Reproductive Management in Goats

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Goats are generally classified as a seasonally polyestrous or short day breeders in the U.S. The degree of seasonally varies among breeds and their location (latitude). The annual reproductive cycle of goats in a temperate region can be divided into breeding season or period, nonbreeding season or physiologic anestrous period and transitional period. Transitional period is between the nonbreeding and the breeding season. The onset of the breeding season commences after June 21st (summer solstice). In July and August or during their transitional period, some of the does will show estrus activity, but majority of the does will start cycling regularly in late September, resulting in the kids born late winter or early spring. With the rapid increase in meat goats in the U.S., estrus synchronization has been used as an effective tool in the reproductive management of these herds. Synchronization early in the breeding season will allow increased proportion of doe’s becoming pregnant early, older and uniform size of kids at weaning, take advantage of the niche in the market during religious events and rising price trends in the market. Synchronization of estrus in does includes techniques such as alteration of light patterns, manipulation of social interaction with the buck exposure early in the breeding season, and manipulating the estrous cycle by extending or shortening the luteal phase of their cycle. In does during the breeding season the opportunity to control their cycle is greater during the luteal phase, which is of longer in duration and is more responsive to manipulation.
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Introduction

The goat (Capra hircus) and sheep (Ovis aries) are two distinct species in the family Bovidae. The world sheep population is estimated at 1.3 billion and the goat population around 1.0 billion. Both species were among the first to be domesticated by man for meat and fiber. There are different breeds seen throughout the world. The goats tend to be located in the more arid areas of the world while the sheep are raised in very diverse environments. In North America goats are seasonally polyestrous or short day breeders. The length of the breeding season is influenced by photo period, breed, location and nutrition. There is not only great variation between breeds as regards to the length of the breeding season, but there are variations within breeds. Selecting a breed, and also individuals with long breeding season could be utilized as a management tool in managing goats for production. Photoperiod and its influence on the secretion of melatonin from the pineal gland are important signals for cyclicity of does in the fall. The influence of photoperiod, and its effect on cyclicity, is mediated through the release of gonadotropic releasing hormone (GnRH) from the hypothalamus, and the release of luteinizing hormone (LH) from the anterior pituitary gland.

Reproductive management:

Breeds: Common lactating breeds seen in North America are Alpine, Saanen, Toggenburg, Nubian and LaMancha. Meat breeds seen are Boers, Spanish, Kiko and Tennessee Stiff Legged. Fiber producing breeds seen are Angora and Spanish (Cashmere). Nubian, Nubian-crosses and Boers tend to have a longer breeding season (June-March) due to their origin near the equator. In contrast British and European goat breeds (Saanen, Toggenburg and French Alpine) have a more restricted breeding season (September – February).1,3-5
Puberty: Puberty in goats is defined as onset of changes when the doe or buck becomes sexually mature and able to reproduce. It is the maturation of the hypothalmo-pituitary-ovary/testicular axis.\textsuperscript{1,3-5} Onset of puberty in goats primarily depends on age, breed, nutrition, body weight or size, management, season and disease status of the herd. Goats reach puberty around 6 to 8 months of age, some breeds or individuals within a breed may reach puberty as early as 3 months. The range is around 3 to 15 months. Bucklings usually reach puberty earlier than doelings. Cross breeds usually reach puberty earlier than the purebreds. Size or body weight plays an important role when the doe will reach puberty, and it depends on genetics, nutrition and management. Doelings which grow faster in size and weight and will reach puberty earlier. Time of year when kids are born plays an important role when the kids will reach puberty. Kids born early (Jan-Feb) more likely to reach puberty and cycle that fall. Late born kids (March-June) may not reach puberty and breed until the 2\textsuperscript{nd} fall after birth. Chronic diseases or conditions in the doelings (Parasites – internal and external, Caseous Lymphadenitis, and Pneumonia etc.) will delay puberty.

