Goat Reproduction

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Unit Objective

After completion of this module of instruction the producer should be able to use reproduction and breeding skills and concepts in such a manner to improve his/her meat goat operation. The producer should be able to discuss the reproductive process of the male (buck) and female (doe) and make decisions regarding the time to breed and care for the breeding animals. The producer should be able to complete all assignment sheets with 100% accuracy and score a minimum of 85% on the module test.

Specific Objectives

After completion of this instructional module the producer should be able to:

1. Match reproductive and breeding terms with their definitions.
2. Identify the parts of the female reproductive system.
3. Select from a list the different functions of the parts of the female reproductive system.
4. Identify the parts of the male reproductive system.
5. Select from a list the different functions of the parts of the male reproductive system.
6. Name the three parts of a spermatoza.
7. Explain the meaning and implication of puberty.
8. State in days the estrus cycle of the doe.
9. State in days the length of the doe's gestation period.
10. Explain the nutritional demands of open, early-pregnant, late-pregnant, and lactating does.
11. Explain the meaning of seasonal breeding.
12. State the traditional mating system of meat goats.
13. Name things that should be observed and applied as part of a breeding soundness examination.
14. Name criteria that are used to score the quality of semen.
15. Explain the meaning of buck doe ratio and what should be the proper ratio for a successful meat goat production program.
16. Name some factors that affect embryo mortality.
17. State the normal position of the goat kid during the birthing process.
18. Name the two ways a producer can apply or approach to see if the doe is pregnant.
19. Name some signs/symptoms that the doe is coming into or is in estrus.

Module Contents

Introduction

In a meat production system reproductive performance is of vital importance since productivity is largely a function of pregnancy rate, the number of offspring born and weaned, and the frequency with which kids are produced. The aim of meat goat reproductive management must therefore be a high level of fertility (greater than 90%), and an optimum litter size (2 kids) with a high survival to weaning. Understanding reproductive processes in the goat will help producers to manage their herd more efficiently, and breed their does to produce kids that will fit a specific market niche to command a maximum price. Major constraints to reproductive management of goats are the seasonal nature of breeding, and a lack of data on the reproductive performance of domestic meat goat breeds.

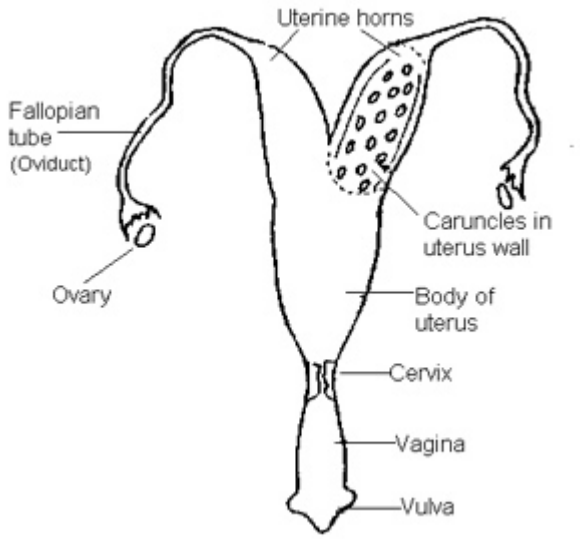
This instructional module will introduce the reader to the fundamental concepts of goat reproduction and how they can be applied towards improving reproductive performance. A glossary explaining some of the terms associated with reproduction in goats can be found at the end of this module.

