Chapter Five

Reproduction in Sheep and Goats

Girma Abebe

Objectives

1. To introduce the basic reproductive tract anatomy and physiology of sheep and goats.
2. To outline causes of reproductive failures.
3. To examine some reproductive traits.

Expected Outputs

1. Ability to locate various male and female reproductive structures and describe their respective functions.
2. Ability to list reproductive traits and factors affecting the level of performance.
3. Ability to list common causes of reproductive failures.
4. Adequate understanding to discuss the advantages and disadvantages of seasonal breeding.
5. Ability to discuss and suggest appropriate measures to be taken to improve reproductive efficiency.
6. Ability to list factors responsible for mortality of newly born animals.
7. Knowledge of the management techniques appropriate for different classes of sheep and goats.

5.1. Introduction

Simply defined, reproduction is giving birth to offspring. The survival of a species largely depends on its ability to reproduce its own kind. Reproduction is a series of events (gamete production, fertilization, gestation, reproductive behavior, lambing/kidding, etc.) that terminates when a young is born. Hence, reproduction is a vital function of all living organisms. Reproduction is a complex process. Sheep and goats are considered to be the most prolific of all domestic ruminants.

Reproduction determines several aspects of sheep and goat production and an understanding of reproduction is crucial in reproductive management. A high rate of reproductive efficiency is important for:

- Perpetuation of the species,
- Production of meat, milk, skin and fiber, and
- Replacement of breeding stock.

Males and females play different reproductive roles, and in most animal species, the role of females is not completed until a viable offspring is produced. Even after birth, females play a significant role in the provision of post-natal care and, in mammals, must lactate to provide nourishment for their young. Understanding basic anatomy and reproductive physiology of sheep and goats is important in implementing appropriate reproductive management.

5.2. Reproductive Organs and Their Major Functions

5.2.1. Female

The reproductive tract of ewes and does is similar and, hence, discussed together. The female reproductive tract consists of the vulva labia, vagina (copulatory organ), cervix, body of the uterus, uterine horns, oviduct (also called Fallopian tube) and the ovary.

Ovaries: The ovaries contain the ova (eggs), and secrete female reproductive hormones (progesterone and estrogens).

Oviduct: The oviduct opens like a funnel (the infundibulum) near the ovary. The infundibulum receives ova released from the ovary and transports them to the site of fertilization in the oviduct. The oviduct is involved in sperm transport to the site of fertilization, provides a proper environment for ova and sperm fertilization, and transports the subsequent embryo to the uterus.

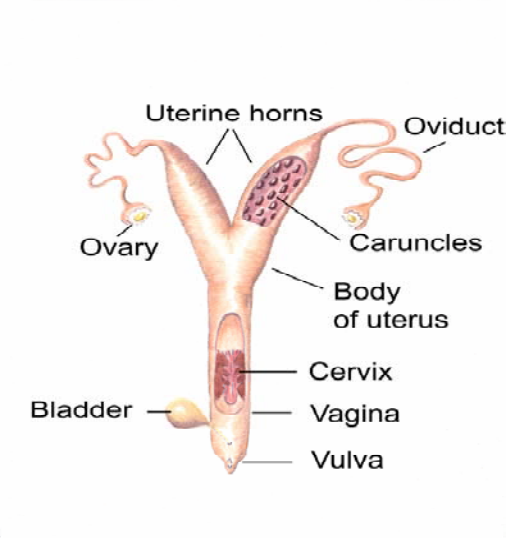

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Figure 5.1. Structure of the female reproductive tract.

Uterus: The uterus consists of two separate horns (coruna). In animals with multiple births, each horn can contain one or more fetuses. The uterus provides a proper environment for embryo development, supports development of the fetus (supplying nutrients, removing waste, and protecting the fetus), and transports the fetus out of the maternal body during birth.

Cervix: The cervix is the gateway to the uterus and is a muscular canal consisting of several folds of tissue referred to as "rings." The cervix has relatively little smooth musculature. It participates in sperm transport,

and during pregnancy, blocks bacterial invasion. The mucus produced during pregnancy (*also during the luteal phase*) forms a plug that makes the opening through the cervix impermeable for micro-organisms and spermatozoa.

Vagina: This is the exterior portion of the female reproductive tract and is the site of semen deposition during natural mating.

Vulva: barrier for preventing external contamination of the female reproductive tract.

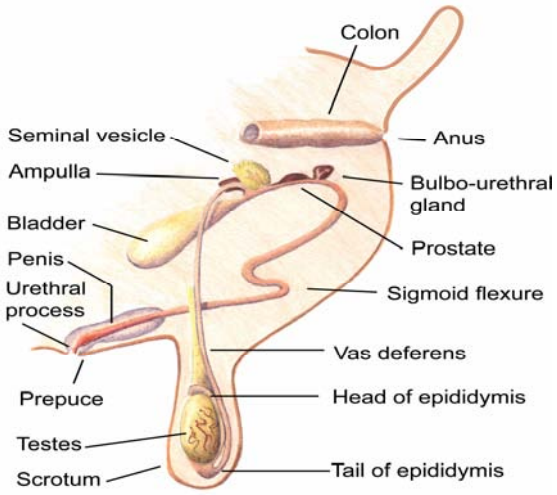

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Figure 5.2. The reproductive tract of the buck.

5.2.2. Male

The male reproductive system consists of testicles, which produce sperm and sex hormones, a duct system for sperm transport, accessory sex glands, and the penis, or male organ of copulation, which deposits semen in the female.

Testes: The testes are paired organs which descend from the abdominal cavity during fetal development to lie in the scrotum. They produce the male gametes (spermatozoa) and secrete the male sex hormone, testosterone. Testosterone is essential for the development of male characteristics, maintaining normal sexual behavior and sperm production.

Scrotum: The scrotum is a muscular sac containing the testes. It supports and protects the testes and also plays a major role in temperature regulation. It maintains the temperature 3 to 5°C below body temperature for optimal function.

