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OPTIMIZING REPRODUCTIVE PERFORMANCE IN THE GOAT HERD

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Abstract

Reproductive efficiency impacts pregnancy rates, kidding/lambing frequency and number of offspring available for market each year. To enhance reproductive performance, consider breed, selection, nutrition and health, and understand basic female and male reproduction. Proper ration formulation and feeding promotes reproductive function and leads to more offspring. Selecting the highest performing females while culling unproductive does increases reproductive rates. Diseases affect the reproduction and survival of kids, so adopting disease prevention strategies including routine vaccinations and deworming protocols that promote good herd health is necessary. Understanding male and female reproduction are critical in managing puberty, minimizing the effects of seasonality on reproduction, and using advanced reproductive techniques for genetic improvement. All breeding males should be evaluated by conducting a standard breeding soundness exam that also evaluates libido/sex drive. In considering these factors, enhanced reproductive performance can be achieved; thus, optimizing production and promoting profitability.

Keywords: Reproductive Performance, Reproduction, Kidding, Puberty, Goat Herd

Introduction

Small ruminants are important for limited-resource farmers who manage their animals for multiple purposes including meat and milk. The most recent National Agriculture Statistics Services (NASS) data reported that U.S goats totaled 2.62 million head (NASS, 2018). Demand for goat meat appears to be very strong in the U.S as demonstrated by the increasing total number of goat meat imports and the number of goats slaughtered under federal and non-federal inspection (NASS, 2011). Therefore, market opportunities abound for small acreage producers to raise 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 in the goat industry, many factors impact forward progress in production and marketing which must be adequately addressed through extension and research activities. A critical factor that many producers face is the failure to take advantage of the relatively short gestation period (pregnancy) in goats and to manage their herd adequately for optimum reproduction. Factors such as breed, 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.

Breed Selection

Breed selection can have an enormous influence on reproductive performance. The characteristics generally impacted most by breed are age to puberty and prolificacy (litter size) and seasonality. Goat breeds are diverse in their reproductive traits and this makes it more important that breed is considered seriously before starting a flock/herd if one wants to optimize reproductive efficiency.

Maternal breeds of goats should possess specific traits such as being fertile, prolific, have easy birthing and good mothering ability, good milk production and the ability to breed out of season. In the U.S, the most popular breeds of meat goats include Boer, Spanish, and Kiko breeds. Of these three breeds, research has indicated that Spanish and Kiko breeds were superior in all survival and reproductive traits measured (Browning et al., 2010). However, different breeds perform best under specific environmental conditions and the decision on which breed to choose depends on your reason for raising goats and how well they perform in your environment and farm.

Sire breed selection is also important in optimizing reproductive traits. Good terminal sire breeds excel in traits such as growth and carcass yield. In the Browning et al. (2010) study, data indicated that Boer bucks excelled in these traits compared to Kiko and Spanish bucks. Boer sires used in this study generally produced heavier birth weights and carcasses with heavier muscling (Browning et al., 2010).

Nutrition

Herd nutrition has a direct influence on reproductive performance. Of all the issues discussed, this is the one factor that the producer has the most control over. Strategic use of nutritional supplements is known to improve a number of reproductive traits including enhancing the breeding condition of males, maximizing ovulation rate to increase litter size, reducing early embryo loss and maximizing postnatal survival and development (Martin et al., 2004). A good plane of nutrition can also decrease the length of the post-partum interval (time between kidding and re-breeding).

All animals, including males, should be evaluated for adequate body condition scores (BCS) two months before the breeding season and their feet trimmed as necessary. Flushing is the technique of increasing nutrition prior to breeding to increase body weights or condition and increase the number of ovulations per female. Flushing should begin 3 - 4 weeks before breeding and be continued through to the first 3 weeks of breeding. Generally, results from flushing vary and it is seen to be most beneficial if used early in the breeding season and when there are a significant number of thin females. Every producer should be familiar with how to assess BCS. Langston University has a great reference on how to correctly do BCS in goats (http://www.luresext.edu/?q=content/body-condition-scoring).

During the first 90 days of pregnancy, adequate nutrition is important, especially for placental development. However, only a small increase relative to what is required for maintenance is needed. Inadequate feeding can result in reduced survival rates at birth and all pregnant females should be fed to maintain a BCS of 2.5-3 during early gestation and onwards. If this cannot be maintained on pasture or moderate-quality hay, supplemental grain might be required, especially during winter-associated increases in feed requirements.

