In finishing programs in which young goats are pushed on concentrate feeds, conditions such as bloat, urinary calculi, grain overload, and enterotoxemia are likely to be seen.

Conditions that could cause markdown or condemnation at slaughter, such as caseous lymphadenitis leading to lymph node and visceral abscesses, also need to be controlled. Finally, when therapeutic efficacy is not compromised, drugs and vaccines should be given subcutaneously rather than intramuscularly to minimize damage to muscle tissue. Subcutaneous injection is best made into the

loose skin of the side of the neck or on the chest wall about 2 inches behind the shoulder. The skin of the injection site must be cleaned with 70% alcohol. A 20-gauge, one-inch needle can be used for an adult goat. Limit the volume of medication to 5 ml per site. If you have to inject a medication intramuscularly, inject it in the neck or thigh muscle. Gluteal muscle ***should not*** be used for IM injections in goats. Owners who find it necessary to administer drugs to goats should become familiar with the limitation of the medication. They should read the label and get advice from their veterinarian. Drug withdrawal times vary widely depending on the type used. Do not market or use meat and milk until the end of this withdrawal period. If meat and milk are tested and found to contain violative residues, the producer is identified and is subject to investigations.

Caprine Arthritis Encephalitis (CAE)

Caprine arthritis-encephalitis, caused by a retrovirus, is a relatively new disease of goats first diagnosed in 1974. In spite of this, CAE is now considered as one of the most important disease affecting the goat industry in the United States. All breeds of goats are susceptible to CAE, however, serological surveys indicate that the disease is most common among the dairy goat breed. CAE virus is transmitted naturally in the neonatal period from an infected adult goat to the kid through consumption of colostrum and milk. There is evidence to suggest that CAE can also be transmitted directly from goat to goat possibly through saliva, nasal secretions, urine, or feces.

Under natural conditions, the CAE virus is associated with two disease syndromes. The encephalitis form is most commonly encountered in kids 2 to 4 months of age and is characterized by paralysis that may or may not progress to seizures or death. The arthritic form is most common, and is seen in adult goats 1 to 2 years of age. Affected goats gradually lose weight and develop a poor hair coat and enlarged joints, particularly the carpal, hocks, and stifle. Early in the course of the disease, affected animals may show a progressive and sometimes shifting, leg lameness, however, as the disease progresses, affected goats may walk on their knees and refuse to rise. A presumptive diagnosis can be made based on the history and clinical findings, taking into consideration the age of the animal and disease pattern. Serological tests are available for diagnosis and screening of herds.

There are no known treatments for any of the clinical forms of CAE. Animals with mild cases of the arthritic form can be made more comfortable by providing regular, correct hoof trimming, providing easily accessible feed and water, and by long-term use of oral nonsteroid antinflammatory drugs to relieve pain (aspirin at the dose of 10 to 20 mg/kg every 8 to 2 hours and phenylbutazone at a dose of 10 mg/kg once a day). Goats with advanced cases of the arthritic form, unable to extend the legs and forced to walk on their flexed knees, should be humanely euthanized.

Before a control program can be instituted, the incidence of infection in the herd should be established using the serological test. If a herd is negative for CAE, it can be kept free of CAE by managing it as a closed herd and only introducing new genetic stock that has been tested free of CAE. Periodic herd test for CAE should be performed to monitor the herd's status. In an infected herd, culling should be considered. Kids should be removed from their dams before they are able to stand and suckle, and should be fed a pasteurized goat colostrum and raised on pasteurized milk or milk

replacer. Kids should also be kept separate to avoid contact with adults.

Caseous Lymphadenitis

Caseous lymphadenitis is a bacterial infection of goats, caused by Corynobacterium pseudo tuberculosis. It is frequently referred as "abscesses" because swelling, rupture, and drainage of pus from affected lymph nodes is how it is expressed.

Transmission is by goat-to-goat contact through wounds, abraded or even unbroken skin, or by indirect means via brushes, clippers, or contaminated premises. Pus from ruptured abscesses can contaminate the environment, such as feed, fence posts, feeders, or other structures, which can in turn infect other goats.

Clinical signs include enlargement of one or more of the superficial lymph nodes. The most common ones in goats involved are lymph nodes of the parotid followed by prescapular. The abscesses commonly rupture and a thick, green pus is discharged. Internal abscesses, especially in the lungs, may develop and lead to respiratory disease.

Diagnosis of the condition is based on the presence of a firm to slightly fluctuant subcutaneous swelling in the anatomic location of a lymph node. In a herd with a history of caseous lymphadenitis, the clinical findings alone are considered presumptive evidence. A definitive diagnosis can be made by isolation and identification of the organism.. Some serological tests have been developed and are used in the diagnosis and screening of goats for the disease.

Treatment with repeated injection of antibiotics does not resolve or eliminate the problem. The infected animal should be separated and isolated. Ripened abscesses can be lanced and flushed with diluted disinfectants. People performing this procedure should wear gloves, because the infection is potentially enzootic. The pus should be collected and destroyed and the goat should be isolated until the lesion is completely healed, typically 20 to 30 days later.

Eradication from a herd is difficult. The owners must be willing to cull animals with multiple abscesses and stop purchasing animals from infected herds. Control can be accomplished in part by removing clinically infected animals from the herd and avoiding contamination of the environment. A vaccine is available and should be considered as a last resort. The vaccine causes severe reaction in infected animals and interferes with serologic testing.

Floppy Kid Syndrome

Floppy kid syndrome (metabolic acidosis without dehydration in kids) was first reported in the Spring of 1987. This unique condition was first recognized in herds on the west coast and in Canada. It has more recently been recognized throughout the United States. With the increase in popularity of Boer and other meat goats, there has been an apparent increase in reports of floppy kid syndrome in Texas and other states where meat goat number is increasing.

The affected kid is normal at birth and develops a sudden onset of muscular weakness (flaccid paresis or paralysis) or ataxia at 3 to 10 days of age. Cases tend to occur most commonly late in kidding seasons. Affected kids are depressed, cannot use their tongues to suckle but can swallow and have marked paradoxial metabolic acidosis (8 anion gap 9 HCO_3, normal chloride). There are no signs of diarrhea, respiratory disease, or other signs.

The clinical signs of paresis/paralysis/ataxia in 3 to 10-day old kids and supporting blood chemistry value are diagnostic features. The causative agents have not been identified. However, infection and endotoxemia could likely be the cause. Differential diagnoses include white muscle disease, abomasal bloat, colibacillosis, septicemia, or enterotoxemia.

Early detection and correction of a base deficit as well as good supportive care are critical. Since the etiologic agent is not known, no preventive or treatments, aside from correction of electrolyte imbalance and supportive care, is recommended. Less severe cases are most commonly treated by owners with oral bicarbonate or peptobismol at the onset of signs. Kids may need to be fed milk by stomach tube. More severe cases may require blood chemistry and intravenous fluid. A mixture of 2 teaspoons of baking soda, ½ teaspoon salt in a quart of water has been used successfully. Give 4 oounces of this mixture by mouth every 4 hours. Recovery has been seen in 12 hours.

Contagious Ecthyma

Contagious ecthyma, also known as orf and sore mouth, is a contagious, zoonotic disease of sheep and goat caused by parapox virus. The virus forms scab or pus-like sores typically around the mouth and on the lips of goats. These sores can also appear on face, ears, feet, scrotum, teats, or vulva. The incidence of the disease may be increasing.

Infection spreads among animals by direct or indirect contact. Infected suckling kids contaminate the udder of dams and spread viruses among siblings. There is no specific treatment. One or a few lesions on the lips or nostrils cause little discomfort to the animal, however, lesions over both lower and upper lips cause intense pain, anorexia, and weight loss. Feeding softer concentrate feed may be beneficial to prevent severe weight loss. Diagnosis is usually by herd history and characteristic lesion.

The virus causing this disease is contagious to humans and any person handling goats with sores should wear rubber gloves. Affected goats should be isolated. When buying goats at a sale or direct from the farm, check for the history of a sore mouth. Some states require quarantine of the farm and no animal can be sold until symptoms are gone.

A live vaccine is available. Do not use vaccine in flocks exposed to the disease. The vaccine is recommended only if a sore mouth is a problem in the herd.

Urolithiasis

In goats, clinical obstructive urolithiasis is most frequently seen in young, castrated males fed grain. Urinary calculi can also cause obstructive disease in intact male and may result in their destruction as breeding animals. The tendency for urinary calculi to become lodged in the urethra derives from anatomic factors and castration practices in male ruminants. Increased urine concentration from a decreased water intake or increased water loss are other contributing factors. This condition is a well-recognized, highly prevalent, and costly disease of fattening steers and sheep wethers maintained in feedlot conditions and fed high a concentrate ration. This could be a potential condition in meat goats raised on a high concentration ration.

Clinical signs include restlessness and anxiety. Tail twitching is an early sign. There may be excessive vocalization and animals will strain frequently and forcefully to urinate. Marked abdominal press may produce some degree of rectal prolapse. Inexperienced owners may assume that the animals are constipated and medicate goats inappropriately rather than seeking veterinary attention. Drops of bloody urine and(or) crystals may be seen attached to preputial hairs. Animals with partial obstruction may be able to void small intermittent streams of urine, but show discomfort.

When the obstruction goes uncorrected, rupture of the bladder or urethra usually results within 24 to 48 hours. Subcutaneous filling of the preputial or perineal region becomes noticeable when the urethra is ruptured. Advanced cases often are presented in a terminal stage and the condition is fatal if left untreated.

When conservative treatment does not alleviate the condition, or if urinary tract rupture has occurred, then some sort of surgical intervention is necessary. Dietary management is the key to control and prevention of obstructive urolithiasis. Providing a continuous supply of clean, fresh water, increasing the concentration of salt in the ration up to 4% to promote water consumption and diuresis are other management factors. Prophylactic uses of urinary acidifiers have also been advocated. Continuous administration of ammonium chloride along with grain at the level of 1 to 2% has been recommended in goats. Concentrations as low as 0.5% have been used successfully to control urolithiasis in Angora goats in Texas.

Polioencephalomalacia

Polioencephalomalacia (thiamine deficiency) in goats is increasingly recognized under intensive management conditions when goats are fed more concentrated feed to encourage accelerated growth or increased production. The cause of this disease is either a thiamine deficiency or an inhibition of thiamine activity. In goats, the disease typically targets animals that are two months to three years of age. The condition has also been seen in young goats consuming thiamine- deficient milk replacers. Sudden changes in diet, the use of horse feed high in molasses, the feeding of moldy hay, the dietary stress of weaning, deworming with levamisole, and thiabendazole, some species of a fern, and overdosing of amprolium have all been associated with cases of caprine polioencephalomalacia.

Clinical signs may occur acutely or slowly over several days. The initial signs are depressing, anorexia, and(or) diarrhea with gradual expression of a neurological dysfunction over a period of one to seven days. Early neurological signs include excitability, elevation of the head while standing, drowsiness, circling, ataxia, muscle tremors, and apparent blindness. As the disease progresses, rigidity, recumbency, nystagmus, and convulsions are observed. If there is no therapeutic intervention, goats will usually die between 24 to 72 hours after an onset of clinical signs.

Diagnosis is primarily based on the history and observation of clinical signs under field condition. Other diseases with similar signs such as enterotoxemia and pregnancy toxemia should be ruled out. The critical nature of this disease demands swift intervention by a veterinarian. Goats that are diagnosed during the early stages of polioencephalomalacia respond well to parental administration of thiamine. The vitamin can be given at a dose of 10 to 20 mg/kg intramuscularly or subcutaneously three to four times, for 24 hours. Thiamine hydrochloride is more frequently used. If only multiple B vitamins are available, be sure to dose according to thiamine content. Some cases may require intravenous fluids and tranquilizers.

Common control measures include an increase in roughage feeding with a concomitant decrease in concentrate feeding, avoiding moldy feeds and feeds containing a large amount of molasses such as horse feed. Weaning procedures should be reviewed to ensure that kids are obtaining adequate roughage before weaning. In problem herds, supplementation of the grain ration with thiamine (50 to60 mg per animal daily) or brewer's yeast may be initiated.

Pinkeye

Infectious keratoconjunctivitis (pinkeye) has been reported in goats as well as sheep and cattle. Mycoplasma and Chlamydia are currently believed to be the most common cause of keratoconjunctivitis in goats in the United States. Moraxella bovis, an important cause of pinkeye in cattle, is not involved in caprine keratoconjunctivitis. Cattle pinkeye vaccine has no place in goat medicine.

Early or mild cases show lacrimation and red and swollen conjunctiva. The cornea may be slightly hazy at the corner or entirely opaque. Some animals develop corneal ulcer, and the ulcer may perforate. The eye is painful and held partially closed. If both eyes are opaque or ulceration occurs, the goat will lose body condition due to inability to eat.

The intensity of treatment varies according to the number of infected goats and concern of the owner. Local treatments with antibiotic ophthalmic ointments or solutions, systemic antibiotics, and subconjuntival injections are the treatment options.

Ringworm

A variety of dermatophytes have been cultured from ringworms in goats. These include Microsporum and Trichophyton species. Lesions in goats consist of alopacia, scaling, erytherma, and

crust. They typically involve the face, ears, neck or limbs, as well as scrotum. Young animals or those living in a dark, damp, and dirty environment are most at risk for developing ringworm. Management changes may be required to control an outbreak in goats. People handling infected goats should wear gloves to avoid contracting the infection themselves. Lime sulfur (2 to 5%), iodophors as total body sprays, or shampoo daily for five days and then weekly are recommended for treatment. Captain (3%) is effective but not approved for food-producing animals in the United States. Topical iodine ointment and thiabendazole paste can be used on small lesions. All in contact animals should also be treated. Griseofulvin has been used in goats at the dose of 20 mg/kg daily for 1 to 2 weeks orally with good response. Griseofulvin is not approved for use in food animals.

Zinc deficiency in goats can cause weight loss, alopacia, itching, a thick crust on the back of the leg, face, and ears, dandruff, stiff joints, hoof deformities, and small testes that results in reduced libido. Skin lesions caused by zinc deficiency is very similar to ringworm and can only be differentiated by a skin biopsy.

Tetanus

Tetanus (lockjaw) is a well-known clostridial disease of man and animals that produces a characteristic syndrome of muscular rigidity, hyperesthesia, and convulsions. The disease largely arises out of wound becoming contaminated. Goats are susceptible to tetanus and routine vaccination against tetanus is recommended in goats.

Clinical disease has been seen in a one week-old kid within four days of disbudding, and in an adult doe several months after dystocia. Early signs of tetanus include stiffness, “sawhorse” stance, and the ears and tail become stiff. There is reluctance to move, and difficulty opening the mouth. Over time, animals become hyperesthetic and respond dramatically to touch and loud noise by stiffening, collapsing to the ground, followed by seizure. Eventually animals are permanently recumbent, with rigid extension of all limbs and opisthotonus. Affected animals will show convulsion periodically at the slightest disturbance. Once recumbent, death usually occurs within 24 to 36 hours.

In almost all cases, there is a history of recent injury, surgical procedure, dystocia, or vaccination. The disease is almost always diagnosed on the basis of history and symptoms. Treatment and management of the tetanus patients often become very expensive and involved. This includes high doses of antibiotics, high level doses of tetanus antitoxins, wound therapy, fluids, and parental feeding.

The prognosis is always guarded. Tetanus can readily be prevented by a combination of vaccination and good hygiene. When the immune status of young kids is unknown, routine procedures such as disbudding and castration should be accompanied by injection of 150 to 250 units of tetanus antitoxin. When the status of adult is unknown, 500 to750 units of antitoxin can be administered when treating wounds and dystocias. It is recommended that routine vaccination for tetanus be incorporated into the herd health program for does, kids, and bucks.

Enterotoxemia

Enterotoxemia or overeating disease (OD) is caused by Clostridium perfringens, which is found commonly in the environment and intestinal tract. OD is a highly fatal disease mostly affecting young kids. The typical history is a young healthy kid found dead. The affected kid has a history of nursing a heavy milking doe or being on full feed.

The causative organism produces toxins which damage the intestinal tract causing a fatal toxemia. Adult animals can also be affected by OD.

Diagnosis of OD is best made based on a history of the sudden death of a previously healthy animal that is on full feed. Animals have actually been seen to drop to the ground, convulse, and be dead within a matter of minutes. Final diagnosis would include necropsy findings and the identification of the causative bacteria or toxin.

There is usually no opportunity to treat these animals. Specific antitoxin is available and should be given according to label directions. Affected animals should be treated with a high level of penicillin (5 cc/100 lb) and treated with fluids and steroids.

All goat herds need to have a regular vaccination program for OD. This will consist of annual CD/T vaccination given 4 weeks before expected parturition which will protect the kids for 1 to2 months. Kids are given a series of two vaccinations beginning at 4 weeks of age and repeated 3 to4 weeks later.

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Demand for Goat Meat: Implications for the Future of the Industry

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Introduction

Since 1990, several major international, national and regional meat goat production symposia have taken place in the Southern United States. In addition, several publications on improving meat goat production in that same geographical location have been written and distributed. Many goat experts view the South as ripe for the expanding meat goat industry. Why? The answer is simple: demand. If one were to look at a balance sheet state-by-state of goat production versus goat meat consumption, only one state would have a large positive balance on the side of goat production and that state is Texas (Pinkerton et al., 1994). Over half of the remaining 49 states would have a zero balance mainly because both production and consumption are low. The rest of the states would have a fairly large negative balance on the side of goat meat consumption because their goat production is low while consumption is high. Thus, these states need to import live goats or goat meat in order to meet demand. California, Florida and the states of the urban Northeast are in this latter category. The Southern United States is well positioned geographically to supply goats to these areas of high demand. The objective of this paper is to examine demand for goat products and the factors that influence demand.

Goat Meat Demand

In this section, we will examine two indirect indicators of goat meat demand, National Agricultural Statistical Service slaughter data and Foreign Agricultural Service import/export data. We will also investigate seasonal trends in goat meat consumption and who are the consumers of goat meat.

Domestic Slaughter

The demand for goat meat has continued to increase dramatically over the last two decades. In 1977, the first year that USDA began keeping statistics on goats slaughtered at federally inspected plants, approximately 35,000 goats were slaughtered nationwide (Figure 1; NASS, 1998). Before 1977, USDA tallied goat numbers with sheep numbers and knowing exactly many how goats were slaughtered at these plants is impossible. By 1998, slaughter numbers had risen to nearly 450,000, a 1000% increase over the 20-year period. The largest single yearly increase occurred in 1993, which was the first year of the three-year phase-out of the Wool and Mohair Incentive program. With the loss of the incentive program, Texas mohair producers sent marginally productive Angoras to market (Pinkerton and Harwell, 1994). After the August/September 1994 shearing season in Texas, the number of goats slaughtered in federally inspected facilities surpassed 10,000/week for the first time ever (see Figure 6). Texas Angora producers have continued to send large numbers of Angora goats to market due to the stagnant mohair market. Texas Angora goat numbers have dropped from 2.1 million in 1989 (Pinkerton, 1991) to 600,000 today (Livestock Weekly, 1999). In fact, there are now more meat-type goats than Angora goats in Texas (Livestock Weekly, 1999).

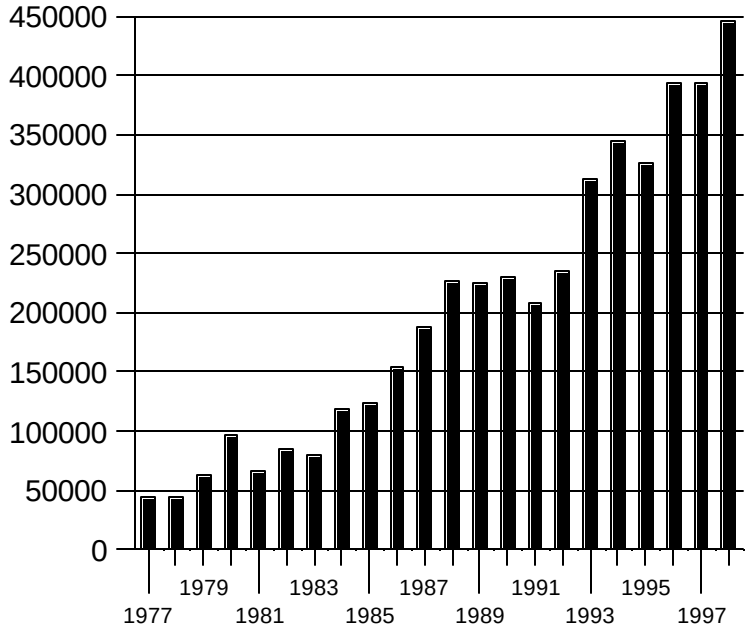

Figure 1. Number of goats slaughtered at USDA-inspected slaughter facilities.

These goat slaughter numbers pale in comparison to the slaughter numbers of the other red meat species, cattle and sheep. In 1998, nearly 450,000 goats, 3.4 million lambs and 34.7 million cattle were slaughtered. The number of goats slaughtered in 1997 represents ~13% of the lambs slaughtered and ~1% of the cattle slaughtered. In other words, there were as many cattle slaughtered in five days and lambs slaughtered in seven weeks as there were goats slaughtered in one year, assuming a constant rate of slaughter. However, of the three red meat species only goat numbers have significantly increased over the last two decades. The other two, lamb and cattle, have decreased or remained steady.

The regional distribution of the number of goats slaughtered is not uniform. NASS data for the number of goats slaughtered and the number of USDA-inspected facilities for each state was available from 1980 through 1991. Presently, that information is no longer available due to disclosure issues. The state NASS data was statistically clustered into three categories: high, medium and low states for the total number of goats slaughtered over the 12-year period, which was 1.8 million goats. Two states, Texas and New Jersey, were clustered into the high group and accounted for 52.5% of the goats slaughtered at USDA-inspected facilities during that time period, with nearly an equal split between the two states. Only one state, Connecticut, was clustered into the medium group and it accounted for 15% of the goats slaughtered. The other 47 states were clustered into the low group and accounted for 32.5% or approximately 0.7% of the goats slaughtered for each state. The number of USDA-inspected facilities for Texas, New Jersey and Connecticut remained stable over that 12-year period with Texas averaging 17 facilities, New Jersey 15 and Connecticut 11. The number of goats slaughtered increased significantly in those three states, therefore, the existing USDA-inspected facilities were increasing production but no new facilities came into production. These three states may have

been the leaders in terms of the number of goats slaughtered but not in the number of USDA-inspected facilities. Using the same NASS state dataset, states were clustered into high, medium and low groups concerning the 12-year average of the USDA-inspected slaughter facilities. One state, Pennsylvania, was clustered into the high group with an average of 83 USDA-inspected facilities that slaughtered goats from 1980 through 1991. Two states, New York and Missouri, were clustered into the medium group with an average of 50 facilities and the remaining 47 states averaged seven USDA-inspected facilities over the 12-year period.

It should be noted that goats, more so than lambs and cattle, also pass through other slaughter channels, e.g., state-inspected slaughter facilities and on-farm slaughter. Data on these other slaughter channels are unavailable or nonexistent. Therefore, knowing exactly how many goats are slaughtered in the United States annually is not possible.

Import/Export

Even with this significant increase in domestic slaughter, the United States is a net importer of goat meat (Figure 2; FAS, 1998). Since 1989, importation of chilled/frozen goat meat has continued to increase linearly while exportation of goat meat has decreased quadratically. Goat meat that was once exported to Canada, Mexico and the Caribbean is now being diverted to satisfy domestic demand. In 1991, imports surpassed exports and the United States became a net importer of goat meat. Last year the United states exported approximately 150 metric tons but imported nearly 4,500 metric tons. On a live goat

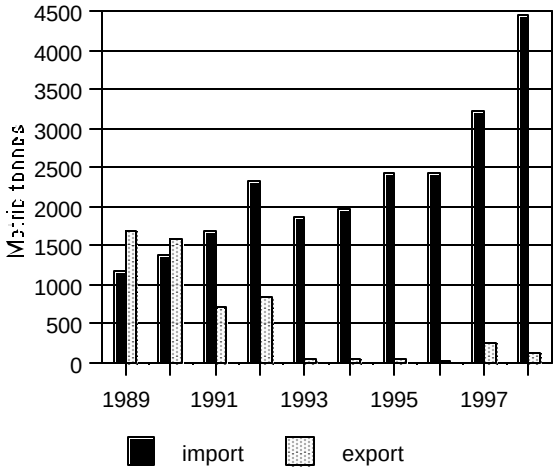

Figure 2. Importation and exportation of chilled/frozen goat meat

equivalent, the United states imported nearly 330,000 goat-equivalents in 1998, based on a 30 lbs. carcass, to satisfy demand. If this is coupled with the 1998 NASS data, then over three-quarter million goats were slaughtered last year to satisfy domestic demand with nearly 45% being derived from imports. In 1989, the United States imported 1,200 metric tons of frozen or chilled goat meat valued at $1.7 million (Figure 3; FAS, 1998). In 1998, imports rose to 4,500 metric tons valued at $11 million. That is an average annual rate of increase of over 600,000 lbs. of goat meat per year and an average annual increase of 7¢ per lbs.

Where does this large quantity of imported goat meat originate? Basically, only two countries are net exporters of goat meat worldwide and they are Australia and New Zealand. Both countries have large populations of feral goats and periodically these goats are rounded-up and harvested for export. New Zealand's share of the importation averages about 9% of the total importation and peaked in 1993 at 25%. This peak has been attributed to a devastating drought in Australia in the early 1990's from which it has since recovered (Pinkerton, 1995).

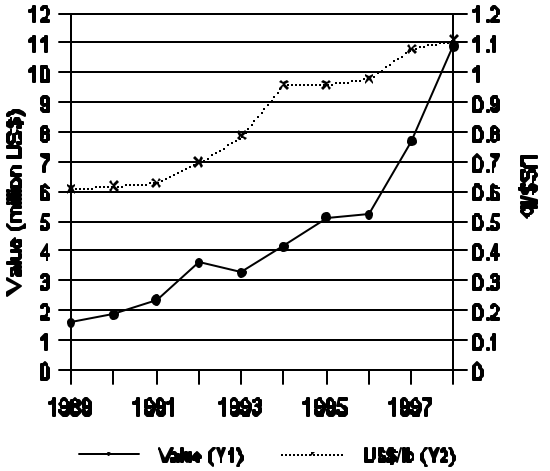

Figure 3. Total and per pound value of imported chilled/frozen goat meat

The importation of goat meat is not uniform across the United States. In 1998, three seaports, Philadelphia, San Francisco and Miami, accounted for 83% of the goat meat imported into the United States (Table 1). In this decade, these three ports accounted for 73% of the imported goat meat. The port with the greatest increase in import was Miami, FL with an annual rate of 101.6 metric tons.

Table 1. Ports of entry for chilled/frozen goat meat into the United States.

Port	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total
Los Angeles, CA	30	35	56	64	51	8	56	267	358	925
Miami, FL	222	11	265	295	573	776	614	886	795	4,437
Philadelphia, PA	213	483	448	238	397	639	514	909	1,580	5,421
San Francisco, CA	157	293	513	432	630	823	1,063	863	1,280	6,054
San Juan, PR	497	239	393	255	89	176	138	219	119	2,125
Tampa, FL	189	577	650	578	152	0	25	85	140	2,396
Others	53	46	35	6	77	3	7	0	174*	401

*140 metric tonnes imported through Savannah, GA

Seasonal Trends

The demand for goat meat appears seasonal. Many goat producers have cited Easter, Muslim holidays, 4th of July and Christmas as periods of peak demand for goat meat. However, only Easter is substantiated as a peak demand using the NASS weekly data (Figure 6). The number of goats slaughtered doubles the two weeks before Easter. The increased demand for goat meat at Easter is predominately attributed to the "Easter kid" market. This market is driven by the Greek and Italian ethnic populations residing in the urban Northeast. Except for the cabrito market of Mexico, there might not be a year-round market for kids. The 4th of July, Christmas, Eid al-Fitr and Eid al-Adha do not significantly affect the baseline number of goats slaughtered (see Table 2 for Islamic holidays and explanation). A possible explanation for the nonsignificant effect of the Muslim holidays on goat slaughter is that the goat meat market is largely an ethnic market. The author has visited several slaughter facilities in the Northeast that cater to the Muslim (halal) slaughter trade. These wholesalers/retailers see only a slight increase in goat slaughter volume preceding the two Muslim holidays. They feel that the Muslim clientele is the group that bought goat meat last week and will be

the ones buying goat meat next week. Another possible explanation for the nonsignificant effect of the two Muslim holidays is that culturally Muslim prefer to slaughter the small ruminants themselves for these holidays. It is possible that for these holidays, Muslims are purchasing animals and slaughtering them on-farm. Unfortunately as was stated earlier, statistics for on-farm slaughter are nonexistent, therefore this hypothesis is untestable.

Table 2. Approximate Islamic Dates (Hijra 1420-1425)

	New Year	Ashura	Mawlid	Ramadan	al-Fitr	al-Adha
1420	4/17/99	4/26/99	6/26/99	12/9/99	1/8/00	3/16/00
1421	4/6/00	4/15/00	6/14/00	11/27/00	12/27/00	3/5/01
1422	3/27/01	4/5/01	6/5/01	11/17/01	12/16/01	2/23/02
1423	3/16/02	3/25/02	5/25/02	11/6/02	12/6/02	2/12/03
1424	3/5/03	3/14/03	5/14/03	10/27/03	11/25/03	2/1/04
1425	2/22/04	3/2/04	5/2/04	10/16/04	11/14/04	1/21/05

The Islamic calendar is a lunar calendar and the beginning of each month is the day after a new moon when a thin crescent can be seen. Eid al-Fitr and Eid al-Adha are two major Islamic festivals in which sheep and goat meat play an important role. Eid al-Fitr is the festival of the breaking of the month-long fast of Ramadan. Muslims are required to fast from sunrise until sunset during the ninth month (Ramadan) of their calender year. Fasting requirements vary from sect to sect but generally a Muslim may not eat, drink or even swallow their own spittle during daylight hours. After sunset, food and drink are allowed but the observer is generally so dehydrated and exhausted that the only things they care to do are drink water and sleep. The breaking (al-Fitr) of the month-long fast is indeed cause for celebration and a lavish feast of beef, mutton and goat meat is prepared. The preference is for

dishes prepared with mutton and goat. Eid al-Adha is a festival in celebration of God's deliverance of Abraham's son, Ismail (Ishmeal), from the sacrificial altar. In the Koran as in the Bible, a ram was substituted for Ismail/Isaac. On this feast day, every male head-of-household is required to slaughter a fatted ram but a goat may be substituted for the ram. Ashura is a celebration in remembrance of the martyrdom of the prophet Mohammed's grandsons. Mawlid is celebrated in honor of the prophet Mohammed's birthday

Ethnic Populations and Immigration Patterns

The portion of the American population that has a taste for goat meat appears to be increasing. According to the United States Census Bureau, 87,172 persons per month immigrated to the United States from 1990 through 1995. Pinkerton and coworkers (1995) estimated that a majority of these immigrants are goat meat consumers. The majority of these immigrants settled in the northeastern and western states, which received 62% (31% each region) of the immigrants, while only 12% of the immigrants settled in Midwestern states (Figure 4). However, within regions the immigration pattern is not uniform. Five states account for nearly two-thirds of the immigrants during the first half of this decade. California was the most popular destination with 23% of the immigrants settling there. New York accounted for 18%, Florida 9%, Texas 7% and New Jersey 6% of the immigrants.

