

Application of Artificial Insemination (AI) on commercial sheep and goat production

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Abstract - This paper I present an overview of the techniques available for the application of Artificial insemination (AI) in practical sheep and goat breeding programs. Statistics on the application of AI in 4 countries is given. The improved capacity of the male animal by making use of different techniques is demonstrated. The following techniques available for controlled breeding is described in more detail: Importance of semen collection by artificial vagina and by electric stimulation. Handling and examination of semen . Cervical AI with fresh semen and intrauterine laparoscopic insemination with fresh and frozen semen. Semen diluents for fresh semen, fresh chilled semen and to freeze semen in pellets on dry ice. The use of vasectomised rams to identify ewes in oestrus. Oestrus synchronisation devices and drugs. Time of ovulation and difference in time for AI with fresh and frozen semen. Effect of season, daylight length, and age of animals on AI program. Feeding and condition of animals. Estimated costs for different techniques. With a viable small ruminant industry in a country, it is essential to make full use of all available techniques.

Key words: Sheep and goat; Artificial Insemination; Controlled Breeding; Laparoscopic intra-uterine AI; Semen diluents; Freezing of semen; Synchronisation of oestrus.

Introduction

The term “Controlled Breeding” is a better description of the special techniques that are available in the field of reproduction to the modern sheep and goat breeder. The term ‘Artificial’ is somewhat displaced as insemination of farm animals has become a natural process over many decades and all across the world.

The following techniques and procedures can be classified under Controlled Breeding: AI with fresh and frozen semen; synchronization of oestrus and fixed time AI; freezing and storage of semen; transport of chilled semen; more frequent lambings; advancing the sheep breeding season; multi ovulation and embryo transfer (MOET); ovum pick up (OPU) and invitro fertilization (IVF).

The purpose of this article is to focus on Artificial Insemination and the application in practice.

The reproduction rate of sheep and goats is an important economical factor in small ruminant farming. However in practice many ewes rear only about 5 lambs in her lifespan, which is far from the potential of most breeds.

A few points on AI as practiced in 4 countries.

- 1) In the former USSR, serious efforts to promote AI started in the 1920’s to a point that a report in 1979 claimed that 42-44 million sheep were inseminated each year. Ewes in natural oestrus were identified with teaser rams and AI was done once a day with fresh undiluted semen.

- 2) In France, AI mainly with fresh chilled semen, steadily increased from 200 000 sheep in 1979 to 450 000 in 1986 and further to 740 000 in 1994. Semen produced and distributed from more than 20 AI centres.
- 3) In South Africa AI with fresh semen in practice since the 1950's. During the 1960's came the introduction of Repromap sponges for synchronisation. Used mainly in the Karakul industry at that time. Technique of semen freezing and Laparoscopic AI was introduced in 1985. Since then a steady increase in delivery of services. During 2002/2003 a total of 37 000 ewes were inseminated laparoscopically. Five times more ewes are inseminated cervical with fresh semen per year. A total of 50 592 doses of sheep and goat semen are frozen per year and a total of 150 000 units of synchronization drugs are used by studbreeders per year.
- 4) In Australia practice of AI with fresh semen also since early 1920's. Development of semen freezing techniques during the early 1970's by Salamon. Introduction of the laparoscopic AI technique for frozen semen a major breakthrough in 1982. At present in Australia an estimated number of 250 000 ewes done per year by laparoscopic AI. Services rendered by 25 AI centres across the country. AI with fresh semen at least 500 000 per year. AI with fresh semen on natural oestrus – unknown number.

Reasons to do AI and methods of mating

One basic drive force namely: Better usage of the ram or buck.