Excess losses in bodyweight can place females at risk for developing pregnancy toxemia. Nutrition during the last 4 - 6 weeks is extremely important as approximately 70% of fetal growth occurs during this period. During this time, most of the female's mammary (udder) development is occurring as well, and under-feeding can affect subsequent colostrum and milk production. Inadequate nutrition can also result in abortions, low birth weights in kids and increased death loss. On the other hand, overfeeding results in obesity, contributing to dystocia and again increased risk in pregnancy toxemia risk. Therefore, it is very important that feeding regimes minimize the energy being supplied by body fat reserves and strive to maintain the flock at an optimum BCS. Grain supplementation is usually necessary to meet increased energy demands, especially when forage quality is low and when you have high producing females. The amount of grain supplementation needed will depend on the quantity and quality of available forage, breed, the number of fetuses, doe size and age.

Because adequate nutrition is critical, it is important to ensure sufficient feed bunk space for pregnant and lactating does. Some females, especially small/young ones, might not get enough to eat and it might be necessary to feed them separately. Feeding on the ground should always be avoided due to the potential spread of infectious abortive diseases. Higher producing females should be fed higher quality feed, especially does nursing twins and triplets. During pregnancy and lactation, free-choice minerals might not ensure adequate intake, especially of calcium. Calcium requirements generally increase during early and late gestation and peaks during lactation. Calcium requirements are highest for females carrying multiple fetuses and those producing more milk making adequate mineral supplementation more important.

Health

The overall objective of a good health management plan that enhances reproductive efficiency is the successful completion of pregnancy, the birth of healthy, strong offspring, optimal birth and weaning weights, and optimum milk production (Fthenakis et al., 2012). A good health management plan for does should include nutrition, udder health, and internal parasite management, vaccinations and the prevention of abortive and metabolic disorders (pregnancy toxemia and hypocalcemia).

Effective udder health management includes careful examination by palpation for any hardness, abscesses, or nodules. It has been documented that mammary infections increase during the weeks following the cessation of lactation (Barkema et al., 1998). Evaluating the mammary glands at this time will help to identify any females with abnormalities that should be culled, especially since kids from does with mammary gland abnormalities tend not to thrive as well as those from dams with healthy udders.

Heavy infections with internal parasites can reduce the BCS of breeding females and may reduce reproductive performance in the herd. To minimize any negative effects, a regular parasite control program has to be implemented. Goat producers should be utilizing tools such as the FAMACHA© system and Five Point Check® in a targeted selective treatment approach. This is especially important around the time of kidding when females experience a decline in their normal immunity to internal parasites (peri-parturient rise in fecal egg counts). This then becomes the primary source of parasite infection for new offspring who are highly susceptible to infections due to their naïve immune systems. As expected, kidding on pasture, spring and winter kidding, and younger females increases this risk. Selective deworming, utilizing FAMACHA© and the Five Point Check©, 2 - 4 weeks prior to kidding helps to kill parasites and reduce pasture infestation. The suppression of the peri-parturient rise in fecal egg counts depends on the effectiveness of the anthelmintic/dewormer used. Finally, the impact of good nutrition, especially protein and trace minerals needed to support a strong immune response should never be underestimated in an effective parasite control program. Research has shown that ewes receiving higher levels of protein for 6 weeks prior to lambing have significantly lower fecal egg counts (Donaldson et al., 1997).

A good health management plan should also aim to ensure the health of pregnant females as well as their offspring. Vaccination against Clostridial diseases, including enterotoxemia (overeating disease or pulpy kidney disease; Type D), bloody scours (Type C) and Tetanus (lockjaw; Type D), are generally effective and all females should be vaccinated 2 - 4 weeks prior to giving birth. This allows dams to provide passive immunity to their offspring through colostrum. The antibodies from colostrum can only be absorbed within the first 24 hrs after birth and it is critical that kids nurse soon after being born so that they are protected against these diseases.

Small ruminants are also susceptible to infectious abortive diseases such as Chlamydia, Toxoplasmosis, Brucellosis, Listeriosis, Q fever, and a host of others. A few of these have vaccinations available and if there is a history of abortions and/or weak small kids born in your herd the cause should be diagnosed. Detailed history, blood tests and/or isolation of bacteria from placenta or fetal tissue can be used to accurately diagnose an infectious abortive disease in your herd. If a vaccination was not carried out or is not available, feeding (chlorotetracycline (aureomycin) at a rate of 80 mg/hd/day during last 6 weeks of gestation) or administering injections of antibiotics (LA-200; oxytetracycline) at 2 week intervals during last 6 weeks of gestation has been shown to be effective in preventing abortions. Abortions due to toxoplasmosis can be prevented by feeding a coccidiostat in the feed 6 weeks before lambing/kidding. Pregnant women should never handle aborted material due to risks to her own pregnancy. For instance, *Clamydia abortus*, the agent responsible for causing Chlamydia, is zoonotic (spread from animals to humans) and can cause serious health problems in pregnant women.

