INDUCTION OF ESTRUS IN SHEEP IN & OUT OF SEASON

Dr. Paula Menzies
Presented to the 2018 Alberta Lamb Producers AGM, November 2018

Reproductive Characteristics

<table>
<thead>
<tr>
<th>SHEEP</th>
<th>Puberty</th>
<th>Age @ 1st breeding</th>
<th>Pregnancy Progesterone</th>
<th>Gestation length</th>
<th>Cervical Anatomy</th>
<th>Chromosomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ram</td>
<td>6 months</td>
<td>6 – 8 mo or 60-70%</td>
<td>Secretered by the ovary (corpus luteum) but mostly placenta after day 75</td>
<td>144-151 days</td>
<td>Complex 7 rings &amp; offset</td>
<td>54 N – different from goats which are 60 N</td>
</tr>
<tr>
<td>Ewe</td>
<td>5 – 7 mo &amp; 50% of mature bw &amp; season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This presentation is designed to aid in understanding of sheep breeding management

- Normal reproductive function
- Induction / synchronization of estrus
- Causes of infertility
- Accelerated breeding programs

Reproductive Characteristics

- Puberty:
  - Rams: 6 months
  - Ewes: 5 - 7 months and 50% of mature body weight & season

- Age at 1st breeding:
  - 6 - 8 months or 60-70% of mature body weight

- Pregnancy Progesterone:
  - Secreted by the ovary (corpus luteum) but mostly by the placenta after day 75

- Gestation length:
  - 144-151 days

- Cervical Anatomy:
  - Complex 7 rings & offset

- Chromosomes:
  - 54 N – different from goats which are 60 N

A bit of anatomy first

- Uterus

Hormonal events of the estrous cycle

- Pineal gland
- Hypothalamus
- Pituitary
- Follicle Stimulating Hormone (FSH)
- Luteinizing Hormone (LH)
- Progesterone

Seasonality of Ewes

- Transition season
- In season
- Out-of-season
**Induction of Estrus in Sheep - ALP 2018**

### Estrous Cycle Characteristics of Sheep

<table>
<thead>
<tr>
<th>SHEEP</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length estrous cycle</td>
<td>17 days (14-19)</td>
</tr>
<tr>
<td>Duration of estrus</td>
<td>30 hrs (15-45)</td>
</tr>
<tr>
<td>Optimal breeding time after onset of estrus</td>
<td>Towards end of estrus, e.g. 18-24 hrs</td>
</tr>
<tr>
<td>Ovulation rate</td>
<td>Breed dependent – multiple common</td>
</tr>
<tr>
<td>Behavioural estrus</td>
<td>Anorexia; vulvar swelling; small amounts of mucus; follow ram; more subtle than goats</td>
</tr>
</tbody>
</table>

### Meat Sheep Production Cycle

Replacement females are bred at 7 months of age. Females joined with makes. Breeding exposure 30 to 42 days.

- Direct to slaughter or sales barn
- Lambs weaned at 60 days. Some producers may wean on longer
- Lambs may be marketed at weights from 50 lb (3 to 12 months old) to 110 lb

### ANNUAL Spring Lambing Flock

- 1 Lambing every 12 months
- Flushing ~ 2 weeks
- Breeding 28 to 42 days
- Lambing 35 to 60 days
- Lactation 60 to 120 days

### Why manipulate the estrous cycle?

- **Benefits of Synchronization of Estrus**
  - Concentration of breeding and lambing
  - Lambing management
  - Neonatal management
  - Uniform market animals
  - More efficient use of labour & facilities
  - Pregnancy diagnosis
  - Health management procedures

- **Benefits of induction of estrus during the transition or anovulatory season**
  - Milk supply
  - Off-season higher priced markets
  - Accelerated lambing programs
Hormones used to induce / synchronize estrus

Hormones - Prostaglandin
- Dinoprost
  - Lutalyse, Zoetis Animal Health
  - 10 mg i.m. (2 ml)
- Cloprostenol
  - Estrumate, Merck Animal Health
  - 125 μg i.m. or 75 μg i.m. / 45 kg bw