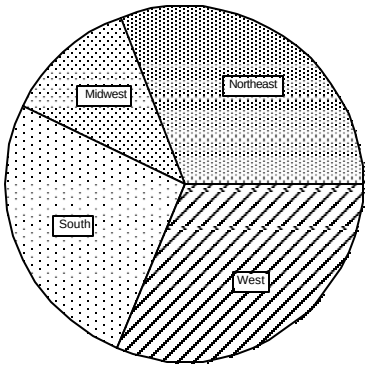

Figure 4. Regional immigration patterns from 1990 through 1995

At the turn of this century, the majority of the immigrants to the United States were from Europe. After World War II, immigration patterns shifted and now the majority of the immigrants to the United States come from Latin America, Asia, India and Africa. The three largest goat consuming ethnic populations in the United States are Hispanics, Muslims and the peoples from the Caribbean.

According to the most recent census information, Hispanics number more than 19 million, Muslims 14 million and peoples from the Caribbean slightly less than two million. Hispanics settled predominately in Texas, California and the Southwestern United States; however, sizable populations live in New York City and other cities of the urban Northeast. The US Census Bureau projects that from 1995 to 2050 Hispanics will account for 57% of the immigration into the United States. Hispanics are the fastest growing ethnic group in the United States and the Census Bureau projects that the percentage of the US population that is Hispanic will increase from 10% in 1995 to 25% by 2050. The vast majority of the Muslims in the United States reside in the urban belt stretching from Washington, D.C. to Boston, MA. Two cities in the United States account for a majority of the Caribbean immigrants, Miami and New York City (Pinkerton, 1995).

Each of these three ethnic groups have different preferences as to the type and weight of the carcass purchased. Hispanics prefer either young kids, cabrito, weighing 15-25 lbs. live weight or young goats that yield a 25 lbs. carcass (approximately 50 lbs. live weight). Muslims prefer a slightly heavier carcass in the 35 lbs. range (approximately 70 lbs. live weight). Muslims also prefer a lean carcass and will discriminate against an overly fat carcass because they think that the retailer is trying to slip them a sheep carcass in place of a goat. Animals destined for the Muslim market must be slaughtered in halal fashion with specific rituals and personnel prescribed by the Koran. Muslims prefer to purchase a carcass with its head on, so that they know that it has been slaughter in the halal style. This presents no problem for sheep which are typically hornless but is a problem for goats which are naturally horned. Federal inspection regulations require that horns be taken off the carcass at the time of slaughter. If the horns are not taken off properly, the carcass can be contaminated and therefore condemned. Processors feel that dehorning a carcass does not warrant the time and effort required

and generally will take off the heads of goats. Peoples from the Caribbean, especially Haitians and Jamaicans, prefer mature bucks from which they prepare goat's head soup and other dishes that are reported to have aphrodisiac qualities (Pinkerton, 1995). Goat curry, a popular goat dish for Jamaicans and Haitians, requires "cubed" bone-in pieces of meat which can be and is often derived from older, poor-conditioned goats.

It is often proposed that the meat goat industry concentrate on increasing goat meat consumption among the non-traditional consumers, i.e., Americans of European ancestry. This is usually proposed in conjunction with a marketing emphasis on developing packaged retail cuts of goat meat which can be sold in supermarket chains. It has been noted by several authorities on marketing that this is an uphill battle (Pinkerton et al., 1994; Degner, 1996). This section of the population consumes very little goat meat and is predicted to remain at this low level in the foreseeable future. However, if the low fat aspect of goat meat was promoted the health-conscious segment of the American population regardless of ethnic origin might be an important avenue for marketing.

Dietary preference is not hereditary and second generation immigrants are as likely to eat pizza and hamburgers as they are to eat ethnic dishes. The percentage of the US population that is foreign-born has increased since the 1970's, when it was at the lowest point of the 20th century (Figure 5). California leads the states with 25.1% of its population being foreign-born. Other states with a foreign-born percentage greater than 10% are New York with 17.7%, Hawaii with 16.6%, Florida with 15.2%,

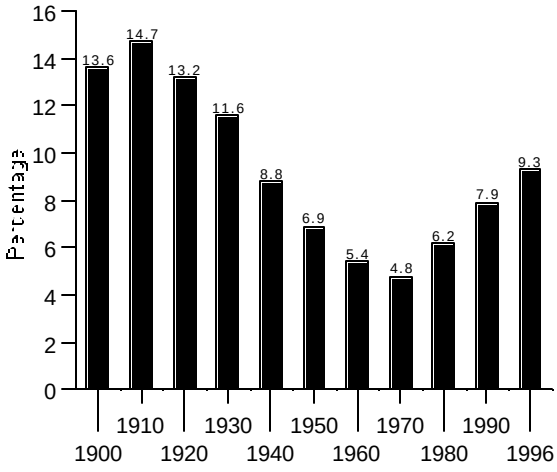

Figure 5. Percentage of US population that is foreign-born.

New Jersey with 14.6%, Nevada with 11.4%, Texas with 11.1%, Arizona with 10.9% and Rhode Island with 10.4%.

Conclusions

As can be deduced from National Agricultural Statistical Service and from Foreign Agriculture Service data, the demand for goat meat is increasing significantly. Domestic slaughter and imports continue to rise annually. However demand can be seasonal with Easter influencing significantly the number and type of goats slaughtered. The ethnic populations that fuel this demand are also increasing with regional concentration in the Northeast and West. Therefore, the prospects for the meat goat industry are promising. However, is the ethnic market enough to sustain the meat goat industry? The answer is yes and no. Yes, because an increasing ethnic population means increasing demand for goat meat, especially in the Northeast, California, Florida and Texas. No, because there is little or no emphasis placed upon product quality within many of the ethnic groups. If the price of fresh goat meat is too expensive relative to fresh lamb many ethnic consumers will switch to fresh lamb. Also, if the price of fresh domestic product is high compared to imported frozen goat or lamb many ethnic consumers will switch to imported product, be it goat or lamb. Therefore, the goat producer servicing the ethnic market must adopt management skills that will optimize the profit of their operation.

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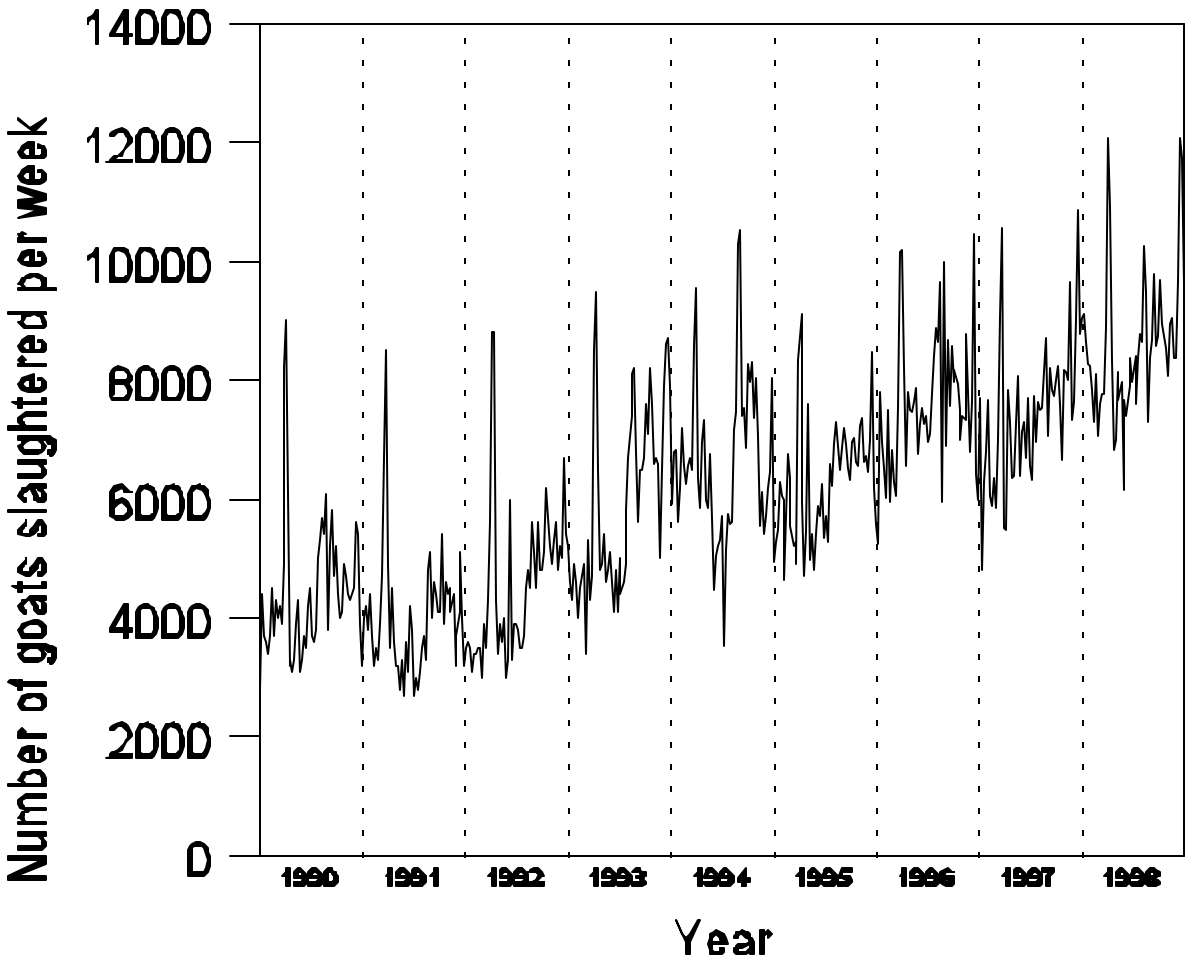


Figure 6. Time line of the number of goats slaughtered by week from 1990 through 1998.

The proper citation for this article is:

Gipson, T. A. 1999. Demand for Goat Meat: Implications for the Future of the Industry. Pages 23-30 in Proc. 14th Ann. Goat Field Day, Langston University, Langston, OK.

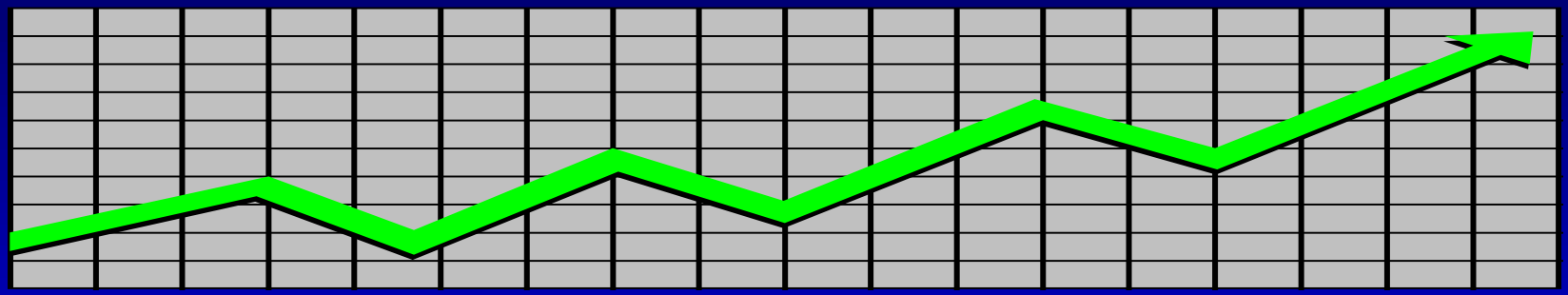
Demand for Goat Meat: Implications for the Future of the Industry

Terry A. Gipson
Langston University

Objective

- To examine current demand for goat meat and the factors influencing demand

Demand

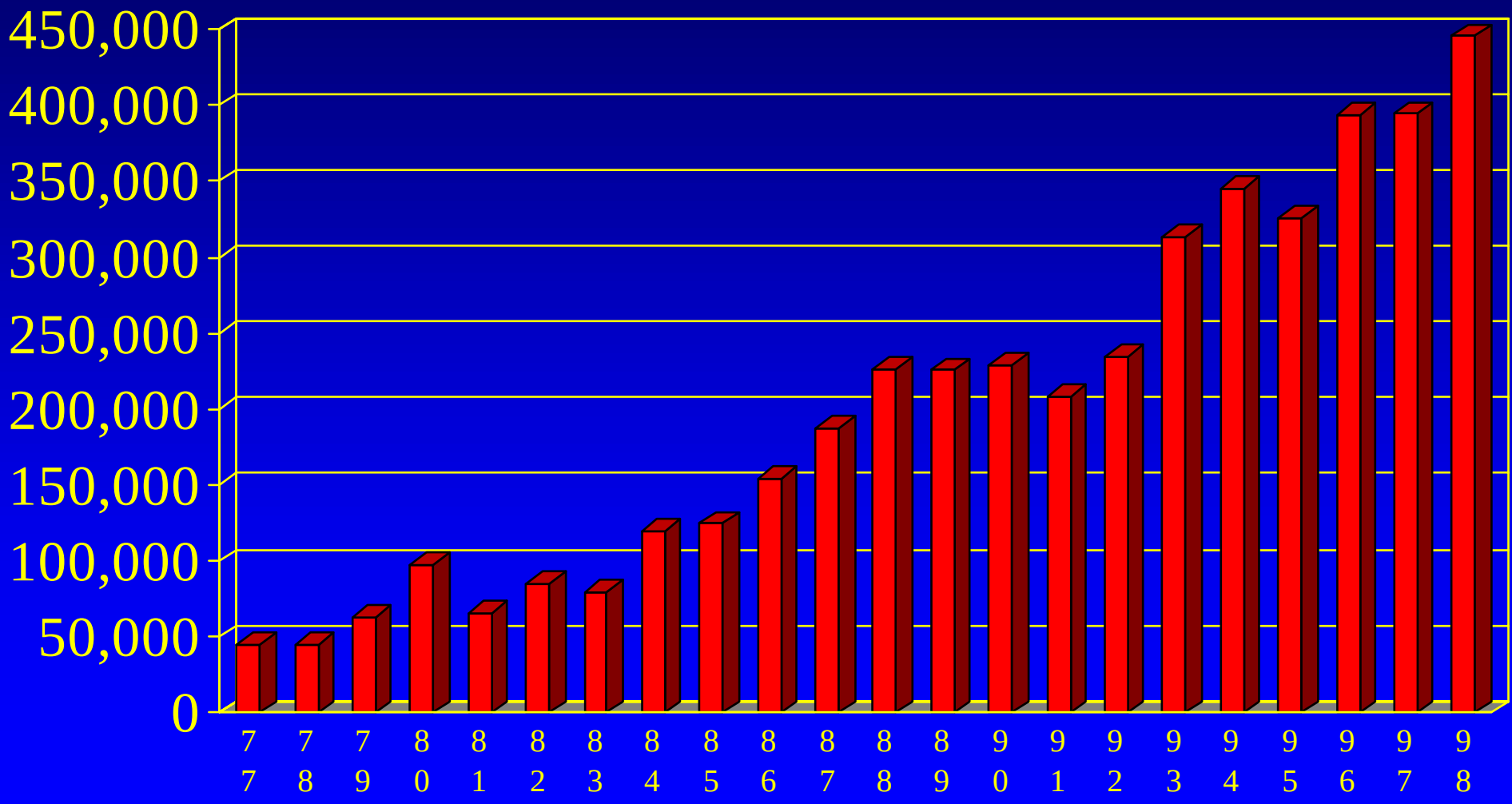


- Indicators
  - National Agricultural Statistical Service (NASS)
  - Foreign Agricultural Service (FAS)
- Regional Distribution
- Seasonal trends

NASS

- tracks the number of animals slaughtered only at federally inspected facilities
- goats: 1977 to present

Number of Goats Slaughtered at USDA-Inspected Facilities



Source: USDA / NASS, 1999

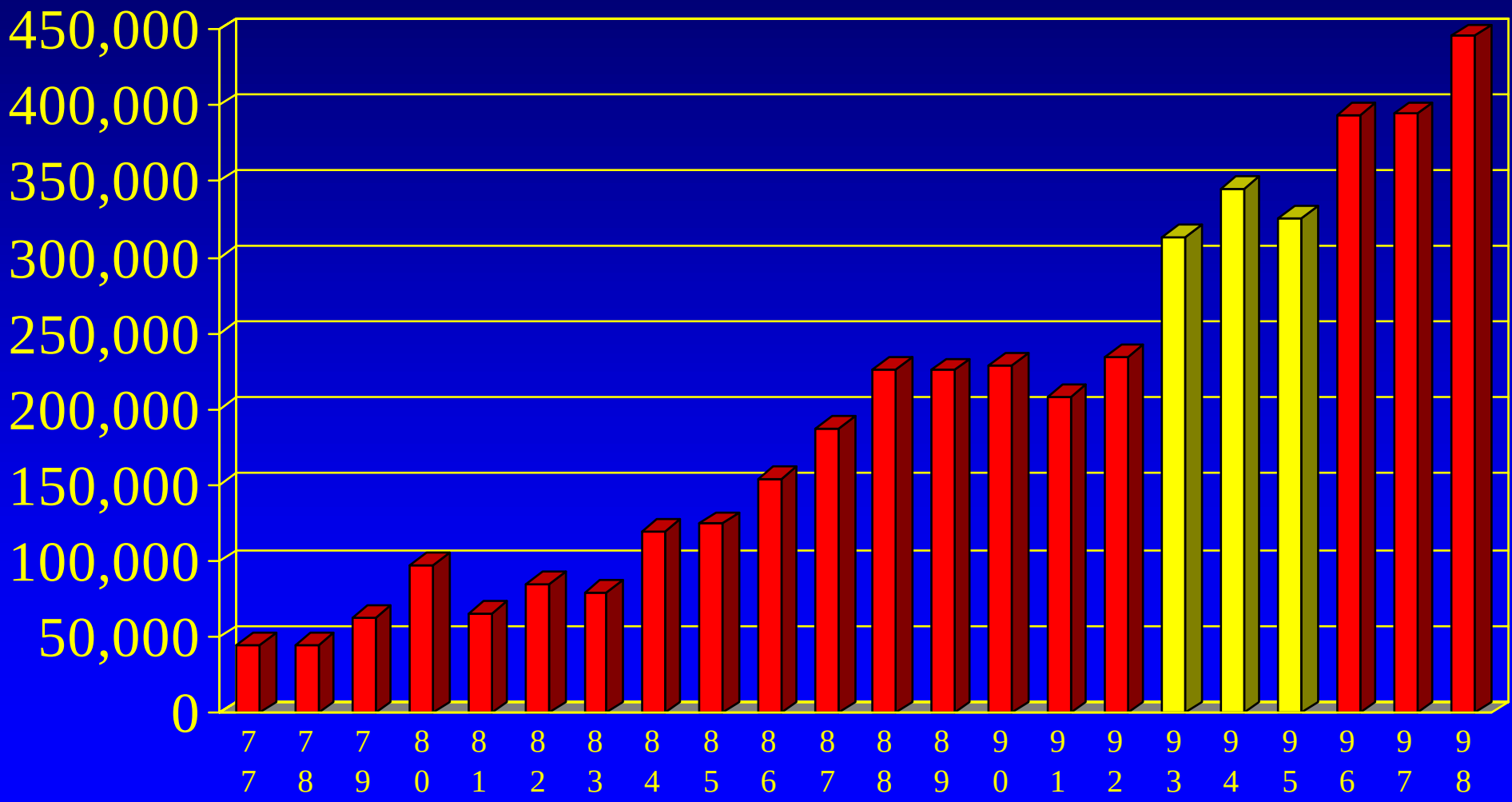
Species Comparison (1998)

Species	Number
Goats	445,723
Lamb	3,770,700
Cattle	35,566,800

Percentage Change from 1997

Species	% Change
Goats	+13
Lamb	-3
Cattle	-2

Number of Goats Slaughtered at USDA-Inspected Facilities



Source: USDA / NASS, 1998

Wool and Mohair Incentive Program

Year	Level of Incentive	Number of goats slaughtered	Percent increase over base*
1993	75%	313,500	40%
1994	50%	344,900	54%
1995	0%	326,122	45%

*Average of previous three years (1990, 1991, 1992)

Regional Distribution

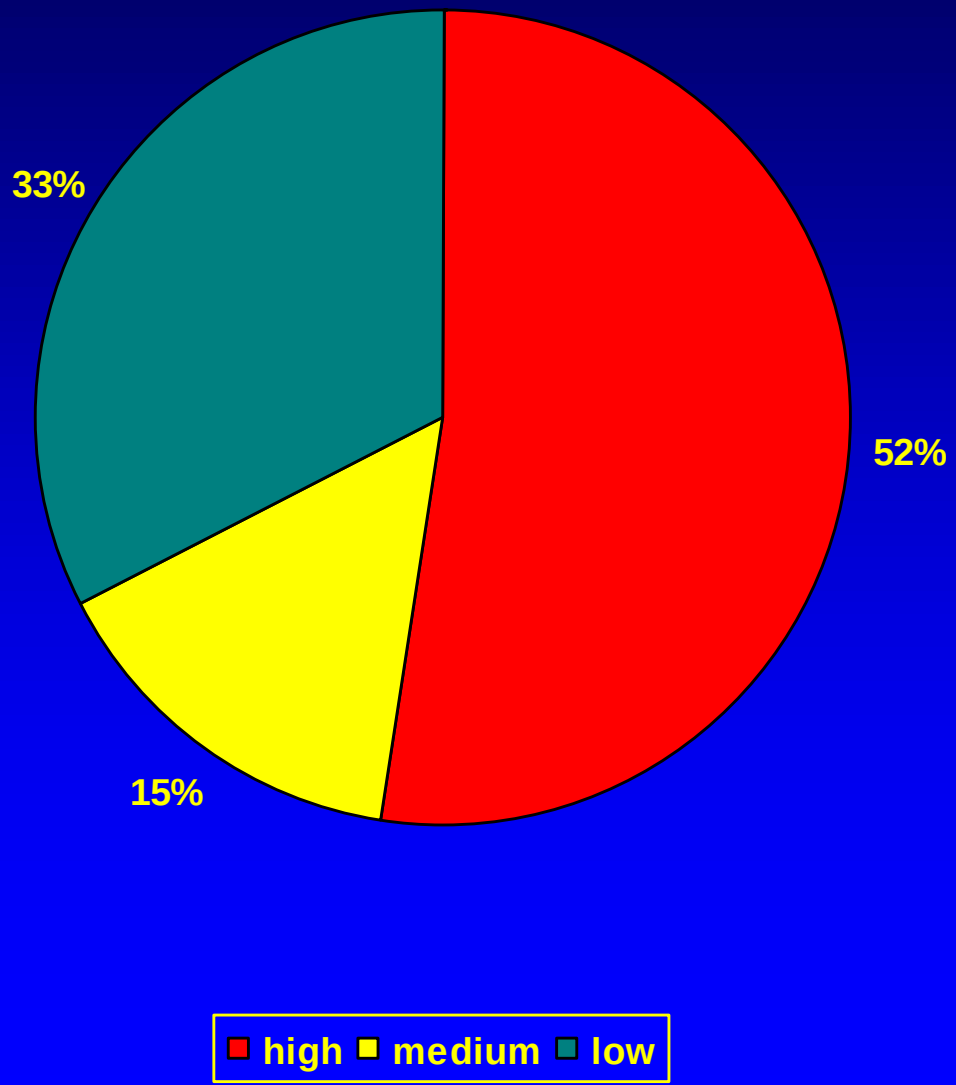
- Number of goats slaughtered
- Number of USDA-inspected facilities slaughtering goats

Regional Distribution

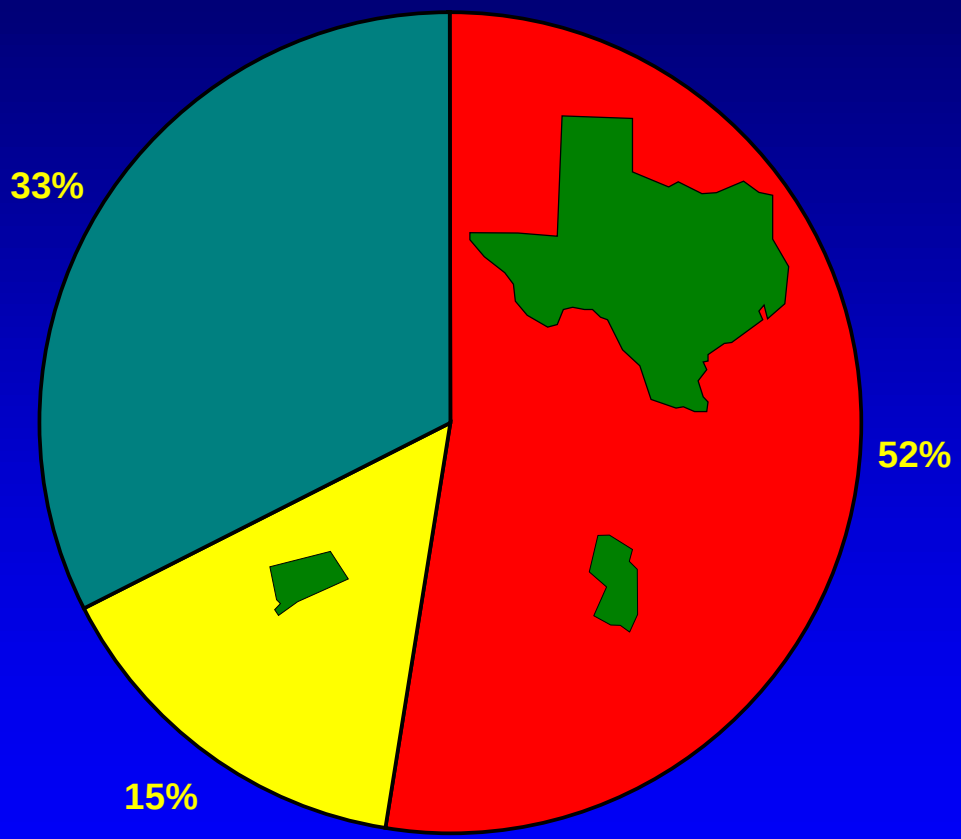
- NASS data from 1980 to 1991
- Cluster Analysis in SAS
- Three categories
  - high
  - medium
  - low

