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APSC-157P

Enhancing Reproductive Performance in Small Ruminants: Part I. Biology of Reproduction

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Small ruminants are important for limited-resource farmers who manage their animals for multiple purposes, including meat and milk. Recent data from the National Agriculture Statistics Services reported U.S goats totaled 2.62 million head while sheep and lamb inventory was at 5.23 million head. Ethnic demand is driving the small ruminant industry as demonstrated by the increasing number of market sheep and lambs (NASS 2019), goat meat imports, and number of goats slaughtered under federal and nonfederal inspection (NASS 2011). Therefore, market opportunities abound for small-acreage producers to raise sheep and goats to meet this demand.

In addition, there are opportunities to sell value-added meat products for direct sale to local niche markets (roadside markets, farmers markets, community supported agriculture, online sales, buying clubs, regional food hubs). Although these opportunities exist for producers, many factors impact forward progress in production and marketing that must be adequately addressed through extension and research activities.

Two opportunities that many producers fail to take advantage of are (1) the relatively short gestation period (pregnancy) in sheep and goats and (2) the ability to manage their herd adequately for optimum reproductive performance. Efficiency of reproduction can be characterized by the number of offspring available to market each year and the frequency of kidding/lambing. Factors such as a basic understanding of male and female reproduction, breed/selection, maintaining a good nutrition and health program, and efficiently utilizing reproductive technology to minimize seasonal impacts are critical for increasing production and profitability in herds.

This series of fact sheets has been designed to assist producers in enhancing reproductive performance in their herd so that overall production can be optimized to promote profitability. Fact sheet topics included in the Enhancing Reproductive Performance in Small Ruminants series include:

Part I. Biology of Reproduction

Part II. Puberty and Estrous Cycles

Part III. Breeding and Management Systems

Part IV. Breed/Selection

Part V. Nutrition and Health

Part VI. Reproductive Management Techniques

An important part of this discussion is included in VCE publication APSC-143, Preparing Females for the Breeding Season in Meat Goats and Hair Sheep. This fact sheet can be found at https://www.pubs.ext.vt.edu/APSC/APSC-143/APSC-143.html.

Female Reproduction

The structure of the female reproductive tract includes the ovary (gonads), oviduct, uterus (horns and body), cervix, vagina, and vulva (external genitalia) (fig. 1 and fig. 2). The female gonads produce eggs and secrete the reproductive hormones — estrogen and progesterone. Females are born with a finite number of eggs that decreases in number and quality as the female ages. Estrogen is secreted by growing follicles (which contain eggs) on the ovary and is responsible for estrus behavior when the animal is in heat, as well as the development of secondary sexual characteristics.

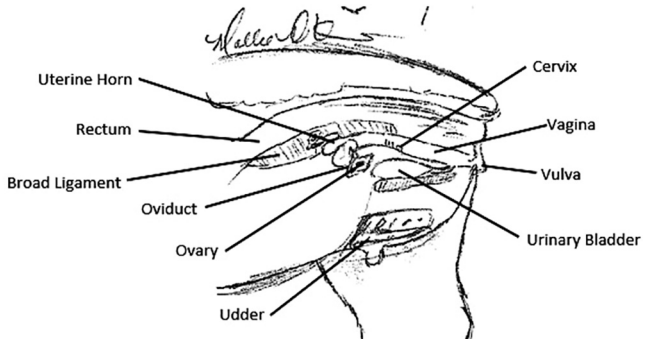

Figure 1. Lateral view of reproductive anatomy of the ewe. (Reproduced by permission from Mollie Klein. 2019).

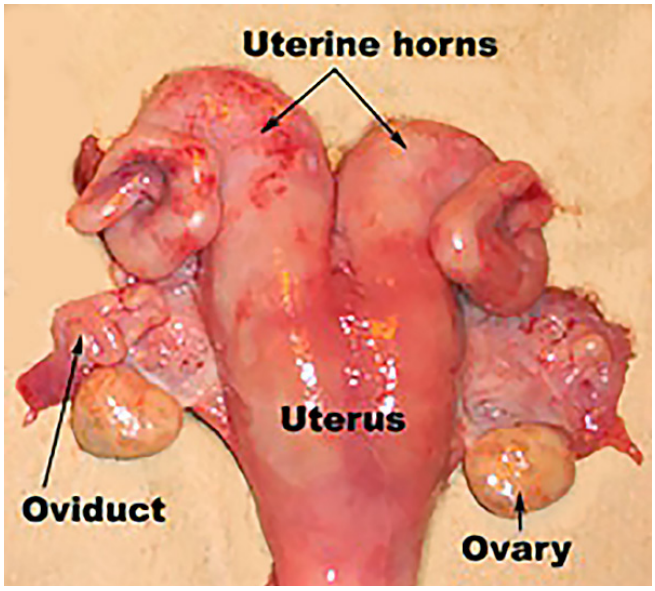

Figure 2. Dorsal view of a doe reproductive tract. (Reprinted by permission from Stephen Wildeus. 2005).