Not licensed for use in sheep or goats – VetPr only

Hormones - Progesterone
- Natural progesterone impregnated in medical silicone elastomer over a nylon core
  - CIDR 330 (Zoetis Animal Health)
  - 0.35 g progesterone
  - Licensed for use in sheep but not in goats

CIDR 330 Label (Zoetis Animal Health)
- 0.35 grams progesterone
- Induction of ewes during seasonal anestrus.
- Insert for 5 days
- Ewe to ram ratio of 18:1 for multi-sire situations
- 12:1 for ram lambs and up to 18:1 for yearling rams.
- No recommendation for use during ovulatory season
- I will provide you with more useful instructions

Hormones - Progesterone
- Melengestrol acetate
  - 220 mg/kg of premix
  - MGA 100 Premix (Zoetis Animal Health)
  - Approved for beef heifers only
  - Not approved for small ruminants
  - Must only be used with a veterinary prescription and VCPR
  - Withdrawal meat – 48 hours

Induction of estrus outside of the ovulatory period
- During the out of season period – no progesterone secreted
- Supplemental progesterone given during this time will not reliably induce ovulation
- Equine chorionic gonadotropin (eCG) is required for follicle maturation and ovulation
  - FSH and LH activity
  - AKA pregnant mare serum gonadotropin (PMSG)
- Dose is important to assure proper level of fertility and prolificacy
Hormones - ECG
- Approved for sheep, not goats
- Folligon (Merck Animal Health)
  - 5000 IU in 25 mL
  - 500 IU = 2.5 mL
- Novormon 5000 (Partnar Animal Health)
  - 5000 IU in 25 mL
  - 500 IU = 2.5 mL
- Pregeneol 6000 (Vetoquinol)
  - 6000 IU in 20 mL
  - 500 IU = 1.67 mL

Use appropriate ratio of rams to ewes to achieve optimal fertility

<table>
<thead>
<tr>
<th>Breeding Situation</th>
<th>Ram : Ewe Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature – breeding paddock</td>
<td>1:40 to 1:80</td>
</tr>
<tr>
<td>Yearling – breeding paddock</td>
<td>1:20 to 1:25</td>
</tr>
<tr>
<td>Mature – rough terrain</td>
<td>1:20 to 1:30</td>
</tr>
<tr>
<td>Mature – transition synchronization*</td>
<td>1:20 to 1:25</td>
</tr>
<tr>
<td>Mature – synchronized in season</td>
<td>1:10 to 1:15</td>
</tr>
<tr>
<td>Mature – synchronized out-of-season</td>
<td>1:5 to 1:7</td>
</tr>
</tbody>
</table>

* When using ram effect

Ram lambs are less fertile than mature rams
Rams are less fertile out of season

Prostaglandin Program - In Season Only

Single PGF2α = 60-70% synchronization of estrus.
Double PGF2α 9 to 11 days apart = virtually 100% synchronization of estrus
Fertility is lower than progesterone programs
Sheep: estrus 24-72 h after injection

CIDR Program In-Season

Sheep 11-14 days

CIDR In

CL Present on Ovary
Exogenous progesterone from CIDR
 Estrus

CIDR out

Prolongs luteal phase
All females will enter estrus at the same time
Rams introduced at or 24 h after CIDR removal
Use of eCG is not necessary

Sheep > 5 days

CIDR In

CL Present on Ovary
Exogenous progesterone from CIDR
 Estrus

CIDR out

All females will enter estrus same time
Inject PGF2α at or 1 day before CIDR removal to eliminate any CL's still present
Rams introduced at or 24 hrs after CIDR removal
Need 1 ram for every 10 ewes

CIDR Program In-Season

Sheep 11-14 days

CIDR In

CL Present on Ovary
Exogenous progesterone from CIDR
 Estrus

CIDR out

Prolongs luteal phase
All females will enter estrus at the same time
Rams introduced at or 24 h after CIDR removal
Use of eCG is not necessary

Sheep > 5 days

CIDR In

CL Present on Ovary
Exogenous progesterone from CIDR
 Estrus

CIDR out

All females will enter estrus same time
Inject PGF2α at or 1 day before CIDR removal to eliminate any CL's still present
Rams introduced at or 24 hrs after CIDR removal
Need 1 ram for every 10 ewes
CIDR Program in Transition or Out-of-Season