Single versus split scrotum: This could be breed-specific as in Somali goats. Some breeders consider the split scrotum as an undesirable trait and select against it. However, the important thing is to check if equal-sized testicles are present and sperm production is normal.

a. Single scrotum b. Partially split scrotum c. Split scrotum

Figure 5.3. Single versus split scrotum.

Epididymis: The epididymis is located in the testes and is a long and convoluted tube in which sperm cells produced by the testicles are stored and mature to a stage capable of fertilization. This change occurs as sperm cells move from the head to the body of the epididymis with mature sperm being stored in the tail of the epididymis.

Vas deferens: The vas deferens is the duct that rises from the tail of the epididymis into the abdomen, where it joins the urethra at the neck of the bladder. It is often referred to as the 'spermatic cord.' Removal of a section of the vas deferens in each testis is known as a vasectomy, preventing passage of sperm from the epididymis.

Accessory sex glands: The accessory sex glands include the bulbo-urethral, prostate, and seminal vesicle glands and the ampulla. Accessory glands secrete additional fluids, which when combined with the sperm and other secretions from the epididymis, form the semen. Some of the secretions contain nutrients like fructose while others produce alkali secretion to raise the pH of the ejaculate. These secretions are added quickly and forcibly during the mating to propel sperm into the urethra.

Penis: This is the final part of the male reproductive tract and its function is to deposit semen into the vaginal tract of the female. At the end of the penis is a narrow tube called the urethral process (or 'worm') that sprays the semen in and around the cervix of the ewe/doe. The preputial sheath protects the penis, except during mating.

5.3. Effect of Temperature on Reproduction

Increased body temperature can lower the reproductive rate in ewes/does by decreasing ovulation rate, delaying heat cycles or by increasing embryonic mortality. Heat stress in males affects the process of spermatogenesis and can render bucks and rams temporarily sterile for 6 to 10 weeks. For these reasons, it is important to assist animals in maintaining body temperature, especially during times of the year when ambient temperature is high. A simple provision of shade in range production systems could reduce the negative effect of heat. Physiological mechanisms in the male assist in regulating temperature.

- The external cremastor muscle contracts during cold weather to hold the testicles closer to the abdominal wall and relaxes during warm weather to allow the testicles to be more remote and hence cooler.
- Smooth muscle fibers in the scrotal sac, known as the *tunica dartos*, contract to reduce the total surface area and hold the scrotum closer to the body during cool weather and relax during warm weather to keep testicles away from the body.
- A network of blood vessels above the testicles, known as the *pampiniform plexus*, works to reduce the temperature of blood entering the scrotum. In this system of closely intertwined blood vessels, the cooler venous blood cools the warmer arterial blood as it enters the area of the testicles. This heat-exchange mechanism is especially important in animals where the scrotum is less pendulous (stallion and boar).

Activities

Activity 1:
Female as well as male reproductive organs of sheep or goats can be obtained from abattoirs or slaughter houses. Different parts of the reproductive tract and respective functions of each part should be examined and studied.

Activity 2:
Participants will be required to measure height of scrotum on bucks in the morning and in the afternoon and discuss their findings. This will help participants to appreciate mechanisms involved and the importance of regulating scrotal temperature.

5.4. Puberty in Females and Males

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 animals are not yet fully sexually mature at this stage. Sexual maturity is the time when the animal expresses its full reproductive capacity. In both the male and female sheep and goat, puberty may often be reached without adequate physical growth to support reproduction, and in females the first ovulation may not necessarily coincide with first estrus.

In males, puberty is the time when complete separation of the prepuce and the penis occurs and motile spermatozoa are first detected in the ejaculate. In immature rams and bucks, the penis has adhesions that prevent it from being fully extended. At puberty, these adhesions dissolve under the influence of testosterone and the penis can be fully extended. This may occur as early as 5 months. However, full reproductive competence may not occur until 15 months of age. Spermatogenesis has been found to begin as early as 84 days of age, with spermatozoa present in the epididymis at 140 days of age.

5.4.1. What causes puberty?

Puberty is caused by an increase in secretion of pituitary hormones, which in turn lead to an increase in size and activity of the gonads.

5.4.2. Factors affecting puberty

Several factors such as nutrition, body weight, breed, season of birth and growth rate are known to influence the age at puberty. Nutrition is among the most significant factors influencing reproductive development and the onset of puberty.

- A low plane of nutrition delays first estrus and reduces uterine and ovarian development.
- Increasing the overall plane of nutrition generally advances the onset of puberty.
- Overfeeding will decrease subsequent fertility and impair mammary gland development and, therefore, care must be taken to avoid overfeeding.
- Energy and protein restriction influences age at puberty, with energy restriction having a greater influence on delaying onset of puberty than protein restriction.
- In most sheep and goat breeds, attainment of puberty is dependent on achieving satisfactory body weight, usually between 40 and 70% of the mature body weight. A late-maturing breed like the Somali goat is known to attain puberty at a later age.
- Age, weight and growth rate seem to be interacting in determining the process of onset of puberty. In general, faster growth rates resulting from higher planes of nutrition enable kids to attain puberty at a younger age and heavier body weight than kids reared on low planes of nutrition.
- Complete separation of males and females during the early growth period may delay the onset of puberty.

Different investigations on the reproductive performance of Ethiopian sheep and goats have shown the following: ewe lambs of the Menz breed attain puberty at 10 months of age and 16.9 kg mean weight or 56% of mature body weight. The onset of puberty was earlier in animals with higher weaning weights. Somali kids were 19 months and weighed 26 kg at puberty, indicative of a late maturing breed.

In Horro sheep kept under low-to-high nutritional regime, age at first mating was reported to be 206 to 285 days while weight was 18 to 21 kg. From on-farm monitoring work in Ada District, weight and age at first successful mating for sheep was reported to be 20 kg and 8.7 months, respectively, while for goats it was 17 kg and 7.4 months.