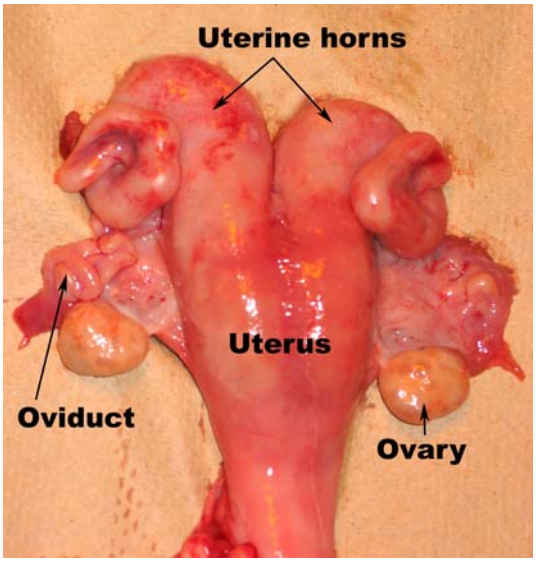
Goat Reproductive Biology

The doe

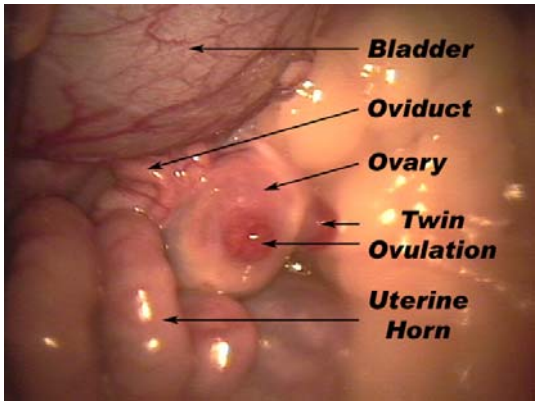
Goats in the U.S are usually "seasonally polyestrous," meaning that they have estrus cycles during late summer, fall and winter. Some relevant characteristics of the estrous cycle are listed in Table 1. The estrous cycle length of goats is 20 to 21 days, with a range of 17 to 24 days. Does are in heat (estrus) for approximately 30 hours, and ovulate 33 hours after the onset of estrus. Most goat breeds are prolific, and mature females shed more than one egg when ovulating.

The reproductive tract of the mature doe consists of several segments. The ovaries are the primary sex organ and produce the ova (eggs) and secrete the female reproductive hormones (i.e. progesterone and estrogen). The oviducts transport the ova to the uterus and are the site of fertilization. The uterus is the site of embryonic implantation and consists of two uterine horns with a common uterine body. The fetus grows and develops in the uterus during gestation. The uterus is closed to the outside by the cervix, a muscular canal consisting of several cervical folds or rings. The exterior portion of the doe reproductive tract is the vagina which is the site of semen deposition during natural mating; it also supplies a fluid environment to support this process during the appropriate stage of the estrous cycle.



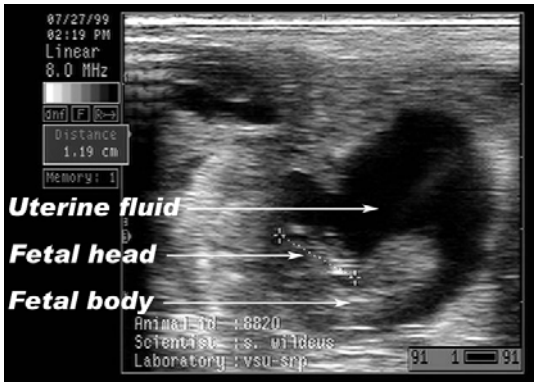


The events of the estrous cycle are largely controlled by the hormonal interactions of the ovaries with the secretory glands (pituitary, hypophysis) located at the base of the brain. In addition to internal stimuli, this system is also responsive to external stimulation such as changes in day length and the presence and absence of males. Follicles in the ovaries, containing primary oocytes (eggs), develop in successive waves and until some will rupture and release a secondary oocyte during ovulation. The released egg passes through the oviduct to join with spermatozoa, whereas the ruptured follicle transforms into a corpus luteum. The development of the follicle is under the control of gonadotropins (follicle stimulating hormone - FSH, and luteinizing hormone - LH) released by the pituitary gland. The gonadotropins, via a hormonal feedback loop, also control the release of estrogens by the ovary, which control the estrous behavior displayed by the doe (flagging, mounting, etc.). Following ovulation, the luteinized follicle (corpus luteum) secrets progesterone, which prepares the uterus for a possible pregnancy, and suppresses the secretion of gonadotropins to halt further follicular development.