Results of cluster analysis

- number of goats slaughtered
- 12 yr total

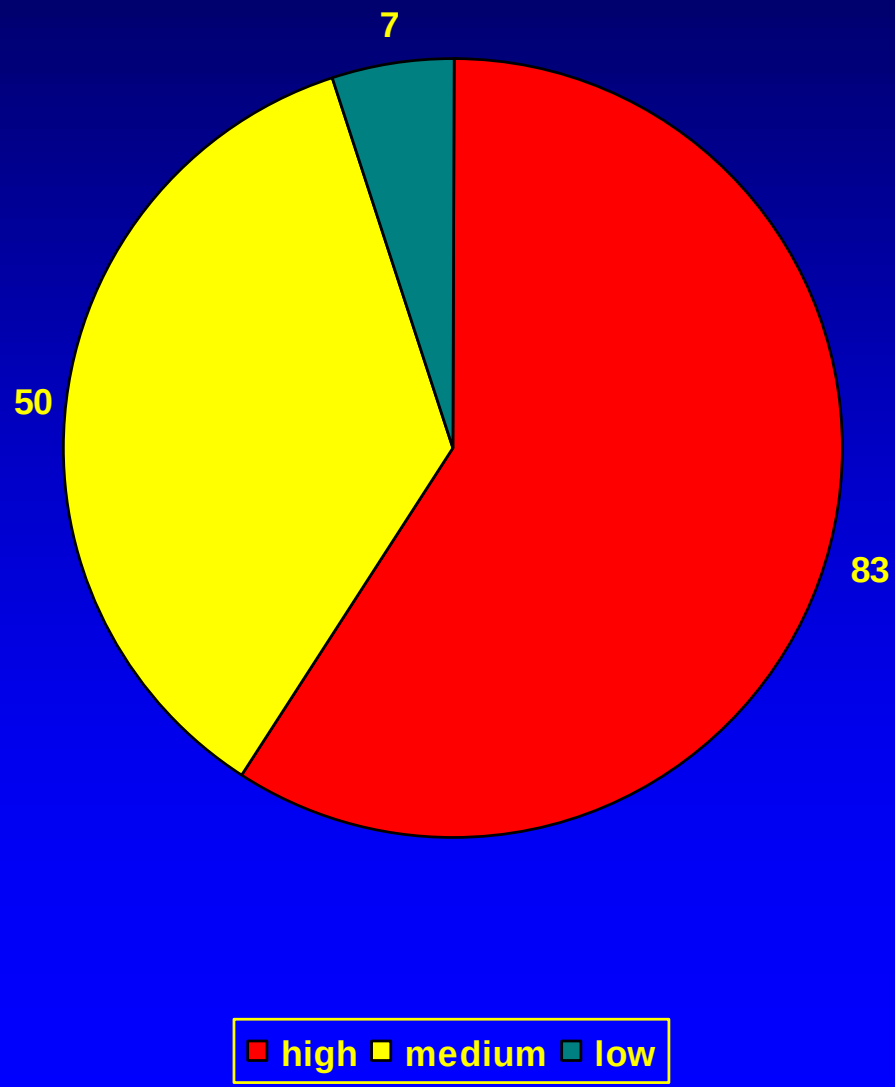


Top states

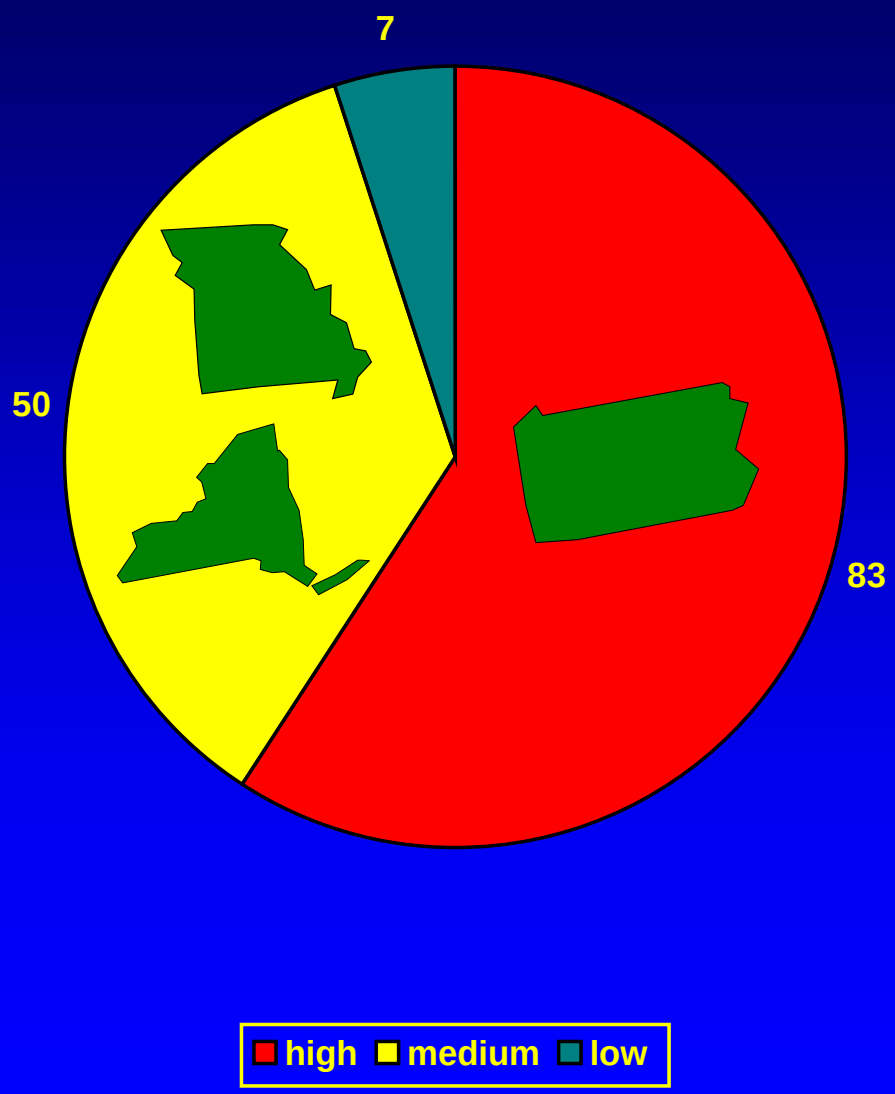


Results of cluster analysis

- number of slaughter facilities
- 12 yr average



Top three states

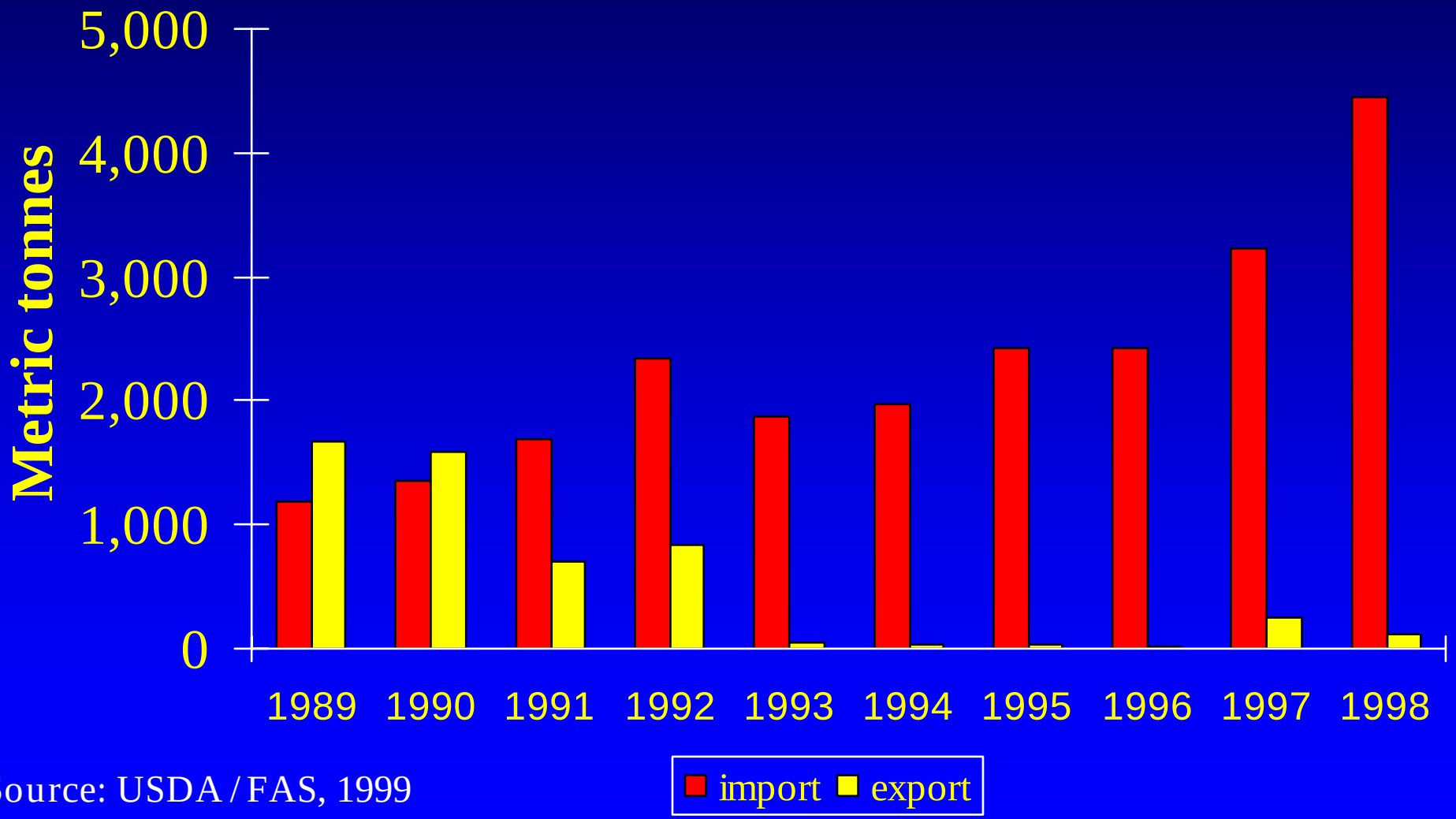


FAS

- tracks the importation and exportation of live animals and frozen / chilled carcasses

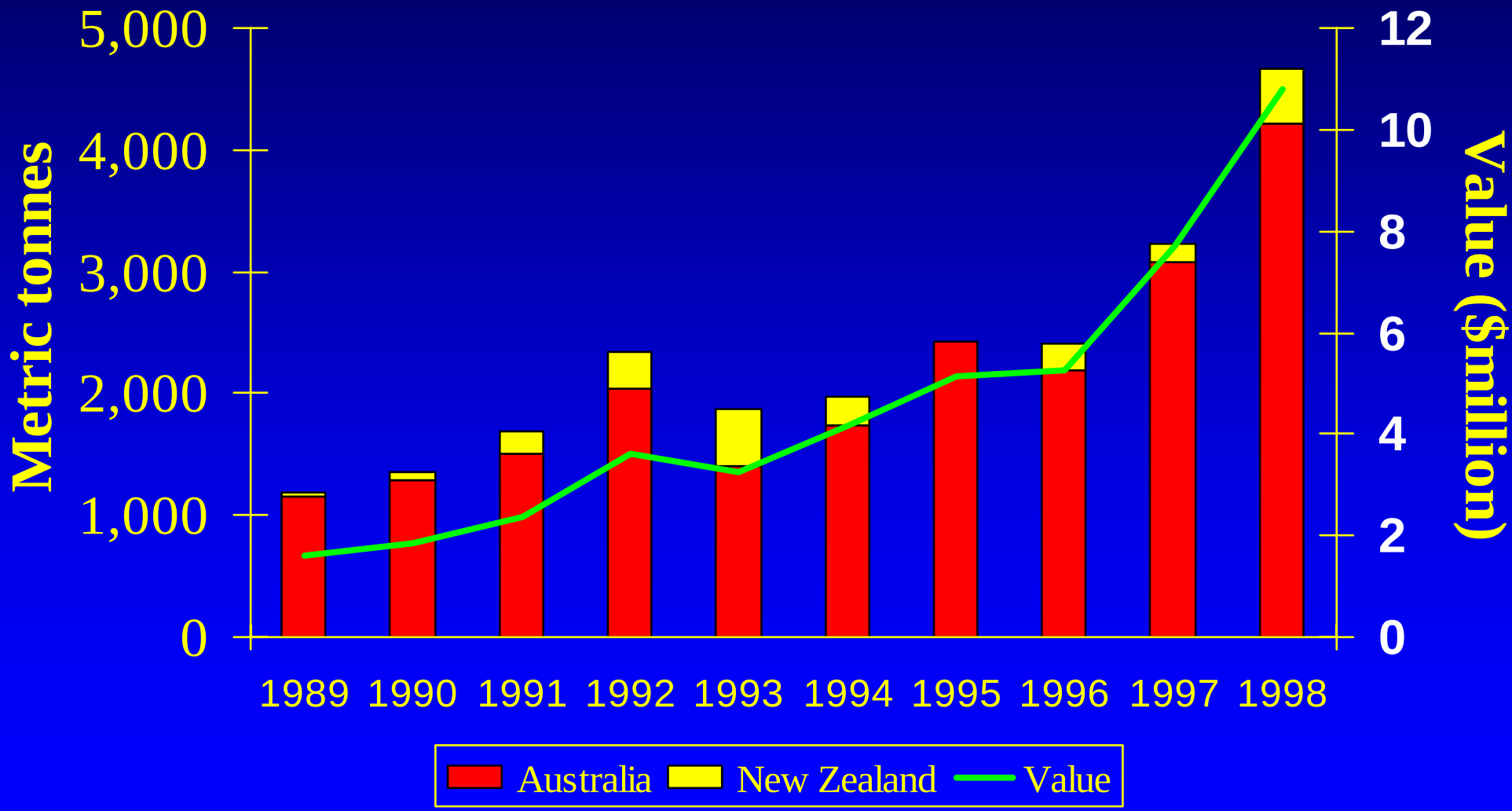
- goats: 1989 to present

Importation and Exportation of Chilled / Frozen Goat Meat



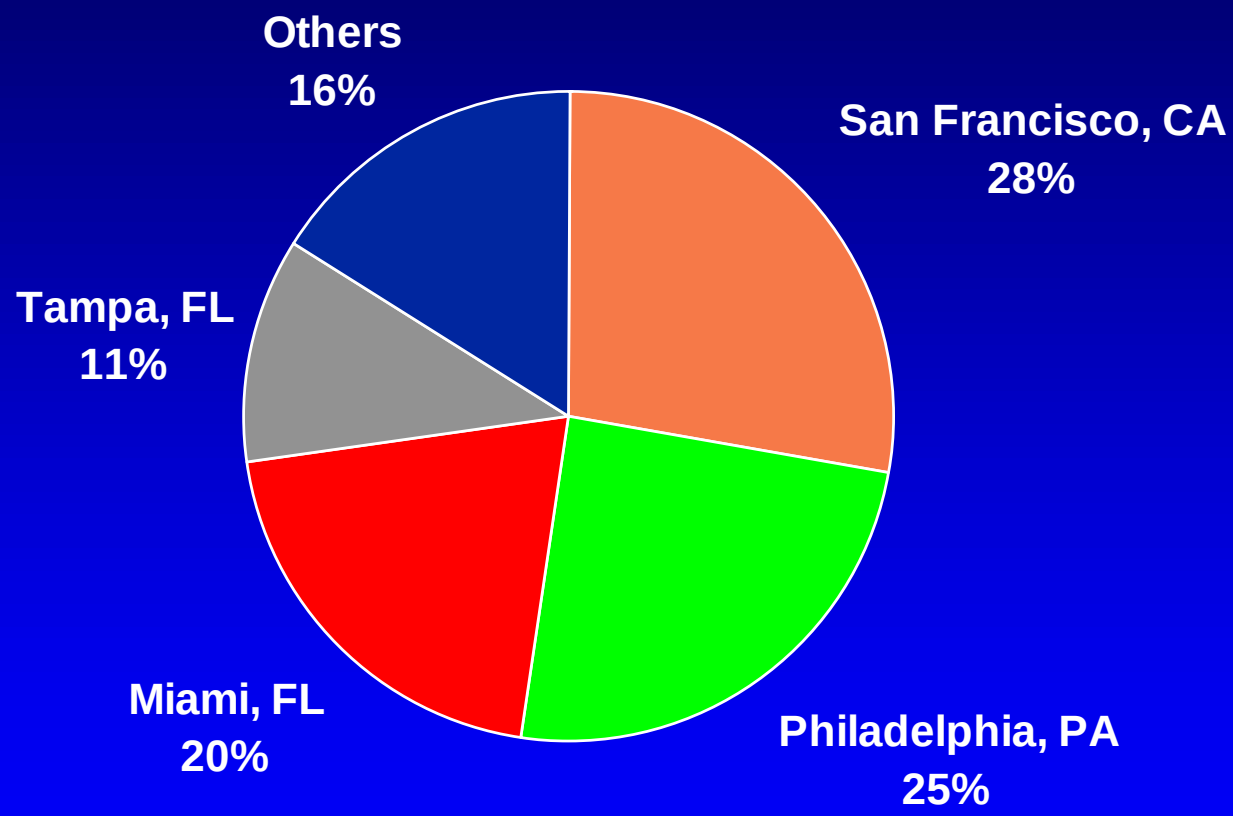
Source: USDA / FAS, 1999

Importation of Chilled / Frozen Goat Meat



Source: USDA / FAS, 1999

Ports of Entry in 1990-1998



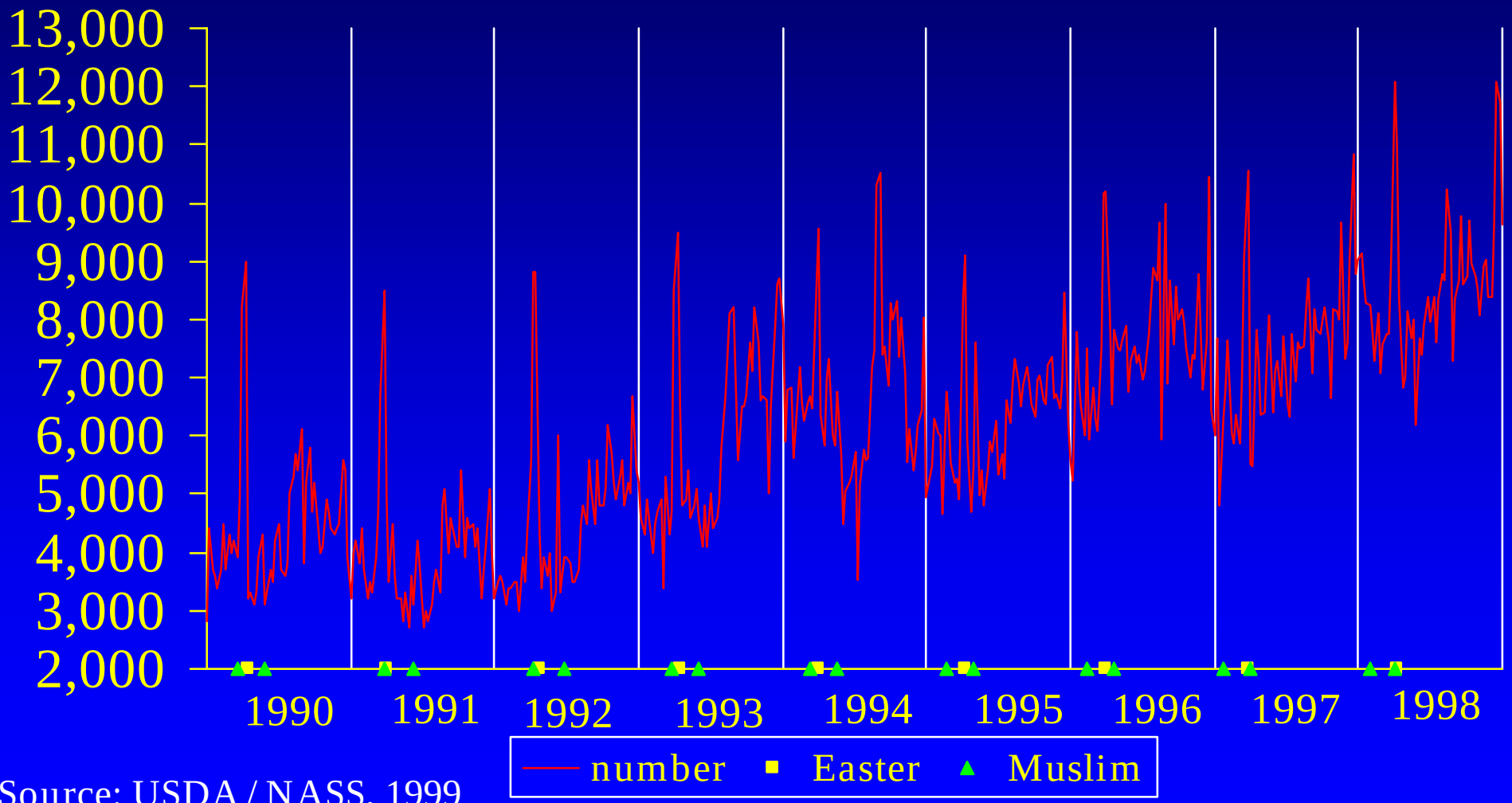
Seasonal Trends

- weekly NASS slaughter data
- role of major holidays

Holidays

- Easter
- Eid al-Fitr
  - (end of Ramadan)
- Eid al-Adha
  - (story of Abraham)
- 4th of July

Number of Goats Slaughtered Weekly: 1990-98



Source: USDA / NASS, 1999

Q. What do Texas, New Jersey, Connecticut, Pennsylvania, New York, Florida and California have in common?

A. Proximity to large ethnic populations with preference for goat meat.

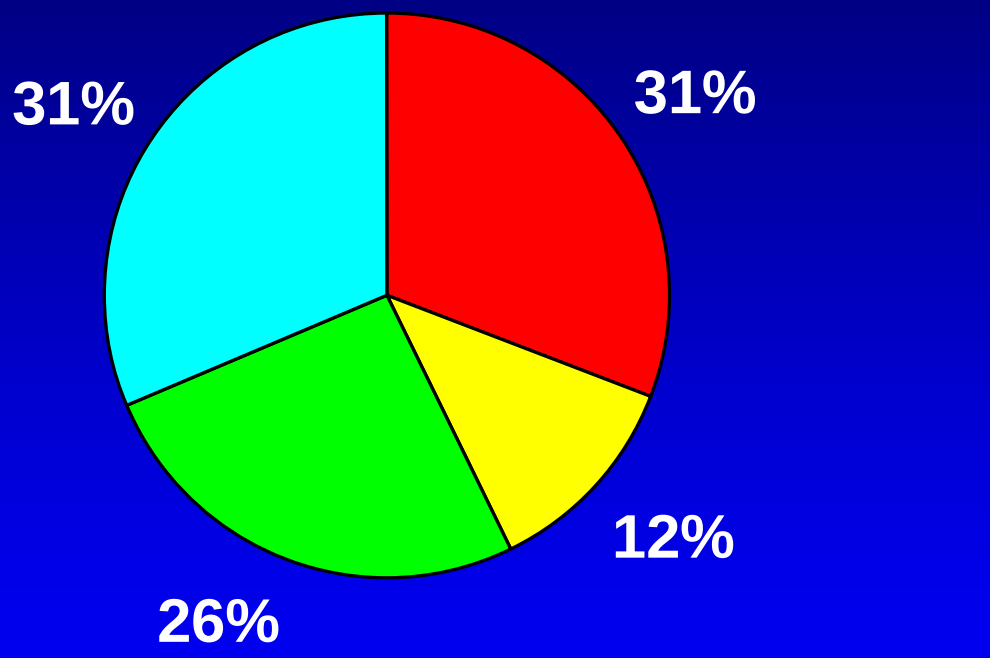
Immigration 1990-1995

- 87,172 immigrants / month
- Majority of these immigrants prefer goat meat

Goat Meat Aficionados

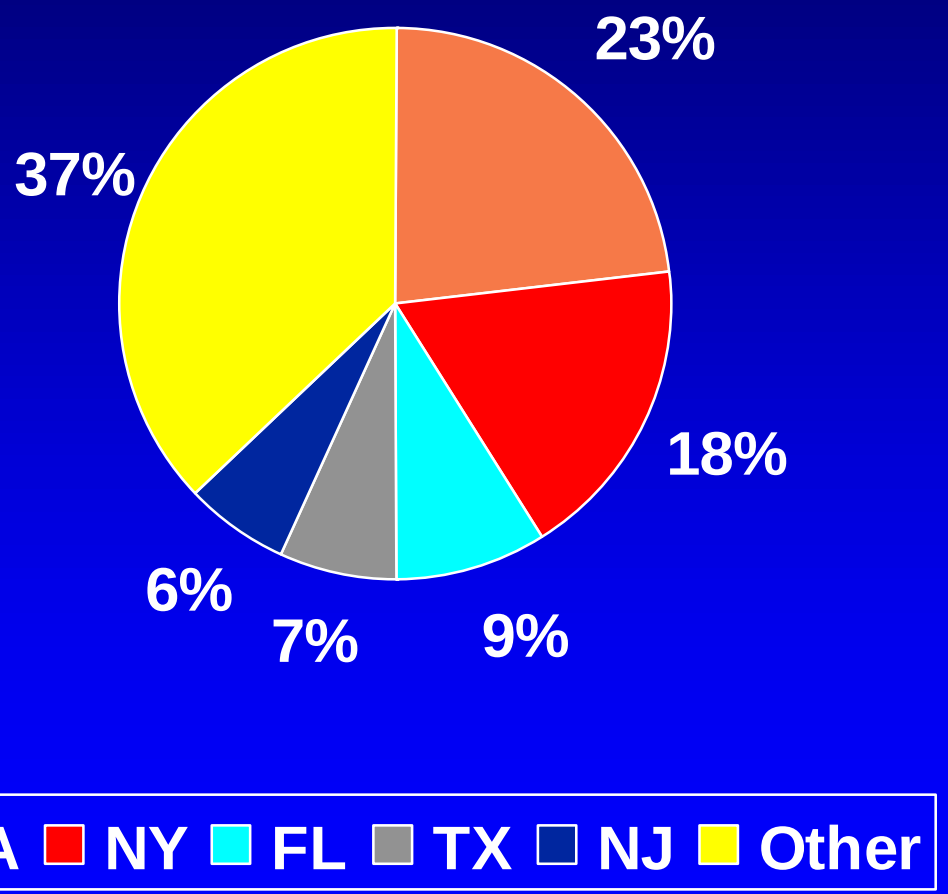
Group	Census
Hispanics	19 million
Muslims	14 million
Caribbean	2 million

Regional Distribution of Immigration - 1995



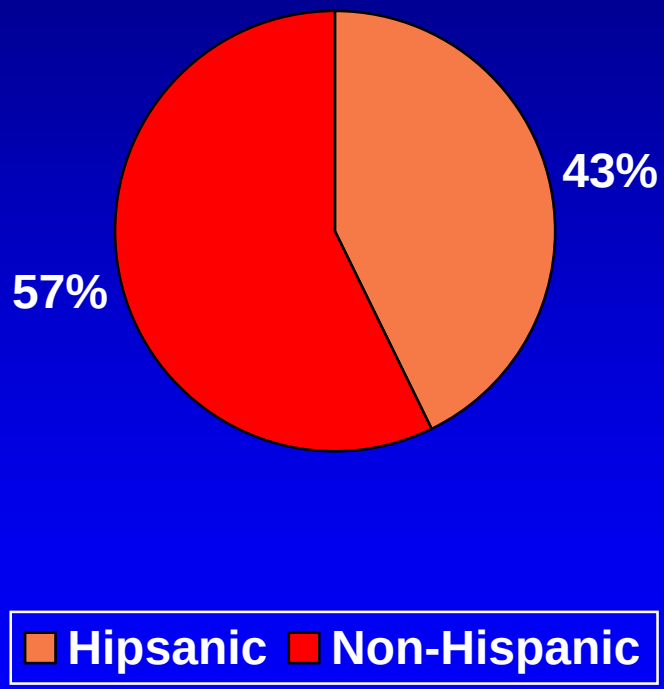
Source: US Census Bureau

Regional Distribution of Immigration - 1995



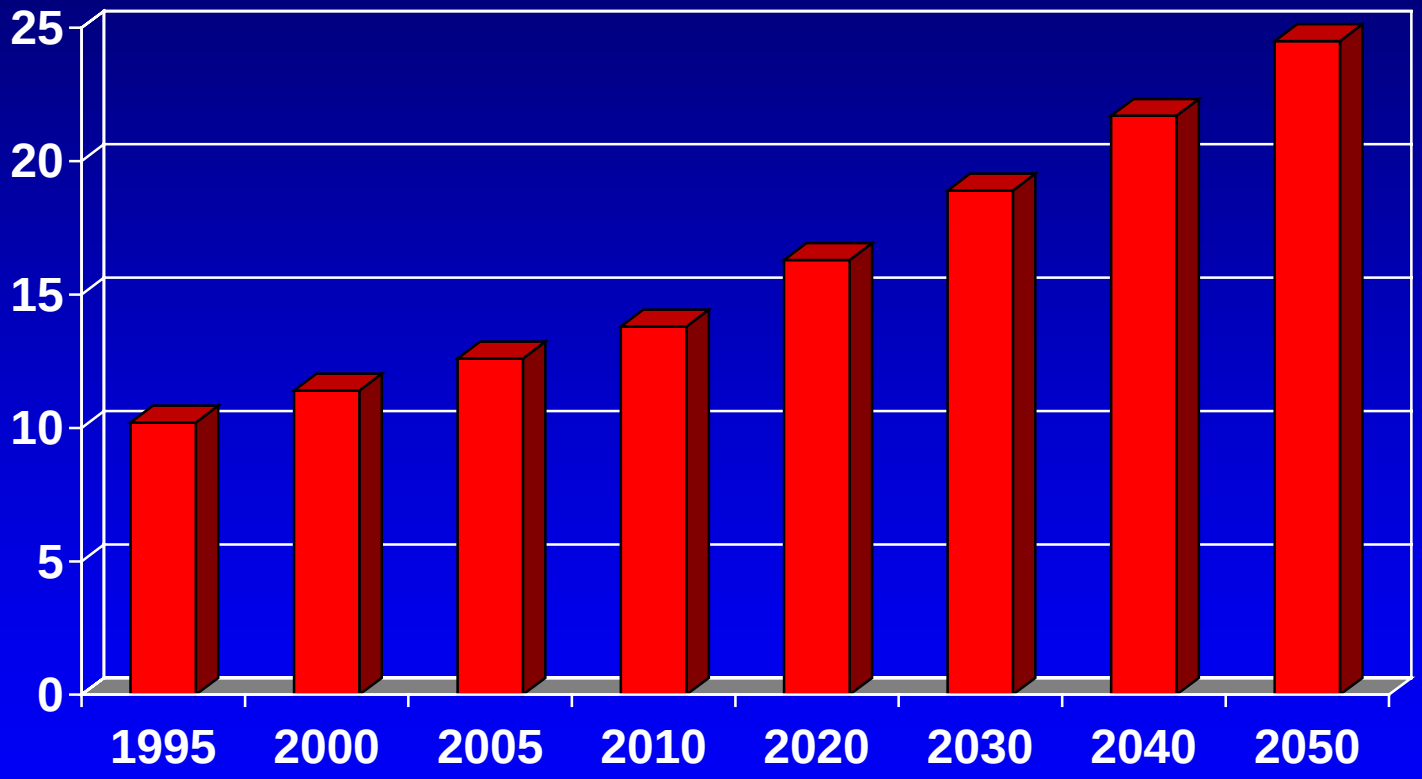
Source: US Census Bureau

Expected Immigration (1995-2050)



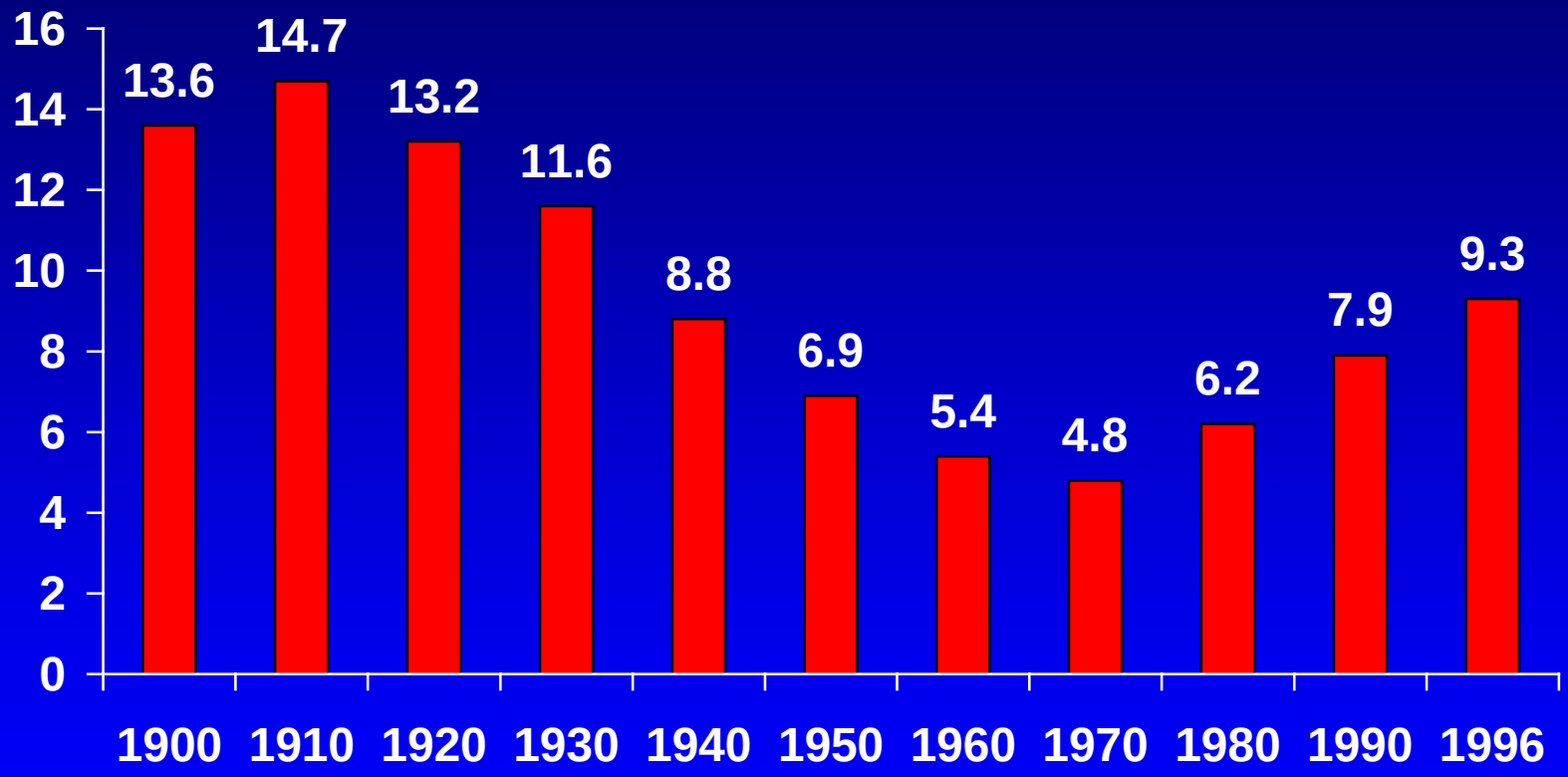
Source: US Census Bureau

Projected Hispanic Percentage of US Population



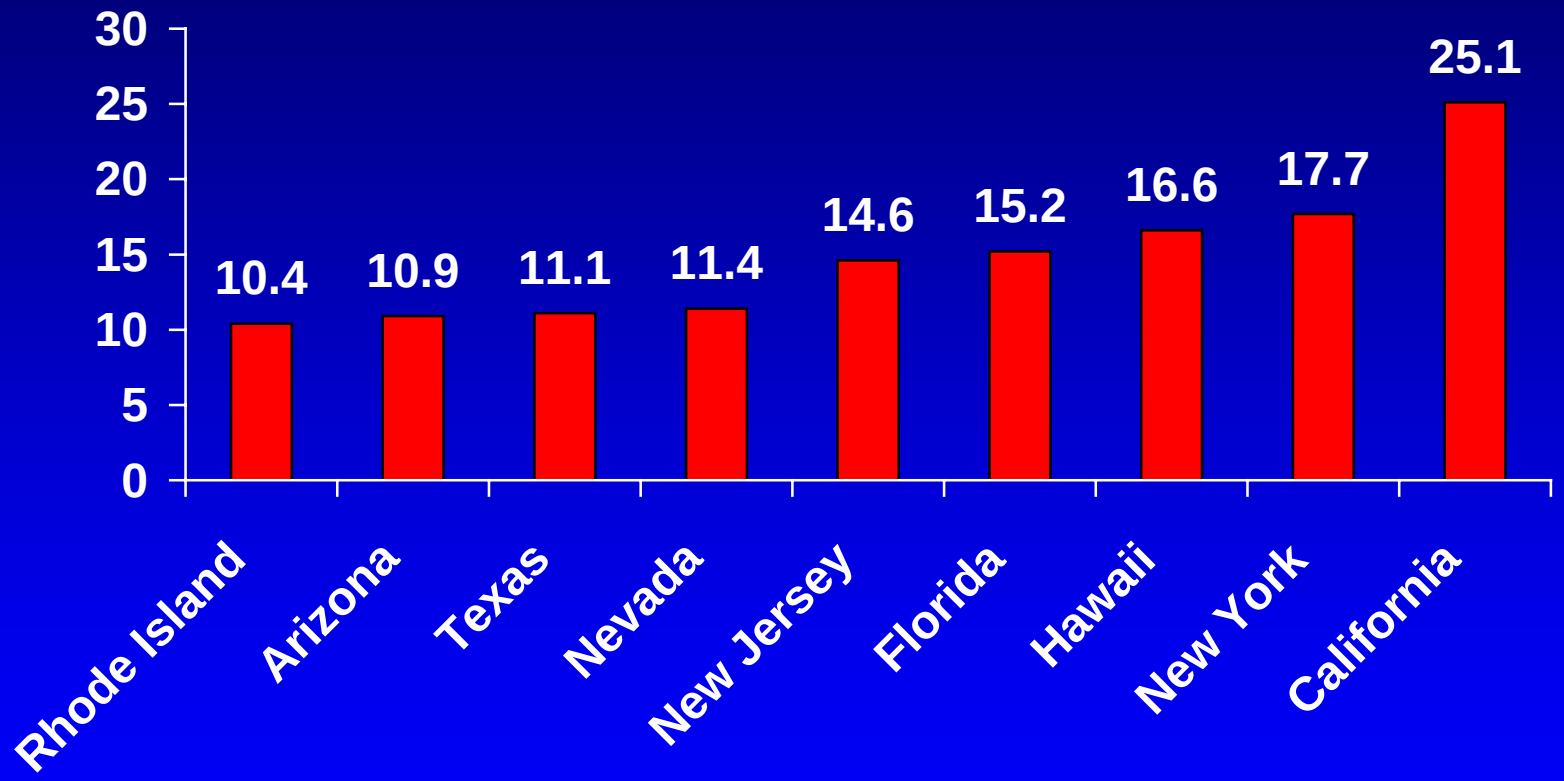
Source: US Census Bureau

Percentage of Foreign-Born US Population



Source: US Census Bureau

Percentage of Foreign-Born US Population



Source: US Census Bureau

Preferences

Group	Preference
Hispanics	cabrito (15-25 lbs. liveweight) yearlings (25 lbs. carcass)
Muslims	older yearlings (35 lbs. carcass)
Caribbean	mature bucks older animals

Is an ethnic market enough to sustain the meat goat industry?