Release of an egg (ovulation) at maturation results in the formation of a corpus luteum (CL) at the site that secretes progesterone, the hormone of pregnancy. If more than one egg is released, an equal number of CLs will be formed. The oviduct's major function is in transporting egg and sperm toward each other and is the site where fertilization takes place. If fertilization occurs, the uterus supports growth of the developing fetus(es), and the female will be in gestational anestrous (no cycling) until after lambing/kidding. If fertilization does not occur, a signal is sent to the ovary that will lyse any existing CL, and normal estrous cycling resumes. The cervix functions mainly in lubrication and acts as a barrier to infections, especially during pregnancy. Finally, the vagina functions as the organ of mating and as the birth canal during lambing/kidding.

Male Reproduction

The structure of the male reproductive system includes the spermatic cord, testes (gonads), scrotum, epididymis, vas deferens, urethra, accessory sex glands (such as the prostate gland), and the penis (fig. 3 and fig. 4). The spermatic cord connects the testicles to the body and provides a pathway for muscle, vas deferens, nerves, veins, arteries, and lymphatic supply. It also aids in temperature regulation of the testes for optimal sperm production. Similar to the ovaries, the testes are responsible for sperm production (occurs continuously) and the secretion of the male hormone testosterone. The process of sperm production takes approximately 47 days in rams and bucks. The testes are housed in the scrotum, a protective sac that also aids in temperature control. Following production, the epididymis allows for maturation, storage, concentration, and transportation of sperm. From the tail of the epididymis, the vas deferens (pair of ducts) transports sperm to the urethra for subsequent discharge and ejaculation.

Secretions by the epididymis and accessory glands contribute a liquid portion to the sperm, providing nourishment and protection during its transport, especially in the female tract. These secretions combined with sperm give rise to semen. During ejaculation, semen is transported from the male to the female by the penis, which functions as the organ of mating.

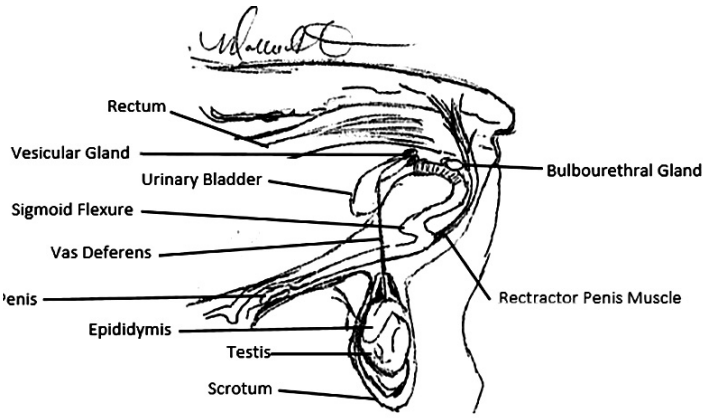

Figure 3. Lateral view of reproductive anatomy of a ram. (Reproduced by permission from Mollie Klein. 2019).

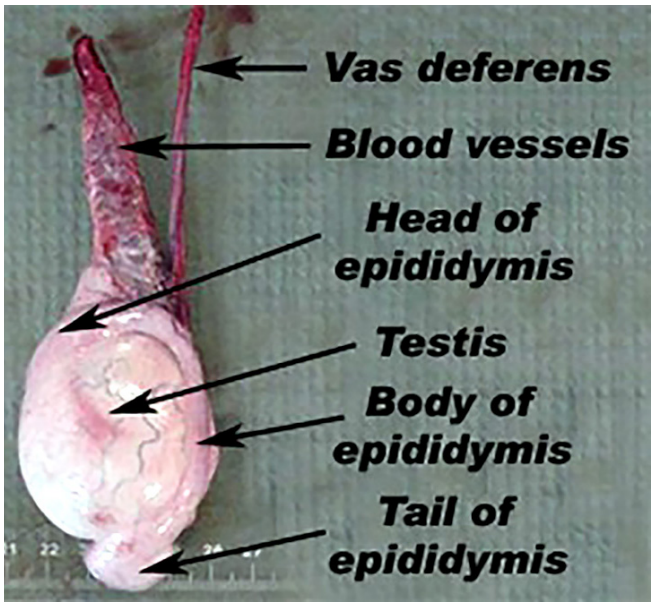

Figure 4. Scrotal content of the ram reproductive tract. (Reproduced by permission from Stephan Wildeus. 2005)

Hormonal Control of Reproduction

Reproduction is controlled by specific chemicals, called hormones, that have either a direct or an indirect impact on target organs in the body. Hormones can be proteins or steroids and are transported in the bloodstream.