Failure to establish pregnancy will result in the release of prostaglandin from the non-pregnant uterus, which will regress the corpus luteum and allow a new cycle to proceed.

Pregnancy is established once fertilization of the ovum by the spermatozoon occurs. Fertilization occurs in the oviduct and requires the proper timing of insemination and ovulation, as spermatozoa remain viable for only 12 hours in the female reproductive tract, and the life span of the ovulated egg is limited to 12-24 hours. A healthy sperm will penetrate the zona pellucida surrounding the egg using enzymes contained in the cap of the sperm head. Fusion of the sperm cell with the egg will prevent penetration of other spermatozoa. Fertilized eggs move from the oviduct towards the uterus and initiate cell divisions within 24 hours. The developing embryo will continue to divide and remain free-floating until it attaches to the uterine wall 15 to 20 days after fertilization.



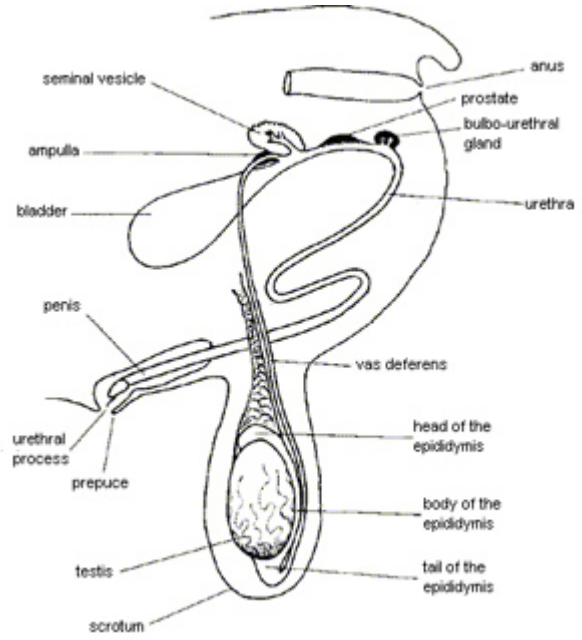
The uterus requires priming with progesterone for attachment of the embryo and membrane development to occur. In goats, in contrast to sheep, the corpus luteum is the primary source of progesterone throughout gestation. The developing fetus is contained in the placenta, a membrane that facilitates the exchange between the maternal and fetal circulation. While the placenta experiences the most rapid growth between 90 to 110 days, fetal growth increases exponentially during the last trimester of pregnancy. Gestation length in the goat is approximately 150 days, but is affected by breed and sex of kids, and tends to increase with age, and decrease with litter size.

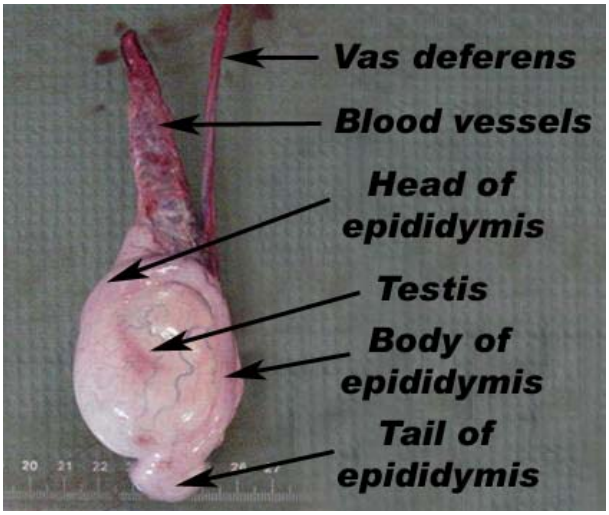
Parturition is initiated by regression of the corpus luteum approximately 24 hours before delivery, associated with an increase in estrogen. In preparation for parturition the ligaments in the pelvic region relax, uterine contractions stimulated by oxytocin are initiated, and placental membranes rupture. Kids are usually born within 2-3 hours of initiation of labor. The rise in estrogen concentration at parturition is also involved in initiating maternal behavior and acceptance of the newborn. Maternal behavior is also fostered through stimulation of the cervical region as the kids pass through the birth canal.