5.4.3. Appropriate age or weight at first mating

There are two schools of thought regarding the appropriate age of mating. One school of thought advocates early mating of ewes/does regardless of what is called 'critical body weight.' It is argued that this will increase the lifetime productivity of the females, despite the fact that some abortions are evident. However, the concept of 'critical body weight' is favored. According to this concept, animals should attain a minimum body weight in order to avoid growth retardation (in most cases two-thirds of mature body weight) before they are mated. This reduces reproductive wastage (abortion) that could result from mating small-sized and sexually immature animals.

Activities

Meet at least 5 knowledgeable farmers who have experience in sheep and goat production and find out the age at which sheep and goats are first mated.

1. What is the estimated age at first breeding for females in the area?
2. Are there differences in age at first mating between ewe lambs and doelings?
3. Are farmers/producers in your area aware of the advantages and disadvantages of early mating?

5.5. The Estrus Cycle in Ewes and Does

Once puberty is reached, large domestic animals such as sheep and goats display a polyestrous (repeated reproductive cycles) pattern of reproductive activity. The estrus cycle, defined as the number of days between two consecutive periods of estrus (heat), is on average 17 days in ewes and 21 days in does. The estrus cycle may be divided into two phases, namely:

- the follicular phase (growth and expulsion of the ova or egg), and
- the luteal phase, which starts after ovulation and formation of the corpus luteum (yellow body).

Further classification of the estrus cycle is possible as shown in Table 5.1. Estrus cycles show variation and thus are classified as short, normal and long. Short estrus cycle and irregular estrus periods may be seen in some goats.

Occurrence of estrus in Somali goats was shown to be positively correlated with monthly rainfall and monthly minimum temperatures, while a negative correlation was observed with monthly maximum temperatures and monthly sunshine.

Table 5.1. Different phases of the estrus cycle in does.

Stage	Day of cycle	Characteristics
Estrus	1–2	Final growth and ovulation of 1–2 pre-ovulatory cycles. Sexual receptivity of does. Cervical mucus thinner and more copious, cloudy towards ovulation.
Metestrus	3–4	Functional organization of corpus luteum.
Diestrus	5–18	Luteal phase.
Proestrus	19–21	Growth of pre-ovulatory follicles.

5.5.1. Hormonal control of the estrus cycle

- Estrus cycle is controlled by GnRH (Gonadotrophic Releasing Hormone) released by the hypothalamus.
- Just before the onset of estrus, the pituitary gland, under the control of the hypothalamus in the brain, releases an increasing amount of Luteinizing Hormone (LH) and Follicular Stimulating Hormone (FSH).
- Growth of follicles is regulated by pituitary hormones – FSH, LH.
- LH stimulates the final maturation of the follicle containing the eggs (oocytes) and stimulates the follicle to produce the hormone estrogen.
- Estrogen brings the ewe into behavioral estrus or 'heat.'
- The rising concentration of estrogen stimulates a surge in LH that stops further secretion of estrogen by the follicle.
- Once the egg has been released, LH transforms the follicle into a Corpus luteum (CL).
- CL produces progesterone, which in turn suppresses pituitary activity.
- If pregnancy does not occur, lysis (destruction) of the Corpus luteum occurs due to endogenous release of prostaglandin from the uterus, thus causing a fall in the progesterone level, and the cycle starts again.

5.5.2. Detection of estrus

The detection of estrus is very important when artificial insemination is conducted and when mating is controlled, i.e., sires do not run with females. For this reason it is important to know the signs of estrus.

5.5.2.1. Behavioral signs of estrus

Does

- Bleating continuously
- Swollen – red colored vulva
- Flagging of the tail
- Frequent urination
- Cervical mucus discharge, which causes hairs to stick together
- Restlessness
- Mounting other goats and seeking the buck

Ewes

The signs of estrus in the ewe are not obvious unless a ram is present. As in the doe, the vulva is swollen and redder than usual, and there is a discharge of mucus but is difficult to see in a ewe with a tail or fleece.

All of the symptoms mentioned may not be exhibited by a doe or ewe in estrus. The best confirmation of estrus is when the doe or ewe stands when being mounted. This is commonly called '*standing heat.*' The duration of estrus is variable in that it is shorter in younger ewes and does but longer in older animals. Normal duration will be 24 to 36 hours.

5.5.2.2. Estrus detection techniques

Estrus in sheep and goats is relatively easy to detect compared to that in cattle as heat signs are well pronounced, particularly in goats. Still, where controlled mating or artificial insemination (AI) is used, regular detection of estrus is necessary through:

- using a teaser ram or buck: Teasers are males that have been either vasectomized or epididymized.
- tying an apron made of leather or canvas around the body of a ram/or buck to prevent the penis from entering the vagina of females.
- using a teaser with a marking harness: When a ram/buck with a marking harness mounts a female in

estrus, some of the marking pigment will be transferred to the rump of the female.

The behavior of rams and bucks used for heat detection should be known as some may not do the job well.

Apron tied around body of buck

The buck can detect does that are in heat but cannot breed them

A ram wearing a crayon marking harness

Figure 5.4. Estrus detection techniques.

Caution

1. Frequent supervision is important when an apron is used as the canvas or leather can slip, resulting in unwanted pregnancies.
2. A mark is not an absolute indicator of estrus activity in the female because males may incidentally or purposely mount females that may not be in estrus. But with experience it is possible to differentiate such marks resulting from false mounting because the place and intensity will be different.

5.6. Measures of Reproductive Performance

Measures of reproduction commonly used in sheep and goats include age at puberty, age at first lambing/kidding, post-partum interval, parturition interval and fertility indices.

5.6.1. Age at puberty

It is difficult to have an accurate measure of puberty unless hormonal assays are done at certain intervals (bi-weekly). On experimental stations, puberty may be recorded as the first behavioral estrus observed. This estrus is called pubertal estrus. The manifestation is not strong and its duration is short, hence, requiring close attention for heat detection.