- Yes
  - increasing ethnic population means increasing demand for goat meat
- No
  - price elastic
  - no emphasis placed upon quality

Expanding the Meat Goat Market

- Americans of European ancestry
- push for retail cuts / primal cuts of goat in supermarket
- restaurant trade
- health-conscious
  - low-fat
  - not low cholesterol

Potential

- Supermarket and restaurant trade
- 4.8 million goats required annually.
- 5 times more goats than presently required
- $370 million at the producer level.

Source: Davis, 1997

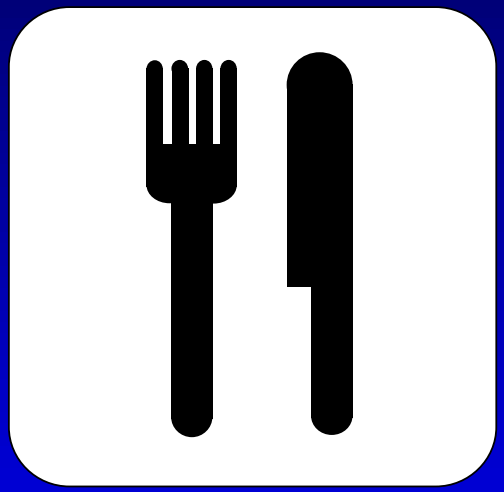
Summary

- Slaughter number have increased significantly
- Importation of goat meat has increased significantly
- Ethnic market is driving force
- Unequal ethnic distribution
- Exploration of other markets

Conclusions

- Ethnic populations in the US will continue to increase, thereby increasing demand.
- Profit margins will remain slim for operations targeting the ethnic market.
- Increased competition from AU and NZ goat/lamb or US lamb

Conclusions



- Expansion into restaurant and supermarket trade will provide an avenue for expansion and will greatly benefit the industry.

MAKING GOAT MILK FETA CHEESE

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Step-by-Step Procedure

Feta cheese is a heavily salted cheese variety (up to 7% salt). Feta cheese was invented by Greek people and made mainly from raw sheep and goat milk. Due to its increased popularity in many countries in the world and the shortage of sheep and goat milk, cow milk is commonly used for Feta cheese manufacturing in the modern time. This cheese is relatively easy to make. It can be consumed fresh or aged and stored for a long time for later use. It is customly used as a flavor enhancer in many fresh salads.

The following is a step by step procedure of Feta cheese making at home. Two gallons of fresh goat milk is used.

Pasteurize at 145^{B}F for 30 minutes

Cool down to 86-88^{B}F

Add one (1) gram (1/4 teaspoon) of starter (MAO11)

Ripen the milk for 1 hour (do not stir)

Add 3 ml (1/2 teaspoon) of cheese rennet (diluted with water: 1:40)

Mix well for 30 seconds

Leave the milk unstirred for 45 to 60 minutes to form cheese curd while keeping the temperature at 86-88^{B}F

Cut the curd into ½ inch cubes and leave the curd undisturbed for 5 minutes

Stir the curd gently for 20 minutes at the same temperature

Pour the curd in colanders with cheese cloth

Drain the whey for a few minutes

Hang the curd to drain for 4 hours or longer. For a shortcut, use a cheese press for 1 hour

Cut the curd into ½ inch cubes and apply 5-7% salt (cheese weight) and cure the cheese at refrigerator temperature for 7 days before consumption

Or cut the cheese into slices/blocks and salt in 18-20% brine solution for 2 hours, or up to one month for stronger flavor

Package the cheese into cups or jars with or without olive oil and herbs

The proper citation for this article is:

Zeng, S. S. 1999. Making Goat Milk Feta Cheese. Pages 31-32 in Proc. 14th Ann. Goat Field Day, Langston University, Langston, OK.

HIGHLIGHTS OF NUTRITIONAL CONCEPTS FOR GOATS

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Introduction

In previous Field Days of the E (Kika) de la Garza Institute for Goat Research, nutrition and feeding programs for dairy and meat goats have been discussed. However, for the maximum benefit to be realized from such information and to most effectively apply this knowledge to the broad array of nutritional scenarios encountered by goat producers, a background in general, practical nutritional concepts for goats is necessary. Likewise, many answers to common questions from goat producers regarding feeding programs involve the basics of nutrient utilization. Therefore, the purpose of this overview is to highlight most important general nutritional concepts for goats, so as to lay a strong foundation for future feeding management decisions.

Crude Protein (CP)

Crude protein refers to the total amount of nitrogen in a feedstuff rather than 'protein' per se. Crude protein concentration is typically estimated as total nitrogen level multiplied by 6.25, assuming an average nitrogen concentration in protein of 16%. Therefore, CP concentration does not provide information pertaining to feedstuff levels of nonprotein or true protein nitrogen or to quality of true protein. A number of dietary factors dictate how well CP concentration correlates with the quantity of actual protein or amino acids being absorbed by the animal, which will be addressed later. For this reason nutrient requirement systems for other ruminant species now entail usage of absorbed or metabolizable protein.

Ruminants have requirements for amino acids (building blocks of true protein), rather than for CP or even true protein. The rumen is a compartment of the stomach hosting a large population of bacteria, protozoa, and fungi. These microorganisms degrade ingested feedstuffs to form new cells, yielding volatile fatty acids as endproducts of digestion. The animal then absorbs volatile fatty acids, which are used for energy and other purposes such as glucose synthesis. Primary origins of amino acids absorbed in the small intestine are feed, microbial cells, and endogenous substances (of animal origin). On most diets, the majority of amino acids passing from the rumen are found in microbial cell protein, although passage of intact feed protein to the small intestine can be appreciable with some diets and feedstuffs. Thus, two common ways by which the intestinal protein or amino acid supply can be increased are through elevating ruminal outflow of protein in feed or in microbial cells.

Nitrogen in feedstuffs can be fractionated into components differing in their behavior in the rumen. One such fraction is soluble protein, rapidly solubilized after consumption and typically completely degraded by ruminal microorganisms. Final products of ruminal microbial degradation of protein are largely ammonia and volatile fatty acids, with lower levels of amino acids and peptides (short chains of amino acids) that change with time after consumption. A second important fraction is protein not soluble in ruminal fluid but degradable both by ruminal microbes and in the small intestine if passing from the rumen intact. The rate of microbial breakdown of this protein fraction in the rumen is quite variable among feedstuffs. The last common fraction of feed protein is not degraded in the rumen or in the small intestine, being particularly high in heat-damaged feedstuffs. Therefore, feedstuffs high in soluble protein tend to be extensively degraded in the rumen, and the opposite applies to heat-damaged feedstuffs high in indigestible protein. The extent of ruminal degradation of insoluble protein potentially degradable in the rumen, again, depends on the nature of the specific protein. An example of a feedstuff high in protein largely insoluble in ruminal fluid but rapidly degraded by ruminal microbes is soybean meal. Typically 70 to 75% of soybean meal protein is degraded in the rumen, with only 25 to 30% passing intact to the small intestine. Much of the protein in alfalfa is soluble in the rumen and, therefore, quickly broken down after consumption. Rates of ruminal degradation of protein in feedstuffs such as blood, feather, fish, and corn gluten meals are slow, with normal ruminal undegradable protein (**RUP**) concentrations of approximately 80 to 90% for blood and feather meals and 60 to 70% for fish and corn gluten meals.

Cell Walls and Non-Cell Wall Plant Components

The old analytical system for characterizing feedstuff carbohydrates has been largely replaced by the Van Soest or detergent analysis system. However, in some instances crude fiber levels are still listed. The crude fiber/nitrogen free extract system was replaced because of not consistently accurately fractionating feedstuff constituents into a highly or completely digestible component and a component only partially digestible. Thus, Van Soest fractions will be highlighted below.

Neutral detergent fiber is often referred to as “cell walls” or “fiber” and includes three general cell wall components differing in chemical properties: cellulose, hemicellulose, and lignin. Actually, lignin is not a carbohydrate and is generally indigestible. In fact, lignin limits the extent to which ruminal microbes can degrade hemicellulose, in part through bonding and physical associations. Effects on cell wall digestion of lignin vary among feedstuffs. For example, legumes are usually higher in lignin concentration than grasses, but adverse effects on hemicellulose and cellulose digestion per unit of lignin are less for legumes. The acid detergent fiber fraction includes cellulose and lignin, and one assay for lignin is called acid detergent lignin. The rate and potential extent of cell wall degradation are quite variable among feedstuffs. For example, as forages mature digestibility declines because of the increasing lignin concentration and changes in the structure of plant tissues that limit access of microbes to digestible cell wall components.

The neutral detergent soluble fraction usually is completely potentially digestible in the rumen, and includes substances like starch, sugars, and proteins. Feedstuffs low in fiber, such as corn, have high neutral detergent soluble concentrations. However, the nature of neutral detergent solubles varies considerably among feedstuffs. For instance, dependent on processing a considerable amount of corn starch reaches the small intestine intact without being degraded by ruminal microbes, whereas neutral detergent solubles of alfalfa consist largely of soluble proteins and sugars that are rapidly and completely broken down in the rumen by microbes. Nonetheless, the fractionation of plant material into neutral detergent fiber and solubles provides a great deal of information regarding nutritive value of plant material. But, as for CP fractions, components of each fraction can differ markedly in the rate they are broken down by ruminal microorganisms.

Energy

There are a number of different classifications of energy that need to be understood for proper livestock feeding programs. First, there is gross energy, which is the total amount of energy in a feedstuff, not accounting for energy losses upon consumption by the animal. Apparent digestible energy is that which is absorbed or enters the animal, and is calculated as total energy intake minus energy excreted in feces. The term "apparent" is used because feces also contains endogenous products, or substances such as epithelial cells and enzymes from the animal, that did not originate from the food being consumed at that time. Metabolizable energy considers or accounts for energy that is lost in urine and fermentation gases. These losses are subtracted from digestible energy because this energy did not become available for metabolism or was not completely metabolized by the animal. However, as for endogenous energy in feces, urinary energy includes energy in a small quantity of products of animal metabolism that theoretically would be present without feed consumption. Total digestible nutrients (**TDN**) is a very commonly used energy term, expressed in percentage units and based on concentrations and digestibilities of different chemical fractions of a feedstuff or diet. Although, TDN of feedstuffs typically is predicted based on levels of chemical fractions such as CP, neutral detergent fiber, acid detergent fiber, etc. Rankings of feedstuffs or diets by TDN concentration are similar to those by digestible and metabolizable energy, since TDN considers fecal energy losses and includes a partial correction for energy loss in urine. The next classification of energy is net energy, taking into account energy given off as heat in normal metabolism due to feed ingestion, since chemical events in the body are not 100% efficient. Thus, net energy refers to actual quantities of energy used for different functions, such as body weight maintenance, growth, and lactation. Very importantly, the efficiency of energy use, or energy loss in metabolism, varies with the purpose energy is being used for. For example, energy is metabolized for maintenance more efficiently than for growth, although the overall efficiency of energy metabolism for lactation is similar to that for maintenance. There are a number of reasons for these differences in estimates of efficiency of metabolism, which would require a great deal of time to thoroughly address.

The amount of energy required for body weight maintenance is typically estimated as a quantity of energy multiplied by body weight raised to the three-quarter power, commonly known as metabolic body weight. Previous experimentation over many years and around the world has determined that, in general, maintenance energy requirements increase linearly with increasing metabolic body weight.

This maintenance energy requirement can also be expressed as metabolizable energy, TDN, or digestible energy, with appropriate assumptions of the efficiencies of energy use for maintenance and other losses accounted for by each system. The same applies for growth or lactation, with requirements expressed per unit of live weight gain or milk production.

Efficiencies of energy metabolism have not been extensively studied in goats, but presumably are similar to those for other ruminant species. Besides the effect of functions for which energy is used, efficiencies of energy metabolism differ among feedstuffs. Efficiencies are greater for concentrates than for forages. That is, for each unit of feed consumed, more heat is lost with forage versus concentrate. Secondly, differences between concentrates and forages are less with low feed intake and when most or all energy is used for maintenance than with high feed intake and when an appreciable amount of energy is used for growth. This is one of the reasons why mature ruminants can be maintained on diets composed solely or primarily of moderate-quality forage, whereas rapidly growing animals require dietary inclusion of concentrate and(or) high-quality forage. Similar differences in efficiencies of metabolism exist among forages, with efficiencies increasing and energy losses decreasing as forage quality rises. Hence, increasing dietary concentrate level and increasing forage quality decrease energy losses in both feces (i.e., increasing digestibility) and in heat given off in metabolism (i.e., increasing efficiency of metabolism, or an increasing ratio of net:metabolizable energy). However, this is somewhat of a simplification, in that these factors influence level of free-choice or voluntary feed intake. For example, up to certain dietary levels of concentrate, free-choice level of feed intake increases as diet quality rises, which may lessen the magnitude of these differences among feedstuffs or diets in digestibility and efficiency of metabolism.

Nutrient and Energy Demands

Energy is actually a property of nutrients rather than a nutrient per se, since energy is derived from feedstuff components such as protein, starch, fiber or cell walls, fat, etc. However, in much of the following discussions “nutrients” will refer to energy as well as particular nutrients like protein and amino acids.

The various classes and production stages or states of goats are accompanied by requirements for different quantities of nutrients. Also, the types or array of nutrients needed can vary. These demands or potentials for nutrient use have critical effects on diet or supplementation decisions that a goat producer must make.

Does

Lowest nutrient requirements are probably for nonpregnant, mature does, although requirements in the first one-half to two-thirds of gestation are not much greater. For nonpregnant does, other than perhaps during the last 2 or 3 weeks preceding breeding and for the first 1 or 2 weeks of the breeding period, a nutritional plane only slightly greater than that adequate for body weight maintenance is necessary, depending of course on initial body condition.

But, severe undernutrition in early and mid-gestation can adversely affect the number of kids born, kid health, and in some instances productivity of kids when grown. With doelings or does in low body condition, the nutritional plane during early and mid-gestation should be increased to allow for growth or tissue replenishment, which is unlikely to be easily achieved in late gestation. In this regard and as has been presented in previous Field Day discussions, most kid growth occurs in the last one-third or 50 days of gestation. Thus, nutrient intake should be increased during this time to ensure healthy kids at birth and so that the dam is prepared for the nutrient demands of lactation. A high nutritional plane in the last few weeks of gestation is particularly important to the immune system of does, for formation of colostral antibodies, and for minimal doe health problems after parturition such as mastitis. As will be discussed later, these shifts in nutrient intake can be achieved through changes in the level or composition of concentrate supplements or in the quality of forage being offered. Another factor to be noted is the number of fetuses; obviously, does with twins or triplets require more nutrients in late gestation and during lactation for proper fetal development and postnatal growth, respectively, compared with does bearing a single fetus. Because of the ability of does to use tissue stores of nutrients for support of fetal growth, a slight limitation in nutrient intake during late gestation might not adversely affect kid or litter birth weight, but kid health may be impaired. Also, excessive tissue loss by the doe in late gestation is accompanied by decreased birth weight and a lessened ability to draw upon maternal tissue nutrient reserves in early lactation, when it is not possible for the level of feed intake to be great enough to achieve maximum milk production. Both energy and protein needs are very high during early lactation and decline as lactation advances after the peak in milk production. Again, in meat and fiber-producing goats milk production and associated requirements for nutrients are influenced by the number of kids. A limiting nutritional plane during this period restricts milk production and growth of kids from multiple births more than that with single kids. Likewise, the associated high degree of tissue mobilization by the doe would necessitate an increased nutritional plane later for tissue replenishment.

Kids

Bottle-feeding milk replacer or milk in the suckling period has been addressed in previous Field Day discussions. An important aspect is early adaptation to dry feed in preparation for weaning. As for other ruminant species, nutrient requirements relative to body weight of young animals are quite high, decreasing as animals age and approach maturity. In accordance, concentrations of nutrients required in diets decrease with time. However, much less is known about the rate of maturation of goats than of cattle or sheep, suggesting that change with age in nutrient requirements may not be exactly the same. Limited research suggests a slower rate of maturation of goats, implying less change with time in nutrient requirements. In this regard, compensatory growth should be mentioned. Compensatory growth is when the rate of growth while on a high nutritional plane is greater than expected, following a period of restricted growth with a low plane of nutrition. However, compensatory growth by goats has not been extensively studied, and it is not known how compensatory growth by goats compares with that by sheep and cattle.

Another factor to be recognized regarding differences among ruminant species is in fat deposition. Goat meat is generally viewed as being leaner than beef or lamb, although goats appear to

deposit more internal fat. First, little is known concerning dietary and management factors influencing internal fat deposition. Secondly, assuming the rate of internal fat deposition to be relatively steady as age and body weight increase, live weight gain of growing-finishing goats may decrease at a slower rate than cattle and sheep that deposit more carcass fat. Thus, because of the aforementioned factors that are not well understood, post-weaning growth will be referred to rather than use of separate growing and finishing phases, as is common when describing cattle and sheep production systems. Further research at the E (Kika) de la Garza Institute for Goat Research will allow a refined description of how goat nutrient requirements change with advancing age, body weight, and stage of maturity.

Important Considerations

Protein

The two primary factors influencing the quantity of microbial protein synthesized in the rumen are adequacy of compounds containing nitrogen that microbes need to reproduce and the quantity of organic matter that can be fermented to yield energy for microbial cell replication (i.e., reproduction). Other factors also have impact, such as the rate at which digesta passes from the rumen and the timing of the availability of nitrogen-containing compounds and energy, but these effects are less than, and depend upon, the two factors mentioned above.

The nitrogen-containing compound needed by most ruminal microbes in the greatest amount is ammonia, although some microbes require, and growth of others may be stimulated by, amino acids and peptides. As noted earlier, proteins degraded in the rumen largely end up as ammonia and volatile fatty acids. Nonprotein nitrogen sources such as urea are also degraded to ammonia in the rumen. An important source of ammonia for ruminal microbes with diets very low in CP is recycled nitrogen. Ruminants are able to add nitrogen to the rumen through urea contained in saliva and by transfer of urea from blood vessels lining the rumen wall, with most derived from the latter mode. However, even with nitrogen recycling, with diets very low in CP (e.g., less than 5 or 6%) ruminal microbes will not have adequate ammonia to efficiently grow or reproduce, which limits the amount of microbial protein passing to the small intestine and results in insufficient amino acids available to animal tissues. Another item worthy of mention here is sulfur. When ruminal microorganisms synthesize protein, in addition to nitrogen such as from ammonia, sulfur is needed to form some amino acids (e.g., methionine). The National Research Council currently lists a sulfur requirement of 10% of the nitrogen requirement or level in the diet, or 0.16% of dry matter intake for a 10% CP diet. However, higher sulfur requirements have been suggested for high fiber-producing goats. Furthermore, the amount of organic matter that is available for ruminal microbes to digest or ferment for energy sets the quantity of nitrogen-containing compounds such as ammonia that microbes can potentially use to form new cells. For example, the potential for use of ammonia by ruminal microbes to form new cells or microbial protein is greater with a diet that is 60% digestible than with a lower quality diet 50% in digestibility. This is a very important relationship to note, regarding various types of diets fed to animals with different requirements for protein or amino acids and energy. For instance, this relationship helps explain why the CP requirement for a moderate-quality (i.e., moderate digestibility) forage fed to nonpregnant goats is lower than that for a higher quality forage diet, perhaps with some concentrate, being consumed by weaned, growing-

finishing goats. Relatedly, an oversupply of ruminally degradable nitrogen eliciting a high concentration of ammonia in the rumen, results in considerable nitrogen wastage if the quantity of fermentable organic matter is not sufficient to allow use of this nitrogen in formation of protein in new microbial cells. This high ammonia concentration causes high ammonia absorption in the rumen and excretion of nitrogen as urea in urine.

The above information should hopefully highlight the existence and importance of interrelationships between dietary concentrations of digestible organic matter or energy and CP. Interrelationships of absorbed energy and amino acids or protein at the animal tissue level exist as well, which will be touched upon later. Besides the significance of a sufficient quantity of ammonia in the rumen to allow high synthesis and flow from the rumen of microbial protein, it is critical for maximal digestion of the forage or diet as well, which impacts energy that the animal will absorb. That is, a low ruminal ammonia level can limit not only microbial protein synthesis but also the ability of the microbes to digest. For example, the digestibility of a forage such as wheat straw or prairie hay, 5% or less in CP, is limited by low activity of ruminal microbes that is a consequence of the low quantity of ammonia in the rumen available. Thus, supplementation with a ruminally degradable nitrogen source will increase forage digestibility and also the amount of microbial protein being synthesized. In addition, free-choice feed intake will be elevated. This is one of the means by which ammoniation is effective. Ammoniation increases potential digestibility and rate of digestion of forage cell walls primarily through solubilization of bonds between the cell wall component hemicellulose and lignin. But, the increased CP concentration also contributes to the positive effect on animal performance through the increase in availability of nitrogen-containing compounds for microbes. This enhances microbial activity and increases digestion, resulting in greater formation of new microbial cells to elevate amino acids of microbial protein being absorbed in the small intestine of the animal.

As mentioned before, most amino acids absorbed in the small intestine typically are from microbes passing from the rumen. However, for animals with very high protein or amino acid requirements, the quantity of microbial protein and protein of normal feedstuffs passing from the rumen intact may be inadequate to achieve the potential level of productivity. In such instances, ruminal degradability of dietary feedstuffs should be viewed, and increased levels of feedstuffs high in RUP can be used. In general, forage proteins are thoroughly and rapidly degraded in the rumen. Because ruminal protein degradabilities for corn and sorghum grain are greater than for forages, ruminal undegradability of total dietary CP usually increases as the dietary concentrate level increases.

Probably the best example of a goat possibly requiring an increased dietary level of RUP is the high-producing lactating dairy goat. For example, in a recent experiment at the E (Kika) de la Garza Institute for Goat Research, lactating does and doelings were fed 17.5% CP diets with 40 or 80% forage and with or without addition of feedstuffs high in RUP. The added RUP was provided by a mixture of blood, fish, and feather meals, substituting for two-thirds of the CP in control diets being provided by soybean meal. Added RUP increased milk production in weeks 3 to 7 of lactation but did not have impact later when milk production had declined. Also, the effect of RUP tended to be greater with the diet higher in grain (40% forage) than with the high-forage diet (80% forage). These results bring out two important points. First, only when nutrient demand or potential for use is very high will

addition of RUP be beneficial. In accordance, in the first year of an experiment with Angora does and kids grazing different cool season grasses in the spring, fish meal added to a grain-based supplement did not affect doe or kid performance. Secondly, animals require a high quantity of absorbed energy to make efficient usage of the increased quantity of absorbed amino acids achieved by use of feedstuffs high in RUP.

Regardless of the potential for use of additional amino acids in the small intestine that may be achieved through use of RUP sources, the importance of an adequate supply of ruminally degradable protein or nitrogenous compounds should not be overlooked. There are numerous examples of experiments in which the level of substitution of RUP sources for feedstuffs providing needed ruminally degradable protein was too great, resulting in low availability of nitrogenous compounds for ruminal microbial growth and(or) digestion and decreased microbial protein synthesis and flow to the small intestine. For beef cattle, currently the ruminally degradable protein requirement is calculated as 13% of the TDN concentration, which when combined with a consideration for recycled nitrogen yields a ruminally degradable protein requirement of about 10% of the TDN level in the diet. Thus, the ruminally degradable protein requirement is 5% of dry matter for a 50% TDN forage or diet, and 6% for a diet or forage 60% in TDN concentration.

Another aspect of RUP sources that should be considered is protein quality, or the array of amino acids in relation to requirements of the animal. First, amino acid requirements of goats have not been well defined, as is also the case but to a lesser extent for other ruminant species. Secondly, many of the feedstuffs highest in RUP that are commonly used in ruminant diets are high in many essential amino acids but low in others. Thus, for cattle and sheep it is standard to add blends or mixtures of feedstuffs high in RUP rather than only one. Until further research is conducted, the same practice also seems advisable for meat and dairy goats. However, for fiber-producing goats, particularly Angoras, and for wool-producing sheep, amino acid requirements differ from animals reared for milk or meat production. The requirement for sulfur-containing amino acids, such as methionine, is particularly high for Angora goats. Thus, the optimal profile of amino acids in a supplement high in RUP for Angora goats may differ from that for lactating Alpines, Spanish, or Boer crossbreds.

Feed Intake

An obvious and important consideration in goat nutrition is feed intake, which has been or will be addressed for the other major nutritional concepts being dealt with in this overview. Feed intake by cattle can be empirically predicted reasonably well based on the chemical composition of feedstuffs and nutrient requirements or potential for use by the animal, although presently the underlying physiological processes in ruminants responsible for feed intake control have not been well defined. The state of knowledge regarding prediction of feed intake by goats is not advanced, which is in part due to the wide array of production conditions and types of goats used. Also, goats are more selective in grazing or foraging habits than other ruminant species. However, it is known that nutrient and energy demands by the animal and quality of the diet ingested are the two biggest factors influencing voluntary feed intake.

Diet "quality" is a vague and general term that typically refers to digestibility. Digestibility is directly related to the concentration of neutral detergent fiber, cell walls, or fiber, and to fiber digestibility. Normally, a low-quality forage does not necessitate a low CP concentration, although in many instances forages low in digestibility are also low in CP (e.g., wheat straw, prairie hay). Overall, there is a positive relationship between diet digestibility or quality and voluntary feed intake, but with very high grain levels this association may not exist.

There are many examples of factors influencing diet quality. Legumes are generally more digestible than grasses at a comparable relative stage of maturity, largely because of their lower level of cells walls. The same general differences exist for comparisons such as concentrates versus forages and leaves versus stems. The rate of cell wall digestion usually is more rapid for legume than for grass cell walls, but legume cell walls are more lignified, and so extent of cell wall digestion often is less for legumes. Other differences between legumes and grasses include a greater CP concentration in legumes and physical characteristics that influence particle breakdown with mastication. Such factors lead to greater potential voluntary intake of legumes than grasses.

At the same relative stage of maturity, cool-season grasses are usually more digestible and consumed at least in slightly greater amounts than warm-season grasses. However, forage management practices impact forage quality. For example, a mature cool-season grass can be of lower digestibility and have lower feed intake potential than a vegetative warm season grass. In accordance, digestibility and voluntary feed intake potential decrease with increasing plant maturity. But, there are other factors that influence differences among forages in selection and voluntary intake. One example is anti-nutritional factors. Condensed tannins will be addressed later. Ergot alkaloids are found in endophyte-infected fescue, which depress feed intake in cattle. Similar effects are presumed for goats. In support, in a recent experiment at the E (Kika) de la Garza Institute for Goat Research, live weight loss of Angora does was greater and gain by their suckling kids in the spring was less for endophyte-infected fescue than for orchardgrass, wheatgrass, or wheat pastures.

Overall, as animal nutrient needs increase, voluntary feed intake increases. For example, voluntary feed intake (relative to body weight) is greater for lactating versus dry does. Likewise, feed intake (relative to body weight) decreases as animals mature, since nutrients required for maintenance decrease slightly as animals mature and requirements for live weight gain obviously decline as well. However, diet composition affects such differences. For instance, feed intake (relative to body weight) of unsupplemented wheat straw or prairie hay will be no more and probably less for a growing meat goat than for a mature doe. But, with proper supplementation of such diets or use of any other high-quality diet, intake will be greater for the growing meat goat. Likewise, the strength or existence of the relationship between diet quality and voluntary feed intake generally increases as nutrient and energy needs of the animal increase, other than with diets very low in digestibility. The greater potential for nutrient use by growing or lactating (particularly the former) goats compared with nonpregnant or early gestation goats facilitates greater intake (relative to body weight) only if diet quality is moderate to high.