The buck

The male reproductive tract can also be divided into several segments. The primary sex organs are the testes, which produces the male gametes (spermatozoa) and sex hormones (i.e. testosterone). Sperm production (spermatogenesis) takes place inside the germinal epithelium, whereas Leydig cells in the interstitial tissue are responsible for hormone production. The testes are located in the scrotum, which aids in temperature regulation, and maintain the testes at 3-5°C below body temperature for optimal function. Spermatozoa produced by the testis enter the epididymis, also located in the scrotum, which serves as the site of sperm maturation (sperm acquire motility and fertilizing capacity), and storage prior to ejaculation. The vas deferens connects the epididymis to the ampulla and accessory sex glands. These glands are located in the

pelvic region and provide the spermatozoa with the fluids that make up the ejaculate. The penis is the final component of the male reproductive tract and used to deposit the semen into the female. In the buck, erection is achieved through the extension of the sigmoid flexure that allows an extension of up to 12 inches and by filling of the cavernous tissues with blood. In the non-erect state the penis is contained in the sheath.





Just like in the ovaries, the events in the testis are controlled by the gonadotropins LH and FSH. In contrast to the female, where all eggs that will be developing are present at birth, spermatozoa are produced through continuous divisions throughout the reproductive life of the male. In the final step of spermatogenesis, cells develop the characteristics of the functional spermatozoa (head, mid-piece and tail). Spermatozoa are then released from the germinal epithelium and pass to the epdididymis, where fluid is removed and the sperm suspension is concentrated. Here sperm are stored in a dormant state prior to ejaculation, or are voided in the urine in sexually inactive male. There is considerable variation in ejaculate volume and sperm concentration, dependent on season, age, and sexual activity. A normal range for volume and concentration is 0.5 to 1.5 ml, and 1.5 - 5.0 billion sperm/ml (Table 1).

Puberty

Puberty is generally defined as the point of sexual development at which the animal becomes capable of reproduction (first ovulation in the female and first spermatozoa in the ejaculate of the male), but often animals are not fully sexually mature at this stage. In both the male and female goat, puberty may be reached without having achieved adequate physical growth to support reproduction. In the doe, this may be expressed as first ovulation not coinciding with first estrus, while in the male ejaculate quality and quantity are insufficient to achieve extensive breeding

success. In immature bucks, the penis has adhesions that prevent the penis from being fully extended. At puberty, these adhesions dissolve and the penis can be fully extended.

Sexual development in the goat, as in other mammals, is a process of gradual maturation, a result of the interaction between the brain and gonads, initiated during embryonic development. Sexual development is influenced by both genetic and environmental factors. In does and bucks the age at puberty ranges from 120 to 230 days, dependent on nutrition, location, breed and season of birth. Nutrition is among the most significant factors influencing reproductive development and the onset of puberty. Inadequate nutrition delays occurrence of the first estrus. Increasing the level of nutrition generally advances the onset of puberty, but overfeeding prior to puberty will decrease subsequent fertility and impair mammary gland development. Season of birth also has a significant impact on the timing of puberty in both doelings and bucklings, with sensitivity to changes in day length already being in effect during the prenatal stages of development. Puberty in spring-born kids has to be achieved in the same year's fall breeding season or will be delayed until the following year's breeding season. There are some indications that the introduction of bucks may encourage doelings to reach puberty early.

Seasonal breeding

The environmental cue most dominantly affecting seasonal breeding in small ruminants is the annual change in day length (short day breeders). As the day length decreases in late summer and fall, does initiate estrus activity and males become more sexually active. However, following extended exposure to decreasing day length, animals become accustomed to the short day length and will again stop cycling.