5.6.2. Age at first lambing/kidding

This trait can be recorded easily in a farmer's flock. There is a big variation among production systems and breeds for this trait (12–24 months). It is usually late in animals living in harsh environments.

5.6.3. Post-partum interval (PPI)

This is the time between parturition and the resumption of cyclic ovarian activity and it is a major component of lambing/kidding interval. It has a significant contribution to productive efficiency. A mean interval of 83.5 days (51–133 days) has been reported for Somali goats. Nutrition, suckling, parity (number of times kidded/lambed) and breed affect this trait. During lactation, the onset of a new cycle is actively inhibited so that the energy is preferentially reserved for milk production for the offspring. This is called lactational anestrous.

Ewes and does giving birth in the dry season have a longer interval compared to those lambing/kidding during the rainy season. Ovarian activity in most tropical breeds commences after weaning. Suckling interferes with hypothalamic release of GnRH, provoking a marked suspension in the pulsatile LH release, resulting in extended postnatal anestrous. Females at earlier parities take longer than older ones to return to reproductive status.

5.6.4. Parturition interval (lambing/kidding interval)

This refers to the number of days between successive parturitions. It is called lambing interval in ewes and kidding interval in does. Under normal circumstances (no drought), tropical sheep/goats should be lambing/kidding at least three times in 2 years. For this to be realized, lambing/kidding interval should not exceed 8 months (245 days). As the major component of parturition interval is post-partum interval (PPI), accelerated lambing or kidding revolves around manipulating PPI because a shorter PPI will result in a shorter parturition interval. Better nutrition and early weaning could impact this measure of reproductive performance.

Tests on an eight-month lambing interval under controlled mating in Horro sheep has shown acceptable results in both ewe and lamb performance. One of the most important ways of increasing offtake rate is through reduction of the parturition interval and, if done with optimal input, this may help in meeting the growing demand of the export trade.

5.6.5. Fertility

Various definitions of fertility exist in literature such as conception rate, fecundity, prolificacy, birth rate, etc. A general definition of fertility is the number of ewes lambing or does kidding divided by the number of ewes/does mated. Fertility is affected by factors such as nutrition, age, diseases and season of mating. In most cases, there is a positive effect of supplementation. Supplementation during the mating period (shortly before the mating period and afterwards) could increase the number of ova shed and improve embryo survival. This practice is called flushing and is discussed in the nutrition and management sections. Age of the ewe or doe is also an important factor. Fertility increases with age, and also starts to decline with old age.

5.6.6. Litter size (LS)

This is a combination of ovulation rate and embryo survival. Litter size (LS) varies between 1.08 and 1.75 with average of 1.38. Positive relationships between LS and age and LS and parity have been noted. LS increases with parturition number until the fifth kidding/lambing. Increases in ewe or doe weight (prior to mating) by 1 kg over the mean of the population results in an increase of about 3.8% in LS. Breed differences in litter size are common. Finnish Landrace and the Romanov breed are considered the most prolific sheep in the world. In Ethiopia, the Horro breed is said to be prolific as compared to the Menz sheep.

A litter size of 1.93 has been reported in Boer goats. This is said to increase to 2.5 with selection. Sheep and goats in the pastoral areas are known to give birth to singles only. This might be due to negative selection that has taken place in the environment. Heritability estimates suggest the possibility of genetic improvement in LS through selection.

5.6.7. Annual reproductive rate

This is defined as the number of lambs/kids weaned per ewe/doe of reproductive age per year. Some authors use litter size at birth rather than litter size at weaning. However, the latter is preferred as it takes the mothering ability of the dam into consideration.

Apart from single traits, a combination of two or more traits can be used as a measure of reproductive performance.

5.7. Seasonality of Breeding

Different sheep and goat breeds have developed in a wide range of environments and have consequently evolved a variety of reproductive strategies to suit these environments. Local breeds of sheep and goats in tropical conditions are either non-seasonal breeders or exhibit only a weak seasonality of reproduction. Females ovulate and exhibit estrus almost the whole year round, even though short periods of anovulation and anestrous are detected in some females. Two main hypotheses can be raised to explain the near-absence of seasonality: either the females are insensitive to photoperiod, or the amplitude of the photoperiodic changes is too small to induce seasonality.

The principal advantage of non-seasonal breeding regime is a continuous supply of milk, meat and surplus animals to producers and the low-input labor and management required. Yet this strategy produces low milk yields, lowers kid survival and growth whenever late pregnancy and birth fall into periods with suboptimal forage availability. Moreover, conception rate, prolificacy and kidding rates are compromised whenever mating occurs under poor nutritional conditions. It should be noted, however, that there are months with clearly reduced sexual activity. These months differ from region to region and appear linked with the temperature regime and to feed availability.

In the Ethiopian highlands, most conception in sheep and goats occurs during or following the periods of the short rains in March through May. In Zimbabwe, two major peaks of kidding (before the rains in October and November and after the rains in April) have been observed in small East African indigenous goats. Adult female Boer goats have shown a tendency towards greater sexual activity at lower ambient temperatures. In some goat breeds (e.g., Creole goat), monthly percentage of estrus was negatively correlated with minimal temperature. As seen in Figure 5.5, kidding in Ethiopia takes place all year-round. Peak kidding is observed in May–June on research stations and in August under farm conditions.