Associative Effects

When considering grain supplementation of forage-based diets, associative effects of feedstuffs need to be kept in mind. An associative effect exists when a response, typically in digestibility and(or) feed intake, to feeding two or more feedstuffs together is not as expected based on measures when the feedstuffs are fed alone. Associative effects can be positive or negative. An example of a positive effect is when a low level of supplemental soybean meal or cottonseed meal increases intake and(or) digestibility of a low-protein forage like prairie hay or wheat straw. As noted previously, this response is largely elicited through the increase in ruminal ammonia concentration that increases fiber digestibility and microbial protein synthesis, for increased volatile fatty acid absorption for energy and small intestinal absorption of amino acids from microbial protein. A good example of a negative associative effect is the depression in fiber digestibility elicited by a high level of supplemental grain given with a low- to moderate-quality forage. This response is brought about by two changes in the rumen environment, which involve the ability of many ruminal microbes to degrade both starch and fiber and the adverse effect of high acidity or low pH on production and activity of fibrolytic enzymes (ones degrading fiber) produced by microbes that are only capable of degrading fiber. Small depressions in fiber digestion elicited by low levels of grain inclusion in forage-based diets occur via preferential starch digestion by fibrolytic microbes than also can degrade starch. More severe depressions resulting from high levels of grain addition to diets are largely elicited by reductions in pH (when below 6.0) and concomitant decreases in the number of microbes degrading fiber (particularly those that only and are most capable of breaking down fiber) and increases in ones breaking down starch. However, it is important to note that these negative associative effects do not become appreciable until grain composes at least 25 to 30% of the total diet. Also, even though fiber digestibility may be depressed, the overall quantity of energy being absorbed by the animal is usually increased because of the greater digestibility of grain than forage, and this increased quantity of ruminally fermentable organic matter increases microbial protein synthesis. In relation, increased ruminally fermentable organic matter and microbial protein synthesis increase the need of ruminal microbes for ammonia. Thus, moderate to high levels of supplemental grain may necessitate simultaneous supplementation with a ruminally degradable protein source. In fact, if this is not done, high levels of supplemental grain will have a greater deleterious effect on fiber digestion, because the generally earlier microbial fermentation of grain starch than fiber can lessen the availability of ammonia for later degradation of fiber.

Besides the impact of the level of concentrate supplementation on forage digestibility and intake, the type of supplemental feedstuff also has impact. For example, feedstuffs high in fiber that is highly degradable in the rumen, such as soybean hulls, can increase energy absorption by the animal with little or no adverse effect on digestibility of the basal dietary forage. However, one of the most important factors determining the type of supplement used is cost per unit of nutrient or energy that a supplement is being provided for. Potential associative effects then should be used to adjust such cost comparisons.

High-Concentrate Diets

As for other ruminant species, switching from forage-based diets to diets high in concentrate for goats should be done slowly and gradually, allowing normal changes in types and activities of ruminal microbes to take place. Too rapid of change can cause digestive disturbances such as acidosis and diarrhea. In fact, any kind of dietary change should be slow and gradual, as digestive tract conditions in goats seem relatively more adversely affected by shifts in the nature of the diet compared with cattle and sheep.

There has not been a great deal of research conducted with very high concentrate diets for goats compared with cattle and sheep. From casual observations, goats appear more comparable to sheep than cattle in regard to minimum dietary levels of structural roughage or effective fiber. Saliva in ruminants contains buffers necessary to prevent ruminal fluid from becoming too acid or having too low of a pH. The amount of saliva flow relates directly to time spent in mastication during eating and rumination. Time of mastication is very short for grains compared with long-stemmed or chopped forages. Because grains generally are quickly and thoroughly digested in the rumen, with resultant high and fast volatile fatty acid production by ruminal microbes, inclusion of some forage in the diet is essential with high-grain diets to lengthen total mastication time and achieve adequate salivary buffer flow. It is also important to note that the cell wall or neutral detergent fiber concentration in a feedstuff does not necessarily indicate its effect on salivary buffer flow. For example, the particle size of soybean hulls is small, which results in short mastication time. Also, soybean hulls fiber is highly digestible in the rumen and, thus, not present in the rumen for very long to stimulate mastication. Hence, dietary inclusion of feedstuffs such as soybean hulls certainly cannot preclude use of feedstuffs that have a substantial effect on salivary buffer flow such as long-stemmed or chopped grass hay or cottonseed hulls.

Herbage Selection and Browse

Goats have very mobile mouthparts and necks, which allow them to select nutritious plant parts, including leaves, buds, and fruits and to avoid poor-quality stems, dead leaves, and spines. Therefore, most goats in the world are under raised under grazing, foraging, or browsing conditions rather than in confined settings. They are agile, frequently stand on hind legs, reach high, and easily feed from a wide range of plants, including trees, bushes, and leguminous and grass forages. Determining supplementation needs for grazing goats is difficult because of the often wide array of types of plants available for consumption and the ability of goats to select specific plants and plant parts. However, with experience and through observation, many goat producers can reasonably describe what his or her goats are consuming at particular times of the year while occupying particular areas of land.

It is well known that goats consume more tree and shrub plant parts than do sheep or cattle. Trees and shrubs are important food sources for goats, particularly in arid areas of the world. In the US there is great potential for goat production on rangelands. It has been estimated that approximately 60% of the ½ billion acres of US rangeland has been invaded by undesirable browse species, which could be utilized for raising goats. In Oklahoma and surrounding states, goats are being used to control

weeds (forbs) and brush. Many such plants are high in condensed tannins (**CT**). Condensed tannins are quite interesting, in that animal performance may benefit from their consumption at low levels but be severely impaired at high concentrations. Condensed tannins are compounds that can bind to proteins at normal pH in the rumen. However, at pH typical of the abomasum or "true stomach" and in the first part of the small intestine, these complexes come apart, allowing the proteins to be digested and amino acids to be absorbed by the animal. Furthermore, when the intake of ruminally degradable CP provides more ammonia than is needed by ruminal microbes to ferment the quantity of organic matter that is available, resulting in high ammonia absorption in the rumen and consequent loss of nitrogen in urine, low levels of CT have beneficial effects through the lessening this nutrient loss. Goats are able to tolerate higher dietary levels of CT than sheep or cattle, and all ruminants can adapt somewhat to high dietary CT concentrations, but, adverse effects of very high levels of CT still can occur with goats.

In recent years, considerable research has been conducted with CT in various areas of the world, and the E (Kika) de la Garza Institute for Goat Research has such a project underway as well. However, presently there is not a thorough understanding of how CT in plants being consumed impact supplementation considerations. Nonetheless, based on the current state of knowledge, such general concepts can be outlined. It is important to mention that effects of CT depend on their level in the diet, with effects gradually changing as the CT concentration varies. Nonetheless, supplementation considerations highlighted below are categorized for low (e.g., 2.5% of total dry matter intake or less) and high levels of CT (e.g., greater than 5% of total dry matter intake).

With low total dietary levels of CT, as long as the dietary CP concentration is at least slightly more than needed for ruminal microbial growth and digestion, CT should increase the quantity of amino acids being absorbed in the small intestine, without any appreciable negative effects. If the goats have high nutrient and energy demands, and if the overall digestibility of the herbage being consumed is low to moderate, then perhaps a low to moderate level of a cereal-grain based supplement would be beneficial to facilitate efficient use of the greater quantity of amino acids becoming available to animal tissues. However, because the CT will at least slightly depress the concentration of ammonia in the rumen, probably a supplement CP concentration of 15 to 25% would be advisable to make sure that ammonia in the rumen is ample for microbial needs. Otherwise, if cereal grain is supplemented alone, as mentioned before a ruminal ammonia deficiency might be caused, which could increase the potential depressing effect that the high-starch cereal grain might have on ruminal microbial digestion of fiber. If the particular goats being used do not have high nutrient and energy demands, then a low level of CT should not alter supplement needs.

A very common plant in this region with a low to moderate level of CT is Sericea lespedeza, although the CT level in lespedeza and other plants can vary markedly with plant variety, time of the year, and forage management practices. Legumes such as lespedeza are actually excellent plants for low to moderate levels of CT. As noted before, the rate at which CP in legumes is broken down in the rumen is normally quite rapid and degradation is thorough, resulting in considerable nitrogen loss through ruminal absorption of ammonia and urinary excretion of urea. However, the low to moderate level of CT lessens the extent of ruminal microbial breakdown of the protein in lespedeza, to increase ruminal outflow of intact feed protein for small intestinal digestion and amino acid absorption. The total

CP concentration in such legumes is moderate to high, so that even with these CT effects there is still ample nitrogenenous compounds such as ammonia available to microbes in the rumen.

With high dietary levels of CT, fiber digestion is depressed, reducing the amount of energy the animal is absorbing. This limited ability to digest fiber appears to be caused by CT complexing of microbial enzymes in the rumen. Depending on the level of CP in the diet, binding of feed protein in the rumen that limits ammonia available to microbes may be important as well. Also, high CT levels can have adverse effects on epithelial cells of the rumen wall. Quite importantly, CT appear to bind enzymes in the small intestine that break down proteins to peptides and amino acids, and complexes with feed proteins that are not available for digestion can be reformed in the intestines. These factors ultimately limit small intestinal protein digestion and amino acids becoming available to the animal. However, typically when goats and other ruminants can select among plants, some of which have high CT levels and some that do not, the high-CT plants will be selected against. When forced to consume these plants high in CT, animal performance will be low. If no other grazing areas are available, one course of action is to substitute another feedstuff (e.g., grass or grass/legume hay) for the CT-rich plant. Recent research in Israel has shown that the efficiency of usage of concentrate supplements high in cereal grain or soybean meal is low with a basal diet very high in CT, due to the factors mentioned above. Although, very high levels of supplemental concentrates would have beneficial effects, but feed costs would be high as well.

The research project underway at the E (Kika) de la Garza Institute for Goat Research pertaining to CT involves use of polyethylene glycol (**PEG**) as a supplement. Research at other countries such as Israel has shown promise in use of PEG to enhance utilization of herbage high in CT. This potential lies in the ability of PEG to bind to or form complexes with CT, thereby preventing their complexing with feed proteins or enzymes of ruminal microbes or in the small intestine of the animal. Again, low levels of CT can be advantageous in some instances, but very high levels are not. Relatedly, work in Israel has indicated that with consumption of high-tannin oak leaves, very little benefit was achieved through supplementation with cereal grain- or soybean meal-based concentrates, whereas substantial improvements in digestibility, feed intake, and live weight gain occurred when PEG was also given. Supplementation with PEG alone had positive effects as well. Although goats do have the ability to tolerate higher levels of CT than other ruminant species, PEG supplementation someday might be a way of enhancing the use of goats to control and decrease levels of undesirable plants such as shinnery oak, through altering plant selection to increase quantities of oak consumed, broadening the growing season during which appreciable oak consumption occurs, and improving animal performance while consuming different levels of oak.

Example Diet or Supplementation Considerations

For a discussion of example diet or supplementation considerations, for simplicity three general types or categories of forages will be considered. The first is low-protein forages, harvested or grazed, which are also high in fiber of limited potential digestibility (i.e., less than 50%). Examples include wheat straw and mature prairie hay. The second general type is medium quality forages moderate in both CP concentration (e.g., 8 to 13%) and digestibility (e.g., 50 to 60%). Examples are harvested or

grazed vegetative bermudagrass, cool-season grasses such as orchardgrass in late vegetative or early reproductive stages of growth, and annual cool-season grasses such as wheat at or near maturity. The last type includes high-protein and highly digestible cool-season grasses such as vegetative wheat and orchardgrass, with CP concentrations 14% or greater and digestibilities higher than 60%.

Four types of goats, highlighted earlier, will be used to outline how animal and forage characteristics interact in the type of concentrate supplement warranted. These are goats that are nonpregnant or early gestation, in late gestation, in early lactation, or in a growing-finishing phase. The first questions that must be asked when making supplementation decisions are what is the most limiting factor and what level of animal performance is desired. Obvious other things to be contemplated include acceptability or palatability and costs.

For any class of goat, with forages very low in CP concentration and digestibility, the most limiting factor is the ruminal supply of nitrogen-containing compounds, primarily ammonia, which limits microbial fiber digestion and microbial protein production. For nonpregnant goats or ones in early gestation, perhaps only a limited amount (e.g., 0.15 to 0.25% of body weight of dry matter) of a protein source or commercial supplement with protein highly degradable in the rumen, such as soybean meal, will be required, bringing the total dietary CP level to at least 7 or 8%. For goats with higher protein and energy requirements, such as in late gestation, it will be necessary to supplement with a highly digestible feedstuff such as a cereal grain as well. As noted earlier, the level of supplemental CP may also need to be elevated when grain is supplemented. In such instances, often a commercial supplement perhaps 15 to 25% in CP can be used, given at least at twice the level of the higher CP supplement used before. For females in early lactation, particularly dairy goats, such low-quality forage will not permit acceptable performance to be realized, or would necessitate too high of a dietary level of concentrate. The same thing somewhat applies to growing-finishing goats, in that it is not possible to achieve a fast rate of growth with such forage composing a large portion of the diet. However, dependent on the nature of compensatory growth by goats, a relatively slow rate of growth for a limited period after weaning might be partially or perhaps totally compensated for by use of a higher quality diet later, depending on factors such as the length and severity of nutrient restriction in the early growth period.

With the medium-quality forage characterized earlier, goats that are not pregnant and ones in early gestation will not require concentrate supplementation. Although, one thing that should be pointed out is potential effects of stocking rate or grazing pressure on time spent grazing or harvesting herbage. Energy used for grazing relates closely to time spent grazing. With low available forage mass, grazing time can be long, and ruminants will therefore expend a great deal of energy foraging. In such instances a low level of a high-energy supplement composed solely or primarily of grain will decrease energy used in grazing, thereby improving energy status. The same sort of accountings should be made for topography of the land. For females in late gestation, depending on the specific herbage being consumed, only a low to moderate quantity of a concentrate supplement would be required, which should be primarily of a high-energy feedstuff such as a cereal grain with a lesser proportion of a high-protein feedstuff with protein highly degradable in the rumen. A supplemental CP level from 15 to 25% in this instance would be appropriate, perhaps with a feeding level of 0.5 to 1.0% of body weight of dry

matter. In early lactation the level of supplementation or dietary inclusion of this 15 to 25% CP supplement should be increased, depending on the level of milk production possible or desired, as influenced by breed and number of fetuses. The number of fetuses also impacts supplement needs in late gestation. As noted earlier, for lactating dairy goats at highest stages of production, other dietary considerations such as use of RUP sources should be made. The supplement CP level may be increased slightly for such high-producing animals, particularly with high levels of dietary concentrate (e.g., 50 to 65% of total dry matter), but there are limits above which no added benefits are derived. For high-producing dairy goats, once the dietary CP level is raised to somewhere around 15% via use of ruminally degradable protein sources such as soybean meal, further increases in soybean meal consumption will only increase ruminal ammonia absorption and loss of this added nitrogen in urine. Conversely, feedstuffs high in RUP increase amino acid absorption in the small intestine that can be used for milk synthesis or replenishment of animal tissues. As the lactation period advances, the dietary levels of concentrate, CP, and RUP can be gradually decreased. For grazing goats such shifts will, of course, be influenced by changes in the quality and quantity of herbage available for consumption. For growing-finishing goats, as noted before, supplementation will depend on the desired levels and patterns of growth desired. For relatively low growth early after weaning to be compensated for later with a higher plane of nutrition, with such moderate-quality forage no concentrate supplementation is required. For more rapid growth, a moderate level (e.g., 0.5 to 1.0% of body weight) of a supplement 15 to 25% in CP, with the supplemental CP source being high in ruminally degradable protein such as soybean meal, can be used. However, as noted for highly productive lactating dairy goats, with high levels of dietary concentrate, for most rapid growth total dietary levels of CP perhaps greater than about 15% CP should only be achieved through use of feedstuffs high in RUP. The total dietary CP concentration requirement does decrease as animals increase in stage of maturity, depositing proportionately more fat and less protein, but again, such changes have not been well characterized in goats and may be slower than with sheep and cattle.

High-quality forages are in most cases used for animals with high nutrient requirements, or for animals with moderate requirements with a high stocking rate and low available forage mass to limit feed intake. Most efficient supplements of high-quality forages have not been clearly delineated for goats, as is also true for cattle and sheep. Responses have been quite variable. Overall, most economical production for animals with moderate nutrient requirements has been without supplementation. Performance can in some instances be increased by concentrate supplementation, usually for animals with high potential performance, but in most instances the cost per unit of added performance is high. This may even be more true for meat goats than for sheep or cattle because of the apparent relatively slow rate of growth. Although, little research has been conducted with Boer goats consuming such forages. Supplementation is a valuable means, however, to extend forage supplies. For very high-producing dairy goats in the period of highest production, a moderate to high dietary level of concentrate or a grain-based supplemental concentrate typically increases performance, as occurs with lactating dairy cows. Because protein of such forages is rapidly and extensively degraded in the rumen, there is little or no need for added protein sources highly degradable in the rumen. Alternatively, protein sources high in RUP can increase the intestinal protein supply to increase milk production if the absorbed energy supply is adequate.

Conclusions

The ruminant digestive system is unique and complex. Consideration needs to be given to microbial growth and digestion in the rumen and to nutrients becoming available to animal tissues. Feedstuffs differ in composition, and nutrient and energy needs vary with properties of the animal. Only by understanding key nutritional concepts integrating feedstuffs characteristics and animal nutritional needs can most efficient goat management systems be achieved.

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MEASURING FINANCIAL PERFORMANCE

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Introduction

Enterprise budgets are not only useful in determining the profitability of an enterprise, they also provide an integral link between enterprises and financial statements. Their estimated cost and returns form a basis for documenting business strengths and potential as shown in financial statements. For example, most of the information necessary to complete a cash flow plan can be gathered from individual enterprise budgets. While the information is summed into totals on the cash flow plan, details can be obtained from budgets used to develop the plan.

A good information system contributes to the financial success of the farm business. The information system should provide the manager with production information as well as current measures of the financial position, financial progress, income performance, and debt repayment capacity. A financial information system contains four essential and interrelated components: 1) the cash flow statement, 2) the balance sheet, 3) the income statement, and 4) farm records and budgets.

A cash flow plan (figure 1) is a recorded projection of the amount and timing of all cash inflows and cash outflows expected to occur throughout the planning period. Larger farms, substitution of capital assets for labor, and inflation increase the amount of cash required to operate the farm or ranch and make the cash flow plan an increasingly valuable tool in farm financial management. The cash flow plan:

- establishes target levels for income and expenses, which can be used in monitoring progress towards goals
- points out potential problems in meeting financial obligations
- indicates when cash is available for new investments

Although the cash flow plan is important in farm management, it is most effective when used with the balance sheet (OSU F-752) and income statement (OSU F-753). These three statements, supported by good farm records and enterprise budgets, form the core of financial decision making information. Financial planning involves projecting the consequences and results of possible actions, using the financial statements, and then analyzing the projected results. Thus, the potential effect of actions and decisions can be analyzed prior to their implementation and the financial requirements can be evaluated in advance. Comparing budgeted flows with those actually occurring is a useful

management technique for monitoring performance.

The balance sheet (figure 2) indicates the financial position of the farm business at a particular point in time. The balance sheet shows what is owned versus what is owed and is used to analyze the financial position of the farm business. The difference between what is owned and owed represents the owner's claim to the assets of the business, or owner's equity.

The income statement (figure 3) indicates whether a business has earned money or suffered a loss. Actual financial statements help evaluate past performance so that improvements can be made as needed. Projected financial statements allow for evaluating options from production to marketing strategies to risk management. It is important to keep good farm records throughout the year to help ease the burden of financial statement preparation and planning.

To be useful, analysis needs to be done at regular intervals using consistent reporting techniques. Annual reviews should be standard, but for some businesses monthly, quarterly, and/or semi-annual evaluation are necessary. Most people prepare tax information on a calendar year. Therefore, financial planning is often done on the same calendar year basis. The balance sheet, cash flow, and income statement planning periods need to align to be effective.

Cash Flow

As stated earlier, a cash flow plan is a recorded projection of the amount and timing of all cash inflows and cash outflows expected to occur throughout the planning period. Target levels are estimated for income and expense items by using farm records and budget information. Because this is an estimated plan, the projected target levels can periodically be compared to what is actually occurring during the year to point out any problems that may be occurring. The problems could be a result of lower than expected sales prices, higher than expected death loss, increased expenses, or other discrepancies from the plan. By monitoring the plan against what is actually occurring, changes can be made which may help offset problems before they become severe. The cash flow plan will also indicate when cash is available for loan payments or other investments, and when cash is needed from loans or other sources. To be most effective, the cash flow plan should be prepared annually (at approximately the same time) and monitored on a regular basis. A brief discussion of the sections used in the OSU cash flow worksheet is given below. For more information about cash flows and the layout of the OSU cash flow plan, consult OSU F-751 "Developing a Cash Flow Plan".

Revenue - The OSU Cash Flow worksheet is separated into revenue, expense, loan payments, new borrowing, and a summary section. Revenue is further distinguished by cash received from operations, cash received from capital sales, and other cash received. Cash received from operations includes livestock (except breeding livestock) sales, crop sales, government payments, crop insurance, custom work, patronage dividends, and other receipts from normal farm operation. Cash received from the sale of breeding livestock, vehicles, machinery, real estate, and buildings is included in the capital sales section. Non-farm cash receipts that will be available for use in the farm or ranch business during the coming year are included in other cash received.

Expenses - Projecting expenditures is generally easier than projecting revenues. Operating expense figures can come from several sources. The previous year's cash expenditures serve as a good starting point. If an actual past cash flow statement is not available, hand records, year-end summaries of computerized records, or tax forms from prior years are useful. For some expenses, adjustments may be needed to reflect changes in the farm plan and expected prices. For other expenses, simply inflating or deflating the previous period's actual expenditures by an appropriate factor may adequately estimate upcoming expenditures. Use your judgment in applying one or both methods to develop good estimates of anticipated cash outflows. Cash operating expenses refer to those cash expenses incurred for the on going operation of the business. Purchased feed, fuel, seed, and rent are examples of operating expenses. Any livestock purchased for resale, such as stockers and feeder cattle, should be included in cash operating expenses. Cash outlays to acquire assets with a productive life typically longer than one year, e.g. breeding livestock, machinery, equipment, buildings, fences, land, and major repairs or improvements that depreciate, are also included. Other cash payments include cash withdrawals for family living, income and social security taxes, and dividends and capital distributions.

Loan payments - Cash expenditures for scheduled loan payments include both scheduled interest and principal payments on loans. In projecting these payments, the previous year's balance sheet, current loan schedules, or a liabilities schedule (OSU WF-792)[1] should be useful in determining balances of principal and interest due by the end of the year. Check your loan schedule to see if the interest portion of payments due is listed separately from principal payments. If other than annual payments are to be made, the amounts must be prorated to the proper periods. A loan schedule or a copy of the original note should indicate the exact amount and timing of the payments.

To estimate payments for this coming year on new term loans, review capital asset purchase plans and expense categories. If financing payments are expected on new loans for capital purchases, make the proper entry(s). A discussion with the lender and use of OSU WF-792, "Liabilities Schedule", should increase the accuracy of this estimate.

New Borrowing - Money flowing into the operation from new loan obligations is summarized in the new borrowing section. New loans for short term operating notes, new term debt, and new non-farm debt are included in this section. Advances on the line of credit note are not included in this section, but are shown in the summary section.

Summary and loan balances - The cash flow summary section is used to calculate the beginning cash balance, inflows minus outflows, cash position, and expected line of credit borrowing (if any). It also shows payments on line of credit interest and principal, tracks accrued interest on the line of credit and determines the ending cash balance. If the calculated cash position is in excess of the minimum balance, payments are made on the line of credit, interest first then principal. If the cash

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[1]WF indicates a fact sheet that is available through the Oklahoma Cooperative Extension Service (OCES) website, http://www.okstate.edu/OSU_Ag/agedcm4h/pearl/agecon/agecon.htm. If you do not have access to the www, contact the author for copies of the fact sheet of interest.

position is less than the minimum cash balance, then the line of credit increases to obtain the desired minimum cash balance.

Loan balances are maintained for line of credit, operating notes, term debt, and non-farm debt. If payments are made during the month, the appropriate balance is reduced by the amount of the principal payment. If new borrowing occurs then the balance increases by the amount of principal borrowed.

Balance Sheet (Assets = Liabilities + Owner Equity)

The balance sheet indicates the financial position of the farm business at a particular point in time. The balance sheet shows what is owned versus what is owed and is used to analyze the financial position of the farm business. The difference between what is owned and owed represents the owner's claim to the assets of the business, or owner's equity. An accurately prepared balance sheet measures the financial position of a firm at a given point in time. It shows the value of assets that would remain if the business were liquidated and all financial obligations to others were paid. A series of balance sheets prepared at the same time of year for successive years shows the change in financial position and the progress being made by the business.

One of the difficulties in preparing a balance sheet is the valuation of assets. Market-basis valuation is an estimation method based on fair market value less selling costs. Cost-basis valuation adjusts the original cost of the assets for accumulated depreciation. Base value is a stipulated amount which roughly approximates cost and may be used when valuing raised breeding livestock (OSU WF-323) to reduce the amount of record keeping necessary in accounting for all costs of raising each animal. Market-basis valuation is an appropriate method for evaluating financial position for credit analysis and estimating owner equity. Cost-basis valuation is typically more useful when measuring the financial progress of an individual business from year to year. For more information on balance sheet preparation, see OSU F-752 "Developing a Balance Sheet".

The balance sheet is one of the most commonly used financial tools. Time invested in keeping records and preparing financial statements including the balance sheet yield positive returns. However, the balance sheet does not measure profitability except to the extent that profits increase retained earnings and total owner equity from one period to the next. It also does not measure the repayment capacity or the ability to meet financial obligations when they come due. Thus, for financial analysis and credit management purposes, the balance sheet should be supplemented with an income statement and cash flow projection.

Current & non-current assets - Assets are usually defined as items of value owned by the business plus items owed to the business. The assets include items held for sale (e.g. stocker calves, grain) or resources used in the business operation (e.g. breeding livestock, machinery, land). For financial analysis, the assets are usually categorized according to their liquidity or how readily they can be converted to cash. Further, both current and non-current assets are divided between farm and non-farm.

Current assets are cash and other assets which are typically and easily converted to cash in the course of business during the year without any loss in value. Examples of current assets include cash and checking, marketable securities, accounts receivable, prepaid expenses, marketable livestock, crop and feed, and supplies among others.

Non-current assets are not normally for sale but rather are held for the production of livestock or crops to be sold later. Non-current assets are usually not easily and quickly converted to cash without some expense or loss in value. Some non-current assets are depreciable; others are not. Breeding livestock, machinery, and buildings are used up in the production process over more than one production cycle. These are depreciable assets (see OSU WF-791, "Schedule of Assets"). Land is a non-depreciable asset and is typically the least liquid of the assets. Most non-current assets are entered at current market value when preparing a market-based balance sheet. Book value (cost less accumulated depreciation) is entered on a cost-based balance sheet and is also needed to calculate valuation equity (WF-938). Tax basis for assets is needed to calculated deferred taxes. For more information on deferred taxes see OSU WF-939 "Deferred Taxes".

Current & non-current liabilities - Liabilities are claims by others against the assets and are categorized according to the time period in which the obligations are to be paid. Like the assets, liabilities are either current or non-current. OSU WF-792, "Liabilities Schedule", may be used to summarize the liabilities for an individual or business. Like assets, current and non-current liabilities are separated between farm and non-farm liabilities.

Current liabilities are those which are due in the current operating period, usually within 12 months. Examples of current liabilities include accounts payable, line of credit and operating notes, current portion of term debt, accrued interest, deferred taxes, and taxes.

Non-current liabilities are those which are not due in the current operating year, but are due beyond this year. The non-current portion of term debt is found by subtracting the principal balance due in the current year from the total principal owed. Machinery notes, land notes, and non-current deferred taxes are examples of non-current liabilities.

Owner Equity is a calculated residual after the claims of others (liabilities are subtracted from the value of assets). Total equity is, therefore, easy to determine once the value for total assets and total liabilities has been calculated. Division of total equity into contributed capital, retained earnings, and valuation equity is very useful in analyzing the farm's productivity and financial position.

Contributed capital represents the original investment into the business (or reporting entity) plus additional amounts which may have been added by some source from outside the entity such as gifts and inheritances. When the farm business alone is the reporting entity, additional investment of the owner's personal funds (e.g. wages from off-farm work) would be added to the initial investment and withdrawals from the business (e.g. family living expenses) would be subtracted.

Retained earnings are an accumulation of net earnings which have not been withdrawn or distributed. A series of retained earnings provides strong historical evidence of the ability of the business to generate profits above withdrawals. The amount may be difficult to determine directly if adequate records are not available to show net farm income for each year since the beginning of the business. However, the amount may be determined indirectly by subtracting contributed capital and valuation equity from total equity.

Total valuation equity is the change in owner equity due to changes in the market values of assets owned. Valuation equity equals the sum of market values of assets minus the sum of book values (cost less accumulated depreciation) and minus non-current deferred taxes.

Income Statement

The income statement indicates whether a business has earned money or suffered a loss. Actual financial statements help evaluate past performance so that improvements can be made as needed. Projected financial statements allow for evaluating options from production to marketing strategies to risk management. It is important to keep good farm records throughout the year to help ease the burden of financial statement preparation and planning.

To be useful, analysis needs to be done at regular intervals using consistent reporting techniques. Annual reviews should be standard, but for some businesses monthly, quarterly, and/or semi-annual evaluation are necessary. Most people prepare tax information on a calendar year. Therefore, financial planning is often done on the same calendar year basis. The balance sheet, cash flow and income statement planning periods need to align to be effective.

The income statement shows whether the farm operation returns a profit or a loss to unpaid labor, management, and equity. Profitability is defined as the extent to which an entity generates revenue over and above expenses with the available assets. Assets include land, capital, labor and management. Information from the income statement is also used to evaluate repayment capacity, capital investment potential, and financial efficiency (see OSU F-790, “Evaluating Financial Performance and Position”).

Two basic accounting methods exist for determining net income. Both the cash and accrual methods are acceptable in tax reporting for farmers, and each has its advantages and disadvantages. Most farms use cash accounting to compute income taxes. Cash accounting requires only single entry record keeping, which is achieved through maintaining receipts for income and expenses. Under the cash method, receipts and expenses are reported for the period during which cash or money actually changes hands. If feed is purchased and used during one accounting period, but not paid for until the next accounting period, the feed expense is not recorded until it is paid in the next accounting period. Here, profits are overstated during the first period and understated during the next accounting period. Reliance on cash income figures can delay recognition of financial problems.

The accrual method more accurately reports net income and is better for financial analysis.

However, accrual accounting requires double-entry bookkeeping which is more complicated. Accrual accounting "matches" associated expenses to revenue as they are earned. The Farm Financial Standards Council (FFSC) recommends that farm financial statements be developed using "accrual adjusted" accounting, a compromise between cash and accrual methods. Accrual adjusted financial statements are based on cash records with accrual adjustments to revenue (e.g. changes in inventories, accounts receivable, and prepaid expenses) and expenses (e.g. accounts payable, accrued taxes and interest).

For more information on the income statement see OSU F-753, "Developing an Income Statement". The basic sections of the OSU income statement format is presented below.

Revenue - Revenue is income generated by the farm operations. Not all cash inflows are income. Cash proceeds from an operating loan are an example of a cash inflow that is not income. Revenue includes proceeds from the sales of market livestock, livestock products and crops, plus government payments. Changes in inventories of market livestock, raised crops and feed, gains or losses from the sale of culled breeding stock, changes in accounts receivable, and prepaid expenses are also recorded in the revenue section. Revenue using the OSU format is broken into gross revenue from market livestock and products, gross revenue from crops, and other farm revenue.

Gross revenue from market livestock and products includes sales of raised market livestock, livestock purchased for resale, and livestock products. Raised livestock may include stockers, feeder pigs and broilers. Livestock purchased for resale may include purchased stocker steers and heifers or feeder pigs. Examples of livestock products are milk, eggs, wool, and mohair. Note that sales of breeding livestock are not included in this section. An accrual adjustment is also made for the change in market livestock inventory.