Differences exist in the onset and length of the breeding season among the various breeds of goats, and even between individual animals within a breed. Geographic location, particularly degree of latitude, has a significant impact on timing and length of the breeding season. At locations close to the equator, tropical breeds of goats often are aseasonal breeders, and breed throughout the year. However, factors such as rainfall/nutrition, and lactational status can also effect breeding season. Other stressors such as transportation or illness may cause a temporary stoppage of estrus activity. In seasonally breeding does, the breeding season is framed by transitional periods during which gonadotropin levels are increasing but not to levels that will trigger estrus and ovulation. Often onset of estrus activity can be hastened through appropriate management techniques (i.e. introduction of males) during this transitional period. In the male, seasonal breeding is associated with changes in testis size and libido, and the development of a distinct buck odor.

Basic Reproductive Management

Reproduction should be a vital component of the overall herd management scheme and closely integrated with nutritional and health management. The incidence of reproductive diseases affecting goats in the U.S. is low, but goats need to be maintained in good health (dewormed and vaccinated) to ensure proper reproductive function. Meat-type does should be capable of giving birth and raising their offspring unassisted, but occasional help may have to be provided with complications during parturition and the acceptance of the newborn. Records should be collected

on kidding and weaning performance (litter size and weight) to be used for selection of breeding stock.

Mating schedule/system

The traditional mating system for goats is once-a-year, annual mating, with does bred in fall during the natural breeding season for spring kidding. This approach ensures the greatest likelihood to establish pregnancy, and optimal ovulation rates. There is some flexibility as to breeding dates, as the breeding season will usually extend from August to January for most breeds. This range allows breeding to be adjusted for favorable climatic conditions during kidding and optimal forage quality for lactating does. Scheduling a breeding season should also take marketing opportunities for kids into account. Duration of mating will impact the length of the kidding season, and associated labor requirements. A 40-45 days breeding season will afford each doe at least two opportunities to breed.

A gestation length of 150 days presents goats the opportunity to kid twice per year or three times in two years. A decreased kidding interval ('accelerated mating') utilize facilities and labor more effectively, while increasing the annual kid crop and providing for more continuous production of kids. However, this theoretical potential is restricted by seasonal, postpartum and lactational anestrous, and the need for uterine involution, while requiring significant additional inputs in management and feed. These additional inputs often make these systems not suitable for extensive meat goat production.

Under extensive conditions, continuous mating is sometimes practiced, and bucks are maintained with the doe herd throughout the year. In such a system only limited supervision can be provided during kidding, but care is required to routinely remove offspring from the herd to avoid dam x son and sire x daughter matings. Although buck exposure is continuous, kidding under continuous mating will eventually follow seasonal breeding patterns.

Nutritional considerations

Diets and feed supplies have to be adjusted to account for the physiological stage of production of the goat, particularly in the female (lactation, gestation). Prior to breeding (2-3 weeks) does in poor condition should be placed on a gaining plane of nutrition to stimulate higher ovulation rates ('flushing'). The mechanism accounting for this improvement in ovulation rate is not fully understood, nor have results been consistent. It is also not clear if improvements are linked more directly to changes in energy or protein intake, but changes are more pronounced in does where the improved diet results in changes in body condition.

During the early stages of gestation the nutritional demands of does are moderate and only in later stages of pregnancy, at the time of increased fetal growth, the plane of nutrition should be increased. Inadequate nutrition during late gestation can result in abortion, and stillborn and weak kids, and may limit availability of colostrum for the newborn kid. Low nutrition may also affect the acceptance and bonding of the mother. Late pregnant does should have access to high quality roughage, and moderate levels of concentrate feed, as both undernourished or overly fat does are prone to pregnancy toxemia (ketosis) during the late stages of gestation. Does nursing

their kids are nutritionally challenged and may require supplemental feed if pastured to ensure adequate milk supply for multiple litters.

Breeding season management

Bucks, because of their size, odor and sometimes temperament, often require special management considerations and experience in handling. Pens and working facilities need to be strong to hold bucks when not used for breeding. Bucks used for breeding should have characteristics that will advance the production potential of the herd and should be able to mate successfully to transmit these characteristics.