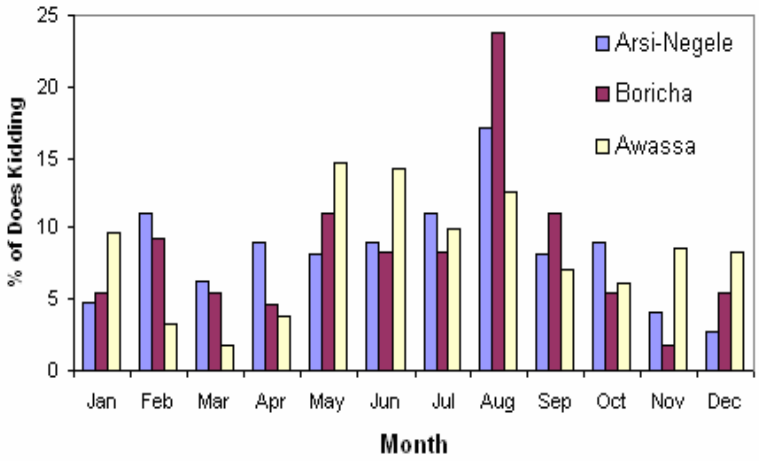

Figure 5.5. Kidding pattern of Arsi-Bale goats.

Most results show that in the absence of nutritional stress, there are no periods of the year when the whole flock is anestrus. A study conducted in the central highlands (Ada District) reported that most lambing and kidding occurred during the heavy rains (August–September), indicating that most of the conception occurred during or following the small rains in March–May.

Questions for Discussion

1. When do most births (lambings/kiddings) occur in your area?
2. Are there any attempts to control breeding so that most births occur when feed is available?

5.8. Mating Systems

Once males and females are sexually mature, they will display characteristic behavior prior to mating. Unless restrained, both sexes will make an effort to reach each other and mate. Smell, sight and noise are the common attractants. In sheep, the fat tail of a ewe may make mating difficult or even impossible. Experienced rams push the tail aside to let the penis penetrate the vagina. Young and inexperienced rams may need assistance, i.e., hand-mating may be essential. The following types of mating could be practiced depending on the system of production.

5.8.1. Flock-mating

Fertile rams or bucks are allowed to remain continuously with a group of females. This mating system is commonly practiced by pastoralists. Under smallholder conditions, a flock may constitute all sheep or goats in a given village. This method avoids the need for heat detection but makes recording the mating date, the sire and calculation of the expected date of parturition difficult unless breeding males are fitted with a marking harness. Flock mating provides the best result in terms of fertility and lamb/kid crop given an appropriate male-to-female ratio. However, inbreeding and subsequent declines in productivity could occur unless males are rotated or replaced on a predetermined period.

5.8.2. Pen-mating

This involves confining a sire with a group of females, in a paddock for example, for mating during the service period. A variation of this method may include housing groups of females with a selected breeding ram/buck at night. Continuous supervision is important to make changes of sires if the assigned sire does not perform well. Sires may be fitted with a marking harness that enables calculation of the estimated date of lambing/kidding.

5.8.3. Hand-mating

This involves detecting females in estrus and bringing them to breeding males. In such a system, regular and efficient heat detection methods are essential. The PM–AM method of breeding is used, where females detected in estrus in the afternoon are bred early the next morning and those detected in estrus in the morning are bred in the afternoon of the same day.
In terms of fertility, this method is the least efficient as the male is restricted in breeding the female. A variation of this system is observed where a producer may have few female sheep or goats but no breeding male. One sire kept by an individual will serve sheep or goats of many surrounding owners who bring ewes/does in estrus to the male. In some instances ewes or does in estrus are brought to the market, where male animals are available for breeding.

5.9. Reproductive Phases of the Ewe

A ewe's reproductive timeline is depicted graphically in Figure 5.6. Critical time periods include the first and last months of pregnancy (nutritional stress) and the first month after lambing (period of environmental adaptation for the lamb). Periods in which reproductive wastage occurs are between ovulation and implantation for embryonic loss, between implantation and parturition for fetal loss and between parturition and weaning for lamb loss.

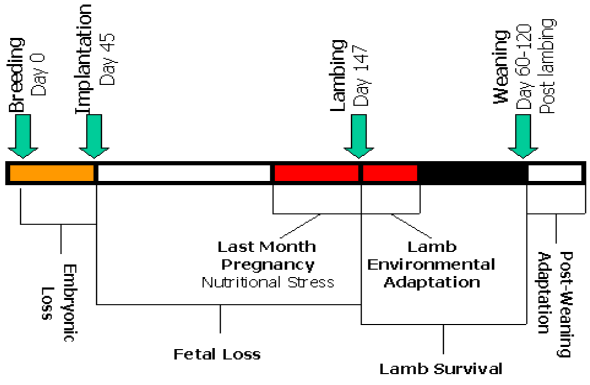

Figure 5.6. Reproductive timeline for sheep.

5.10. Reproductive Failures

The cause of reproductive failures is varied and often poorly understood. Individuals or entire flocks can be affected with acute or chronic problems that can have catastrophic consequences for livestock producers. Depression of reproductive performance can be broadly classified into:

- Failure to mate;
- Failure of fertilization in mated animals;
- Loss during any stage of gestation (embryonic, fetal losses);
- Neonatal mortality and subsequent loss occurring until the time of weaning.

The greatest economic losses occur with late gestation, abortions and neonatal mortalities or pre-weaning deaths. Reproductive failure can also result from structural defects or functional disorders affecting the genital tract. In males, the following could easily be detected:

- Testicular hypoplasia: This is characterized by undersized testicles and very low semen production. It can be diagnosed by semen, testicular palpation and a high return rate to estrus of females mated to that particular male. This commonly occurs in animals that are actually intersexes.
- Cryptorchidism: This is a failure of one or both testicles to descend from the abdominal cavity into the scrotum. Cryptorchidism can be unilateral (failure of one testicle to descend) or bilateral.

5.11. Breeding Soundness Examination

A buck should possess characteristics that will advance the production potential of the herd in which he is used, while being able to successfully mate to transmit these characteristics.