- Sheep 5-7 days
- CL Present on Ovary
- Exogenous progesterone from CIDR
- Estrus

CIDR In CIDR out

- All females will enter estrus same time
- Inject PGF2α at or before CIDR removal if suspect some animals may be cycling
- Inject 500 IU eCG (PMSG) at CIDR removal to induce ovulation
- Males introduced at 24 hrs after CIDR removal

Need 1 ram for every 5 to 7 ewes

Melengesterol (MGA)

- 7 – 9 days anovulatory
- 11 – 14 days ovulatory

Start Stop

- CL Present on Ovary
- Exogenous progesterone from MGA
- Estrus

Animals must consume 0.125 mg / head / q 12 h each day for a total of 0.25 mg / head / day

Ovulatory season: eCG 8 h after last feeding (≤ 500 IU)
Anovulatory season: eCG is required 8 h after last feeding (> 500 IU)

Males introduced 24-36 h after feeding stopped
Ram to ewe ratio: 1:10 in season; 1:5 to 7 out of season

CIDR Program

- Evidence to suggest that rams should not be near ewes until 24 hours after CIDR removal
- Lower # of ovulations but earlier onset of estrus
- Use of PGF2α at or before CIDR removal during ovulatory season may tighten and improve estrus.
- Time to estrus generally 24 h
- Don’t put males in earlier — exhaust selves breeding too early

MGA Programs

- May see lower fertility and prolificacy than with CIDRs (PEI) but other studies show similar results
- Important to mix and feed so consumption is even (fewer fluctuations in P4 levels)
- Link to increased risk of 3-methylindole induced pulmonary edema
- Poor response during hot, humid weather
- If no response, have hold-back sample analyzed but also consider other reasons for ram / ewe failure

Hormone-free solutions to manipulating estrus

- Suitable for lactating dairy sheep
- Lower technology required
- Lower cost?
- Lower risk to operator, environment
- Manipulating length of daylight
- “Male” effect
- Dormitory effect

Dr. Paula Menzies - University of Guelph
Photoperiod Control of Reproduction

Ram Effect – Transition
- Use teasers or fertile males
- New to male at this time
  - Ovulate in ~3 days but estrus is silent
  - CL forms but regresses prematurely
  - Next cycle is behavioral and of normal length
- Introduction of ram / teaser
  - Must be new to ewe at least 30 days
  - Noise and activity most important
  - Introduce abruptly
  - 48 h to work

Ram Effect
- Best during transition season
  - Very good synchronization without hormones
- Poor during ovulatory season when already cycling
- Variable during anovulatory season
  - Breed dependent
  - Other conditions

MAL EFFECT
Teaser effect is used in first few weeks prior to expected onset of natural breeding season
No sight, sound or smell of rams for at least 30 days prior
Rams & teasers give off pheromones which stimulate non-sexually active ewes to ovulate within 2-3 days of joining with teasers
1 teaser per 40 to 50 ewes

Get Lamb

DAY 0
Teasers joined with ewes

DAY 1
Ovulation "silent heat" No mating

DAY 14
Teasers out

FERTILE RAMS IN
Early mating group

LATER MATING GROUP

Ewes will respond in one of 2 ways to teasing:
Or display estrus & mate some 4 weeks after teaser ram introduction
Show behavioural estrus & mate with rams ~3 weeks after teaser ram introduction

DAY 14
18
21
28

11 days = 1 opportunity to breed
Dormitory Effect
- When ewes start to cycle
- ~ 25% of anestrous group will start to cycle too
- Rest may respond within a few weeks
- CIDR insertion to only a proportion of flock if synchronization not that crucial?