As indicated earlier, spermatogenesis is susceptible to outside influences such as elevated temperature, season of year and nutrition, and breeding males need to be evaluated for reproductive soundness 3-4 weeks prior to mating season. Part of such a 'breeding soundness examination' is an evaluation of the overall condition of the buck and includes his health history, physical soundness, particularly of feet and legs, and examination (palpation and visual inspection) of the external genitalia (scrotum and scrotal content, sheath and penis) for signs of infections and other abnormalities. There are currently no age and breed standards for testis size (scrotal circumference) in meat-type breeds, but the testis should be of adequate size (20-25 cm scrotal circumference) and tone (firm).

In case the assistance of a veterinarian or trained personnel is available the breeding soundness examination should also involve the collection and evaluation of an ejaculate. The ejaculate is scored for the percentage of motile, normal and live sperm. If does in estrus are available, bucks should be placed with these does to evaluate libido and mating behavior. Bucks deficient in any part of the examination should be considered questionable, and retested after several weeks. A second failed test would indicate reproductive deficiencies and such a buck should not be used for mating.

The number of does a buck can breed will depend on a variety of factors, including age of the buck, terrain and pre-breeding management (i.e. synchronization of estrus). A mature buck under pasture conditions should be able to breed 30 to 50 does. For yearling bucks this ratio is markedly lower, and dependent on the physical development of the buck. The number of bucks is of less importance if multiple sires are used with a single group of does, but problems with fighting, establishment of dominance, and the ability to establish parentage may occur. A buck may breed only 5-15 does if does are estrus synchronized (hormone treatments that causes all does to be in estrus at the same time) to ensure adequate fertility. An alternative approach to breeding synchronized does is the use of 'hand-mating' where access to the doe is restricted to one or two controlled matings 12 hours apart.

A useful management tool for breeding is the use of a marking harness. A marking harness is a device which holds a marking crayon on the buck's chest which colors the back of a doe when she is mounted. Although most harnesses available on the market are designed for rams (male sheep), adjustments can be made for their successful use with larger bucks. Harness marks will provide an instant confirmation of the breeding activity of a buck, establish mating dates (and subsequently projected kidding dates). The color of crayon should be changed after 15-20 days of breeding to identify does that are rebred, as indicated by marking with the new color. A large number of rebred does would suggest that a buck has fertility problems and should be replaced. In multiple sire mating groups alternative color crayons will provide an indication of mating activity of individual bucks.

Gestation and parturition

Embryonic losses early in pregnancy are usually much higher than fetal losses at later stages of gestation, and can be as high a 20-30%, due to the complexity of events associated with fertilization and implantation. Embryo mortality is also influenced by extrinsic factors such doe age, and environmental and nutritional stress. Abortions during the early stages of gestation can usually not be readily differentiated from failure to conceive. During these early stages of pregnancy the embryo is sensitive to a variety of drugs and mineral deficiencies.

In goats, in contrast to sheep, the placenta does not provide sufficient progesterone, and is dependent on secretions from an active corpus luteum to support pregnancy. Hence spontaneous (non-infectious) abortions resulting from luteal insufficiency are more common in goats. Undernutrition, vitamin and mineral deficiencies, toxic plants, and certain drugs (i.e levamisole) can contribute to non-infectious abortions. Multiple late abortions ('abortion storm') usually suggest an infectious cause for the abortion, of which chlamydiosis and toxoplasmosis are the most common source. To properly diagnose the cause of an infectious abortion, the fetus, portions of the placenta and a blood sample from the doe should be collected for testing.

Parturition can be divided into three stages. During the first stage, the uterine content is pushed toward the cervix, causing it to dilate in a process that may last up to 12 hours. In the second stage contractions increase and the kid(s) move in the birth canal and are expelled in process that may take up to two hours. In the third stage the placenta is expelled and uterine involution commences. Parturition can be induced in goats through the use of prostaglandin which regresses the corpus luteum and removes the primary source of progesterone. Does treated with prostaglandin will usually deliver their kids between 30 to 35 hours after injection, and no further ill effects such as retained placenta and reduced subsequent fertility are generally observed.