5.11.1. Physical examination

This is evaluation of overall condition of the ram/buck and includes:

- Health history, physical fitness, particularly of feet and legs, eyesight, etc.
- Pedigree, i.e., ensuring the sire is free from known hereditary defects.
- Evaluating the smoothness of the hair coat for evidence of malnutrition or chronic infection.
- Body condition scoring and noting of the score.
- Checking for and noting any defects that could interfere with the breeding process.
- A thorough examination of the scrotum, palpation of testicles, and examination of sheath and penis.

5.11.2. Scrotal circumference and diameter

The scrotal circumference can be measured with a specially designed tape or with any other measuring tape or even a cord whose length can be compared with a ruler. The circumference is measured at the widest part of the scrotum with both testes held at the same level. A male with large testicular size at a given age is likely to produce better quality semen.

Measurement technique

- Make sure that the scrotum is relatively clean.

- Measure scrotal circumference by passing a flexible tape around the scrotum (both testes) at the point of maximum circumference when the ram/buck is relaxed. This is most easily done with the animal standing.

For accuracy and repeatability, attention should be given to two aspects of the technique in particular namely placement and tension..

Placement and tension

Placement: It should always be with the tape at right angles to the long axis of the testes. This is most easily achieved in the standing ram, where the circle of tape should be parallel with the ground.

Tension: Tension on the tape should be standardized, particularly between different operators in different locations. The tension should be until a 'slight indentation' occurs on the testes.

Although size could differ between breeds and even within breeds, the following could be used as a guide.

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Figure 5.7. Measuring scrotal circumference.

- For large sized breeds, acceptable sires should have a scrotal circumference of no less than 30 cm for ram lambs and 31 cm for adult rams. However, it should be noted that scrotal circumference may be greatly decreased by recent weight loss as well as by season of the year.
- For dairy goat breeds weighing more than 40 kg, a scrotal circumference of 25 cm or greater is desired.
- For Horro breed of sheep, a range of 21–28 cm has been reported

Apart from scrotal circumference, testicular diameter and volume may be measured. But the repeatability of testicular diameter is low and measuring testis volume is a tedious exercise.

5.11.3. Semen evaluation

The third and final part of the breeding soundness examination involves the collection and evaluation of an ejaculate. In trained rams and bucks, this is achieved using an artificial vagina, but in most instances an electro ejaculator must be used. The method of collection has some effect on the ejaculate characteristics, the volume generally being larger when an electro ejaculator is used, but at times the semen may get mixed with urine. The ejaculate is immediately scored for gross motility under low (mass motility) and high (percentage of motile sperm) magnification of a light microscope on a pre-warmed slide. Morphological abnormalities and viability are determined from stained semen smears. At least 70% of the sperm should have normal morphological characteristics. In the final part of the examination, rams/bucks are allowed access to estrous ewes/does to evaluate libido and mating behavior.

Bucks/rams are classified as either sound, questionable or unsatisfactory, based on all components of the examination. No firm guidelines have been developed to assign bucks into these categories and interpretation rests largely with the experience of the examiner. Animals 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 in natural mating.

5.12. Libido (Sexual Desire)

Libido is a male's desire to mate. The willingness to breed ewes is highly variable among rams and can have a major impact on sheep production, especially in a single-sire mating scheme. Mounting and thrusting behavior, sniffing of the genital region and flehmen reaction (curling of the upper lip of the male in response to detecting sexual readiness of the female) are well established common behaviors of normal sheep and goats. This behavior is regulated by the release of testosterone, produced by specialized cells in the testes.
Some breeds show libido almost continuously once they reach puberty. In other breeds, there is a marked decline in libido during the non-breeding season. Underfed or excessively fat rams/bucks may show reduced libido. The desire to mate also decreases with age and disease conditions, such as arthritis. Some rams have inherently poor libido. Studies have shown that up to 15 percent (average of 8–10 percent) of rams are homosexual and will not mate with ewes.

5.12.1. Test for libido

A "Libido test" can be conducted to determine a ram's desire to mate ewes. In this test, rams are exposed to ewes in estrus and their breeding activity is recorded over a period of two weeks or more. This test, also known as "a serving capacity test," is useful for identifying low- and high-performing rams. Serving capacity or breeding behavior is a heritable trait. Lack of libido may be hereditary or may originate from endocrine imbalance or environmental factors.

5.13. Ram-to-Ewe Ratio

Maintaining the correct ratio of fertile rams/bucks and ewes/does (one ram/buck to 20–25 ewes/does or 3 per 100 ewes/does in a year-round mating) is important as it can affect the overall reproductive efficiency. The age of the breeding ram/buck, the length of the mating season and the environment in which the animals are kept may influence the ratio.

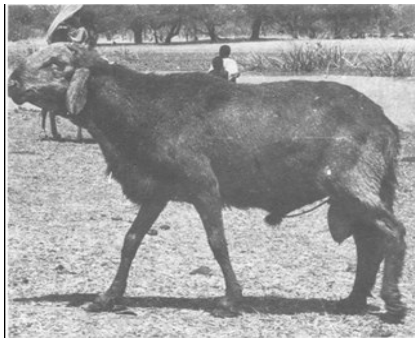
5.14. Culling

This is a method used to improve the overall productivity of the flock. Although reasons for culling could be different for different systems and agro-ecologies, from a reproductive point of view, it is essential to intensively cull ewes/does after 5–6 years of age.

It is important to detect barren ewes or does in the flock. Habitual aborters should be identified early and culled. This is of significance as abortion caused by *brucella* bacteria can be transferred to healthy animals within a short period of time. Frequent screening of the flock for *brucella* could be useful if diagnostic labs are found in the area.

5.15. Control of Mating

In some societies, breeding is controlled either to synchronize birth (lambing/kidding) or to reduce stress during the year when pasture is felt to be inadequate for normal reproductive processes. For instance, use of a leather apron to give a physical barrier to penetration is



A Sudan Desert ram in Southern Darfur with a 'Kunan'

Locations on the testis and the prepuce where the rope is tied

Figure 5.8. Use of a 'Kunan' to prevent breeding.

used in Massai flocks in Kenya. Similarly, 'Kunan,' a cord tied round the neck of the scrotum and looped over the prepuce to prevent extrusion of the penis, is used in West Africa and in some parts of East Africa such as south Sudan.