Compare the following Mating Systems:

- 1) Group Mating: 3% Rams with ewes for a period of 6 weeks. 30-40 ewes/ram/season.
- 2) Hand mating: Ewes in oestrus brought to the ram. Ram mate 5-10 ewes/day or every second day. Mate once and under supervision. 1 Ram can serve 20-30 ewes/week.
- 3) AI with fresh semen: Semen collected on the farm. 10 Ewes inseminated with one ejaculate. On average 20 ewes/ram/day.
- 4) AI with fresh chilled semen: Fresh semen cooled down to 15°C or to 5°C. Semen can be transported and kept for 8 hours or longer. Number of ewes/ram/day: average of 20 ewes.
- 5) Laparoscopic intrauterine AI with fresh or frozen semen: Only 20 million live sperm needed for fertilization. Up to 100 ewes/day/ram with fresh semen. With frozen semen in storage an experienced operator with good assistance can inseminate up to 300 ewes/day.

Semen Collection by Artificial Vagina

This is the first step that has to be mastered to do AI on a sustainable basis. Both the semen collector or operator and rams need to be well trained. The operator has to know his rams, get them tame and used to him – feed and water them. Rams must be used to be put in pens and to be handled regularly. For semen collection get a fixed routine. Put a teaser ewe in a neck clamp and introduce the ram for short intervals until the ram mounts. Identify temperament of each ram. Dominant rams easier to collect. Spend more time with rams of shy and wild temperament. Note 5 stages of collection: Preplay; Erection; Mounting; Ejaculation; Dismount and Rest.

Artificial vagina (AV) is an imitation of the vagina of the ewe and provides thermal (temperature) and mechanical (pressure) stimulation to the erect penis of the male to cause ejaculation.

The AV consists of an outer casing of rubber or plastic 15-20cm x 5-6cm and an inner liner made of rubber or latex. The liner is folded back and secured over the end of the casing. At one end a sterile calibrated semen collection glass is inserted. The space between the casing and liner is filled with warm water through a tap in the casing. The vagina can also be inflated through the tap to exert more pressure. The temperature on the inside of the liners should be 42°C -45°C - this is a critical aspect of successful collection. When the AV is filled with water of 50°C-55°C – this

usually provides correct internal temperatures. Temperature of surroundings affects temperature of equipment and adjustments have to be made. Check with a thermometer to find the correct inside temperature and water temperature. To prevent cold shock, the collecting tube should be warmed to 30°C-37°C before collections. When the ram mounts the sheath is gently grasp and the penis is deflected onto the open end of the A.V. A vigorous upward and forward thrush signifies that ejaculation has occurred. The A.V. is turned with the collecting glass downwards, the pressure of the liner is released and the glass with semen placed in a warm bath at 30°C-34°C.

Collection of Semen by Electrical Stimulation

Electrical stimulators with a bipolar rectal electrode that gives a 10-15 Volt output. The ram is restrained in a lateral position. Straightening of the sigmoid flexure, extends the penis and the glans penis grasped and hold with a piece of gauze swab. The rectal probe is lubricated and inserted into the rectum to a depth of 15-20cm, taking care to avoid injury. The rectal probe is applied towards the floor of the pelvis and short stimuli are applied with intervals. The glans penis shows congestion and with the correct stimulation semen is collected in a prewarmed and sterile tube.

Handling and Examination of Semen

Regard semen as very sensitive, especially, for cold shock – pay particular attention to ensure that all glassware for collection and handling is clean, sterile, dry and warm (minimum 30°C).

Work in a clean, enclosed area, protected against sun, wind, dust and insects. Directly after collection put tube with semen in a water bath at 32°C-34°C. Examine each semen sample for the following:

1) Volume:

This is assessed by a calibrated collecting glass. Semen volume varies from 0,3ml to 2 ml with an average of 1 ml. Variation due to individual rams, size of testes, age of ram, frequency of collection, feeding, condition and health of ram.

2) Density and color.

Density or consistency is an indication of the concentration of the semen.

Density **Concentration (number of spermatozoa (x10⁹) per ml.)**

Thick creamy 5,0 (4-6 x 10⁹)

Creamy 4,0 (3,5-4,5 x 10⁹)

Thin Creamy 3,0 (2,5-3,5 x 10⁹)

Milky 2,0 (1-2,5 x 10⁹)

Thin Milk 0,7 (0,4-1,0 x 10⁹)

Watery Insignificant

Color: Ram semen – white to pale cream.

Buck semen: White to yellow

Presence of blood – pink color

Contamination or infection: Grey or brown color.