Factors affecting success
- Very seasonal breeds less fertile out of season
- Ram:ewe ratio is critical
- CIDR loss
  - higher in ewe lambs
- Nutrition
  - Body condition score
  - Flushing pre-breeding

Factors affecting success
- Timing of Male Introduction
  - If introduced too early, males will breed females not in estrus
  - If too late – may miss estrus (e.g. 48 h after CIDRs pulled)

What is success?
<table>
<thead>
<tr>
<th></th>
<th>UNSYNCHRONIZED IN SEASON</th>
<th>SYNCHRONIZED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnancy rate to first cycle</td>
<td>70 – 80%</td>
<td>60 – 70%</td>
</tr>
<tr>
<td>Pregnancy rate over breeding period</td>
<td>95 – 100%</td>
<td></td>
</tr>
<tr>
<td>Pregnancy rate in season</td>
<td></td>
<td>60 – 70%</td>
</tr>
<tr>
<td>Pregnancy rate during anovulatory season</td>
<td></td>
<td>40 – 70%</td>
</tr>
</tbody>
</table>

Distribution of Lambing – Unsynchronized In Season
- RAM IN
  - 75%
  - First Cycle
- RAM OUT
  - 42 days
  - Second Cycle
  - 20%
  - Third Cycle
  - 5%
- Number of Ewes Lambing

In Season
<table>
<thead>
<tr>
<th>Prostaglandin (double injection)</th>
</tr>
</thead>
</table>
| Make in 48 hrs. Pull males out for 10-12 days then re-expose males for an additional 6 days to breed (those that return to estrus)
| Male in 48 hrs. Pull males out for 10-12 days then re-expose males for an additional 6 days to breed (those that return to estrus)

Transition
<table>
<thead>
<tr>
<th>CIDR or MGA</th>
</tr>
</thead>
</table>
| Male in 48 hrs. Pull males out for 10-12 days then re-expose males for an additional 6 days to breed (those that return to estrus)
| Male in 48 hrs. Pull males out for 10-12 days then re-expose males for an additional 6 days to breed (those that return to estrus)

Out of Season
<table>
<thead>
<tr>
<th>Ram Effect</th>
</tr>
</thead>
</table>
| Male can breed for 1 cycle over 10 days or 2 cycles (10+17) over 28 days
| Male in 48 hrs. Pull males out for 10-12 days then re-expose males for an additional 6 days to breed (those that return to estrus)

Natural
<table>
<thead>
<tr>
<th>Natural</th>
</tr>
</thead>
</table>
| Male in 48 hrs. Pull males out for 10-12 days then re-expose males for an additional 6 days to breed (those that return to estrus)
| Male in 48 hrs. Pull males out for 10-12 days then re-expose males for an additional 6 days to breed (those that return to estrus)

Exposure to male Lambing period
- Lamb over 48 days
- Lamb over 33 days (2 cycles)
Induction of Estrus in Sheep - ALP 2018

Don’t forget to have adequate ram power!

Make sure the rams are fertile before you spend money on hormones

What about mismating?

• E.g. The owner of a small flock of sheep comes to the barn in the morning and finds that the ram lambs intended to be sold that week to market have broken into the ewe pen
• He sees some breeding activity between mothers and sons– what can be done?

Induction of Abortion from Mismating

• The progesterone that maintains pregnancy in a sheep comes from the CL only for the first month or so from pregnancy
• After 45-50 days progesterone is excreted only by the placenta
• Wait 11 days from the event to make sure active corpus luteum
• Sheep
  • < 45-50 d gestation PGF2α will work well
  • > 50 d gestation, PGF2α + dexamethasone once/day for 2 to 3 days with poor success – only use on advice of veterinarian
• This can be a big problem for feedlot ewe lambs with teenage pregnancies!

Induction of Lambing

• When length of exposure to the ram is known and short
  • E.g. ram exposure 48 hours or less
  • AI breeding
  • Extremely accurate ultrasound aging
• Induce lambing after 142 days of gestation
  • Can be adjusted by breed if length of gestation is longer but don’t go shorter – lambs can’t tolerate more than a few days of being premature
  • Some will wait until first lamb is dropped then inject the rest
  • Concentrate lambing for labour, facilities
  • Dexamethasone intramuscular (16-20 mg)
    • Will lamb 24 h to 72 h later – average 36 h
    • Can mostly lamb on a weekend!
    • PGF2α will not work as pregnancy not CL dependent

Why do sheep fail to meet reproductive goals?

