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## REPRODUCTIVE TECHNOLOGIES USED TO MAKE GOATS MORE EFFICIENT

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### **Abstract**

With the introduction of Boer and Kiko breeds for meat goat production in the United States, more emphasis is being placed on the reproductive management to increase the number of offspring born and weaned and the frequency with which they are produced. It is also desirable to produce out of season kids to take advantage of a market premium for milk and meat. Reproductive manipulations, commercial Artificial Insemination (AI) programs using fresh or frozen semen, and Embryo Transfer (ET) have been developed and are in use most commonly in goats for reproductive efficiency.

**Keywords:** Meat Goats, Reproductive Technology, Reproductive Efficiency

### **Introduction: Normal Estrous Cycle and Breeding Season**

Goats in a temperate region are polyestrous and breed efficiently when daylight lengths are short (August-March) with a peak breeding season of October through December. The transitional periods are approximately two months before and after breeding season, with the deepest anestrus period in April and May. In tropical areas near the equator, native breeds show less seasonality and breed year-around. There is variation between, and within seasonality which allows for selection of out-of-season breeders. For example, pygmy and Tennessee stiff-legged breeds of meat goats breed year-round in the United States and Nubian, Spanish meat goats, Boer and Kiko are less seasonal. This seasonality can be used to the producer's advantage by introducing males during the summer transitional period to "shock" the female into cycling. This will not occur when males are run year-round with the females. The length of the estrus cycle in the doe is 18-21 days; short cycles of 5 to 7 days are more common at the beginning and end of the breeding season. Estrus varies from 24-72 hours duration, with most females showing estrus for 30 hours. Does in estrus are restless, show tail wagging, vocalize, have a swollen vulva with clear discharge which changes to cloudy toward the end of estrus. These behaviors may be pronounced in the presence of a male.

### **Reproductive Manipulation**

#### **Male Effect during the Transitional Period**

The introduction of a buck or ram into a group of transitional does (after having no contact with a male for at least 3 weeks) will induce a hormone surge and subsequent ovulation within a few days. Teaser males can be introduced to the females several weeks before the first desired breeding, and then a fertile male can be substituted when breeding is desired. Similarly, fence line contact introduced males can be used to achieve a male effect for hand mating. The response to male stimulation can be quite variable and is influenced by breed, prior isolation, and depth of anestrus, nutrition and stage of postpartum. This technique can be used in combination with some drugs for out-of-season breeding manipulation.

## **Synchronization of Estrus during the Breeding Season**

### **Prostaglandins**

Goats must be in the luteal phase for prostaglandin (PG) to be effective. Adequate nutrition, heat detection capabilities, and adequate sire or insemination capabilities are essential prior to a synchronization program. Prostaglandin F<sub>2α</sub>, 10-15 mg (Lutalyse®) or Cloprostenol, 125 mcg (Estrumate®) will induce estrus in 36-72 hrs (48 hrs. average). Two doses of prostaglandins given 9 to 11 days apart will synchronize the majority of cycling females. An alternative is to observe the flock actively for 4 days, breed all females that come into heat, administer PG on the fourth day, and breed all females that come into estrus during the next 3 days. This should result in most females being bred within a 7-day period. Producers should ensure that none of these ewes or does is pregnant at the time of PG administration because abortion may be induced.

### **Progestins**

Exogenous progestins can be used during the breeding season to artificially control the length and termination of the luteal phase. This is the most common method of estrus synchronization in goats for AI or Embryo Transfers (ET). Intravaginal devices, such as Controlled Intravaginal Drug Release device (CIDR), are also available in the US that contain 300mg of progesterone impregnated in silicone (EAZI-BREED). All of these require removal of progestins after 12 to 14 days from the doe. Estrus occurs 24-36 hrs after removal of the progestin source. Prostaglandins 24 hr. before progestin removal or a small dose of Pregnant Mare Serum Gonadotropin (PMSG, eCG) either 24-48 hr before or at time of progestin removal (250IU) could be used during the breeding season. From our experience, progestins produced better synchronization than prostaglandins.

### **Synchronization of Estrus or Induction of Estrus for Out-of-Breeding Season**

Prostaglandins are not effective for estrus synchronization out-of-season. The most commonly used program for out-of-season breeding is a combination of progestins and PMSG (eCG). CIDR is inserted, the same manner described before for synchronization during the breeding season, for approximately 14 days and a gonadatropin, either FSH or PMSG, is administered 48 hr prior to progestin removal. PMSG is most commonly used because of the need to give only one single injection. The dose of PMSG is 400 IU. Because PMSG is not commercially available in the United States, a product containing both HCG and PMSG (PG 600®), which is labeled for use in gilts, has been used for goats successfully in the United States. The dose of PG 600 is 5ml.

### **Control Lighting**

Artificial lighting, either by itself or in conjunction with the male effect, can be used for effective manipulation of the breeding season. Artificial lighting is mostly employed for a long day simulation. In winter, long days (19-20 hrs. of light) are simulated for two months and then stopped on March 1, to allow normal lighting. After six weeks, males are introduced, and a fertile estrus occurs around 10-20 days later. These females have a short breeding season of around 60 days. Males may also benefit from this treatment to increase libido and quality of semen. Some producers combine hormone and lighting for out-of-season breeding. Lighting manipulation is used in many dairy goat operations successfully.