3) Wave motion and Motility.

Assessment of wave motion is the simplest test for motility of fresh undiluted semen. Good wave motion can be seen in the collection glass with the naked eye. Under a microscope a scoring system from 0-5 is assessed for each undiluted sample.

Score **Class** **Description**

5 Very good Dense, very rapidly moving waves
90% or more of the spermatozoa are active.

4 Good Vigorous wave movement but not as rapid as for score 5

3	Fair	70-85% of sperm cells are active. Only small, slow moving waves 45-65% of sperm cells are active.
2	Poor	No waves are formed but some movement of sperm is visible. 20-40% of sperm cells are alive but with poor motility.
1	Very poor	Only about 10% of spermatozoa, show signs of live. Only weak movement.
0	Dead	All sperm cells are motionless.

With a good phase contrast microscope equipped with a warm stage, a drop of diluted semen under a cover slip can be examined for progressive motility, percentage of live and dead sperm and also an assessment of the morphology of the sperm.

4. Further tests on semen.

Haemocytometer and colorimeter for more accurate assessment of concentration of semen. Stained smears to examine for sperm morphology and presence of infection.

Insemination

Cervical insemination with fresh semen.

Basic equipment consists of a speculum with a built in light source and a pipette connected to a 1ml syringe. The plastic disposable pipettes are popular. For sheep the tip is tapered over a flame and bent at about 30%.

For goats penetration of the cervix is easier with a straight pipette. Restraint of animals by putting the elevated hindquarters over a rail with the head downwards. Height of the rail should be 80-90cm and the front legs should remain standing on the floor of the race. One assistant to stand over ewe and secure the hind legs.

The vulva of the ewe is wiped with cotton wool or a tissue. The speculum with a bit of lubrication is carefully inserted into the vagina to a depth of 10-13cm. The cervix opening is identified and located. A large variation in size and shape of cervix opening between females. In maiden ewes it is sometimes observed just as a split in the anterior vagina, whilst in older ewes the cervix usually protrudes into the vagina and the opening of the cervix has to be found with the bent tip of the pipette between the folds of the cervix.

An assistant loads the inseminating pipette. The plunger of the syringe is withdrawn to 0,2ml to have some air behind the semen. The appropriate amount of semen is drawn into the pipette from the semen collection tube in a water bath at 30°C-34°C. The pipette is kept warm by quaze swab. The inseminator should attempt to introduce the pipette into the cervix without using force. Semen is deposited into the cervix by depressing the plunger of the syringe. The speculum is withdrawn first and then the pipette to prevent backflow of the semen. In sheep deposition of semen deeper than 1cm into the cervix canal is seldom possible. In goats it is easier to achieve deep penetration or even intrauterine insemination. Complete penetration can be felt by the lack of resistance. Avoid pushing the pipette by force too deep as this can cause damage to the cervix canal.

When large amounts of mucus has accumulated in the vagina or when mucus covers the cervix, the vagina should be drained. The assistant lifts the front end of the ewe up high and the mucus drains through the speculum tube.

Instruments must be cleaned between inseminations. Speculum is wiped off between each ewe. Pure alcohol is also used regularly to clean and disinfect instruments. Mild disinfectants can be used to rinse the speculum. Rinse again in clean water as disinfectants are detrimental to semen. AI Pipettes should be wiped with a quaze swap between ewes.

AI with Fresh Chilled Semen.

Using the same technique. Only semen is taken from a thermos flask at 15°C or 5°C.

After care.

After AI the ewes are released in a shaded paddock and they should be left undisturbed for 2-3 hours. No stress procedures on ewes for the first 6 weeks after AI.

Intrauterine or Laparoscopic Inseminations

Reasons to perform this technique: Only way to utilize and to get good results with frozen semen. More ewes can be done per ram /day with fresh semen: 20 million live sperm versus 120 million for cervical AI. Essential to do intrauterine inseminations on superovulated ewes before embryo flushing.