Gross revenue from crops includes sales of raised crops and crops or feed purchased for resale. An accrual adjustment is made for changes in the inventory of stored crops/feed.

Other farm revenue includes government payments, cash rent income, crop insurance claims, patronage dividends, and custom work to name a few. The gain/loss from the sale of culled breeding stock sums gains and losses from sales of raised and purchased breeding animals culled (WF-323). For raised breeding livestock, the gain/loss is calculated by subtracting the base value from the sale proceeds; for purchased breeding stock, subtract the cost basis from the sale proceeds to determine the gain or loss. Only the gain from the sale, not the gross revenue, is recorded; otherwise, revenue will be overstated. Change in value due to change in quantity of raised breeding stock is the sum of the changes in value of raised livestock which are being retained for possible future use in the breeding herd, but for which the related cash costs have been expensed in the income statement. Raised livestock for breeding are not depreciated if using a base-value method. Instead, revenue is recognized each period when the animals are at a transfer point such as changing from market livestock to replacement heifer, replacement heifer to bred heifer, or bred heifer to cow. The value recorded on the income statement is the gain in value (no cash exchanged) of market livestock as they change livestock classes within the breeding herd. Other accrual adjustments are made for the change in accounts

receivable, prepaid expenses, cash investment in growing crops, supplies, other current assets, contracts and notes receivable, and investments in cooperatives. Gross farm revenue is a summation of gross revenue from market livestock and products, gross revenue from crops, and other farm revenue.

Expenses - Operating expenses are those expenses incurred to generate revenue. An expense is the amount of goods or services (cash or non-cash) used to produce a revenue generating item or service. Cash expenditures do not always constitute an expense. For example, principal payments on farm loans are cash expenditures and are recorded on the cash flow statement; however, they are not operating expenses. Only the interest portion of a loan payment is recorded as an expense for the income statement. Expenses included on the income statement include purchased market livestock, chemicals, insurance, labor hired, and supplies to name a few. Accrual adjustments are made for the change in purchased feed inventories, accounts payable, ad valorem taxes, employee payroll withholding taxes, other accrued expenses, other current liabilities, and other non-current liabilities from the beginning to the end of the fiscal year.

Depreciation is considered an operating expense and it is reported on a separate line on the income statement. Economic depreciation is used for the income statement because it tends to better estimate the useful life of assets. It differs from depreciation used for tax purposes. Economic depreciation is a systematic and rational method of allocating the non-recoverable cost of breeding stock, machinery, and buildings over the estimated number of years that the item will generate revenue. Economic depreciation is based on a known quantity and cost, an estimate of the useful life of an asset, and the salvage value at the end of the useful life. Only the appropriate amount of depreciation for the reporting period is recorded. Land is not depreciated, since it is assumed that land will not be depleted and will continue to generate revenue.

Interest expense includes cash interest expense plus the change in accrued interest. Cash interest paid is the sum of cash interest payments for farm loans, including operating notes, line of credit, machinery and equipment notes, and real estate loans. Accrued interest is the amount of interest outstanding at the reporting date from all farm notes and loans. The change in accrued interest is the accrued interest at the end of the accounting period minus the accrued interest at the beginning of the accounting period. Principal payments are not a farm operating expense; rather they are repayment of cash that was received from loan proceeds and so are not included on the income statement.

Net Farm Income from Operation (NFIFO) is the amount of profit (loss) strictly from the farm operations, not including gains or losses on the sale of farm capital items or personal and income tax. Thus, net farm income from operations equals gross farm revenue minus total farm expenses. NFIFO is useful for comparisons over time periods as it focuses on the net returns to normal farm operations (capital sales are expected to be occasional).

Net Farm Income is a standard measure of profitability for a farm business, calculated by matching revenue with expenses incurred to generate the revenue, plus the gain or loss from the sale of farm capital assets, before taxes. It is a residual return to the unpaid labor and management and owner equity. Net farm income equals NFIFO plus/minus gains or losses on sales of farm capital assets and

gains or losses due to changes in base value of breeding livestock. Net farm income must be positive for the farm to be profitable. A profit shows that operating expenses and debt interest are paid and that owner and family labor and management have earned a positive return. Generating profits over time allows the farm business to expand, replace capital, and reduce debt.

Non-Farm - The OSU income statement also provides for non-farm revenue and expense entries. Further, entries can be made for cash income taxes paid, change in accrued income taxes, change in current portion of deferred taxes, and extraordinary items.

Integrated Farm Financial Statements (IFFS)

IFFS is spreadsheet-based software to facilitate farm/ranch financial planning and analysis. Enterprise budgets can be summed to build a cash flow plan or actual summary data can be entered in a cash flow statement or plan. Both version 3 and 4 can generate enterprise budgets, customized budgets, a monthly cash flow statement, debt worksheets, balance sheet, income statement, and financial measures. Version 4 requires detailed asset information to generate additional statements conforming to the FFSC recommendations: schedules of assets and liabilities, schedule of deferred taxes and valuation equity, statement of cashflow (annual), and owner's equity.

Currently two Lotus 1-2-3 based versions of IFFS are available on 3 1/2" diskettes for $150.00. Both versions handle multiple-year planning. To request additional information or to order, contact Department of Agricultural Economics, Oklahoma State University, 515 Agricultural Hall, Stillwater, OK 74078, or (405) 744-9835. More information on IFFS can also be obtained from the Farm Financial Management Resources web page at http: //www.okstate.edu/OSU_Ag/asnr/agec/ffmr.htm.

Intensive Financial Management and Planning Support (IFMAPS)

IFMAPS, a special program provided through the Oklahoma Cooperative Extension Service, has helped farm and ranch families develop sound financial plans since 1985. Trained financial specialists work one-on-one with agricultural producers to increase their financial management skills, analyze the current financial condition of their farm or ranch operation, identify options for change, and evaluate alternative plans. Over 4,700 farm families have received IFMAPS one-on-one assistance while broadening their personal planning and management skills. Oklahoma farm and ranch families receive assistance free and financial information is kept confidential. The only cost to the producer is the time spent working with the financial specialist to prepare the plan. For further information contact IFMAPS at (800) 522-3755. More information on IFMAPS can also be obtained from the Farm Financial Management Resources web page at http://www.okstate.edu/OSU_Ag/asnr/agec/ffmr.htm.

Quicken Training

Quicken is a popular and inexpensive personal financial record-keeping software package that can be adapted for farm use. The Oklahoma Cooperative Extension Service offers "hands on" Quicken workshops to help producers use and adapt Quicken to their operation.. Contact your extension office to determine the next available training. Instructions are also posted on the WWW at http: //www.okstate.edu/OSU_Ag/asnr/agec/Doye/QUICKFRN.HTM.

Fact Sheets

Oklahoma Cooperative Extension Service publishes OSU Fact Sheets that describe many different topics. Some of the more relevant Fact Sheets which will supplement this article are listed below.

Fact Sheet Number[2]	Title
F-139	Budgets: Their Use in Farm Management
F-779	The OSU Livestock Enterprise Budget
E-887	Goal Setting for Farm/Ranch Families
F-751	Developing a Cash Flow Plan
F-752	Developing a Balance Sheet
F-753	Developing an Income Statement
F-790	Evaluating Financial Performance and Position
WF-323	Valuation of Raised Breeding Livestock
WF-791	Schedule of Assets
WF-792	Liabilities Schedule
WF-935	Capital Leases
WF-937	Consolidated Financial Statements
WF-938	Owner Equity Section

Petermann - Cash flow 1
Petermann - Cash flow 2

[2]WF indicates a fact sheet that is available through the OCES website, http://www.okstate.edu/OSU_Ag/agedcm4h/pearl/agecon/agecon.htm.

Petermann - Balance

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GOAT FARM BUDGETING

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Introduction

Management is the most important factor in the success of any farm operation. Profit maximization is traditionally assumed to be the overriding goal in most management decisions. In reference to the economic feasibility of a goat enterprise, producers should understand the probable cost and returns of such an operation, the profit equation, financial and production risk, and potential alternatives. Questions may arise as to whether goats will help supplement farm income or if a larger goat operation is even technically feasible. Enterprise budgets are designed to provide a decision framework for assessing both short- and long-range economic analyses of production agriculture.

Three basic types of budgets can assist with the farm and financial planning process. Each type of budget provides different information to the manager for use in the decision making process. Like a puzzle, each budget brings to the table an important piece that will help address how available resources best fit together on the farm. Specific questions such as how and what to produce, production levels, and achieving goals can then be answered once the puzzle is completed.

Whole-Farm Budgets

How to best organize and manage the farm business in a manner that is consistent with the goals and objectives of the family are vital issues in charting the future direction of the farm organization. The decision as to whether the enterprise in question will help achieve goals rests on the farm family acting as managers. OSU Circular E-887, "Goal Setting for Farm/Ranch Families", can help with the process of farm and family goal creation, prioritization, and the maximization of resources owned or controlled by the operator.

The whole-farm budget is a summary of the major physical and financial components of the entire farm business. The budget identifies the resources available to the farm business and assists in the selection of overall management strategies that complements the goals in mind. More information on whole-farm budgeting can be found in OSU F-139, "Budgets: Their Use in Farm Management".

Enterprise Budgets

An enterprise budget incorporates information about the specific resources, management practices, and technology used in the production process. More specifically, an enterprise budget illustrates the expected costs and returns, inputs and production, and timing for a particular farming activity. Among the various uses for enterprise budgets are:

1. Evaluating options before a commitment of owned or controlled resources.
2. Estimating potential income for a particular farm.
3. Estimating the size of farm needed to earn a specified return.
4. Uncovering costs that have not been previously considered.
5. Providing the documentation necessary to obtain/maintain creditworthiness.
6. Learning how to better organize and reorganize.
7. Comparing the profitability of two or more different systems of production.
8. Estimating the amount of rent that can be paid for land or machinery.
9. Identifying production and financial risks and whether they may be managed.
10. Projecting cash flows for a specific period of time.

Enterprise Budgets - Components and Concepts

Budgets estimate the full economic costs and returns projected to accrue to an enterprise. The goat budgets (Tables 1 and 2) are provided to assist goat producers in estimating their costs of production. Unless costs of production are known, you will not even realize if you are making a profit. And like the old adage says, "Nobody ever went broke while making a profit". Profit is shown as residual earnings in these budgets and will be discussed in greater detail later. An individual may use the column at the right of the budget (Your Value) to make planning adjustments.

The front page of the Oklahoma State University livestock enterprise budget contains a summary of operating inputs, fixed costs, and production. These values represent the economic outcome expected for a production period. Details of monthly operations, as well as monthly labor and capital requirements, are provided on a second page (not shown).

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

Variable Costs

Variable costs are those operating inputs that vary as the level of production changes. They are items that will be used during one operation year or one production period. They would not be purchased if production were not undertaken. Variable costs may also be classified as cash or non-cash in nature. For instance, labor expenses are included in the operating input section. An assumption is made where there is no differentiation made between owner supplied or hired labor. If the farm operator or his family supplies the labor, a wage rate that represents a salary if employed elsewhere would be shown.

Fixed Costs

Fixed costs are those that do not change with the level of production. Generally, fixed costs are those ownership costs associated with buildings, machinery, and equipment that are pro-rated over a period of years. Fixed costs may also be cash or non-cash in nature. Real estate taxes, personal property taxes, and insurance on buildings are examples of cash fixed costs. Non-cash costs such as depreciation and interest on capital investment result in foregone opportunities. A closer inspection of the fixed costs in a typical livestock budget follows.

The interest charge for durable assets such as machinery, equipment, and breeding livestock used in the goat operation is based on the average amount of capital invested over the ownership period, usage per year, and an interest rate. Money that is tied up in these capital assets could have earned a return in an alternative use. This foregone opportunity is what economists define as opportunity costs and reflects a payment to the farmer's owned resources.

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

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

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

Production

The total quantity of production is multiplied by the actual or expected price to determine a value for production. In the goat budgets, the expected returns to the 100 doe unit are averaged for reporting on a per doe basis. This averaging process yields a realistic estimate of per doe returns to the herd given death loss, replacement rates, and kidding percentages.

Returns Above Total Operating Costs

The returns to fixed cost, land, risk, and management is computed by subtracting total operating costs from total receipts. As long as returns are greater than total operating costs, production is economically rational for an enterprise already in production. As shown in the goat budgets, both operations generate enough revenue to more than offset variable costs.

Returns Above All Specified Costs

In determining overall enterprise profitability, fixed costs also have to be part of the profit equation. Returns to management, land, and risk is calculated by subtracting total variable and fixed costs from operating revenues. This amount is residual earnings to the producer for management and to land (because land/pasture costs can have a large variation within a region, the goat budgets show no land cost). Each individual must decide whether this return is a sufficient reward for management skills, risk taking, and land devoted to the enterprise. It should be noted that since non-cash items may be included in fixed costs, profits as shown here are not the same as net cash or operating receipts as shown in a cash flow statement.

Dairy Goat Operations

Most often, dairy goat enterprises mainly supplement income and milk consumption at home. If a dairy goat operation is primarily viewed as a hobby, the discussion of economics may be of lesser importance than a commercial dairy. That is not to say that an enterprise budget as a decision tool is not needed for home dairies. A small herd producing milk is sometimes an expensive hobby and an enterprise budget will help illustrate why.

The whole economic emphasis changes when the discussion turns to a commercial dairy. If plans are to go public with milk sales or sell to a commercial processor while building the herd to over 50 head, the farm manager is faced with a different set of resource requirements needed to develop a productive and profitable enterprise system. An enterprise budget would be an essential tool in evaluating whether such an alternative would be to the manager's financial advantage. Farm management skills and knowledge are a very integral aspect of success with commercial dairies. The ability to bear losses from business risk, a large capital base, and well trained labor are also important considerations.

As illustrated in Table 1, the producer is faced with a decision whether a return of $8,000 per 100 goats is satisfactory. Does it contribute enough revenue to general farm maintenance and family living? Is it adequate compensation for management efforts? If the returns are high enough, then resources may be committed to the operation in the long term.

The budget in Table 1 allows break-even analysis for the defined enterprise. Break-even analysis is a useful technique in balancing demand (revenue) and cost factors. Revenue per output is found in terms of price times production volume. If one revenue component were kept constant, what would the other part need to be for that item's revenues to equal costs? For example, the break-even costs for producing 20 hundredweight (cwt.) of milk per doe when considering only operating inputs (and leaving other receipts constant) would be $15.89 per cwt. In other words, this is the market price of milk one would need just to cover variable costs in the operation while separating out other revenue items from consideration. This break-even price is found by subtracting other revenues per doe unit ($60.50) from total variable costs ($378.29) and then dividing by the production level of 20 cwt. Revenues of $317.79 (20 cwt. × $15.89/cwt.) is equal to $317.79 (adjusted operating costs) and net returns above total operating costs are zero. To determine the break-even production level needed to cover operating inputs, one would divide the adjusted variable costs ($317.79) by the budgeted milk price per cwt. of $24 to get approximately 13.25 cwt. of milk required. Similar calculations using total variable and fixed costs may be made when determining break-evens to cover all specified costs.

Risk assessment recognizes that production and price parameters are subject to considerable variation. Production and market uncertainty exist in goat operations due to the inability to accurately forecast productivity and prices. The producer should consider a range of outcomes in addition to average or expected values. Scenarios that produce unfavorable returns will jeopardize cash flow and financial solvency.

Table 3 provides a sensitivity of expected returns above operating costs at various milk price and production combinations. Each producer would need to evaluate their options given individual financial strengths, track record/experience, price outlook, and wiliness to assume risk.

Table 3. Sensitivity of Milk Production versus Price on Per Head Net Returns above Total Operating Costs for a 100 Head Commercial Dairy Goat Herd. *

Milk Prod. (cwt.)	-10% $21.60	-5% $22.80	Expected Price/cwt. $24.00	+5% $25.20	+10% $26.40
-20% 16.0	$27.81	$47.01	$66.21	$85.41	$104.61
-10% 18.0	$71.01	$92.61	$114.21	$135.81	$157.41
Expected 20.0	$114.21	$138.21	$162.21	$186.21	$210.21
+10% 22.0	$157.41	$183.81	$210.21	$236.61	$263.01
+20% 24.0	$200.61	$229.41	$258.21	$287.01	$315.81

Break-even milk production/cwt. above total operating costs is 13.24 using the $24.00 price of milk.
Break-even milk price/cwt. above total operating costs is $15.89 using a production of 20 cwt.
*** As shown in Table 1. Break-even price and production are calculated to cover total operating costs only while keeping revenues from kid and cull sales constant.**

Meat Goat Operations

Although meat may be produced from Angoras and dairy goats, other goats are raised exclusively for this purpose. Income from meat goat production may not generate as much income as other livestock, except in areas where land areas will not support other grazing livestock such as beef cattle. Many herds are utilized for smaller land areas where brush or weeds are a problem. As with dairy goat operations, there are a number of management practice considerations that influence profitability more than perhaps buildings and equipment.

Due to a lack of a developed nationwide marketing system in the United States, prices tend to vary widely and fluctuate seasonally. However, goat meat is favored by a number of ethnic groups in this country and many producers cater to these populations on an individual basis. Improved production practices and management techniques will be needed to insure profitability within the commercial production sector. On the demand side, meat quality standards will need to be in place before national distribution systems develop.

In Table 2, revenues are sufficient to cover all variable costs and a portion of the fixed costs. However, returns above all specified costs are negative. The enterprise would not be self-supporting in the long run and is not rewarding the operator financially for management skills. If meat goats are viewed as a hobby or for home consumption, then once again, economics may play a lesser role in deciding whether to produce or not. Many producers in this situation realize that the operation may not 'pay for itself', but that is a sacrifice they are willing to make. However, if long-run returns appear unsatisfactory, the best decision may be to exit the enterprise and employ resources in a different enterprise or investment.

The meat goat budget also allows a break-even analysis for this enterprise. One could determine a break-even cost above operating cost when separating fed kid revenues from culled does. For example, when considering only male kid production (and keeping other receipts constant), the break-even price per male kid would be close to $14. This is found by dividing adjusted operating costs ($41.63-$32.64=$8.99) by .65. Once again, revenues of approximately $9 ($13.88/hd. × 0.65) equals total operating costs (adjusted by subtracting other revenues not in consideration). Therefore, net returns above total operating costs are zero.

Production and price uncertainty will also impact a meat goat operation. Several 'what-if' scenarios consisting of male kid prices and overall kidding percentages are shown with their effects on net returns above operating costs in Table 4.

Table 4. Sensitivity of Kid Crop Percentage versus Male Kid Price on Per Head Net Returns above Total Operating Costs for a 100 Head Meat Goat Herd. *

Kid Crop %	-10% $54.00	-5% $57.00	Expected Price/hd. $60.00	+5% $63.00	+10% $66.00
0.8 of Exp. 115%	$12.39	$13.95	$15.50	$17.06	$18.61
0.9 of Exp. 130%	$19.20	$20.95	$22.70	$24.45	$26.20
Expected 144%	$26.00	$27.94	$29.89	$31.83	$33.78
1.1 of Exp. 158%	$32.80	$34.94	$37.08	$39.22	$41.36
1.2 of Exp. 173%	$39.61	$41.94	$44.27	$46.61	$48.94

Break-even kid crop percentage above total operating costs is 84 using the $60.00 price per male kid.
Break-even male kid price per head above total operating costs is $13.88 using the 144% kid crop.
*** As shown in Table 2. Break-even price does take into account adjustments in female sales while keeping other production parameters constant. Break-even kid crop percentage assumes a constant price structure from other revenue sources with respect to male kid prices.**

Partial Budgets

The third type of budget that is useful in farm management and planning is the partial budget. Partial budgets reveal the effects of a specific change from an existing operation. It only considers the net economic effects of a proposed change and its impact on the total farm budget.

For example, one may consider kid sales at weaning versus at 90 days postweaning. Will the cost savings more than offset a loss in revenues? A partial budget format as shown below helps determine the positive and negative economic effects.

If I Sell Kids at Weaning Instead of 90 Days Later.

Additions to Income		*Subtractions from Income*	
Added Receipts Kid sales at weaning weight of 15-20 lbs.		**Added Expenses** None, assuming marketing expenses are constant.	
Reduced Expenses Expenses associated with feeding kids 90 more days.		**Reduced Receipts** Kid sales at heavier weights, approx. 65 lbs.	
Total Additions	$$$	***Total Subtractions***	$$$

	Net Change of selling weaned vs. heavier kids

For more information, please refer to OSU F-139, "Budgets: Their Use in Farm Management".

Sources of Budget Information

To enhance their use as a decision aid, goat budgets should be based on the best information possible. And many times, that begins with the operator's own records. The sample budgets previously discussed may be tailored to fit an individual producer's operation. Their reliability as a planning tool is only as good as the quality of the data. Keep in mind that experiences from one year is only an indicator and not a guarantee of a future occurrence.

Several informational systems are available to goat producers in Oklahoma. The record-keeping system that a farm manager should use depends on the cost, time, effort, and cash of obtaining a system, maintaining it, and the value of the output as a decision tool. Farm record systems vary in the amount of information collected, the method of entering data, and the structure of final reports. Goat producers should choose the method appropriate to the size and complexity of their operation.

For smaller and less complex operations, hand-kept record books may be the most practical and most efficient system. Two alternatives offered by the OSU Cooperative Extension Service are:

1. Oklahoma Farm Family Account Book (Circular E-823, $2). Production and financial items by income and expense item may be recorded. Copies may be obtained from University Mailing Services, Publishing and Printing East, N. Monroe St., Stillwater, OK 74078-0505.
2. The Oklahoma Looseleaf Enterprise Record Book ($8). In addition to farm receipts, expenses, depreciation, and inventory, separate enterprise accounting allows the user to determine the relative profitability of crop and livestock enterprises. Copies can be purchased from the Department of Agricultural Economics, 515 Agricultural Hall, Stillwater, OK 74078-0505.

3. A number of computerized record-keeping systems (e.g., Quicken) are now available and are becoming more affordable. Although a computer probably won't reduce the amount of time spent keeping records, whole-farm and enterprise analysis of a large volume of transactions will be more efficient. A few keystrokes is all it takes to generate income and expense summaries, and a wide variety of financial statements. For more information on using Quicken or reviewing other commercial software packages, contact:
   Damona Doye
   Extension Farm Management Specialist
   Department of Agricultural Economics
   529 Agricultural Hall
   Stillwater, OK 74078
   405-744-9836

Other sources of information are:

1. Books on goat husbandry and industry.
2. Goat organizations.
3. Other goat producers/breeders.
4. University specialists, educational materials, and meetings.
5. Goat web sites on the Internet.

Oklahoma State University crop and livestock enterprise budgets are available via the Internet, disks, or paper copies. Front-page budget summaries in Excel spreadsheet format can be found on the Internet at http://www.okstate.edu/edu. Spreadsheet budget summaries on diskettes are available for a fee. Paper copies with front and back page formats are available at a fee. To request additional information or to order, contact:

Mike Hardin
Extension Farm Management Specialist
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532 Agricultural Hall
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Budget Limitations

Budget projections may become incomplete or unrealistic resulting in little or no value to the producer or lender if adequate farm records are not available. It is also important to understand that 'best estimates' are influenced by production and price uncertainty. Everything doesn't always proceed just like you planned it. Identifying the potential sources of risk and reducing potential unpleasant surprises will result in fewer repayment problems in the future.

Budget preparation is also time consuming and hard work. Who has time to do budgets when work has to be done outside? Sitting down and documenting creditworthiness through budget planning can generate major dividends. Not only is it important to work hard, but to work smart.

Summary

Budgets, whether they are whole-farm, enterprise, or partial, are a management tool that is invaluable when evaluating the profit potential of the farming business. Although managers lack the information needed to make perfect decisions, they are forced to make decisions on the basis of information available and must accept the risk associated with that decision. Knowledge of budgeting and the ability to use them will help them make the right decision.

Two goat budgets developed at Oklahoma State University were shown to demonstrate the basic economic concepts and components of an enterprise budget. Their apparent profitability or lack thereof was not meant to mislead individuals into believing that dairy goats are always more successful than meat producing ones. They are only intended to be used as guidelines for the kinds of expected costs and returns typical with these operations. Alternatives that appear profitable for one producer may not work for another. Every goat producer's experience levels, managerial abilities, and willingness to assume risk is different. Because of these variations, each budget will need to be examined in detail to see if it is representative of his unique situation. The budgeting process is a continuous one and requires hard work. But it has become a prerequisite for survival in the goat industry.

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THE BASICS OF TANNING GOAT HIDES

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Why Tan Skins?

We have all seen rugs and furs made from animals, trophy bucks mounted by a taxidermist, and maybe even own a sheepskin. We may have goats with hides that would make an attractive rug or cover. Possibly, there is even a market for colorful goat hides or crafts made from them. To produce a goat rug requires knowledge of the art of tanning. When speaking of tanning hides one naturally thinks of large tanneries producing leather and furs; however, it is possible to tan hides at home. In the distant past tanning meant taking the bark of certain trees, oak for example, and pounding the bark into a mush, mixing it with water, and soaking the dehaired hide of an animal in the mixture for several weeks or even months. Deer buckskin was made by native Americans using animal brains as a source of preserving agent. Later, chemical methods of chrome tanning were developed, which are still in use. Today, in addition to the above methods, there are synthetic tanning agents that are easy to use and fairly inexpensive. One advantage of tanning at home is cost. For example, professionally tanned sheep or calf skins can cost $70 to $100. Tanneries can be found where you can send preserved hides to be professionally tanned. Costs for such services may be on a per hide or per square foot of hide basis. Alternatively, one can purchase tanning kits, one of which will tan up to 20 pounds of hide (the equivalent of two deer skins) for between $25 and $35, and finish the job in two to six weeks. The equipment needed to tan hides can be purchased or much of it can be fashioned from items found around most households or farms. Although home tanning may not match the quality of a professional tannery, good quality, long-lasting products can be made. In addition to home use, some of these products could be sold, or someone who earns a good reputation as a home tanner could receive hides to tan.

Where Can One Find Information?

Books on tanning or taxidermy or speaking with a taxidermist are good places to start learning about tanning. At the end of this article is a list of some of the texts that may be available at your local library. These texts outline the steps required, equipment needed and provide many tanning recipes and tips on how to successfully tan hides. Additionally, they list the chemicals you will need to purchase to finish your project. Often, these texts recommend that a beginner purchase a tanning kit designed to tan a small amount of hides. These kits come complete with tanning chemicals, instructions, and a list of the needed equipment. Two examples[1] of such kits are:

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

Tannery in a Box - a chrome sulfate based tan which includes chemicals for hair-on or hair-off tanning offered by Tandy Leather Co.; and EZ-100 Kit - a synthetic tanning agent touted as environmentally safe manufactured by Rittel and offered through taxidermy supply companies. Some tanning agents come in a paint-on form in which the tan is applied directly to the prepared hide with no other chemicals needed. Two examples of these are: Tannit[7] Solution - offered by Tandy Leather Co.; and Liqua-Tan[J] - a liquid tanning agent manufactured by Knobloch=s, Lafayette, CO. Taxidermy supply companies and sources for tanning chemicals can be found through speaking with a taxidermist, the phone book or on the Internet at www.taxidermyonline.com or www.taxidermy.net under taxidermy supplies.

Basic Tanning Steps

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

It is not the goal of this paper to present all of the variations of the steps needed in tanning hides. Rather, some pertinent information on each of the basic steps will be given. More detailed information can be found in the texts listed at the end of this paper or one of the other information sources previously mentioned.

Skinning

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

Many people who hunt or butcher at home have experience skinning and have their own favorite tools and methods. Skinning can be done with the carcass hanging or lying. Generally, hanging is easier as after the initial cuts are made the skin can be pulled downwards or Afisted@ away from the body, thereby lessening the need to use a skinning knife. A skinning knife should be very sharp and used sparingly to decrease the chance of cutting the skin which can mar the hide. Care

should also be taken to not take large amounts of fat or meat with the skin as this material will have to be removed later and can impede salt penetration when preserving (see following section). A good job in skinning will make some of the tanning steps easier.

Preserving

If the hide is not to be tanned immediately it must be preserved. The goal of preservation is to stop the putrefication and decay begun by bacteria immediately upon death. The main methods of preservation are salting, freezing and drying. Salting the hide to remove moisture is the most common method. In salting a hide use only non-iodized salt such as non-iodized table salt or pickling and curing salt. Rock salt should never be used as it has impurities. A fine grain salt is preferred as large grain salt will not penetrate the hide well. To salt a skin, lay it flat and pour a generous amount of salt down the middle of the hide. Use approximately one pound salt for each pound hide and rub it in thoroughly, covering every portion. Fold the hide flesh to flesh, roll it up and place it on a slanting board allowing it to drain. The following day shake off the wet salt and resalt with new salt. If the skin has finished draining it can be laid out flat to dry, which may take several days, or longer, depending upon the weather. Hides should not be dried in direct sunlight or where temperatures are very high. Once dry, the skin can be stored in a dry place until tanning.

To freeze a hide, fold the hide flesh to flesh, roll, and place inside a plastic bag. A frozen hide will last for months or even years with no damage to the hide (G. Dimaio, Industrial Specialist, USDA-ARS Hides, Lipids, and Wool Research Unit, Eastern Regional Research Center, Wyndmoor, PA, personal communication). However, it has also been written that hides to be tanned with the hair on should not be frozen as this can cause hair to fall out (Tannery in a Box Instruction Sheet). As few people own a freezer in which they wish to freeze goat hides, salting will likely remain the preferred method of preservation. Air drying, also called flint drying, is a less effective preservation method than salting. It is extensively used in developing countries where hides are stretched and tied in frames to air dry (Kniefel, 1991).

Fleshing

To flesh a hide means to scrape all fat, meat, and membranes off the skin in preparation for the actual tanning process. Fleshing can be done before the hide is salted and some authors recommend this as the salt then penetrates the skin more easily. Conversely, other sources state that salting, in addition to preserving the hide, makes fleshing easier. If a fresh hide is to be tanned immediately after fleshing, it does not need to be salted. Fleshing is accomplished through the use of a fleshing beam and a fleshing knife. A fleshing beam is a piece of wood over which the hide is draped and can be fashioned out of a 2"$\times$ 6" or 2" $\times$ 8" board five or six feet long. One end should be cut to a blunt point and all edges rounded and smoothed. The board is then mounted on legs so that the pointed end comes around waist high. A fleshing knife is a blade with a handle on both ends so that even pressure can be exerted as the blade is pushed down the hide. These can be purchased through a taxidermy supply company or a long-bladed butcher knife can be used with the pointed end driven into a block of wood providing a handle. Alternatively, a draw knife could also be used. Churchill (1983) describes methods to make fleshing knives and other knives from used industrial

hacksaw blades.

To flesh a hide drape it over the pointed end of the fleshing beam. Using the fleshing knife, push down the hide scraping off unwanted material. Either the blunt or sharp edge of the knife can be used, depending upon one=s preference and experience. To make fleshing easier and lessen the chance of cutting the hide, it is important to flesh with the lay of the hair. The legs should be fleshed towards the belly and the hide from the tail pushing towards the neck (Rittel, 1994b). It is also important to not cut too deeply into the hide as this will expose hair roots and cause subsequent hair loss. Fleshing is time consuming but must be done properly, removing even the thin membrane tightly held onto the skin. Fleshing machines, found in taxidermy supply catalogs, are available that can speed up the process, although the least expensive models cost well over $100. An alternative to purchasing a fleshing machine is to use a wire wheel mounted on an electric grinder (Knobloch=s, Lafayette, CO, personal communication). However, great care must be taken to not damage the hide or expose hair roots while using mechanical fleshing machines.