Bucks: Scrotal circumference in rams plays an important role, when their sons and daughters will reach puberty, and also has influence on the twinning rates in their daughters. Bucks with ↑ scrotal circumference will potentially produce good quality semen; and have a positive influence on fertility and litter size.\textsuperscript{6, 7, 11-13}

Seasonality: The underlying influence of photo period effect on estrus activity is mediated through the secretion of luteinizing hormone (LH) from the anterior pituitary gland. Final maturation and ovulation of ovarian follicles is dependent on sufficient LH secretion. During the anovulatory (anestrus) season, estrogen secretion from the follicles strongly inhibits LH release. As photoperiod begins to decrease (late summer-fall), this inhibitory effect is lost
and there is increased LH release leading to ovulation and cyclicity. Alternating inhibitory influence of estrogen from cycling to non-cycling seasons may be due to changes in melatonin production from the pineal gland, mediated through changes in light perceived by the eyes. Regardless, the important point to remember is that the does become anestrus due to reduced LH secretion. Thus, without sufficient LH, the ovaries are virtually inactive. To get anestrus does to cycle out of season, one must increase the LH release by increasing follicular growth, by providing Follicular Stimulating Hormone or gonadotropins containing FSH to stimulate ovarian activity. Under natural circumstances the onset of estrus activity within a group of does is characterized by an increasing percentage of the group exhibiting estrus over a time. The time of the year, 90% of the group will cycle regularly will depend on the breed, location and nutritional status. Majority of the does will exhibit estrous activity in fall, between September to November in North America.

**Buck exposure:** Exposure to bucks during the non-breeding or off season can trigger low percentages of does to cycle. The male effect is probably mediated through pheromones produced by the buck and increasing LH production in the does. Exposure of does to vasectomized or intact bucks late in the transition period induces estrus and ovulation in the majority of the does. 30-60% of the does will later short cycle in 8-10 days due to premature luteal regression after buck exposure. Normally there are three peaks of estrous activity when first introduced to bucks in late transition (3-4 days, 7-12 days, and 28-35 days).

**Flushing:** To increase the ovulation rate in does, a period of “nutritional flushing” (increased energy intake) for 4 weeks is effective prior to breeding. Flushing seems to help does which are poor in body condition during the transition period.
**Estrous cycle:** The normal length of their estrous cycle during the peak of their breeding season is around 19-23 days (average 21 days). The peak of the breeding season in the mid-west is between October to December. The estrous cycle length in Angora’s are shorter, and is around 16 to 18 days, whereas for a pygmy is greater than 21 days. The period of receptivity or estrus is around 24 hours (12-36 hours). Doelings are in estrus for about 24 hours, and does 24 to 48 hours. Ovulation is towards the end of the estrus period. Usually 12 hours after the onset in a doeling, and 24-36 hours after the onset in a doe.\(^1\text{-}^5\)

**Bucks:** Bucks are seasonal breeders too. Decreasing the daylight stimulates the pulsatile release of GnRH. Thereby stimulating the release of LH and FSH, resulting in increasing spermatogenesis and testosterone production in the testes. Increased androgens in turn stimulates accessory sex glands and sexual behavior (libido), increase in testicular size (↑3-5 cms of scrotal circumference), testicular weight and gonadal sperm reserve. Sperm quality like motility, morphology and concentration are lower during the longer daylight or anestrus period.\(^1\text{-}^3\text{1}1\text{-}^3\text{13}\)

**Estrus:** Estrus behavior seen in a doe are, restlessness, increase vocalization, occasional mounting, rapid tail wagging, swollen vulva, mucus discharge, frequent urination and decrease in milk production. Bucks will nose the perineum and udder, flick their tongue, strike with their forelimb and make low bleating sounds. He may butt or push doe’s hindquarters with his shoulder, and line up directly behind the doe and mount.\(^1\text{-}^6\)

**Breeding:** Common breeding techniques used in goats are, hand mating, pen mating and artificial insemination. Hand mating is a common practice done in dairy goats, by taking the doe to the buck to be bred. Pen mating is leaving the buck with the does for a certain period in a pen or pasture. Artificial insemination is a technique to deliver the semen other than a buck to the
doe. And are usually performed 12 and 24 hours after onset of estrus, when the cervical mucus changes from clear to cloudy.\textsuperscript{1-5}

Estrus detection is very important if artificial insemination is going to be practiced.