Kidding generally should not require human assistance. However, assistance may be needed when a fetus is not presented properly for delivery, or the cervix is not sufficiently dilated to accommodate a large kid (dystochia). Intervention should be considered once the second stage of labor exceeds two hours. In case of failure of the cervix to dilate properly (ringwomb), cautious manual stretching can be applied. Continued failure to dilate may require veterinary assistance and a Cesarian section to deliver the kids. The normal presentation of kids for delivery is with the head positioned between the front legs. Presentation of the hind legs first may also allow the kids to be born without further assistance. However, abnormal presentations such as the head and leg(s) facing back, and multiple kids entangled during birth, will require manual repositioning of the kids by experienced personnel. Once a kid is positioned correctly assistance may be provided by pulling the legs.

Membranes covering the kids will usually rupture during birth and are removed through cleaning by the doe. If membranes cover mouth and nose, and are not attended to by the doe, they need to be removed manually and breathing should be stimulated and the kid(s) dried off. Newborn kids should be nursing within a couple hours of birth to ensure that proper amounts of colostrums are consumed. The udder of the doe should be checked to ensure that milk is present and can be expressed. The navel of the new born kid should be dipped in iodine. In general, handling of new-born kids and does should be limited to allow the proper bond between dam and off-spring to form.

Reproductive Management Techniques

The utilization of advanced reproductive management techniques can be a useful tool to improve performance of a more closely managed herd. However, additional inputs may be needed in labor and handling facilities.

Buck effect

Exposing non-cycling females to intact or sterile bucks, following a period of isolation, has been demonstrated to induce estrus and ovulation in the doe. The physiological basis for this response is partly due to smell and partly due to sight, with neither stimulus completely accounting for the response. The buck-induced estrus is usually synchronized, with ovulation occurring within 2-3 days of stimulation. The response to buck stimulation can be quite variable and is influenced by breed, season of the year, completeness of prior isolation, nutrition and stage postpartum. Unless male-induced estrus activity is initiated preceding the natural breeding season the response is temporary in nature, and the doe will return to anestrus. Hence the practical application of the 'buck effect' lies primarily in initiating breeding season early, or in combination with some drug-induced out-of-season breeding manipulation.

Controlled lighting

Controlled lighting can be used to manipulate the breeding season in goats. Artificial lighting is mostly employed for 'long day' simulation, administered as 16 hours of daylight followed by 8 hours of darkness. To simulate long days it is not necessary to provide the entire 16-hour light period, but treatment can be divided into the natural daylight period followed by an appropriately timed 1 hour light stimulus at the time of desired dusk. Most practical systems have focused on the extension of the natural breeding season, combining a period of long days followed by short day simulation. Use of controlled lighting requires the availability of a light proof barn to house the goats.

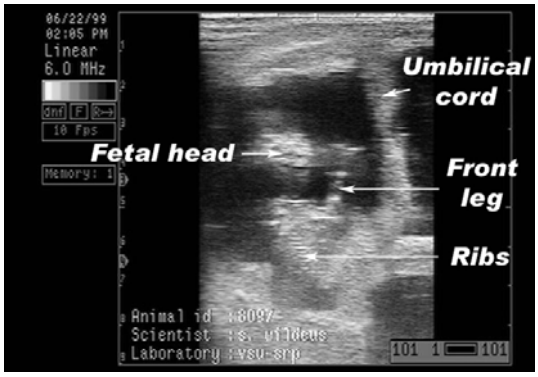
Pregnancy testing

The early determination of pregnancy can be a useful management tool to identify open females for culling, and/or allow the separation of pregnant and open females for differential management. When fetal numbers can be determined as part of the pregnancy diagnosis, different feeding regimes can be applied to single and multiple litter bearing females to optimize nutritional management. To be most useful to the producer, pregnant animals need to be identified as early as possible in gestation.

The most practical approach to pregnancy testing is the observation of mating activity during the breeding season to identify repeat breeders. This can be extended beyond the scheduled breeding season through the use of a sterile harnessed teaser male to identify does that are returning to estrus. The effectiveness of this approach is dependent on the accuracy with which observations are made and libido of the male. Other simple farm-based techniques are associated with the detection of physical changes resulting from pregnancy through palpation (fluid accumulation and presence of a detectable fetus), but are applicable only during the late stages of pregnancy.