Pickling and Neutralizing

Pickling, as described by Rittel (1993), is the use of an acid solution to acidify and temporarily preserve a skin while physically and chemically preparing it for tanning. Most tanning recipes will call for an acid pickle, though it may be included in the tanning process itself and not a separate step. Some paint-on tans, such as Tannit[7] solution and Liqua-Tan[J], are applied directly to the fleshed hide without the skin undergoing a pickle. Pickling solutions are mixtures of water, salt, and acid. The pH must be carefully checked and proper precautions, i.e., use of rubber gloves, eyewear, etc., should be followed when using acids. Any powders should be mixed with a small amount of water before mixing in the larger solution. Acids should be added slowly to the pickle, pouring them along the side of the container so as to run gently into the solution. Mix slowly, but well. There are a number of acids and formulas that are used in pickling and the tanning recipe one follows, or kit that is used, will have specific instructions.

Skins are usually left in the pickling solution for three days after which time they must be neutralized. Neutralizing raises the pH of the skin through the use of an alkaline substance such as sodium acetate, sodium formate, sodium bicarbonate or others. Neutralization is generally brief, 15 to 20 minutes, after which the skins should be rinsed with clean water and put into the tanning solution (Rittel, 1993). Again, the tanning recipe or kit should have complete instructions on the neutralization method.

Care should be taken in disposing of the pickling and neutralizing solutions. Acid pickles should be raised to a pH of 6.5 to 7.0 before dumping. Rittel (1993) states that sulfates can be considered as hazardous solutions and if an acid is used in which sulfates are formed local health authorities should be contacted concerning proper disposal. Rittel (1993) continues that as solutions contain salt they should never be put into septic systems and should be dumped in a driveway or other area where vegetation does not grow.

Tanning

To describe the varying tanning recipes and methods is beyond the scope of this paper and those can be found in various texts, taxidermy supply, or tanning chemical dealer catalogs and in the instructions included with tanning kits or chemicals. The main tanning process may be as simple as one of the paint-on tans mentioned earlier or more complex entailing the application of tanning chemicals in a tanning soak or bath. Each individual method will have its advantages and disadvantages and the reader is urged to gather information on different methods through reading, obtaining catalogs, and speaking with experienced tanners.

The main categories of tanning as described by Hobson (1977) are: vegetable; mineral; oil tanning; and combination tanning. The vegetable methods, using tree bark or other plant parts, were those first used and are still in use for some leathers, albeit that plant extracts are used rather than tree bark. Vegetable tanning can even be tried at home by grinding bark, leaves, twigs, seeds, and other parts of tanning-containing plants into a solution in which small hides could be soaked. Vegetable tans, however, stain the hair or fur and can take up to six months or more to finish. To test if the tanning process is complete, cut a thin strip of the hide and see if the color is the same throughout without a lighter layer in the middle that indicates the tanning process is not complete. The ultimate test of a properly tanned hide is to put a small piece of the tanned hide into boiling water. If incompletely tanned, the piece will curl up; a properly tanned hide should be unaffected by boiling water (Hobson, 1977). Others state that a piece of well-tanned hide should withstand at least two minutes of boiling before it begins to curl (G. Dimaio, Industrial Specialist, USDA-ARS Hides, Lipids, and Wool Research Unit, Eastern Regional Research Center, Wyndmoor, PA, personal communication).

Mineral tanning and vegetable tanning are the main methods used by commercial tanneries. Mineral tanning can be done at home and two popular recipes are alum tanning and chrome tanning. While both recipes result in a well-tanned hide, alum tanned hides tend to Asweat@ if atmospheric humidity becomes too high. Tanning using mineral methods also requires closer attention to the tanning process than the use of vegetable tanning solutions. The addition of chemicals, such as sulfuric or other types of acids, and solution pH levels must be carefully monitored. Rubber gloves and eye protection should be worn and care taken when mixing solutions. Tanning should be done in a plastic barrel, never in metal. Leaving a hide to soak in a mineral tanning solution too long can damage the hide. Additionally, inadequate washing of the hide after tanning to remove all chemicals may result in acid residues left in the skin, which could react with moisture and damage the hide. Leftover tanning solutions may also pose a disposal problem. Whatever tanning method is used, local laws concerning waste water disposal must be followed. In rural areas care must be used in disposing of solutions and they should never be dumped where they can contaminate streams or ground water. Chemical solutions, and salt water solutions, should never be put into septic systems as these can kill the microflora upon which such systems depend to break down waste. Consult your local municipality for proper disposal methods.

Oil tanning is a means of preservation and not a true tanning method. A warm oil is brushed into the hide and the hide is left in a warm place for the oil to soak in. Several applications are needed and this method is not suitable for hair-on tanning. Combination tans are those that use one

or more methods.

A tanning method gaining popularity is the use of a synthetic tanning agent or syntan. Syntans are described by Rittel (1994a) as man-made tanning agents which are highly reactive, form strong bonds and, when properly used, result in well-tanned, long-lasting hides. Syntans are used by commercial tanneries in conjunction with mineral tans as they improve the dyeing ability of leathers (Rittel, 1994a). At home, syntans can be used alone or in combination with mineral tanning agents. One example of a syntan is EZ-100 by Rittel. EZ-100 is administered as a soak or bath in which the hides are placed after pickling and neutralizing. EZ-100 also touts itself as environmentally safe by using acids and tanning agents that degrade to fertilizer. Hides tanned with EZ-100 can be washed in lukewarm water.

Drying, Softening, and Finishing

After the tanning process is over the hide must be dried. Again, follow the drying instructions for tanning method you are using. Drying methods can range from simple hanging or laying flat to tacking on wood or tying in a frame. Usually, an oil will also be applied in this process to help soften the skin. While the hide is slightly damp is the time to begin softening the hide. To do this, make a staking beam out of a 2" $\times$ 6" board cut and fashioned in the shape of a braced, inverted T with the upright end rounded to a blunt point. The damp hide is taken and the flesh side is rubbed across the point in much the same way as one shines shoes. This movement stretches and breaks the skin fibers leaving a soft hide. Staking takes time and effort and the time spent in this activity will determine how soft the finished product will be. It is important to do this while the hide is still damp. If the hide becomes too dry, rewet it and begin again.

Commercial tanneries use equipment for softening such as large, rotating drums that tumble the hide, generally with sawdust, as it dries. In addition to softening the hide, a solvent may be added to the sawdust to help clean hair or fur. Some texts recommend using an old laundry dryer with the holes plugged for tumbling hides. While this will help clean the hair it will not help significantly in softening the hide. To do this requires a tumbler with at least a six foot drop along with 100 pounds of hardwood sawdust (P. Helms, McKenzie Taxidermy Supply, personal communication). Finishing the softened hide entails cleaning the hair and removing excess oil. This can be done with a tumbler or by simply rubbing sawdust into the hair. Rittel (1994a) recommends that local sawdust not be used as it may contain pitch and be unevenly grained. Taxidermy or tanning chemical supply houses sell sawdust and solvents to be used in cleaning. Alternatively, Hobson (1977) explains how to use cleaning substances such as cornmeal, oatmeal, bran, chalk, and plaster of Paris. Finally, the skin side of the hide can be sanded or rasped to remove rough spots or a buffing machine could even be used.

Optional Steps

The above steps and tips are meant only as a guideline for someone to begin tanning. When reading about tanning, additional steps such as dehairing and degreasing will be found. Dehairing is usually done by soaking the hide in a lime or caustic lye solution after which the hair is scraped off and the hide tanned for leather using the same or similar methods as those described. Degreasing is done on hides with large amounts of oil, such as raccoon, bear, and the like. It is unlikely that goat

hides would need degreasing.

Use of Tanned Hides

Tanning is not easy and failures should be expected. But, through practice and experimentation the techniques can be learned and good quality hides can be produced. The uses for tanned goat hides are limited only by quality of the finished product and the imagination of the tanner, or purchaser. Rugs, seat covers, decorative wall hangings with a pattern shaved in the hair or a square shaved in which a picture is painted, goat leather picture or mirror frames, key chains, place mats, etc., all of these ideas and many others are possible.

Partial List of Supplies Needed to Tan Hides

$ skinning knife if skinning will be done
$ sharpening stone
$ non-iodized salt, not rock salt
$ fleshing knife or butcher knife with pointed end driven into a small block of wood
$ fleshing beam
$ plastic garbage can or other plastic tub (tanning should never be done in metal containers)
$ wooden pole or paddle to stir tanning solutions
$ tanning kit or chemicals
$ rubber gloves and eye protection for handling chemicals and solutions
$ pH paper if pH of solutions must be checked
$ staking beam (fleshing beam could also be used for this)
$ comb or brush for hair
$ suitable place for tanning, not too hot or cold
$ area where hides can be laid upon wood or a bench, not concrete floors
$ scale to weigh hides and chemicals
$ source of hot water to mix solutions

List of Some Available Books on Tanning and Taxidermy

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

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

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

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

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

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

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

Addresses of Some Taxidermy and Tanning Chemical Supply Companies

Jonas Supply Company
2260 Industrial Lane
Broomfield, CO 80020
Phone: 800-525-6397
www.jonastaxidermy.com

Knobloch-s
10675 Empire Road
Lafayette, CO 80026
Phone: 303-666-9045

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

Rittel-s Tanning Supplies
51 Summer Street
Taunton, MA 02780
Phone: 508-822-3821
Fax: 508-828-3921

Tandy Leather Co. (Has locations throughout the U.S.)
4910 N. May Ave.
Mayfair Village
Oklahoma City, OK 73112
Phone: 800-647-9347

Other companies can be found in the Yellow Pages or on the Internet at www.taxidermyonline.com or www.taxidermy.net

References

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

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

Kneifel, E. 1991. Goat skins supply, demand and utilization. In: T.H. The (ed.). Proceedings of the National Symposium on Goat Meat Production and Marketing. Langston University Agricultural Research and Extension Program and E. (Kika) de la Garza Institute for Goat Research. pp. 42-47.

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

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

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

GOAT DHIA LAB TRAINING

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Introduction

Langston Goat DHIA (Dairy Herd Improvement Association) Workshops are open to all interested parties. We have trained producers and any potential testers invited by the producer. The course covers National DHIA and ADGA rules, how to fill out the paperwork, the costs involved in testing, and a short quiz to certify the testers.

Information presented on the following pages is from the DHIA website.

Uniform Data Collection Procedures

PURPOSE: The purpose of these procedures is to provide the framework for a uniform, accurate record system which will increase dairy farmers' net profit.

These basic and minimum standards are to be uniformly followed throughout the service area of National DHIA. They serve to ensure that National Dairy Herd Improvement Association (National DHIA) records will provide the accuracy, uniformity, and integrity essential to all segments of the dairy industry. All DHIA Service Affiliates, field services, laboratories, dairy records processing centers (DRPCs) and meter centers will be evaluated annually under the National DHIA Quality Certification Program to maintain and verify compliance with these standards. To be eligible to participate in this dairy record keeping program, a dairy farmer must be a member of a DHIA Service Affiliate. Special conditions affecting member eligibility and participation by others will be the responsibility of the DHIA Service Affiliate.

The uniform records and data thus provided are used for (1) making farm management decisions; (2) educational programs and research, including the genetic evaluation of cows and sires; and (3) the promotion and sale of animals. DHIA organizations at all levels and DHIA technicians and herd owners as well as persons in their employ, are individually and collectively responsible for the adherence to the procedures set forth.

AUTHORITY: These uniform data collection procedures have been developed and adopted under the direction of National DHIA. A Memorandum of Understanding with National DHIA, Agricultural Research Service of the United States Department of Agriculture (USDA), National Association of Animal Breeders (NAAB) and the Purebred Dairy Cattle Association (PDCA) exists to ensure the flow of DHIA records for industry purposes, including genetic evaluation programs.

RESPONSIBILITY: DHIA Service Affiliates are responsible to uphold the uniform data collection procedures and standards defined by National DHIA.

DHIA producer-members sign an agreement to conform with these procedures and the associated Code of Ethics. A breach of the Code of Ethics may result in independent legal action by the injured party.

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 National DHIA record plans:

1. All cows of one breed, housed or managed under a single management system, regardless of ownership;

2. On farms with two or more distinct breeds, either a composite herd average or separate herd averages may be calculated and reported.

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

1. A single member may operate separate units under separate management systems, with no movement of cows between management units.

2. Two groups of cows may be housed as a single entity, but under different ownership with different management goals, and with no movement of cows from one ownership group to the other; one owner may wish to test and the other owner may not.

3. On farms with two or more distinct breeds, it is acceptable to enroll one breed on test and not the other(s).

Application for herd codes that differ from the principles in A and B will be evaluated by the DHIA Service Affiliate which should encourage participation in the DHIA System for the mutual benefit of the

dairy farmer and allied industry. The decision of the DHIA Service Affiliate regarding the assignment of separate herd codes shall be final.

TEST is defined within the long tradition of DHIA to be the entire process of information collection at the farm. This may include some or all of the following: weighing and sampling and/or analyzing of milk during the milking process, weighing of milk only, or electronic collection of milk weights with periodic component analysis sampling. Since the actual component testing does not generally occur at the farm, this procedure should be labeled as the laboratory test or component test.

DHIA TECHNICIAN/SUPERVISOR These equivalent terms define the person approved by the DHIA Service Affiliate to certify the production information collected at the farm.

DHIA SERVICE AFFILIATE is defined as the organization authorized by National DHIA, through Quality Certification and appropriate memoranda, to conduct DHI service. Responsibilities assigned to the DHIA Service Affiliate board of directors by these procedures may be carried out by their designated representative.

DAIRY RECORDS PROCESSING CENTER (DRPC) is defined as the organization approved by National DHIA which contracts with, or is owned by, a DHIA Affiliate for the purpose of electronically processing DHIA records. A DRPC must comply with approved procedures and rules for records calculations. A Dairy Management System (DMS) shall be considered as a DRPC for the purpose of these procedures.

LABORATORY is defined as the facility approved by National DHIA, through Quality Certification, to analyze DHIA component samples.

METER CENTER is defined as the facility approved by National DHIA, through Quality Certification, to calibrate approved weighing devices.

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. Provision must also be made for collecting a sample which is representative of the milk yield of the cow at any one milking. All weighing and sampling devices must at all times be used strictly according to the manufacturer's written instructions.

A. Supervised Tests: The DHIA technician is expected to collect data as accurately as possible. All production data and animal identification will be collected in the presence of the DHIA technician. Facilities or milking processes which do not permit a single DHIA technician to handle such observation will require the addition of other DHIA technicians as necessary.

The technician should secure samples by following approved procedures outlined in the National DHIA Quality Certification Manual.

Test day data may be electronically transferred to the DRPC by the DHIA technician who has prior authorization from the DHIA Affiliate. A secure procedure will be used during the transfer of data which certifies that all uniform procedures have been followed.

B. Unsupervised Tests: The DHIA member will assume the responsibility for accurate data collection in accordance with these uniform procedures.

2. Standard Equipment and Methods

A. DHIA Service Affiliates: All equipment, owned, leased or used by DHIA Service Affiliates, and not owned by a DHIA producer-member, will be checked annually by a DHIA QC-approved meter center or a qualified manufacturers representative, using procedures specified in "The Periodic Inspection, Repair, and Recalibration of Devices Used in DHI Testing." A durable label shall be affixed to each device stating the date of certification and the DHIA Affiliate responsible. Any equipment out of tolerance must be removed from DHIA service and repaired before further use. The DHIA Service Affiliate (or member in unsupervised plans) will report the calibration status of the metering devices. This status will accompany the DHIA record used by USDA-AIPL for genetic evaluations.

B. Producer-Owned Equipment: To ensure the highest quality data, it is strongly recommended that DHIA producers owning their own equipment follow the same guidelines as DHIA Service Affiliates. These guidelines must be followed for records to be coded as using QC- certified weighing devices. In the event a producer-member chooses not to follow the guidelines outlined for certified meters (See 2.A.), the DHIA Service Affiliate may provide service, and the records are to be coded as using uncertified meters. The DHIA Service Affiliate (or member in unsupervised plans) is responsible for ensuring proper coding.

C. The tolerances allowed for the approval of the design of milk weighing, measuring, and sampling devices used in DHI testing plans are outlined in National DHIA procedures. These devices shall be conspicuously labeled as approved for use in DHIA. Instructions for operation and any limitations of such equipment as approved shall accompany each device. A current list of approved devices is available from National DHIA.

Milk fat, protein, and other component determinations are made using National DHIA-approved procedures and equipment. Solids-not-fat (SNF) may be determined directly or through calculation based on individual components determined by approved procedures.

3. Recording Programs

DHIA offers numerous recording programs. Four commonly found programs are described:

A. DHI-Conventional-Supervised: The DHIA technician weighs and samples the milk from each milking for all cows in the herd during a single 24-hour period. The beginning and ending times for each milking shall be recorded.

B. DHI-AP-Supervised: The DHIA technician weighs and samples alternately at AM and PM milkings. For herds milked two times during a single 24-hour period, weigh and sample alternately for two consecutive test periods. For herds milked three times during a single 24-hour period, rotate the two consecutive milkings weighed and the one sampled across consecutive test periods. A/P factors must conform to National DHIA tolerances.

For these types of data collection protocols, at least one part of the milking system may or may not be equipped with a DHIA-approved milking interval recorder which provides an authentic record of the milking intervals. On test day, the DHIA technician will determine and record the reference time at the beginning and ending of the sampled milking and the previous milking. To be acceptable for this purpose, an approved monitoring device must display or print the starting and ending times of the sampled milking and the previous milking. Monitored times are to be within 15 minutes of actual times. At the end of the sampled milking, the starting and ending times of the sampled milking and of the previous milking shall be recorded for the DRPC to use in determining the milking interval. In cases where strings or groups of cows are milked in a different order at the PM milking as compared to the AM milking, a herd may be enrolled on one of the APT or APCS plans only if the monitoring device can record milking times by string, and the DRPC can process strings or groups with different milking intervals. The same policy also applies to herds milked in strings or groups with breaks longer than 15 minutes between strings.

C. DHI-APCS-Supervised: The DHIA technician weighs the milk from each milking during a single 24-hour period. Collect samples for component testing at ONLY one milking.

For herds milked two times in a single 24-hour period, alternate the sampled milking between AM and PM milkings for consecutive test periods. For herds milked three times in a single 24-hour period, rotate the sampled milking among all three milkings. Beginning and ending times of all milkings will be recorded to determine the milking interval for computing component credits.

D. DHI-MO and DHI-MO-AP-Supervised: The technician weighs the milk ONLY from each milking or selected milkings during a single 24-hour period. NO samples are collected for component testing. A/P factors must conform to National DHIA tolerances.

E. Other Recording Programs are available through DHIA Affiliates. The off-farm use of data from these programs will be determined by the users of the records.

4. Test Interval

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. 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 reflect actual milk production and current test day. The next test interval begins on the following day. DRPCs 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.

5. Cows to be Tested

A. All dairy cows in the herd with the same herd code, which have ever calved, will be enrolled on a DHI record plan. Dairy cows may be removed from a DHI record plan 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. These cows must be verified dry each test day by the DHIA technician. A certificate which identifies the cow and is signed by both the herd owner and the person performing the embryo transfer work must be filed with the DHIA Affiliate. Dry Donor Dams which later calve will be returned to the milking herd, and a 365-day dry period with 0 production data applied against the herd average in the current test interval.

6. Identification

A. All cows must be identified with a permanent number for genetic evaluation. Permanent identification consists of a national uniform series eartag, VIP certificate, grade identification, or registration certificate. If the eartag is not in the ear, the number must be cross-referenced to a picture, sketch or a brand or tattoo that is unique to that herd.

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

C. For all DHIA records (both supervised and unsupervised collection) changes in identification after the second test following the cow's entry into the herd will result in the cow's records being permanently labeled on the records transmitted throughout DHIA and on all publications of the records. Changes in identification refers to one or any combination of the following data fields: cow ID number, cow birth date, sire ID, (consistent with reference notes for USDA-ARS-AIPL formats).

7. Bulk Tank Measurements

Bulk tank pick-up weights shall be recorded (data for three shipments immediately prior to date of test) indicating the number of milkings (or days) included in each shipment. If bulk tank weights are not available, the fact that they cannot be obtained, and the reasons why, should be reported in writing to the DHIA Affiliate.

Bulk tank pick-up weights for appropriate days may be used as verification of the accuracy of production credits of the herd.

8. Fresh Cows -- Dry Cows -- Cows Leaving the Herd

A cow fresh six or more days will have her milk weighed (and if applicable) sampled beginning the evening milking of the sixth day after calving (morning of the seventh day for AP records), counting the day of calving as the first day. The record begins on the calving date. The dry date is the first calendar day the cow is not milked. Cows turned 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. The calendar day the cow leaves the herd counts as the last day in the herd, with production being credited for that day. Any lactating cow purchased will start receiving production credits in the new herd, one calendar day following the last day of credits.

9. Sickness or Injury

In case of severe sickness, injury or a cow in heat on test day, production will be considered abnormal. If such conditions are reported on the barn sheets at the time of milking, and the percentage decrease in total daily pounds of milk from the previous test day (from the succeeding test day if the first test day of lactation is involved) exceeds the percentage obtained with the following formula: Percentage = 27.4 plus 0.4 x days in the first test interval. As an example, for a 28-day test interval: Percentage = 27.4 + (0.4 x 28) = 27.4 + 11.2 = 38.6%, the milk weight will be considered abnormal and computations will be done only by the DRPC. Actual test day data will be reported even though the milk weights are coded abnormal. This does not apply to milk weights routinely adjusted at the beginning or end of lactation.

10. Cows Aborting, Calving Prematurely, Calving Without Going Dry, Prepartum Milking

When a breeding date is available, and a cow freshens less than 30 days prior to the expected calving date, it will be considered a normal calving. Cows freshening 30 or more days prior to the expected calving date, whether in milk or dry, will be coded as abnormal.

If a cow aborts 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 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.

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.

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

11. 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. (See 13.I.)

12. Missing Milk Weights and/or Samples

When complete milk weights or samples are not obtained or are lost, the missing data will be estimated or the test period spanned by the DRPC, 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 DHIA technician. All adjustments to production credits will be made by the DRPC with routine programming. Exceptional cases should be referred to the DHIA Affiliate.

(A) First Test Day Weights or Samples Missed

(1) Missing milk weights and component percentages shall be calculated in the succeeding test interval by appropriate factors and procedures approved by National DHIA.

(2) If the milk sample cannot be tested, 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

(1) 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.

(2) The milk weights and component percentages may be held open and later computed as described in the Test Interval Method.

(3) If the sample cannot be tested, component data will be estimated according to National DHIA procedures.

(4) 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:

(1) A cow purchased in milk with transfer credits will have credits computed through the sale date in the seller's herd. Her credits will start the next day in the 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 seller's herd through the sale date, and will start on test in the purchaser's herd the next day.

(2) A cow purchased in milk with unavailable previous 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.

13. Standard Calculations

1.Days carried calf = current sample date - effective breeding date +1

2.Days open = effective breeding date - previous fresh date

3.Gestation days = resulting fresh date - effective breeding date

4.Days dry = next fresh date - dry date

5.Calving interval = next fresh date - current fresh date

6.Days in milk = dry date - previous fresh date, or left herd date-previous fresh date +1, or current test date - previous fresh date +1.

7.Assumptions:
• The day of freshening is an open day, a day in milk, and not a dry day;
• The day of breeding is a day carried calf.

8.Calculation of Ages of Cows (Truncation Method) From the year, month, and day of the fresh date, subtract the year, month, and day of 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.

9.Adjusting Records to 24 Hours. When herds are normally milked on intervals such that the test day is other than 24 hours, the milk weight shall be adjusted to a 24-hour interval using the following procedure approved by National DHIA:

Divide 24 by the interval, then multiply by the milk weights.
As an example:
(1) For a 25-hour interval, (24/25) x 65 lbs = 62.4 lbs.
(2) For a 20-hour interval, (24/20) x 65 lbs = 78 lbs.

14. Verification Testing

DHIA Service Affiliates will conduct verification tests to verify the performance of cows and herds at the request of a member or allied industry representative.

DHIA verification tests requested by a member will include the entire herd. Acceptable verification procedures are as follows:

- A different DHIA technician conducts a duplicate test immediately following the regular test.
- A different DHIA technician tests the herd for one milking, in addition to the regular milking schedule.
- A different DHIA technician tests the herd using the regular milking schedule (i.e. no additional milkings).

Herd Profiles will also be used to verify test results on a routine basis. Such information may be used to call verification tests as deemed appropriate by the DHIA Affiliate.

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

15. Retesting -- Member's Request

If a member is not satisfied with the regular testing of the herd, a retest may be requested. Such a request will be made within 15 days of the original test day and be directed to the DHIA Affiliate. The member will pay the cost of the retest, unless otherwise determined by the DHIA Affiliate.

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 DHIA Service Affiliate.

16. 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 National DHIA-approved DRPC. Electronic herd summary reports and cow lactation records will carry Record Standards variables to describe the conditions under which the records were collected.

17. Yearly Averages

Herd and Affiliate 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 DHIA credits for 365 days before a DHIA herd average is published.

PROCEDURES THAT APPLY TO DAIRY GOATS ONLY

All the rules of the American Dairy Goat Association (ADGA) and all of these National DHIA rules apply to dairy goat testing, except as agreed by ADGA and National DHIA.

Refers to Procedure 1A
Dairy goat producers may use the Group Testing Program as described in dairy goat association guidelines and the NCDHIP Handbook.

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

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

Refers to Procedure 14
For DHIR verification tests, when an individual doe is in milk at least 60 days, and a 305-day record is predicted on an actual basis to be 3,000 pounds of milk and 105 pounds of butterfat, or on a mature equivalent basis of 3,500 pounds of milk and 125 pounds of butterfat, and when on a 120-day basis, the mature equivalent is predicted to be 4,000 pounds of milk and 140 pounds of butterfat, a verification test is to be called by the DHIA Affiliate.

The proper citation for this article is:

Brown-Crowder, I. 1999. Goat DHI Lab Training. Pages 86-96 in Proc. 14th Ann. Goat Field Day, Langston University, Langston, OK.

PREGNANCY DIAGNOSIS IN GOATS

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Introduction

During recent years, there has been increasing awareness in the need for early diagnosis of pregnancy in goats. Examination of the goat for pregnancy may be done as part of a reproductive herd health program or may simply be requested by the pet goat owner who would like to know the pregnancy status of his or her doe. A reliable technique for early detection of pregnancy would allow early culling or rebreeding of barren does. Perhaps the most important reason for pregnancy diagnosis is detection of pseudopregnancy or hydrometra, which may occur in pet and commercial goats, especially in dairy herds where breeding is delayed to adjust milk supplies. Does pronounce open or pseudo pregnant are often culled or given prostaglandin to make them come in eshrus. So there is great emphasis placed on a highly accurate pregnancy test.

A variety of examination methods have evolved over the years. Ultrasonography, hormone assay, and radiography have emerged as the most useful methods utilized today. Older described methods of laparotomy, cervical palpation, abdominal palpation, or ballottement, and rectal-abdominal palpation with a rod have limited utility or have been abandoned. Although non-return to estrus following breeding is suggestive of pregnancy, however pathologic conditions of the uterus and ovaries, physiologic anestrus late in the breeding season, and out of season breeding may cause postbreeding anestrus in nonpregnant does. Many does also exhibit estrous behavior during pregnancy, making this an unreliable means of pregnancy diagnosis. Choice of the above methods depends on availability of equipment, number of days postbreeding, number of animals to examine, desired accuracy, need for immediate results, cost to the client and experience of the examiner.

Different Methods of Pregnancy Diagnosis in Goats

1. *Non-return to estrus*

2. *Progesterone Assay*

Blood

Ewes = 15 to 17 days
Does = 18 to 22 days
Plasma P4 > 1.0 ng/ml
Accuracy = 75 - 86% pregnant
= 90 - 100% non-pregnant

Milk

RIA milk P4 above 10 ng/ml = 86% pregnant
< 10 ng/ml = 100% non-pregnant

Plasma concentrations of progesterone tend to be more predictable of the true endocrine status.

3. *Radiography*: 65 - 70 days

4. *Rectal - Abdominal Palpation*

Hulet rod = 1.5 × 50 cm plastic rod

5. *Abdominal Palpation: Third Trimester*

The gravid uterus or fetus can sometimes be palpated through the relaxed abdominal wall of the standing doe or ewe by placing a hand on either side of the abdomen and squeezing or lifting upward.

6. *Estrone Sulphate Test*: Estrone sulphate is produced by the feto-placental unit and can be measured in the blood, milk, and urine by radio-immuno assay.

> 50 days post breeding this test is close to 100% accurate for the detection of pregnancy and non-pregnancy.
Milk = 82% accurate for pregnant
= 83% accurate for non-pregnant

7. *Ultrasonography*

a. A-mode ultrasonography: Amplitude depth ultrasound for pregnancy diagnosis is detection of the fluid-filled uterus and is thus not pregnancy-specific. A-mode units emit ultrasonic waves from a hand held transducer placed externally against the skin of the abdomen and directed

towards the uterus. Ultrasound waves are converted to electrical energy in the form of audible or visual signal. These units detect fluid-filled organs at a depth of 10-20cm. The transducer is placed low in the right flank near the udder of the standing doe. Clipping a small area of hair in this region will allow optimal contact. A coupling agent such as commercial ultrasonic gel, K-Y jelly, carboxymethylcellulose lubricant or vegetable oil should be applied to the transducer to eliminate air spaced between the skin and the transducer head. Some units emit a light or audible signal when a fluid-filled structure is detected. Units with an oscilloscope display reflections as peaks or blips on the screen. Nonpregnancy is suggested when the peaks are present only in the left half of the screen. When a fluid filled structure is detected, peaks will also appear on the right half of the screen. Accuracy = 80-85% if performed between 60 to 120 days of gestation.

b. Doppler: The principle of Doppler ultrasound for pregnancy diagnosis is the detection of movements- blood flow in the middle uterine artery, umbilical arteries, fetal heart beat and fetal movements. Transducer emit ultrasound waves, sound reflected from motionless structures has the same frequency as the transmitted sound, whereas sound reflected from moving organ or blood has a different frequency. Difference in frequency is converted to audible sound. Audible signals, which may be distinguished by the observer, include the fetal heartbeat, arterial blood flow in the middle uterine artery and umbilical arteries, fetal body movement and maternal intestinal movement.

The transducer can be applied externally to the skin of the abdomen or intrarectally using a rectal probe. The transducer, coated with a coupling agent, is applied to the clipped skin low in the right flank in front of the udder and the abdomen systematically searched. In the intrarectal technique, a specially designed rectalprobe is inserted in the rectum and slowly rotated. A positive diagnosis of pregnancy is made by listening for the rapid, pounding sound of the fetal heart beat; rapid, swishing sound of the fetal pulse which is faster than the maternal pulse; sharp, short duration sounds of fetal movement; or the swishing sound of blood flow in the middle uterine artery which is at the same rate as the maternal pulse.