Male and Female Reproduction

Puberty

From a practical point of view, puberty in females is not only when she reaches sexual maturity and exhibits estrus (6 – 8 months of age) but is the age at which she can successfully support pregnancy to term (Senger, 2003). Similarly, in males, puberty is not only the age when the ram's reproductive organs become functional and his secondary sexual characteristics develop, but rather the age when the ejaculate contains a threshold number of spermatozoa adequate for successful fertilization (Senger, 2003). There are a number of factors that affect the onset of puberty and these include breed, geographic location, social structure, and photoperiod. It is recommended that replacement females first be bred when a target weight of 60 - 70% of mature adult weight for that breed is reached. Replacement females born earlier in the season generally reach puberty earlier because of their age and weight while those born later tend to breed later. In addition, replacements that kid earlier will breed back earlier in the season and this increases the productive life of the animal.

Estrous Cycle

The estrous cycle is defined as the period between one estrus (standing heat/period when the female is receptive to the male) to the next. The average duration of the estrous cycle can vary by breed and environment. The estrous cycle is divided into 2 main phases, namely the follicular phase (follicular growth, secretion of estrogen; short - 25% of cycle) and the luteal phase (following ovulation, corpus luteum produces progesterone; long – 75% of cycle). The average duration of standing heat varies by breed, age, season and presence or absence of a male (Senger, 2003). Estrus detection is based on behavior/signs and typically includes, bleating, mucus discharge, interest in bucks, tail wagging, swollen vulva, and standing for mounting in does. During anestrous, the normal cycle stops and this could be due to any stressor such as under-nutrition, disease, gestation, lactation and season. Please see Table 2 for a list of normal reproductive traits of goats.

Table 1. Normal Reproductive Traits of Goats.

Characteristic	Goats
Age at puberty	
Male	4 – 6 mos.
Female	5 – 8 mos.
Estrous cycle length	21 days (18 – 22)
Duration of estrus	12 – 36 hrs.
Ovulation	12 – 36 hrs. after estrus onset
Length of pregnancy	146 - 155 days

Seasonality of Reproduction

As stated previously, during anestrous, the normal cycle stops and this can be due to many factors including increasing day length. Small ruminants are generally considered to be short-day breeders (breeding season: September – February, but varies among breeds.

The pineal gland secretes a hormone melatonin, which is produced in the dark. Increased secretion of this hormone is needed to trigger the hypothalamus to produce gonadotropin-releasing hormone (stimulates egg and sperm production). 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. However, estrus and ovulation can be induced in females experiencing seasonal anestrous by treatment with natural progesterone, synthetic derivatives of progesterone (progestogens; ex. melengestrol acetate), and other hormone treatment protocols.

Estrus Synchronization/Induction

Estrus synchronization allows for parturition at appropriate times to take advantage of niche markets, feed supplies, labor, and increasing price trends. Methods of synchronization in goats include hormonal treatments (ex. natural progesterone, progestogens and prostaglandin), and manipulation of social inputs (i.e., the buck effect). In efforts to synchronize estrus, various forms of progestogens and different methods of administration have been used in cycling females, as well as in seasonally anestrus ones (Wildeus, 1999). Although alternative methods are available during the breeding season, it is commonly accepted that natural progesterone or a progestogen is required for induction or synchronization outside of the normal breeding season. Administration tricks the body into thinking its pregnant and its removal results in the doe demonstrating estrus in a predictable timeframe (within 24-72 hrs). Currently, there is a controlled internal drug-releasing device (CIDR), in the form of a silicone intravaginal natural progesterone insert, approved for use in sheep, and available for purchase in the U.S. (Eazi-breed™ CIDR; FDA approval granted for sheep, but pending for goats). This product has become especially important in the development of effective synchronization protocols for artificial insemination (AI) protocols in goats and is usually inserted for 9-21 days. Progestogen administration can be used with or without supplementary treatments such as gonadotropins (hormones that promote follicle growth and ovulation/release of egg) or prostaglandin (lyse an active corpus luteum).