1) Does actively seek the buck.

2) Does prefer bucks with intact scent glands.

3) “Buck jar” – rub cloth or rag over the scent glands of intact bucks and place it in jar. Opening the jar and exposing the rag to the does may be helpful in detecting estrus in does when there is no buck present.

4) “Buck beard” trimmed during the breeding season, put in a zip lock bag and the bag opened and exposed to does once or twice a day.

5) Fence line exposure by exposing the buck across the fence to the does.

6) Use of intact bucks with breeding aprons or teaser bucks in the pens with the does.\textsuperscript{1-4}

Inducing cyclicity in a doe is mainly done by a) male effect during the late transitional period and early breeding season, b) light effect and 3) using exogenous hormones. During the transitional period (late July to early September), buck effect is a powerful tool to induce estrus (Table1). Sudden introduction of previously isolated bucks will stimulate a surge of LH followed by ovulation, and majority of the doe’s exhibit estrous within 48-72 hours.\textsuperscript{1,7-13,21-23} 30 to 60 \% of the does will cycle back or short cycle and show estrus behavior and ovulate again within 3-5 days or 7-12 days after introduction of the buck. Three peaks of activity have been observed, after the introduction of the buck, 3-5 days, 7-12 days and 28 to 35 days after introduction to the buck.\textsuperscript{1,21} This phenomenon of cycling back in 7 to 12 days is described as early luteal regression (ELR).\textsuperscript{15,16,21-24} The current thinking is that early luteal regression maybe due to lack of
progesterone priming of the uterus during anestrus period, and thereby having positive effects of
estradiol from the follicles on the uterus. Estrogen increases the availability of oxytocin receptors, leading to the release of endogenous prostaglandin from these receptors, and thus lysing or regressin the corpus luteum. Doe’s that were supplemented with progesterone in late-transition, and removed on the day the bucks were introduced, had higher percentage of does showing estrus, and reducing the number of short cycles. Buck effect and exogenous progesterone are methods commonly employed to induce estrus in the transition period and to prevent ELR (Table 1).

Photoperiod manipulation is done by altering the day length. Decreasing day length will increase the levels of melatonin produced by the pineal gland. Melatonin production may influence the secretion of LH from the anterior pituitary gland, and hasten the cyclicity. Melatonin will increase the pulsatile release of GnRH, thereby increasing the frequencies of FSH and LH release. Increase levels of LH release will cause ovulation, and thus enabling doe to cycle regularly. Changes in light exposure or decreasing day length require at least 45-60 days to induce a doe to cycle. Gradual change is not necessary, the amount of change that is perceived by the eye is important. A reduction of light is effective to trigger cyclicity in 30 to 60 days in a doe.

In does during the breeding season the opportunity to control their cycle is greater during the luteal phase, which is of longer in duration and is more responsive to manipulation. Strategies can be employed for synchronization, is to extend the luteal phase by supplying exogenous progesterone (Table 4) or to shorten this phase by prematurely regressing the existing corpus luteum (CL) by using prostaglandins (Table 3). Hormones have been used in goats to manipulate the estrous cycle, but none have been approved for use in goats in the U.S.
Extending the luteal by supplying exogenous progesterone is best done by using Controlled Internal Drug Release devices (CIDR), intravaginal sponges and feed supplements. Regressing the corpus luteum is best done by utilizing prostaglandins. Progesterone or progestagens products commonly used are CIDR’s and sponges (Veramix, Repromap, Sincrocel, Cronolone and Chronogest). Shortening the luteal phase is best done by using Lutylase (Dinoprost tromethamine) and Estrumate (Cloprostenol). To better control or synchrony of estrus and ovulation, extending the luteal phase with progesterone, along with a gonadotropin (FSH) and prostaglandin have been used. The gonadotropin like equine gonadotropin (eCG) is commonly used because of its longer half-life. The drawback of using higher doses eCG may result in larger number of anovulatory follicles, and repeated doses can cause declining fertility due to the buildup of antibodies against eCG. eCG is not commercially available in the U.S. But a product containing eCG and a Human Chronic Gonadotropin (HCG), which has been labeled to be used in swine (PG 600) has been tried and has been in goats. Dosage of PG 600 utilized in does is 200 units of eCG + 100 units of HCG (1/2 dose) during the breeding season or 400 units of eCG + 200 units of HCG (full dose) during the non-breeding or off season. If eCG is used, 200 units of eCG during the breeding season and 400 units of eCG during the non-breeding or off season.