This is a specialized technique to be performed by a well-trained veterinarian. Equipment is expensive and one operator should do a large number of animals to make it economical. In general the technique is too expensive for commercial sheep and goat breeders but studbreeders can utilize it very favourably in there breeding programs.

Equipment consists of an endoscope (6,5mm with a 30° angle) light source and fiber optic cable. Two set of trocars and cannulae, one for 6,5mm instrument (endoscope) and a cannulae for the 4mm instrument – AI instrument. A medical CO₂ cilinder with pressure valve and latex tubing to inflate the abdomen. Transcap and Aspics from IMV France to draw in semen and to deposit it with a short sharp needle into the lumen of the uterine horns. Self-made sharp glass pipettes can also be used. Two special manufactured trolleys are used per operator to restrain the ewes on their backs and to tilt them at 45° with hindquarters elevated.

Ewes and donors have to be starved for at least 12 hours to reduce the content of the rumen and the bladder. The abdomen is prepared by shearing, shaving and disinfecting. The trocars and cannulae are inserted 7-10cm ventral to the udder and 5-10cm on each side of the mid-ventral line.. A local anaesthetic (2-4ml of 2% lignocaine) is injected subcutaneously in each site. For goats is advisable to inject the ewe with a small doze of Xylazine as a tranquilizer before the procedure. A scalpel blade can be used to make a small incision in the skin to facilitate penetration. The 7mm trocar and cannula that is connected with the CO₂ is first introduced and the abdomen is slightly inflated to create space in the abdomen and to reduce the chance of injury to organs. Insertions of the first trocar and cannula should be well controlled and the sharp trocar is withdrawn as soon as the abdominal wall has been pierced. The blunt cannula is pushed well into the abdomen and the second trocar and cannula is inserted, for increased safety, after inflation with CO₂. Endoscope and AI instrument go through the cannulae and the uterus is located just ventral to the uterine bladder. Semen is deposited in each uterine horn approximately halfway between the uterine bifurcation and the utero-tubal junction. A light stab action of the aspic and the turn of the plunger deposit about 0,1 ml of diluted or frozen thawed semen into the lumen of each uterine horn (total 0,2ml). Operators should concentrate to go into the uterine horn on the midventral line of the greater curvature of each horn. Instruments are withdrawn and put into disinfectants (dilution of 5% Chlorhexidene) between each animal. An antibiotic spray is applied to the 2 wounds.

Occasionally bleeding may be caused by perforation of a subcutaneous blood vessel. The wound can be sutured or an artery clamp is applied.

Fatalities can occur when the abdominal aorta is pierced with an uncontrolled insertion of the first trocar. It is possible to pierce a full rumen as well as a full bladder.

Operators should be well trained and practice on culled animals before they perform the procedure on stud animals. A skilled operator with good assistance can inseminate up to 200 ewes/day with ease.

The use of laparoscopy in sheep and goats has become an essential and integral part of controlled breeding of sheep and goats. It is important to have at least one skilled operator for each large sheep and goat farming area.

Semen Diluents and Rate of Dilution

Diluent for fresh semen at 30°C -34°C – Skim milk

Sterilised cow skim milk or UHT skim milk (long life milk) is the most convenient diluent to use on farms. Skim milk can also be prepared by placing milk in a double cooker – milk in one container placed in a container with boiling water for about 10 minutes. Temperature rises to a maximum of 95°C.

Conception depend on number of mobile spermatozoa and not on volume. Diluent used to extend life span of semen for 1-2 hours and to have a slighter higher volume for easier AI.

Semen with density of cream to thick cream and motility of 5 and 4 can be diluted 1+2 to 1+3. Insemination dose 0,1ml/ewe. Thin cream semen with motility of 3 / 4 - diluted only 1+1. No problem if 0,5ml to 0,1ml of undiluted semen is put into ewes 0-20 minutes after collection.

Diluent for semen cooled down to 15°C or to 5°C and kept for 8-12 hours before AI.

21,86g Tri-sodium-citrate + 1000ml double distilled sterile H₂O = Solution

78,5 ml Solution

0,5 g Fructose

20 ml Egg Yolk

100 000 i.u. Penicillin

100 mg Streptomycin (optional)

Transport of Fresh Semen

Fresh semen diluted with the special diluent, can be cooled down to 15°C or to 5°C and kept for 4 –12 hours before AI.