Progestogen

Previously, progestogen sponges containing fluorogestone acetate and methyl acetoxy progesterone were used in the synchronization and induction of estrus (Whitley and Jackson, 2002). Routine synchronization protocols typically combined vaginal sponges inserted for approximately 11 days, together with a prostaglandin (such as dinoprost tromethamine; Lutalyse®) and equine chorionic gonadotropin (eCG; extra-label drug use in the form of PG-600 to promote follicular growth and ovulation) injections 2 days before sponge removal (Leboeuf et al., 2000). The additional use of prostaglandin and gonadotropins assist in further tightening synchronization. This technique and others have been demonstrated to efficiently induce and synchronize estrus and ovulation during the breeding as well as the non-breeding seasons. The CIDR was equally effective in synchronizing and inducing estrus compared to fluorogestone acetate and methyl acetoxy progesterone sponges in studies (Motlomeo et al., 2002).

An alternative, maybe a more practical method of administering progestogens, can be through oral dosing in feeds. Melengestrol acetate (MGA) is a synthetic progestogen that was first used in the dairy industry to suppress heat in heifers. The use of MGA to induce estrus in seasonally anestrus ewes (Wildeus, 1999; Whitley et al., 2003) and does (Jackson et al., 2002) has been well documented and proven to be effective. MGA is usually fed at a rate of 0.25 mg per doe per day for 8 – 14 days alone or in combination with the male effect. Similar to the use of other progestogens, the use of gonadotropins and prostaglandin analogs may assist in further tightening synchronization. The major issue with this method appears to be administering the feed since group feeding has the possibility of some females getting more or less of the required dose to synchronize/induce estrus. Individual feeding or ensuring that there is sufficient feeder bunk space should prevent this from occurring.

Prostaglandin

Prostaglandin is effective in synchronizing cycling females and offers a flexible, economical method to shorten the breeding season in a natural mating situation. A typical prostaglandin protocol includes two injections 11 days apart. This is necessary because for prostaglandin to be effective it requires an active corpus luteum present on the ovary. Therefore, the second injection ensures an increased chance of lysing the corpus luteum and allowing the doe to return to estrus faster. The most commonly available prostaglandin is dinoprost tromethamine (Lutalyse; Pharmacia and Upjohn Co., Kalamazoo, MI) but cloprostenal (Estrumate) is also available. It should be noted that prostaglandin might cause abortions if administered to a pregnant female.

Male effect

Exposure to males after a period of isolation can be used for estrus synchronization during the breeding season without additional treatments. Research has shown that sudden introduction of the buck to females separated from the male for several weeks (>3 weeks) will result in a surge in luteinizing hormone (responsible for ovulation/egg release) and a rise in progesterone concentrations allowing a proportion of females to come into heat within a predictable time-frame. It has been suggested that pheromones from the male lead to the increase in these hormone secretions, thereby inducing estrus or ovulation in goats during the breeding season (Over et al., 1990). However, during the non-breeding season, the male effect is less likely to work on its own and is more effective in conjunction with a natural progesterone or progestogen.

Advanced Reproductive Techniques

Artificial Insemination (AI)

Advanced reproductive techniques, such as artificial insemination (AI), provide a means by which genetic material can be transferred between locations. In addition, it also eliminates health concerns associated with the movement of live animals from one farm to the next, especially with increased concerns with internal parasite resistance. During AI, semen is deposited into the female reproductive tract via artificial techniques rather than by natural means. The primary advantage of this technique is that it permits the extensive use of outstanding sires to maximize genetic improvement. In addition, once you have the necessary equipment, frozen semen might be much less expensive than paying a breeding fee or buying expensive males. Semen is now more readily available from many high quality males, in some breeds more than others, and it’s more possible now more than ever to quickly improve the quality of your herd using such techniques. However, the success of the actual insemination depends to a large degree on the appropriate timing in relation to estrus and ovulation (Wildeus, 2003). The success of AI is also dependent on the ability to efficiently collect and cryopreserve spermatozoa from quality males for use on females from generation to generation.

The beef and dairy cattle industries almost completely rely on timed AI (TAI) reproductive protocols and this has led to many improvements in genetics and consistency in the market. Similar results can be achieved if this technology becomes mainstream in the small ruminant industry. Two AI methods are currently used in the small ruminant industry. Cervical insemination (common in goats) involves deposition of sperm in the cervix while the second method, laparoscopic insemination (less common in goats), involves the use of a laparoscope and manipulating probe to aid in depositing fresh or frozen-thawed sperm directly into the uterine horns. Conception rates using cervical and laparoscopic AI ranges from 40 to 80% during both the breeding and nonbreeding season. To accommodate AI, females are generally synchronized, using techniques described above, and bred according to the AM/PM rule. That is, a female is inseminated 12 hr after first being observed in estrus. However, North Carolina State University has developed a novel ovulation synchronization technique, NC-Synch, which does not require the use of progesterone and allows for all females to be bred at the same time without the need for heat/estrus checks. This protocol, NCSynch-TAI, uses a treatment combination of prostaglandin and gonadotropin-releasing hormone to induce synchronized ovulation for TAI (Bowdridge et al., 2013).