Out of season breeding in doe’s could be done manly by using hormones or manipulating the photo period to fasten the onset of estrus. Out of season breeding will enable the farmer or producer to take their kid crop to market when prices are higher, have year round milk production in dairy animals and also increase the number of kids born to the doe during her life time. Hormones are commonly used effectively to synchronize estrus in this period. Incorporating a follicle stimulating hormone into the protocol is very essential to stimulate
follicular waves during the non-breeding season or off season. Equine Chorionic Gonadotropin (eCG) is commonly used. In the U.S., PG 600 which contains eCG is available in the US and has been used successfully used in goats (Table2).

Table 1

<table>
<thead>
<tr>
<th>Method</th>
<th>Duration</th>
<th>Estrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Buck effect</td>
<td>Late transition</td>
<td>24-96 hours$^{4,9,11,20}$</td>
</tr>
<tr>
<td>2. Progesterone(12-14 days) + equine chorionic gonadotropin(eCG) on the day or 24-48 hours prior to removal</td>
<td>Early transition</td>
<td>24-72 hours$^{21}$</td>
</tr>
<tr>
<td>3. Progesterone(12-14 days) + eCG on the day or 24 to 48 hours prior to removal</td>
<td>Late transition</td>
<td>24-48 hours$^{22}$</td>
</tr>
<tr>
<td>4. Progesterone(10 days) + eCG(removal) + prostaglandin 48 hours prior to removal</td>
<td>Late transition</td>
<td>10.9+- 3.2 hours$^{23}$</td>
</tr>
</tbody>
</table>

This table is adapted from Current Therapy in Large Animal Theriogenology.
Table 2

Methods employed during the non-breeding season

<table>
<thead>
<tr>
<th>Method</th>
<th>Duration</th>
<th>Estrus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progesterone</td>
<td>12-14 days</td>
<td>24-96 hours&lt;sup&gt;1,14,15&lt;/sup&gt;</td>
</tr>
<tr>
<td>+ Equine Chorionic Gonadotropin</td>
<td>On the day of removal or 24-48 hours before</td>
<td>44.6 ± 8.2 hours&lt;sup&gt;27&lt;/sup&gt;</td>
</tr>
<tr>
<td>+Prostaglandin</td>
<td>On the day of removal or 24-48 hours before</td>
<td>25 ± 5 hours&lt;sup&gt;22-30&lt;/sup&gt;</td>
</tr>
<tr>
<td>Artificial lights</td>
<td>Mimic long days for 60 days followed by short days for 60 days or natural light</td>
<td>40-70 days during short days&lt;sup&gt;31&lt;/sup&gt;</td>
</tr>
<tr>
<td>Melatonin (Implant, oral, or injection)</td>
<td>60-100 days</td>
<td>30-60 days</td>
</tr>
<tr>
<td>Artificial lights + melatonin</td>
<td>Mimic long days for 60 days followed by melatonin for 60-100 days</td>
<td>Buck exposure 60 days into melatonin treatment; estrus 2-3 days&lt;sup&gt;36&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
**Table 3:**