An attempt to use these methods, particularly the Kunan (Figure 5.8), on Horro sheep, has not been successful. Developing practical methods for mating control would have a very important contribution to controlling lambing and for genetic improvement.

Questions for discussion

1. Is there an attempt in your region to control breeding of sheep and goats? If yes, what is the main purpose? What are the methods used to control breeding?
2. Preliminary observations made at Awassa indicate that Somali bucks have poor libido. It is hypothesized that this is mainly related to the lack of twinning in the breed as research has shown single-born males are poor with respect to this trait. Have you had such experiences in flocks in your area?

5.16. Reproductive Biotechnology

5.16.1. Estrus synchronization

Estrus cycle control in sheep and goats is useful for synchronizing estrus in groups of animals to be bred or inseminated at a particular time or inducing out-of-season estrus where there is a distinct seasonality of breeding.

5.16.1.1. Why do we need to synchronize estrus?

Estrus in sheep and goats can be synchronized for one or more of the following reasons:

- To facilitate the practice of artificial insemination, either for genetic improvement or to reduce the number of rams/bucks needed to be kept.
- To match the period of lambing/kidding with feed availability such that lambs/kids are born during the period of the year when feed is available.
- Used as an initial step for super-ovulating ewes/does and subsequent embryo transfer.
- Induction of estrus in ewes/does with silent estrus to shorten the lambing/kidding interval.

5.16.1.2. Estrus synchronization techniques

There are two main methods of synchronization:

- Use of exogenous hormones or their synthetic forms, and
- The male effect.

Hormones

Among the hormones of reproduction, progesterone can be considered as the 'organizer' of the estrus cycle. Manipulation of the progesterone status of the animal provides a convenient means of controlling the estrous

cycle. Estrus synchronization techniques revolve around the artificial shortening or lengthening of the period of progesterone dominance of the luteal phase.

Two classes of hormones are available for estrus synchronization. These are progesterone or one of its synthetic analogs and prostaglandins. Progestagens extend the luteal phase of the estrus cycle. Most commonly, progestagen-containing vaginal pessaries are employed. The 'Y'-shaped silicone-coated devices known as 'Controlled Internal Drug Release (CIDR)' impregnated with progestagen are also used (Figure 5.9). As an alternative to vaginal pessaries, implants impregnated with a highly potent synthetic progestagen 'Norgestomate' may be inserted under the skin on the upper side of the ear.

The period of application of exogenous progestagen is approximately equal to the life of the corpus luteum. Withdrawing the exogenous progesterone supplement will enable pulsatile release of GnRH, stimulating FSH and LH release leading to estrus and ovulation.

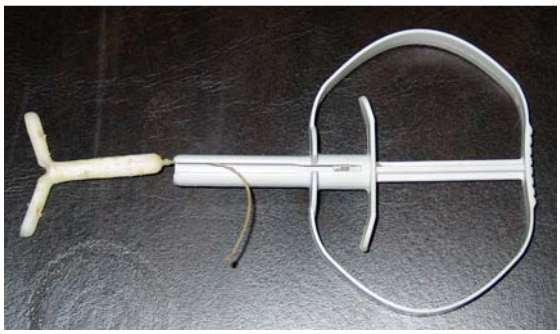


Figure 5.9 CIDR and applicator.

In the second class of hormones, prostaglandin $F_{2\alpha}$ can be used to regress the corpus luteum (interrupt the luteal phase). Prostaglandin $F_{2\alpha}$, by its luteolytic activity, can synchronize estrus, but only when an active corpus luteum exists at the time of application. In most cases, treatment with PG $F_{2\alpha}$ is given twice, 7 days or 11 days apart, to make sure all functional corpora lutea regress.

Caution

It is important to realize that prostaglandin can initiate fetal abortion in a pregnant animal. Hence, great care should be exercised not to expose animals to the product at any stage of pregnancy.

The male effect

The male can be used to stimulate estrus activity of females that have been previously isolated from males for a period of 3–4 weeks. After the period of separation, the male animal is suddenly introduced to the group of females.

In response to introduction of the male, ewes/does secrete increasing amounts of LH and FSH, which result in ovulation after 2 or 3 days of male introduction (in some ewes/does response may be slower, i.e., 4 to 7 days). In cyclic goats, highest frequency of estrus was observed within the first 3 days of buck introduction. The following factors affect response to male introduction:

- Within breeds, rams/bucks with greater sexual activity induce responses in more ewes.
- Rams that were given libido tests and ranked as highly sexual induce estrus more effectively than males with low libido test scores.
- Ewes/does that are on a high plane of nutrition will respond better than those nutritionally stressed.
- The longer lambs/kids have been weaned from ewes/does, the better the response of the ewes/does.

5.17. Artificial Insemination (AI)

Artificial insemination is a technique in which semen is collected from a ram or buck and put into the reproductive tract of a ewe/doe. The standard procedure of inseminating does involves lifting up of their rear quarters with their front legs remaining on the ground. With the aid of speculum and pen light the cervical opening or 'os' is located and, under visual control, an insemination pipette is passed into or through the cervix for semen deposition. If difficulty is encountered in passing through the cervix, semen has to be deposited intra-cervically or caudal to the cervical os.

Use of AI has the following advantages:

- High potential for genetic improvement.
- When introducing a new breed from foreign countries, it is often easier and cheaper to import frozen semen than to import live animals.
- The risk of introducing a new disease is much lower if semen is imported.
- Genetics (semen) from superior animals in other regions or countries can be used.