Other techniques require specialized equipment (ultrasound scanner) or the analysis of blood or urine samples for hormonal and metabolic signals associated with pregnancy in commercial labs. The arrival of lower cost, portable veterinary ultrasound scanners, combined with the advantages of their use (fetal number determination, minimal animal restraint, high throughput), has made the application of this technology more widely available, and in some instances economically

feasible on the farm level. Abdominal scanning allows reliable pregnancy diagnosis at 35 days of gestation, whereas transrectal scanning is effective as early as 25 days. Using ultrasonography, fetal dimensions can be measured to allow aging of the fetus and predict time to parturition.



Conclusions

Reproductive management is vital to a successful meat goat enterprise. Much of the profit to be realized depends on the frequency with which kids are produced, the number of kids that are born and their survival to weaning. A meat goat producer that understands and applies the information provided in this instructional module should be able to implement an effective reproductive management program.

Table 1: Reproductive characteristics of does and bucks

	Average	Range
Doe:		
Cycle length (d)	20	17-24
follicular phase (d)	4	-
luteal phase (d)	17	-
Duration of estrus (hrs)	30	16-50
Ovulation after estrus (hrs)	33	30-36
Gestation length (d)	150	144-155
Litter size	-	1-4
Buck:		
Daily testicular sperm production (billion)	6.0	4.8-7.2
Ejaculate volume (ml)	1.0	0.5-1.5
Ejaculate concentration (billion/ml)	3.0	1.5-5.0

Glossary

Cervix - closure of the uterus to the exterior.
Corpus luteum - follicle after release of egg, site of progesterone production.
Dystocia - problems associated with giving birth.
Embryo - fertilized egg in the early stages of pregnancy.
Estrogen - hormone secreted by the ovary in association with estrus.
Estrus - period of sexual receptivity of the doe (also called 'heat').
Fertility - percentage of females conceiving.
Fertilization - the fusion of the sperm with egg.
Fetus - a young organism in the early stages of development.
Follicle - site of egg development on the ovary.
Gamete - germ cell of either sex carrying half the genetic information.
Gestation - period from conception to birth (also called pregnancy).
Gonad - the primary reproductive organ of each sex (ovary and testis).
Gonadotropins - hormones secreted by pituitary gland controlling function of gonads (i.e. follicle stimulating hormone, luteinizing hormone).
Hormones - biological messengers involved in regulation of the reproductive processes.
Lactation - period of milk production by doe until the kid is weaned.
Ovary - the primary sex organ of the female.
Ovulation - the release of the egg from the ovary.
Ovum - germ cell produced by the female (also called egg).
Parturition - the process of giving birth.
Placenta - membrane holding the developing fetus within the uterus.
Progesterone - hormone secreted by the ovary in support of pregnancy.
Prolificacy - number of offspring born per doe.
Prostaglandin - hormone secreted by the uterus to regress corpus luteum.
Puberty - point of sexual development at which the animal becomes capable of reproduction.
Sperm - germ cell produced by the male.
Testis - the primary sex organ of the male.
Testosterone - hormone secreted by the testis controlling expression of sexual behavior in the male.
Uterus - portion of female reproductive tract holding fetus during pregnancy.

*Information contained in this document is part of a web-based training and certification program for meat goat producers (*http://www2.luresext.edu/goats/training/qa.html*) that was developed with funding received by Langston University from USDA/FSIS/OPHS project #FSIS-C-10-2004 entitled "Development of a Web-based Training and Certification Program for Meat Goat Producers."*

Collaborating institutions/organizations include Alcorn State University, American Boer Goat Association, American Kiko Goat Association, American Meat Goat Association, Florida A&M University, Fort Valley State University, Kentucky State University, Langston University, Prairie View A&M University, Southern University, Tennessee Goat Producers Association, Tennessee State University, Tuskegee University, United States Boer Goat Association, University of Arkansas Pine Bluff, and Virginia State University.