Acetic acid frozen-thawed ampulles (IMV-France) is a practical and easy method to transport semen at 15°C-17°C in a small thermos flask – 3 ampulles needed per flask.

Semen last longer at lower temperatures and can be transported at 5°C in small electronic freezers which operate on 12 V electric supply. Tubes with cooled semen packed in water and ice in a thermos flask or insulated container is practical as well. Add ice during the trip to maintain the temperature at 5°C. Semen tubes protected with cotton wool against direct contact with ice.

Diluent for Freezing of Ram semen in Pellets (Salamon)

	1+1	1+2	1+3	1+4
Tris(hydroxymethyl)aminomethane (g)	5,814	4.361	3.876	3.634
Glucose (g)	0.800	0.600	0.533	0.500
Citric Acid (g)	3.184	2.388	2.123	1.990
Egg Yolk (ml)	24.000	18.000	16.000	15.000
Glycerol (ml)	8.000	6.000	5.300	5.000
Penicillin i.u. (cell culture) (mg)	100 000	100 000	100 000	100 000
Streptomycin (mg)	100	100	100	100

Make up to 100ml with double distilled sterile H₂O.

Diluent for Freezing of Buck semen in Pellets (Salamon)

	1+1	1+2	1+3	1+4
Tris(hydroxymethyl)aminomethane (g)	6.057	4.543	4.039	3.786
Glucose (g)	1.000	0.750	0.667	0.625
Citric Acid (g)	3.475	2.606	2.316	2.172
Egg Yolk (ml)	4.000	3.000	2.600	2.500
Glycerol (ml)	8.000	6.000	5.300	5.000
Penicillin i.u. (cell culture) (mg)	100 000	100 000	100 000	100 000
Streptomycin (mg)	100	100	100	100

Make up to 100ml with double distilled sterile H₂O.

Egg Yolk: Use fresh farm eggs.

Freezing of Semen by the Pellet method

For one-step freezing, good quality semen is diluted at 30°C-34°C with the prepared diluent for freezing. Only the best samples are diluted 1+4. For the rest mostly 1+2 dilution rate. The diluted semen is cooled in a fridge to 5°C over a period of 1½-2 hours. A block of dry ice (solid CO₂ at -79°C) is required. Holes are engraved in the surface and semen at 5°C is pipetted in 0,2ml volumes into the holes on the dry ice surface. It remains on the dry ice for 2-3 minutes and frozen pellets are transferred to liquid nitrogen at -196°C. Pellets are stored in cryo tubes (Nunc-Denmark) or Hexa goblets (IMV – France). ID of the Ram and date of freezing is written on the tubes. One pellet from each batch is thawed the next day and a proper evaluation is done with a good phase contrast microscope equipped with a warm stage at 37°C. Only batches of semen with a progressive motility of 35% are kept for AI. An incubation test, where thawed semen is kept for 2-4 hours in a water bath at 37°C, is useful as an additional quality test. One pellet of 0,2ml with a maximum dilution rate of 1+4 and with good post thaw motility is regarded as a semen dose/ewe. Semen count of 20 million live progressive spermatozoa.

Advantages of Frozen Semen for the studbreeder

More ewes can be done with semen from a single ram. Several co-owners of 1 expensive ram can still make full use of the ram. Frozen semen is a good insurance for a ram – preservation of genetic material. Genetic progress – Semen from rams proven on merit, based on performance testing of their progeny, can be distributed throughout a country and many studbreeders can benefit from a national program. More economical to buy semen from a few top stud rams than to invest heavily in only one expensive ram. AI programs can be planned and executed properly – breeders know exactly how many doses of semen are available.

Storage and Thawing of Frozen Semen

Long term storage in standard liquid nitrogen containers at -196°C
Frozen pellets thawed by putting 2-5 pellets in a dry sterile test tube, with or without an extender. Tube with pellets shaken in water at 37°C - 40°C until pellets are partially thawed. Move the waterbath at 32°C - 34°C and gently shaken until the pellets are completely thawed.