Three methods of semen preservation could be used:

- Fresh
- Refrigeration (Fresh chilled with an extender)
- Freezing

Three methods of insemination are available depending on the site of semen deposition during the process of insemination:

- Vaginal
- Cervical
- Intrauterine

a. Locating the cervical opening with the aid of a speculum and pen light

b. Semen deposition

Figure 5.10. Doe AI during ESGPIP training at Awassa

Vaginal insemination is successful for fresh semen, whereas intra-cervical insemination is used for refrigerated and frozen semen. However, in order to achieve high pregnancy rates (>70%) with frozen semen, intrauterine deposition of semen is required. While in many does it is possible to pass the cervix and deposit the semen intrauterine, in certain categories of animals (e.g., doelings), breeds (e.g., Nigerian dwarf) and individuals this will only be possible using other more technically challenging techniques such as laparoscopic insemination methods.

Fresh semen can be used when the male is present in the flock. The use of chilled, refrigerated semen is a useful strategy when the male is shared among groups of producers located within a relatively small area. In such cases, semen is stored at -4°C and can be used up to 24 hours from collection.

Semen is processed and frozen in liquid nitrogen for long-term preservation. In general the method of semen preservation dictates the preferred method of insemination. As a rule of thumb, the more damaged the semen, the deeper semen has to be deposited to achieve high fertility rates.

5.18. Embryo Transfer (ET)

Embryo transfer involves the flushing (removal) of embryo(s) from the donor and transfer to the recipient animal. Embryo transfer operations rely on provision of sufficient numbers of viable embryos (super-ovulated) to justify efforts involved. This is usually done to exploit the genetic superiority of the dam line. Prior to flushing, the candidate donor ewe/doe is super-ovulated (the production of more eggs than the female would normally produce) and bred or inseminated. For conducting embryo transfer, the estrus cycle of the recipient has to be synchronized such that when the transfer is made, the uterine environment of the recipient ewe/doe is conducive (the reproductive cycle is at a similar stage with that of the donor) for the embryo.

Achievements from multiple-ovulation and embryo transfer (MOET) have not been encouraging for widespread use since the results can vary from complete failure to total success without any variation in the standard operating procedure. The unpredictability of results, combined with high costs and the use of surgical procedures for collecting and transferring embryos, have prevented large-scale use of MOET in sheep and goat improvement programs.

5.19. Gestation

Gestation is the period from fertilization to delivery of the fetus. The average duration of gestation periods in ewes and does is fairly constant and ranges from 147 to 152 days. To some extent, it could be influenced by:

- **Age of the dam:** younger ewes and does have shorter gestation than older ones.
- **Litter size:** dams carrying twins have shorter gestation than those carrying singles.
- **Nutrition of the pregnant ewe or doe:** low level of feeding on range shortens gestation.
- **Breeds:** small and dwarf breeds have shorter gestation periods.

5.20. Pregnancy Detection

Establishing whether bred animals are pregnant or not is important to the commercial producer. The most accurate tests are those that measure or detect something that is only produced by a viable fetus and that is always present when the pregnant animal has reached a certain stage.

Methods of pregnancy diagnosis include:

Non-return to estrus

Frequent checking of animals after the normal estrus cycle (17 days for sheep and 21 days for goats) for visual signs of estrus is the simplest method. Animals not returning to estrus after the normal period are considered to be pregnant.

Progesterone test

Where facilities are available, progesterone assay in milk (in dairy breeds) or in blood samples is a common test. Although progesterone in goats is produced by ovaries only, measurement after 19 to 24 days of breeding will give an accuracy of 87 % for pregnant animals.

Ultrasonography

Ultrasonographic examination can be done as early as 28–30 days using intra-rectal examination. Transabdominal ultrasonography is done after 40 days post-breeding. Both methods can give good accuracy.

5.21. Parturition

The process of parturition in sheep and goats is complex. In the ewe, maternal plasma progesterone declines 7 to 15 days before delivery while in goats such a decline is noted 24 hours before delivery. Estrogens increase during the last days in ewes and gradually in goats. These events stimulate the muscles in the uterus to contract. The fetus and placenta are expelled and this is followed by the involution (shrinking of the uterus to normal size).

Signs of approaching parturition: Approximately 2 weeks before lambing/kidding some changes occur: the udder and teats swell (more prominent in dairy breeds) and the vulva becomes loose.

5.21.1. Stages in parturition

Parturition is traditionally divided into three stages:

Stage One	Stage Two	Stage Three
Is immediately before lambing/kidding (up to 12 hours). • The doe/ewe isolates itself from the flock, seeking a solitary place; • Becomes restless and uneasy; • Paws and scrapes the ground, sits and stands; • Stretches and strains with her neck skyward when sitting; • Forces placenta, fetus, and fluids against the cervix to dilate it; • The water bladder appears or has already ruptured; • The ewe/doe licks the fluid, wanders about.	Is typically faster and lasts about 30–45 minutes: • It is accompanied by straining (contraction of abdominal muscle) • The lamb/kid normally appears front feet and nose first. At this stage, the animal is normally lying on her side. This stage is completed by expulsion of the last lamb/kid in case of multiple births. • Once the lamb/kid is ejected, the dam will lick off the membrane covering of the lamb/kid. This uncovers the mouth and nose and stimulates breathing.	Involves: • Expulsion of the placenta normally within 4 hours, and • Involution of the uterus.

5.21.2. Assistance during parturition

In a majority of cases, ewes and does give birth normally without assistance. However, a few may need assistance. It is important to get acquainted with the normal birth presentation to be able to provide appropriate assistance. This subject is dealt with in more detail in the Management chapter.

1. Approaching

2. Pushing

3. The water bag

4. The water bag close up

5. Approaching kid

6. A foot appears

7. Two feet appear

8. The nose appears

9. More …

10. Delivered

11. Mother and offspring bonding

Source: http://fiascofarm.com/galleries/Goat_Care_and_Information/index.html

Figure 5.11. Stages in parturition and the normal birthing process in a doe.

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