In the ewe/doe, gonadotropin releasing hormone (GnRH) is responsible for cycling. This hormone is secreted from the hypothalamus (in the brain), and it stimulates cells in the anterior pituitary (also in the brain) to secrete two additional hormones: follicle stimulating hormone (FSH) and luteinizing hormone (LH). Both hormones are referred to as gonadotropins because they act on the gonads (ovaries and testes). In the male, FSH and LH stimulate the production of sperm and testosterone. Similarly, in the female, FSH stimulates follicular growth, and as these follicles are growing, they secrete the female hormone estrogen. As estrogen secretion increases and reaches a threshold, it causes LH secretion to surge, resulting in ovulation (release of the egg). Once ovulated, the egg moves to the oviduct and will be fertilized if sperm are present.

As stated previously, ovulation results in the formation of a CL at the site of release. The CL secretes progesterone — the hormone of pregnancy — and will be maintained if fertilization results in a viable embryo. Progesterone is important in creating an environment in the uterus that supports embryo growth and development. It also provides a negative feedback on the hypothalamus that blocks the secretion of GnRH and pauses further cycling. If no embryo is present, a signal is sent to the ovary that will lyse any existing CL. This signal is in the form of another hormone, prostaglandin F2α, that is released from glands in the uterus. Once the CL is lysed, progesterone secretion decreases and normal cycling resumes. Figure 5 depicts two phases of the estrous cycle. The follicular phase is characterized by follicular growth and secretion of estrogen while the luteal phase is characterized by the presence of an active CL secreting progesterone.

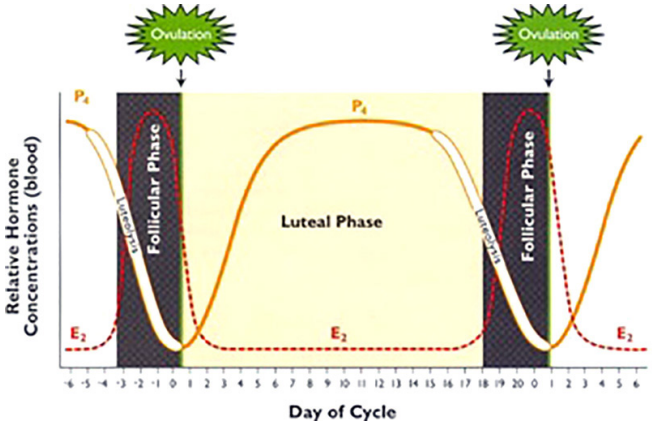

Figure 5. Phases of the estrous cycle diagramed with the relative hormone concentration plotted on the X asis and the day of cycle plotted on the Y asis. (Reproduced by permission from P. L. Senger. 2015. Phases of the Estrous Cycle. "Pathways to Pregnancy and Parturition," 144. 3rd ed. Redmond, OR: Current Conceptions)

Seasonality of Reproduction

An important factor that limits a consistent supply of lamb and goat meat for market is the seasonality of their reproduction. Sheep and goats are generally considered to be short-day breeders, especially in temperate regions; that is, they breed during the shorter days of fall, with an optimal breeding season from September to February that varies depending on breed (fig. 6). The seasonaluity of reproduction is due to the hormone melatonin. The pineal gland is responsible for secreting melatonin in the absence of light (i.e., dark/night). Increased secretion of this hormone is needed to trigger the hypothalamus to produce GnRH. As we learned in the section above, GnRH is needed to stimulate the secretion of FSH and LH from cells of the anterior pituitary. During the longer days of the year (spring and summer), daylight entering the eye inhibits the production and secretion of melatonin in some breeds and leads to a period of anestrous. The effect of day length also impacts males. As day length increases, there is usually a decrease in sperm production, and the quality of the ejaculate decreases.

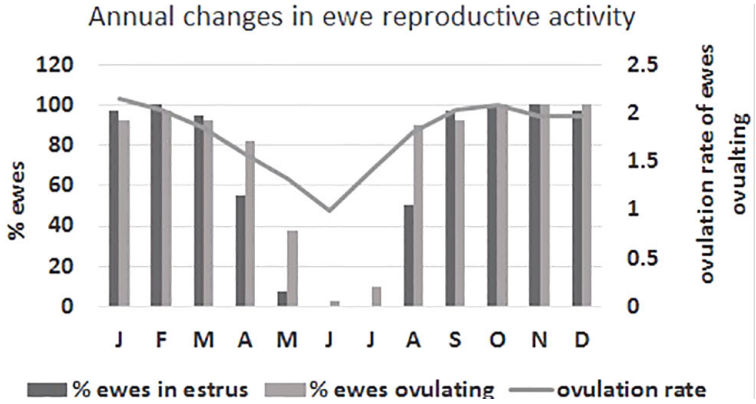

Figure 6. Patterns of seasonal reproduction. (Chart by Stephan Wildeus. 2006)

Acknowledgements

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