Import and Export of Frozen Semen

Frozen embryos are internationally regarded as the safest entity regarding health risks for movement across the globe. Importation of genetic material in the form of frozen semen is however more economical and a lower risk for the importer. With semen the importer can obviously only improve existing pure-bred animals or follow a process of upgrading indigenous breeds with imported semen.

Establishment of import/export protocols for semen between countries will be a great benefit to the livestock industry.

Limiting factors with Frozen semen of rams and bucks

Very low conception results when frozen thawed semen is inseminated cervically. Laparoscopic AI essential to make use of frozen ram (sheep) semen.

Better results can be achieved with buck semen due to deeper cervix penetration. Buck semen more difficult to freeze than ram semen .

Cost of laparoscopic AI and synchronisation.

Identification of oestrus and time of insemination

Teaser/Vasectomised rams to identify females in natural oestru

Teaser rams are prepared by a small operation called vasectomy, it is the removal of a part of the vas deferens from the spermatic cord.

Before introduction of teasers it is a good practice to ensure that females have no contact with males including sight and smell, for at least 4 weeks. Keep males and females about 2 km apart. Introduce at least 3% teaser rams with a group of females. Teaser rams are fitted with harnesses and marking crayons or a marking paint is applied to the brisket area twice daily. Use teaser rams from breeds with a high libido and good serving ability.

Females in oestrus and with marked hindquarters should be drafted/taken out twice a day in the morning and afternoon. Ewes in oestrus in the morning are inseminated in the afternoon and those who have been marked in the afternoon get inseminated the next morning.

To reduce labour and time – marked ewes can be drafted only once a day in the morning. Inseminations then have to be done in the morning.

Total oestrus cycle in the ewe is 17 days and about 21 days in goat does. The oestrus period when the ewe/doe will stand for the ram lasts for about 24-42 hours. During an active breeding season with normal cycles one can thus expect 6-8% of ewes and 5-7% of does to be in oestrus per day over the period of 17 and 21 days respectively.

A high proportion of females show oestrus only 10-12 days after the introduction of teaser rams – thus it is a natural way to get a form of synchronization. This effect varies between seasons and breeds.

The main advantage of this method is economical – only the cost of teaser rams to identify ewes on heat. Main disadvantage – the breeder is constantly busy with drafting and AI for a period of at least 3 weeks. Also uncertainty of the number of females in oestrus per day. Good facilities are essential to work regularly with animals with minimum stress.

Time of Ovulation and AI

Ewes normally ovulate 25-30 hours after the onset of oestrus and goats 30-36 hours after the onset of oestrus. This ovulation occurs in late oestrus. Maiden ewes and does usually have shorter oestrus cycles and they also ovulate earlier. Some differences between breeds and between seasons can occur.

With AI much smaller doses of semen are used and timing is important. Inseminators must remember that the sperm cell has to capacitate in the cervix and uterus for 5-6 hours before fertilization can take place. It is thus too late to inseminate ewes after ovulation.

Mucous membrane of vagina and vulva is congested with reddish color during the peak of oestrus. The type and consistency of mucus changes through the oestrus period. This can be used to estimate the stage of oestrus. At the beginning of oestrus the mucus is clear and sparse, after 12-18 hours it is clear to cloudy and copious, and at 25-30 hours becomes thicker and creamier in consistency.

General rule is to inseminate ewes 12-18 hours after the onset of oestrus.

Synchronisation of oestrus and fixed time AI

The success with which the sheep and goat breeder apply this technique facilitates the application of controlled breeding in practice to a very large extent. It is relatively simple and cost effective and a high success rate can be achieved under normal farming conditions.