The external Doppler technique for detection of pregnancy approaches an accuracy of 100% during the last half of gestation but is not as effective in the 50 to 75 day range or earlier. The intrarectal Doppler technique was superior to the external technique when attempted at the beginning of the second trimester and may achieve an accuracy of 90% or better. The intrarectal technique may be attempted as early as 25 to 30 days postbreeding but false negatives are a problem; it is preferable to wait until day 35 to 40. False negatives may also occur when soft feces around the rectal probe interfere with sound wave transmission; this can be minimized by feeding dry feed 2 to 3 days prior to examination. False positives are unlikely with the Doppler technique when fetal sounds are used as the criteria for pregnancy diagnosis. Hydrometra can cause increased maternal blood flow in the middle uterine arteries but no fetal sounds will be heard. Doppler units with a frequency of 2.25 MHz may be superior in near term pregnancies, whereas a 5 MHz frequency seems better for detecting earlier pregnancies.

c. B-Mode Ultrasonography: Real-time B-mode produces a 2 dimensional image on the screen. For pregnancy examination, it produces a moving image of the uterus, fetal fluids, fetus fetal heartbeat and placentomes. Ideal time for trans abdominal scanning is between 40 to 75 days. Prior to 40-45 days the transducer may have to be placed higher in the inguinal region. 25-30 days is best done transrectally.

Diagnosis. Positive diagnosis of pregnancy is assured by imaging the embryo/fetus or placentomes surrounded by fluid.

1. Fetus and fetal heart beat: Intrarectally > 25 days, Transabdominally > 35 days

2. Placentomes > 40 days (transabdominal)

3. Estimating the fetal age: 40 to 100 days measuring the width of the fetal head or biparietal diameter. A positive diagnosis of pregnancy is assured by imaging the embryo/fetus or placentomes surrounded by fluid. A presumptive diagnosis of pregnancy or Hydrometra can be made by imaging multiple anechoic (fluid-filled) sections of uterine lumen cranial to the bladder from 25 to 40 days of gestation using a transabdominal or transrectal approach. A false positive pregnancy diagnosis during this period may be caused by Hydrometra. This condition occurs commonly enough in goats to advise caution against making a positive diagnosis of pregnancy until the embryo/fetus can be seen. The urinary bladder should not be confused with a fluid-filled uterus. The bladder can be identified transrectally by viewing the characteristic triangular-shaped neck as the transducer is directed causally. The bladder wall can usually be seen as an echogenic white line separating the anechoic lumen of the bladder from the anechoic uterine luminal sections. The fetus and fetal heart can be seen after day 25. The fetus appears as an echogenic mass within the uterine lumen. Visualizing fetal movement or beating of the fetal heart during real-time imaging can assess fetal viability. As a pregnancy advances to the late second and third trimesters, only portions of the fetus such as the thorax and skull and be imaged on the screen at one time. Placentomes can be seen by 35-40 days, appearing as echogenic densities in the uterine wall. They become cup-shaped or C-shaped by 45-50 dayswhen viewed in cross section with the concave surface directed toward the uterine lumen.

The ability to identify multiple fetuses with real-time ultrasonography is a clear advantage over other ultra-sound techniques. Feeding management can be adjusted for does carrying multiple fetuses or single fetuses. The optimal time for counting a fetal numbers is probably somewhere between 40-70 days. At 70 days and beyond, additional fetuses may lie beyond the depth of a 5 MHz linear-array transducer. Twins can be more accurately diagnosed than triplets and fetal numbers are frequently underestimated. Estimating fetal numbers prolongs the time of examination and the reader should be aware of its limitations. Another advantage of real -time ultrasonography is the ability to distinguish a viable pregnancy from a hydrometra, pyometra, and fetal mummification.

Real-time ultrasonography can also be used to estimate fetal age in the goat at 40 to 100 days of gestation by measuring the width of the fetal head (biparietal diameter). A symmetrical image of the fetal head showing the greatest head width is frozen on the screen and the distance between the uppermost edge of the superficial and deep parietal bone images is measured in millimeters with electronic calipers. Image symmetry is crucial to accurate measurements and can be afforded by viewing both fetal orbits in the same image. Table 1 shows the derived equations from several studies for computing the gestational age in various goat breeds based on biparietal diameter measurement. This technique required practice to fully master but should be helpful in predicting parturition dates when actual breeding dates are unknown.

Table 1.* Relationship of the fetal biparietal diameter (BPD) in millimeters and gestational age (GA) in days for various breeds. Biparietal diameter was measured transabdominally using real-time ultrasound with a 5 MHz linear-array scanhead.

Toggenburg	GA	=	27.9 + 1.64 BPD
Nubian	GA	=	26.8 + 1.74 BPD
Angora	GA	=	28.6 + 1.77 BPD
Pygmy	GA	=	23.2 + 2.08 BPD
Suffolk	GA	=	22.5 + 1.81 BPD
Finn	GA	=	21.4 + 1.85 BPD

*Adapted from Haibel, G. K. et.al.: Real-time ultrasonic measurement of fetal biparietal diameter (BPD) for the prediction of gestational age (GA) in small domestic ungulates. Society for Theriogenology Newsletter Vol. 13, No. 5 (1990).

Lionel, preg, Figures 1 and 2
Lionel, preg, Figures 3 and 4

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GOATING FOR NEWBIES

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Introduction

Interest in goats has mushroomed over the past fifteen years. Increased interest in goats and the value of these animals has made us do a better job in managing them. Kid management from birth to breeding is an essential component of the dairy goat enterprise. The kid management along with the nutritional management of the doe herd has the greatest effect on the long-term productivity of the goat herd. The dairy goat kid at birth represents a genetic resource necessary to replenish the herd gene pool which has a changing composition due to death, culling and sales for breeding stock. While the genetic characters of the kid are determined at the hour of conception, survival to lactation and an adequate body size are necessary to realize inherent genetic potential for lactation. Kid mortality has a direct effect on genetic progress, and thus we need to maintain low mortality from birth to weaning.

Pre-Parturition

The kid management program should actually begin prior to parturition with attention to the nutritional needs of the gestating doe in late lactation and during the day period. The tendency is to regard the late-lactation and dry doe as a non-productive part of the milk-producing system. On the contrary, however, an adequate diet for the dry doe is essential to reproduce healthy kids. Pregnant does should receive plenty of exercise. An obese doe should be avoided but the high-producing doe needs to recover body weight lost during the previous lactation. Clean, cool water and free choice trace-mineralized salt should be available.

Vaccination booster for Clostridium perfringens C and D and tetanus toxoid should be given not less than 3 weeks prior to kidding. Vitamin E/sclenwin injections are given during the dry period to prevent white muscle disease in the kids, especially in areas where soils are selenium deficient. Does should be wormed at dry off and also before kidding.

Parturition

The doe should kid in a clean environment, either a well-rotated pasture or 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 location of the kidding stall or pasture should be near a well-traveled area so that the doe can be frequently observed for kidding difficulties. Few adult does require assistance at the time of kidding though problems are always a possibility. First-freshening does should be closely watched, especially if bred to bucks known to sire large kids.

Kid Management

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 to prevent entry of disease-causing organisms through the navel cord and directly into the body of the kid. If necessary, a long navel cord can be cut to 3 or 4 inches in length. A bleeding cord should be tied with surgical suture material. Dipping of 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.

The second critical practice is the feeding of colostrum milk as soon after birth as possible. The colostrum, or first milk, contains antibodies which the doe did not pass to the fetal kid *in utero*. Consumption of colostrum must occur as early as possible and prior to 18 hours after birth as there is a rapid reduction in the permeability of the intestinal wall of the newborn to the antibodies. The colostrum milk should be bottle-fed to the newborn to insure adequate consumption. Excess colostrum can be frozen for use in orphan or bonus kids. Recent research indicates that disease organisms, especially caprine arthritis encephalities (CAE), may pass from doe to kid through the milk and transmission might be avoided through the use of extra colostrum frozen from does tested and shown to be CAE-free or heat treated colostrum. An additional practice at birth which enhances the health of the newborn kid is to give 3 injections of iron dextran and vitamins A and D after birth. A vitamin E/selenium injection may be beneficial in areas of selenium-deficient soils.

Kids should be checked carefully at birth for any deformities or abnormalities. Pneumonia is a major killer of young kids. A dry, draft-free environment is an excellent preventative measure. Kids should receive colostrum 10% of their body weight within 24 hours. For example, a six pound kid will receive 300 ml of colostrum within 12 hours. Kids could be left on does to nurse or started on a good quality milk replacer after they get their colostrum. A lamb milk replacer may be the best substitute for goat milk. Typical lamb milk replacers contain 22 to 24 % protein and 28 to 30% fat. Casein, a protein in lamb milk replacer, can be completely replaced with whey protein concentrate, this allows acidification. Acidification helps maintain the quality of the unused milk and reduces the incidence of diarrhea. Maintaining milk replacer quality after mixing is particularly important when kids are fed ad libitum.

The biggest problem with using lamb milk replacers occurs with the feeding schedule. Frequently, kids become “pets”. 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 of diarrhea. A restricted feeding is necessary.

Age	Amount of Fluid	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

Kids will nibble at fine-stemmed leafy hay at one or two weeks of age. At three to four weeks, 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.

Birth to Weaning

Milk is the principal component of the diet of the pre-weaning kid. There are numerous ways to feed milk including the use of bottles or pails, suckling the dam or nurse does, and 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 2 to 4 times daily for the first week or two and twice 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 body weight 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 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. Consumption of large quantities of milk may lead to bloat due to entry of milk into the reticulo-rumen or rapid passage of milk through the abomasum and small intestines resulting in diarrhea or nutritional scours.

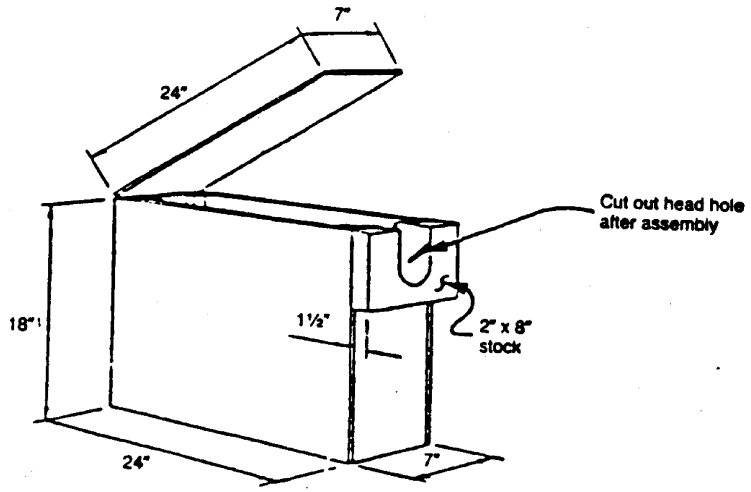
In raising dairy goat kids, increase in size and weight is not the only measurement of success. A well-formed skeleton and proper development of internal organs are often neglected when the emphasis is on rapid gains. An average daily gain of 250 g during the first weeks of life should be the goal. By limiting daily milk consumption to about 2 quarts, daily consumption of dry feed will be encouraged. Dry feed consumption is important in developing body capacity. By increasing body capacity, feed intake and digestion increase. 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 should be consuming forages such as pasture grass or hay by two weeks of age and grain within four. Careful attention needs to 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 to 18%. Ground alfalfa may be added at 5% or less to provide additional stimulation for reticulo-ruminal development.

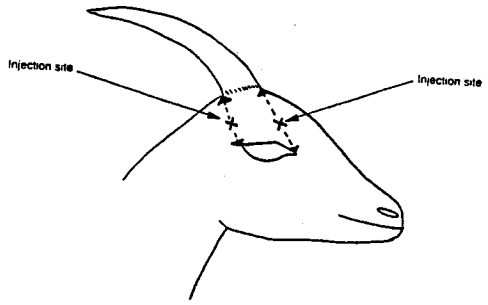
Several factors need to be considered when making the decision as to when to wean dairy goat kids. The most important consideration is whether or not the average daily consumption of concentrate and forage is adequate for growth and development to continue in the absence of milk. Fixed weaning ages are less desirable than weight goals such as 2.0 to 2.5 times birth weight. Many producers who have an erratic or marginal market for their milk delay weaning for longer periods than necessary. While milk feeding may promote more rapid growth than a concentrate-forage diet, maintaining kids on milk may delay the attainment of the dry feed intake level necessary to weaning and also leaves the kid disposed to diarrhea.

Disbudding

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. Disbudding a buck kid is the true test of proficiency and many fail it, judging by the number of scurs seen on adult bucks. If you try to de-horn a buck kid whose horn base is wider than a regular de-horning iron, you will get re-growth of the horn in a crown outside the burned area. If you try to de-horn a small kid with a wide calf de-horner, you may get re-growth of the horn from the center of the ring. If one person is doing the job, a de-horning box offers the best and safest restraining.

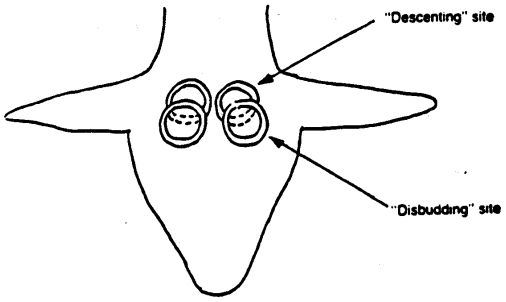


Although local anesthetic is commonly advocated, the actual technique is not easy and the baby goat will scream while being held in preparation for a ring block or a cornual nerve block.



Goats are more sensitive than other ruminants to local anesthesia, and causes adverse reactions as a result of overdosing. If kids are brought to the clinic, the easiest and fastest technique is masking them down with halothane and oxygen. However, remove the mask and gas flow during cautery; otherwise a flash of fire in the goat hair may result. Xylazine at 0.3 to 0.4 mg/kg is commonly used for injection anesthesia, and kids should be kept warm during the prolonged recovery period.

The equipment most commonly used is an electric-heated metal rod with a hollowed-out end. None of the irons can be relied upon to maintain a constant temperature, and it is extremely important to match temperature and time. Underburning will result in scurs and overburning will lead to brain damage or death. The horn bud is located over the sinus close to the cranium in kids. After the dehorning iron is hot, apply the de-horner 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. Descenting could be done at the same time if necessary. Inject the kids with 150 IU tetanus antigen. Although the risk of tenanus after disbudding is not great, it is a good practice to do it.



Dewattling

Many goat breeders believe that wattle detracts from the appearance of a show goat, and it is difficult to show clip the hair evenly and smoothly, so wattles are removed at birth.

Castration

Dairy and pygmy goats should be castrated if they are intended to be companion animals. This will reduce the smell and aggressive behavior. Angora goats are castrated so they can be run in either flocks for mohair production. Angora goats are usually castrated at 6 to 12 months of age so that they can develop bigger horns.

Rubber ring
Burdizzo
Surgical

Reproduction

Doelings are usually bred when they reach a weight of 80 to 95 pounds. Breeding season is usually September to February but some does, particularly Nubians, will breed at any time of the year. They are seasonably polyestrous and cycle every 20 to 21 days. Estrus lasts about two days and is detected by frequent urination, tail erect and swishing, drop in milk production, riding and being ridden by other goats, and hanging around the buck pen. Ovulation is usually towards the end of estrus and gestation is 144 to 157 days.

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SOMATIC CELLS IN GOAT MILK

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Background and Introduction

Dairy goat producers have been deliberating about milk somatic cell counts (SCC) because it is a complex and confusing issue. However understanding the relationships among SCC, dairy goat health and the economic survival of the dairy goat farm are of paramount importance for the goat producer. Somatic cell counts have legal, goat health, milk quality and productivity implications and each is important.

To understand the origin, physiological function and importance of somatic cells in dairy goat production, let=s consider several basic biological concepts.

First, the *ACell Theory@*, provides three fundamental principles:

_ all organisms are made of one or more cells
_ the cell is the basic unit of organization
_ all cells come from preexisting cells

Secondly, there are at least four *Cell Types*:

_ Prokaryotes - cells that have no nucleus. The term *prokaryote* comes from Greek words that mean "before, or pre-, nucleus."

_ Eukaryotes - cells that have a true nucleus.

_ Somatic cells - cells that make up the body [from Greek soma = body]

_ Gametes - sex cells or reproductive cells like eggs and sperms.

The type of cells concerning this workshop is **somatic cells**.

What Are Somatic Cells?

The cells called *somatic cells* are white blood cells (leukocytes) and are the defense against bacteria that penetrate the physical barrier of the udder=s teat canal. Infecting bacteria causing clinical or subclinical mastitis (Greek: *mastos, breast; -itis, inflamation*) produce tissue harm and leukocytes are involved in repairing the damage and destroying bacteria. Somatic

cells are equipped with a variety of tools to accomplish these functions. These somatic cells are constantly circulating in the blood stream and when infection or udder damage occurs, the body then sends high numbers of them to the injured or infected site. Leukocyte (somatic cells) numbers increase markedly in response to invading pathogenic bacteria, and may reach concentrations of millions per milliliter (ml) in acute mastitis cases. Therefore, high somatic cell counts may signal a mammary gland infection (mastitis).

How Is Milk Produced?

Goat milk is produced in the udder, which contains two mammary glands. Mammary glands are considered skin glands made-up of connective tissue (fatty and fibrous) and secretory tissue (epithelium, which is a membranous tissue covering the inside walls of the gland). Each mammary gland has a gland cistern (also called udder cistern) which opens directly into the teat cistern and functions for milk storage. Each gland is divided into numerous lobes; each lobe made up of many lobules. Each lobule contains up to 200 alveoli. The alveolus (Latin*: small sac; plural: alveoli*) is the functional unit and it is a tiny capillary-rich sac where milk is synthesized and released. Capillaries bring the milk building blocks to alveoli cells for milk assembling. The alveoli cells are secretory epithelial cells and myoepithelial cells (Greek: *mous, mus,* muscle) which contract in response to oxytocin, causing milk letdown.

It is important to mention that milk secretion in goats is different to that of cows. Milk secretion in the goat is apocrine, compared to merocrine in cows (see picture 1). Apocrine secretion results in the shedding of nucleated and non-nucleated cytoplasmic particles into milk. Nucleated particles will be included in the total cell count

What Is a Somatic Cell Count (SCC) and Why Is It important?

As explained, leukocytes (somatic cells) migrate into the mammary tissue to provide the first immunological line of defense against bacteria that penetrate the physical barrier of the teat canal. One generally accepted conclusion is that the concentration of somatic cells, in the milk, is directly related to the infection status of the udder. All other possible factors are of lesser consequence. Stated another way, if the somatic cell count is high the doe or cow has mastitis or inflammation of the mammary gland. No other factor(s) influences the milk somatic cell count to the degree that bacterial infections do. Inflammation can and does result in the loss of function characterized in mastitis by lowered milk production. Inflammation is a reaction to tissue injury (change in composition) due to the doe/cow's immune response. Therefore, in the day to day management of the dairy, infection status of the herd can be monitored effectively by monitoring the SCC of bulk tank milk or individual doe or cow samples. Also there are crucial legal aspects related to the SSC. Each producer must be acquainted with the requirements of the governmental agency (State Department of Agriculture or Public Health Department) under whose authority he or she operates. Regulatory agencies generally operate on the basis that milk is milk, whether obtained from a dairy cow or a dairy goat. Thus, the goat milk producers are expected to meet the same requirements as the cow dairy

To obtain a SCC, a dairy producer takes a milk sample (from an individual doe or cow, or from the bulk tank and sends the sample to a laboratory for analysis. Direct microscopic cell count or electronic somatic cell counting can do the SCC. In the first method the sample is smeared on a glass slide, stained and the stained cells are identified and counted. Electronic methods include Coulter Counter and Fossomatic Cell Counter.

Normal goat milk has a higher cell count than normal milk from cows. This has long been a concern of goat owners because of regulatory standards and marketing problems. Current Grade standards require that milk contains no more than 1,000,000 somatic cells/ml. The SCC limit was lowered to 750,000/ml for cow milk in 1993 and there are proposals for a reduction to 450,000 somatic cells/ml. Despite this reduction for cow milk, regulatory standards for goat milk remain at 1,000,000/ml for now. This is because SCC in goat milk may easily approach 750,000/ml and still be wholesome milk secreted by a healthy udder. Extension specialists and researchers at the E. (Kika) de la Garza Institute for Goat Research, Langston, OK, conducted several studies showing that measuring SSC in goat milk is not the best indicator of udder health that SCC is for cows.

The higher cell count of goat milk is in part caused by an increase in rate of sloughing of these epithelial cells and the presence of cytoplasmic masses which occur as a consequence of the apocrine secretory process. Electronic cell counters cannot accurately differentiate between epithelial cells, cytoplasmatic mass, or white blood cells. Consequently, when epithelial cells and/or cytoplasmatic mass are present in high concentrations, cell counts may be artificially elevated if enumerated by electronic cell counters. This results in diagnostic difficulty and circumstances where normal milk would be inappropriately labeled unfit for sale. Only those counting methods that are specific for deoxyribonucleic acid (DNA) can distinguish cell-like particles from somatic cells and thereby give reliable estimates of somatic cell numbers in goat milk. Unlike in milk from dairy cows, the somatic cell count in goat milk is influenced by the presence of nucleated cytoplasmic particles, stage of lactation, parity, and caprine arthritis-encephalitis (CAE). The approved direct microscopic method for SCC in goat milk is the pyronin y-methyl green, which stains the cell DNA. Also, studies conducted at the E. (Kika) de la Garza Institute for Goat Research, Langston, OK, have shown that a 27% reduction in SSC is obtained if the Fossomatic electronic cell counter is calibrated with goat milk standards instead that using cow milk standards. However, in many other respects regulation of bovine and caprine lactation seems to be quite similar.

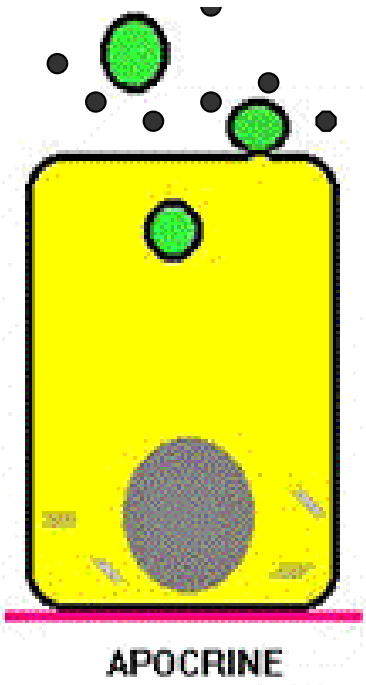
Many dairy goat producers estimate SCC on goat milk and screen for possible mastitis using the California Mastitis Test (CMT). The CMT reagent reacts with genetic material of somatic cells present in milk to form a gel and compare the results with the information in Table 1 to identify potential sick animals early. The CMT detects gel formation when DNA in somatic cells reacts with a detergent. The reaction occurs on a paddle (CMT) and is graded subjectively (negative, trace, 1,2,3). For reliable results, tests should be conducted just before milking after stimulating milk down and discarding the foremilk.

TABLE 1.- Interpretation of California Mastitis Test scores in goat milk

CMT Score	Description of Reaction Between CMT Reagent and milk	Estimated number of white blood cells per ml
0	No reaction	Below 200,000
Trace	Slight slime, tends to disappear with continued swirling	150,000 to 500,000
1	Distinct slime but without gel	400,000 to 1,500,000
2	Immediate gel formation; moves as a mass during swirling	800,000 to 5,000,000
3	Gel develops a convex surface and adheres to the bottom of the cup	Over 5,000,000

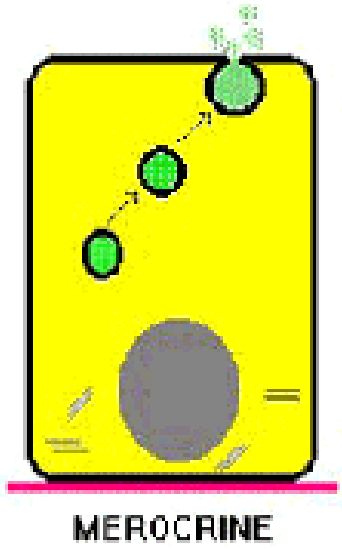
Picture 1.- Milk secretion differences between goats and cows

(Adapted from *http://www.mc.vanderbilt.edu/histo/BasicTissue/Gland.Epith.Top.html*)



APOCRINE MILK SECRETION (Goats, humans)

Milk secretions in the high point of the cell and a portion of the cell itself (including the plasma membrane) is pinched off for secretion. Some cytoplasm may be discharged with the secretion (represented by black dots).



MEROCRINE MILK SECRETION (Cow)

Secretory milk minute droplets form in the cells and accumulate in the high point. The droplets fuse with the uppermost plasma membrane and are secreted into the lumen of the gland by a cellular process called exocytosis (Greek: *exo, outside of; cyto, cell*).

USE OF ANTIBIOTIC RESIDUE TEST KITS FOR GOAT MILK

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Background and Purpose

Mastitis is known as the most common disease syndrome in the dairy industry. Treating mastitic lactating animals with antibiotics is a veterinary practice to cure the disease. However, the antibiotic used may persist in the milk for a period of time depending on drug selected, dosage applied, route administered, body weight of the animal treated, etc. Antibiotic residues in milk are of great concern to dairy farmers, milk processors, consumers and regulatory agencies. Therefore, the Food and Drug Administration (FDA) established tolerance (safe) levels of antibiotic residues in milk for consumer protection (Table 1). Antibiotic residues in goat milk exceeding tolerance levels not only present potential health risks to the consumer but also interfere with milk product processing such as cheese manufacturing.

Table 1. Tolerance levels of antibiotic residues in milk established by FDA and detection levels of antibiotic residue test kits claimed by test manufacturers.

Antibiotic	Tolerance level (ppb)	Detection level (ppb)				
		SNAP Reader	**LacTek (CEF)**	**LacTek (BL)**	**Penzyme Milk**	**Delvotest P**
Amoxicillin	10	8		7.1	6	7.7
Ampicillin	10	8.2		4.7	7	5.1
Ceftiofur	50	10.5	44.2			
Cephapirin	20	3.5		18.7	11.6	7
Cloxacillin	10	N/A		7.7	N/A	N/A
Penicillin G	5	3.5		4.1	5	3.1

There are approximately 1.5 million dairy goats in the United States which generate almost half a billion dollars income annually from goat milk production alone (Haenlein and Hinckley, 1995) . Thus producing safe, high quality milk for consumers is a top priority for dairy goat producers. Violations of the antibiotic residue regulations may damage the image of this growing dairy goat industry. Therefore, use of antibiotics in dairy goats should be strictly monitored.

Screening tests are needed to provide high sensitivity and specificity for testing antibiotic residues in goat milk on the farm, in processing plants and in regulatory laboratories.

Screening tests listed under the Appendix N of the Grade A Pasteurized Milk Ordinance (PMO, 1995) for antibiotic residues in cow milk have been validated and accepted by the Laboratory Committee of the National Conference on Interstate Milk Shipments (NCIMS). The Milk and Dairy Beef Residue Prevention Protocol (MDBRPP) developed jointly by the American Veterinary Medical Association (AVMA) and the National Milk Producers Federation (NMPF) lists all screening tests available for detection of antibiotic residues in cow milk (Boeckman and Carlson, 1994). This protocol also specifies sensitivity levels of each test and tolerance levels of approved drugs. However, these test kits were not verified using milk from individual cows and false-positive results have been reported by many researchers (Jones and Seymour, 1988; Seymour et al., 1988a and 1988b; Cullor, 1992; Cullor et al., 1992; Tyler et al., 1992; Sischo and Burns, 1993; Van Eenennaam et al, 1993; Sischo, 1996). *False-positive* results erroneously call for withholding of individual milk not to be used for food and lead to economic loss for the producer while *false-negative* results allows antibiotic-contaminated milk to enter the food chain for human consumption. Therefore, regulatory agencies, the dairy industry and test manufacturers have been searching for accurate yet quick tests to screen antibiotic residues in milk. Due to the significant differences in milk secretory mechanisms and milk composition between cows and goats, the adequacy of these test kits for dairy goats must be evaluated using goat milk (Zeng et al., 1996). In identifying urgent issues of goat milk to be resolved, Hinckley et al. (1994) stated that "valid antibiotic withdrawal times and residue testing methodology specific for goat milk must be developed and approved". Goat producers as well as regulatory agencies demand scientific evidence regarding the effectiveness of these test kits for screening antibiotic residues in goat milk. Validation of antibiotic residue tests is important for monitoring antibiotic use on the farm as well as for preventing antibiotic-contaminated milk from entering bulk tank milk and milk products. Therefore, extension specialists and researchers of the E. (Kika) de la Garza Institute for Goat Research. Langston, OK, conducted field studies to validate the claimed sensitivity and specificity of antibiotic residue test kits using antibiotic-fortified goat milk and to evaluate the effectiveness and accuracy of the test kits for detection of antibiotic residues in drug-incurred milk from individual goats.

Antibiotic residue tests kits validated in the study were:

- Penzyme Milk Test (Cultor Food Science, Inc., Milwaukee, WI)
- Delvotest P (Gist-Brocades Food Ingredients, Inc., Menomonee Falls, WI)
- SNAP Test (IDEXX Laboratories, Inc., Westbrook, ME) and,
- LacTek Test (B-L and CEF, IDEXX Laboratories, Inc., Westbrook, ME).

Penzyme Milk Test is an enzyme assay. Carboxypeptidase causes a color change in the content of the test vial in the absence of antibiotics as an orange/pink color appears. With the presence of sufficient beta-lactam antibiotics in milk, the enzyme forms a stable and inactive complex and the yellow color of the vial content remains. Results are obtained in 20 min.

Delvotest P is a culture medium screening test, using *Bacillus sterothermophilus var. calidolactis.* This bacterium produces acids from glucose and turns bromcresol purple to yellow. The presence of antibiotics in milk inhibits growth of the culture and prohibits the above reaction.

Therefore, an unchanged purple color in the medium is interpreted as positive while a yellow or yellow/purple color as negative for antibiotic residues. This test takes 2.5 to 3 h to obtain results.

SNAP Test is an Enzyme-Linked Receptor Binding Assay. An enzyme-labeled conjugate (A) binds with drugs present in milk during incubation in the test tube included in the test kit. When the mixture is added to the SNAP device, the unbound conjugate "A" binds to the sample spot while the enzyme-labeled conjugate "B" binds to the control spot. A blue color is developed when the enzyme portion of conjugates on the spots cleaves the substrate after the activator is "snapped" down. The higher the concentration of drugs in milk, the lighter blue the color is in the sample spot. Results can be obtained visually or using a SNAP image reader. This test screens antibiotic residues in milk in approximately 10 min.

LacTek Test is an Enzyme Linked Immunosorbant Assay. Antibiotic residues in milk compete with an enzyme tracer for antibiotic binding sites on the tube wall. The presence of antibiotic residues in milk sample will reduce the amount of tracer which binds to the tube resulting in decreased color development. Qualitative results may then be obtained by running a standard and sample tubes with a spectrophotometer. There are two separate test kits, LacTek CEF for ceftiofur and LacTek B-L for other beta lactam drugs. Results can be obtained in approximately 10 min. Based on the results of drug-fortified goat milkj and drug-incurred goat milk studies, SNAP, Penzyme Milk, Delvotest P and LacTek CEF tests were sensitive and reliable in detecting antibiotic residues in goat milk. They all showed over 90% specificity and 90% sensitivity at tolerance and detection levels. These test kits should be approved for screening antibiotic residues in goat milk. Only LacTek B-L failed to meet the 90% specificity requirement. Therefore, its use for screening antibiotic residues in goat milk needs further investigation.

The objective of this workshop is to familiarize dairy goat producers with two milk residue detection test kits, Penzyme and SNAP. The E. (Kika) de la Garza Institute for Goat Research. Langston, OK, does not endorse these kits and the mention of proprietary names is for educational purposes only.

The procedures and methods to conduct the tests follow.

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