**Shortening the luteal phase**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dosage</th>
<th>Treatment</th>
<th>Route</th>
<th>Estrus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lutalyse (Dinoprost tromethamine)</td>
<td>5-10 milligrams</td>
<td>2 injections, 11 to 12 days apart in does</td>
<td>I/M</td>
<td>24-72 hours (48-60 hours) TAI + 50-52 hours</td>
</tr>
<tr>
<td>Estrumate (Cloroprostenol)</td>
<td>50-150 micrograms</td>
<td>2 injections, 11 to 12 days apart</td>
<td>I/M</td>
<td>24-72 hours (48-60 hours) TAI=50-52 hours</td>
</tr>
</tbody>
</table>
Table 4: Progesterone in Combination with Prostaglandin & Gonadotropin

<table>
<thead>
<tr>
<th>Product</th>
<th>Dosage</th>
<th>Location</th>
<th>Duration</th>
<th>eCG</th>
<th>Prostaglandin</th>
<th>Season</th>
<th>Estrus</th>
<th>Breeding</th>
<th>PG Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIDR-G</td>
<td>330mg Progesterone</td>
<td>Vagina</td>
<td>16 days</td>
<td>+</td>
<td>Removal</td>
<td>Breeding Season</td>
<td>27.2 + - 0.4 hours</td>
<td>AI</td>
<td>47% 53</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Breeding Season</td>
<td>AI 48 - 60 hours after sponge removal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIDR-G</td>
<td>330mg Progesterone</td>
<td>Vagina</td>
<td>9 days</td>
<td>+</td>
<td>Removal</td>
<td>Breeding Season</td>
<td>24-36 hours</td>
<td>Natural Service</td>
<td>95% 54</td>
</tr>
<tr>
<td>CIDR-G</td>
<td>330mg Progesterone</td>
<td>Vagina</td>
<td>9 days</td>
<td></td>
<td>+ Removal</td>
<td>Breeding Season</td>
<td>24-72 hours</td>
<td>Natural Service</td>
<td>65% 54</td>
</tr>
<tr>
<td>CIDR-G</td>
<td>330mg Progesterone</td>
<td>Vagina</td>
<td>13 days</td>
<td></td>
<td>+ Removal</td>
<td>Breeding Season</td>
<td>40.2 + - 10.5 hours</td>
<td>AI after the onset</td>
<td>63% 55</td>
</tr>
<tr>
<td>CIDR-G</td>
<td>330mg Progesterone</td>
<td>Vagina</td>
<td>5 days</td>
<td></td>
<td>+ Removal</td>
<td>Breeding Season</td>
<td>24-36 hours</td>
<td>TAI 54 hours</td>
<td>63% 56</td>
</tr>
<tr>
<td>CIDR-G</td>
<td>330mg Progesterone</td>
<td>Vagina</td>
<td>11-14 days</td>
<td>+</td>
<td>PG600</td>
<td>Non-Breeding Season</td>
<td>Natural Service</td>
<td>60-70% (Dawson)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Non-Breeding Season</td>
<td>TAI 48 hours</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Extending the luteal phase

**CIDR/ Lutylase**

- Insert CIDR
- NS or A.I. = 24 hours after standing estrus
- TAI = 52 to 56 hours after CIDR removal
- Removed 5-10mg Dinoprost tromethamine (1-2cc Lutylase)
CIDR + PG 600 + Lutylase

Day 0

Insert CIDR

Day 5

5-10mg Dinoprost tromethamine (1-2cc Lutylase)

Day 10

NS or A.I. = 24 hours after standing estrus

TAI = 42 to 48 hours after CIDR removal

Day 12

Remove CIDR Give 5cc PG600 during the off season

½ dose during the breeding season (400 units eCG and 200 units HCG)

Day 13

5-10mg Dinoprost tromethamine (1-2cc Lutylase)

NS or A.I. = 24 hours after standing estrus

TAI = 52 to 56 hours after CIDR removal
References