When Progestagen or Progesterone is administered daily to ewes for 12-14 days and to does for 16-18 days, oestrus and ovulation do not occur. The treatment acts in the same way as a corpus luteum and the progestagen treatment must be equal or exceed the life span of a corpus luteum. Once the progestagen treatment is withdrawn the pituitary releases the gonadotrophin hormones FSH (Follicle Stimulating Hormone) and LH (Luteinizing Hormone). A majority of females will come on heat 2-3 days later. For fixed time AI the oestrus of all the females should be well synchronized. Exogenous gonadotrophins in the form of Pregnant Mare Serum Gonadotrophin (PMSG) or eCG (Equine Chorionic Gonadotrophin) that contains high levels of FSH and LH and is relatively long-acting is used.

The progestagen treatment is administered by 2 forms of intravaginal devices namely sponges and CIDR's (Controlled Internal Drug Release Dispenser). Sponges containing 30, 40 or 45 mg FGA or 60mg MAP are available. All devices can be used for sheep for 12-14 days and the 45mg, 60mg sponge or CIDR for goats for 16-18 days. For maiden ewes it is recommended to use the smaller sponges or CIDR's.

Application of Synchronisation drugs

Special applicators for sponges and CIDR's. Sponges can be treated with antibiotic powder or cream before insertion. The applicator should be moistened with an antiseptic solution or cream to lubricate and disinfect. Repeat this between each ewe. The female should be in a natural standing position and hold steady to prevent injury to the vagina during insertion. The applicator with tube and rod is pushed carefully in the vagina for 10-15 cm. The sponge is pushed from the tube with the rod and the string of the sponge should hang out from the vagina. When CIDR's are used in goats and hair sheep the tip of the string can be burned off in a flame to shorten it and to reduce losses of CIDR's.

Removal of Sponges

Sponges and CIDR's are removed by pulling outward and slightly downwards on the string. With sponges there is usually a discharge of distinctive smelling fluid from the vagina. This is normal and 2 days later at the time of AI, only clear mucus is present. Less discharge with CIDR's. Presence of pus or blood is abnormal in the discharge and the ewe should be checked and treated with antibiotics in case of infection. If a string or a sponge cannot be found the ewe should be examined with a speculum and the sponge removed with a long forceps.

Administration of PMSG

PMSG is supplied in a freeze-dried form and has to be dissolved with sterile water or saline. E.g. vials of 6000 international units of PMSG is dissolved into 50ml of water. This means a concentration of 120 i.u. of PMSG per ml. Dosage per animals varies from 300 to 450 i.u. To administer 300 i.u. the volume for injection is 2.5 ml. The concentration of each batch or vial should be checked and the correct dosage calculated.

PMSG is injected at the same time as when sponges or CIDR's are removed. It is best to inject in the fleshy part of the hind leg or rump. Use a long needle of 1½" and make sure that the injection is not in the fat or subcutaneous.

PMSG is a sensitive biological product that should be kept in a fridge. Temperatures higher than 25°C can cause damage to the product. Handle with care after reconstitution.

High doses of PMSG increase the ovulation rate. As too many multiples are undesirable, the dosage for each program needs correct planning. Large breeds and breeds with relatively poor fertility need higher doses. Also animals in the non-breeding season.

A dose of 300 i.u. is relatively low and is a safe dose even for fertile animals in the breeding season. Increase to 400 i.u. for heavier animals in less favourable times of the year. Doses of 500 i.u. or higher only in exceptional cases.

Other advantages of Synchronisation

Apart from the obvious advantages of fixed time AI on specific number of females the studbreeder also gets the following benefits from this procedure:

Better management and feeding over a short period.

Shorter time of lambing that means weaning of lambs of the same age.

More accurate performance testing.

More lambs of better quality from special selected sires – genetic improvement.

Planning of a Synchronisation Program

Work on a calendar and 14 days for sponges in for easier planning.

Day of program	Time	Day and Date	Action
- 30 days		Wednesday, 1 September	Select ewes and rams for AI Program. Access condition – additional feeding minerals and vitamins. Do vaccinations and ecto and endoparasites treatment.
0	am	Wednesday, 1 October	Insert CIDR's
14	10 am	Wednesday, 15 October	Remove CIDR's. Inject 400 i.u. PMSG
15	am	Thursday, 16 October	Introduce teaser rams
			Optional: Draft marked ewes regularly
16	8-10 am	Friday, 17 October	Semen collection and AI with Fresh Semen. (46-48 hours after CIDR removal)
16	12pm-4pm	Friday, 17 October	Laparoscopic AI with frozen semen. (50-54 hours after CIDR removal)

Effect of season, age and type of semen on AI Program

Daylight Length: Less effect close to the equator but further from the equator and with big variation in daylight between winter and summer, there is quite a marked effect. Natural breeding season for all sheep and goat breeds is during the autumn with shortening of daylight and lengthening of night time. This is correlated with Melatonin secretion of the pituitary during the night.