## **Estrus Cycle Manipulation Summary**

### 1. Breeding season:

- Progestins (Oral or CIDR) for 14 days
- Progestins (Oral or CIDR) for 14 days, + 4ml PG 600, 24-48 hrs. before or at time of progestin removal
- Prostaglandins (single or double injection)

### 2. Transitional period:

- Male effect
- Progestins (Oral or CIDR) for 14 days + 5ml PG 600, 48 hrs before progestin removal

### 3. Out-of-Breeding Season:

- Progestins (Oral or CIDR) for 14 days + 5ml PG 600, 48 hrs before progestin removal
- Lighting program

## **Artificial Insemination**

### **Transcervical Insemination**

Vaginal and cervical inseminations have low conception rates and are easier to perform. Transcervical insemination is a more invasive method to place semen directly into the uterus and is a relatively common procedure and one can easily master it with some practice. The necessary speculum, light sources, and insemination equipment are readily available in goat supply data catalogs. Cattle insemination guns and sheaths can be used since they are the same standard size compared to goat guns, but a bit longer which gives an advantage for better handling. In dairy goats, animals could be observed for heat and inseminated accordingly. Because the length of estrus varies between does and ovulation occurs late in estrus, optimal timing of insemination is best determined by changes in cervical mucus. However, the standard AM-PM insemination guidelines can be used together with changes in cervical mucus. As estrus progresses, the mucus turns from clear and thin to cloudy and stringy. Insemination is recommended before mucus turns cloudy, usually 12-15 hr after the onset of estrus. A teaser buck or an intact buck in an adjacent pen could help detect animals in standing estrus.

In meat goats, does are usually synchronized for estrus for artificial insemination. Dairy goats can be inseminated on milking stands. Meat goats are usually not cooperative on stands and need to be restrained by an assistant. After proper preparation, the cervix is visualized through a clear vaginal speculum, the insemination gun is manipulated through the cervix by gentle rotation and forward movement, and semen is deposited in the anterior cervix or uterine body. Conception rate of 50-85% is reported, which depends on the skill of the operator and quality of the semen used. Fresh diluted semen or frozen semen can be used for insemination. The desired number of motile sperm per insemination for fresh liquid semen is 150 million and 200 million for frozen semen. Both fresh and frozen semen should be evaluated before insemination for quality.

### **Laparoscopic Insemination**

Laparoscopic artificial insemination is the most common AI technique used for ewe. This procedure is also used for goats in ET programs and valuable sperm of meat goats since less sperm is needed for laparoscopic insemination. Females are synchronized for estrus and detected as described for transcervical insemination. Fresh or frozen semen could be used for insemination. Females are fasted for 36 hrs prior to laparoscopic AI. They are sedated and are positioned in dorsal recumbency with the head tilted down at 45-degree angles or more. Two trocar-cannulas

are inserted into the peritoneal cavity, at the sites in front of the udder away from the midline. The peritoneal cavity is inflated with CO<sup>2</sup> gas. A 10mm laparoscope is inserted through the appropriate cannula, and the uterus is visualized through the laparoscope. The insemination gun fitted with an insemination needle is inserted through the other cannula into the abdomen and the semen is injected into each uterine horn. The laparoscope and cannula are removed, and the puncture sites are covered by an antibiotic ointment. Animals are moved to a recovery area and left undisturbed for 1-2 hours after insemination.

### **Multiple Ovulation and Embryo Transfer**

Traditional crossbreeding programs using artificial insemination focuses on the male for the availability of superior offspring. Whereas, through multiple ovulation and Embryo Transfer, genetically superior females can contribute to this genetic diversity. The limited economic value of most goats precludes the widespread use of ET for the average production unit. Also, the invasive methods needed make ET less practical in sheep and goats than in cattle. Importation of South African Boer and New Zealand Kiko goats for meat production made ET more widespread in goats. A successful ET Program requires advanced planning and lots of attention to details in donors and recipient selection, superovulation, synchronization of donors and recipients, and successful recovery and transfer of high-quality embryos. ET can be carried out in or out-of-season, but the best response is attained during the breeding season when donors and recipients are cycling normally.

### **Estrus Synchronization and Superovulation**

Most ET Programs rely on exogenous hormones to induce and synchronize estrus in donors and recipients. Synchronization is commonly achieved using progestin sponges or CIAccurate detection of estrus is needed by the use of a teaser male. The method of estrus synchronization is the same for both the donors and the recipients, with the exception that progestin implants should be removed from recipients 12 hr prior to removal from donors, since donors show estrus sooner than the recipients due to super ovulatory drugs they receive. Super-ovulation of the donor is accomplished by injection of PMSG, also called eCG and pituitary extracts of Porcine Follicular Stimulating Hormone (FSH-P or Folltropin-V). PMSG has a longer half-life of FSH activity (about 72 hrs.) and contains more LH. PMSG is associated with overstimulation of ovaries, resulting in large numbers of ovulation with an increased proportion of unfertilized embryos and poorer quality embryos. 1000-1500 IU of PMSG is administered in a single dose 48 hrs before pessary removal for superovulation. FSH has a half-life of about 6 hr and requires twice a day injection for several days. FSH is superior to PMSG in ovulation and fertilization rates and the production of good quality embryos. We use FSH in our research program for superovulation of the donors in the manner showed in the Sample Program (Table 1).