Interestingly, there is current research at Virginia State University on the development of a simple vaginal AI (shot-in-the-dark) procedure for small ruminants, using fresh chilled semen, which provides acceptable pregnancy rates. This has the potential to expand the use of AI in small farm settings and allow for the increase in genetic potential on many farms. Additional research is looking at optimizing the protocol, especially semen extension in goats and minimal concentration (both species) needed for increased pregnancy rates on farms.

Reproductive Failure of the Female

There are instances where females may fail to mate, or mate and not become pregnant or even not be able to maintain a pregnancy. The reasons for reproductive failure in females are difficult to determine and the possibilities are endless. For instance, a female might fail to mate because she is already pregnant, in seasonal or lactational anestrous, experiences nutrition and mineral deficiency, stress, poor health, or it could be some pathology of the reproductive tract to name a few. Reasons for failure to mate, become pregnant or maintain a pregnancy should be evaluated by a veterinarian and efforts made to correct the issue if possible so that she can be bred. However, if the exact reason cannot be determined and a female has failed to conceive in consecutive cycles, it is recommended that this female be culled from the herd.

Reproductive Failure of the Male

Reproductive failure also occurs in males. Bucks might also fail to mate or mate and pregnancy does not occur. As with females, there are a number of reasons for reproductive failure in males and they should be evaluated for any health or other stressors that could be responsible for this failure. To correctly evaluate if a male is breeding or not, a marking harness or raddle powder is recommended. If a male is not mating, then he could be too ill, too thin, and too old or the weather might simply be too hot. Possible diseases to check include pizzle rot, contagious ecthyma (sore mouth) of the penis or prepuce, or lameness and overgrown hooves making it difficult to mount comfortably. The experience of the male should also be considered. An inexperienced male could be dominated by bigger/older females or males in the breeding group and be reluctant to breed. The male to female ratio used during breeding might also be an issue, especially if a synchronization protocol is being followed. The typical ratio recommended during a normal breeding season is 1 male: 30-50 females while in a synchronized mating the ratio should be 1 male to every 15-20 females. It should be noted that younger males can serve no more than 20 females during the normal breeding season.

To help diagnose possible issues due to infertility, all bucks should be evaluated by a veterinarian for breeding soundness at least 1 month prior to the start of the mating season. A BSE evaluation usually includes a physical examination, scrotal circumference measurement, and semen evaluation. The physical examination is to ensure that the male can move around freely without issues of lameness or overgrown hoofs and have adequate BCS to do an effective job during the breeding season. The male should also be free from diseases such as pizzle rot and internal parasites. Measurement of the scrotal circumference is a very helpful tool in determining fertility and breeding ability in males. There are a number of research studies that have indicated that scrotal circumference is highly correlated with sperm concentration, motility and viability. In a mature buck (older than 14 months), the scrotal circumference should be > 25 cm (Merck Manual). The testicles should be palpated for firmness, symmetry and any abnormalities. The season can adversely affect scrotal circumference, with testicles being smaller during the non-breeding season and injury or infection (such as epididymitis) could result in asymmetry or changes in testicular firmness. Finally, a semen evaluation should be conducted. A good quality semen sample will be milky in appearance and free from contaminants including pus, blood or urine. When examined under a microscope there should be a good wave motion indicating sperm motility. Table 2 has the normal semen parameters for breeding bucks.

Table 2. Normal semen parameters for breeding bucks and rams

Parameters	Buck
Volume (ml)	0.5 – 1.0
Sperm concentration (billion/ml)	2 – 5 (2.5)
Motility* (%)	70 - 90 (80)
Normal Morphology* (%)	75 – 95 (90)

Motility – percentage of sperm in progressive motion
Morphology – sperm shape

Conclusion

In conclusion, if not included in your overall management plan, any one of the factors described above can affect on your breeding program and reduce the reproductive efficiency in your herd. Since reproductive efficiency has a direct impact on pregnancy rates and the number of offspring available to market each year, all factors discussed should be given adequate consideration for optimizing reproductive performance. If these factors above are considered, enhanced reproductive performance can be achieved and this will not only optimize production but also promote profitability.

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