Veterinarians, operators and studbreeders should observe and calculate the effect of season on their breeds in their areas. Identify seasonal breeds.

In general during the Spring with lengthening of daylight – not the natural breeding season. Pay more attention to proper feeding and delayed oestrus. During the autumn – natural breeding season – some breeds might come in oestrus earlier than expected e.g. milk goats that are seasonal breeders.

Age: Maiden ewes have shorter oestrus cycles and ovulate earlier than mature ewes. Always inseminate maiden ewes first in a program. A program with a large percentage of maiden ewes – plan to inseminate up to 4 hours earlier than mature ewes.

Fresh and Frozen semen and time of Ovulation:

Fresh semen needs 4-6 hours of capacitation in the female tract before the sperm can fertilize. Frozen semen: Due to the freezing and thawing process and changes in the acrosome, the capacitation time is much reduced. AI with frozen thawed semen, even shortly after ovulation, can still result in good conception rates.

In the case of sponges, ovulation time is about 58-60 hours after sponge removal. With CIDR's ewes and does come on heat and ovulate about 4 hours earlier, thus about 54 hours after CIDR removal.

Keep in mind the differences between breeds and seasonal effects e.g. goat breeds in the southern hemisphere in autumn where there is a marked shortening of daylight, can ovulate as early as 48-50 hours after CIDR removal. Use of teaser rams/bucks to determine timing.

Summary of suggested time of AI

	Time of AI.	Hours after CIDR or Sponge Removal
	Fresh Semen	Frozen Semen
CIDR's	46-48 hours	50-54 hours
Sponges	50-52 hours	54-58 hours

- N.B. 1. Maiden ewes AI up to 4 hours earlier.
2. Differences between Autumn and Spring season.
3. Differences between species and breeds.

Feeding and Condition of animals for A

The subject is very wide but concentrate on the following:

- 1) Condition score of at least 3.5 at time of AI (Score from 1-5).
- 2) Rising plane of nutrition during the 4 weeks prior to AI – so called flushing of ewes – has a marked influence on conception rate.
- 3) Important that ewes did not suffer from very low body condition and bad feeding during 6 months prior to AI. Development of oocysts under influence of hormones takes about 6 months.
- 4) Body condition during the first 2 months of lactation has a marked effect on conception rate in the next breeding season. History of breeding ewes thus important.
- 5) Good food flow program important for a stud that practices controlled breeding programs. Drought survival feeding not good enough.
- 6) Find the right balance between quality protein, energy, essential minerals and vitamins.

Estimated Cost to the studbreeder for Reproduction Services (Average for RSA and Australia)

Cost of Sponge and PMSG per female: 2 US\$
Cost of CIDR and PMSG per female: 2.75 US\$
Cost of semen freezing per dose of frozen semen: 1.50 US\$
Cost of Laparoscopic AI on Farm
(Synchronisation, travelling and professional service); 6-8 US\$/ewe.

Direct cost per mating per ewe in relation with purchase price of Ram for first breeding season

Eg. Purchase price of Ram: 1000 US\$
Direct Cost per mating for 30 ewes: 33,3 \$
Direct Cost per mating for 50 ewes: 20 \$

Conclusion

The several special reproduction techniques available, especially insemination with fresh and frozen semen, provides valuable practical opportunities to the modern sheep and goat breeder to improve reproduction efficiency and to enhance genetic improvement.

Two (2) basic requirements to establish AI techniques: A viable stud and commercial sheep and goat industry. Professional people with a passion for reproduction who want to obtain all knowledge available and put it into practice.

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