Recipients should get 400 IU of PMSG at the time of the implant removal for out-of-season embryo transfer. In donors having more than 10-12 ovulations, fertilization is reduced due to reduced transport of sperm through the cervix. Laparoscopic deposition of the semen directly into the uterine horn can correct this problem especially when frozen semen is to be used.

### Embryo Collection and Surgical Collection

Embryos are usually recovered from the donor’s uterus on days 5-6 following breeding. Surgical collection of an embryo is the most used technique in the goats. Does and ewes require general anesthesia and are positioned in dorsal recumbency with hindquarters elevated on a surgical table

**Table 1. Sample Program**

<i>Day</i>	<i>Treatment</i>	
-16	Donors and recipients receive CIDR	
	AM	Donors 4 mg FSH
-4	PM	Donors 4 mg FSH
	AM	Donors 3 mg FSH
-3	PM	Donors 3 mg FSH
-2 (AM- Remove CIDR from recipients)	AM	Donors 2 mg FSH
	PM	Donors 2 mg FSH (and Remove CIDR from donors)
	AM	Donors 1 mg FSH
-1	PM	Donors 1 mg FSH
0	Estrus, AI or natural breeding, two services at 12 hrs. interval until end-of-estrus.	
5-6	Embryo recovery	

The uterus and ovaries are exposed through a small caudal ventral midline laparotomy. Ovaries are examined to determine response to superovulation. This can also be accomplished with laparoscopy prior to laparotomy to prevent the handling of the ovaries. A 20-gauge Teflon IV catheter is inserted into the tip of the uterus near the utero-tubal junction. The tip of a small pair of artery forceps is used to puncture a small hole through the uterine wall for the insertion of a 10 French Foley catheter at the base of the uterine horn. The cuff is inflated with 5 ccs of air, 20 ml of flushing media is injected through the IV catheter and the fluid is collected from the Foley catheter into a collecting bowl or Petri dish. The procedure is repeated on the opposite uterine horn. There is no need to suture the puncture sites in the uterus. Sterile warm saline should be used to keep the uterus moist during the procedure and large amounts should be poured into the peritoneal cavity as peritoneal lavage prior to routine abdominal closure. Antibiotics and prostaglandin should be administered postoperatively.

### Non-surgical Collection

While research into transcervical collection of embryos continues, there is no practical technique yet that can be recommended for field use.

### Laparoscopic Embryo Collection

Laparoscopic-assisted collection can be performed to exteriorize the tip of the uterine horn and then flushing is done in the same manner described for surgical collection. This can reduce the severity of adhesions that result from the handling of the uterus from the surgical procedure. Laparoscopy is also used for the collection of the embryos within the abdomen without performing a laparotomy. This technique requires considerable skill and is not practical for routine field use.

### **Transfer of Embryos**

Nonsurgical, Laparoscopic, Laparoscopic-assisted and surgical methods for embryo transfer have been described. While the Laparoscopic collection of embryos requires considerable expertise, Laparoscopic transfer of embryos is relatively easy and is recommended for especially large ET Programs. However, Laparoscopic-assisted transfer and surgical transfer are the techniques used the most for transfer of embryos in goats.

### **Laparoscopic-Assisted Transfer**

A Laparoscope is used to examine the ovaries. The uterus is identified and grasped by grasping forceps through a 2cm midline stab, about 10 cm cranial to the udder. The tip of the uterine horn, ipsilateral to CL, is punctured using a blunted needle and embryos are introduced through a tomcat catheter into the uterine horn. The catheter should be inspected under the microscope, to ensure embryos are not retained in the catheter, prior to closure of the abdominal incision.

### **Surgical Transfer**

Most transfers are done surgically. The tip of the uterine horn is exposed as described under surgical collection and the embryos are introduced into the uterus through a puncture at the tip of the horn ipsilateral to the ovary with CL.

### **Conclusion**

Many factors can affect the success of an ET Program. It is difficult to predict the outcome. An average of 8-10 transferable embryos can be expected per donor with a pregnancy rate of 60-80 percent for the transfer of 2 fresh embryos per recipient. Pregnancy resulting from frozen embryos transferred is much lower.

In Vitro fertilization (IVF) and culture technology offers the advantage of producing embryos from animals when the production of embryos might be more difficult or impossible. In addition, efficient IVF procedure is important for development of biotechnologies such as embryo sexing, nuclear transfer and gene transfer. Recent progress in embryo biotechnologies has resulted in increased efforts in the practical and commercial application of IVF for the ET industry. Goat oocytes can now be successfully matured during the breeding and non-breeding seasons and have been transferred to produce live young kids.