Failure to Meet Reproductive Targets

• Ram Failure
  • Failure to mate the female
  • Failure to get the female pregnant
• Ewe Failure
  • Failure to be mated
  • Failure to conceive or maintain pregnancy
  • Poor prolificacy
**RAM: Failure to Mate**

- Crayon failure
  - Mounts not being recorded properly
  - Harness doesn’t fit
  - Too cold for crayon

- Reluctant to mount / breed
  - Pain or physical blockage from infectious balanoposthitis (pizzle rot from high protein diets)
  - Pain from orf infection on prepuce
  - Congenital deformity or traumatic injury to penis
  - Lameness

- Insufficient number of rams to ewes
  - Varies with situation – consider
    - Topography (breeding pasture versus wild terrain)
    - Age and experience of the male
    - Time of the year (ovulatory, transition, anovulatory)
    - Synchronization of the females

- Inter-male aggression
  - Males may fight with each other rather than breed

**Ram: Failure to Mate**

- Uns suited to environment
  - Breed type hardness
    - Hill or range
    - Versus paddock breeding
  - Conformational fault
    - Feet & legs
    - Can’t do the necessary traveling to find females in heat

**RAM: Failure to Mate**

- Low libido
  - Disease
- Low body condition score
  - Will lose at least 1 BCS during breeding
  - Exhaustion
- Photoperiodic effect
  - Seasonality of breed
- Hot weather
**Induction of Estrus in Sheep - ALP 2018**

**RAM: Failure to Mate**
- Preference for specific females
- Rams can fall in love with one ewe
- Or dislike some ewes
- Need to rotate rams in synchronized programs

There will never be another ewe!

**RAM: Failure to Achieve Pregnancy**
- May present as
  - Return to estrus
  - Low pregnancy rate
  - Spread out lambing period
  - Late start to lambing
  - Spread out lambing period
  - May also present as poor prolificacy

**RAM: Failure to Achieve Pregnancy**
- Seasonal sub-fertility
  - Late spring/early summer worst
  - For short season breeds, rams are affected too
  - Fertility & prolificacy ↓
  - Testes are soft, smaller

**RAM: Failure to Achieve Pregnancy**
- Orchitis
  - Inflammation of the testis
- Epididymitis
  - Inflammation of the epididymis
- Can be ascending infection from mounting rams
- *Brucella ovis*

**RAM: Failure to Achieve Pregnancy**
- Excessive heat to the testes
  - Fever due to illness, local inflammation
  - Chorioptic mange of the scrotum
- Excessive cold to the testes
  - Frost bite
  - Inflammation caused by injury
  - Scrotal haematoma
  - Need to heal 60 days to restore semen quality

**RAM: Failure to Achieve Pregnancy**
- Testicular circumference too small
  - Generally > 32 cm in season
  - Poor sperm characteristics
RAM: Failure to Achieve Pregnancy
- Failure of the synchronization program due to poor ram management
- Too few males for the number of females in that particular program
- Rams are subfertile / inexperienced
- Putting the males in with the females right after the CIDR is removed
- Keeping males in with females while the CIDRs are in

EWE: Failure to be Mated
- Pregnancy
  - Accidental exposure
  - E.g. not separating out ram lambs early enough
  - Accelerated lambing systems when may keep early bred ewes with open ewes
- Lactation

EWE: Failure to be Mated
- Out of season
  - Nulliparous (never been bred) have a shorter season than older ewes
  - Breed variation – know your flock

EWE: Failure to be Mated
- Failure of the synchronization program
- CIDR management
  - Loss from individuals
  - Left in too long
  - Didn’t leave in long enough
- Melengestrol (MGA) management
  - Incorrect frequency of feeding
  - Feeding management
- Anovulatory / transition season
  - Didn’t use eCG or insufficient dose
  - Too much light during “dark phase” of day

EWE: Failure to be Mated
- Hormone disruptors
  - Mycotoxins such as zearalenone
  - Some plants produce estrogenic-like substances
- Body condition score
  - Very thin
  - Very fat
  - Dental disease
  - Parasites, other infectious disease

EWE: Failure to be Mated
- Issues with nulliparous ewe-lambs
  - Not well grown due to inadequate nutrition or disease
  - Slow maturing breed
  - Shy because inexperienced
  - Less fertile out-of-season
  - Unable to compete with adult females if bred together
**Induction of Estrus in Sheep - ALP 2018**

**EWE: Failure to Be Mated**
- Undocked long tails of ewes?
  - Impedes physical breeding
- Freemartin / intersex
  - ~5% of ewe lambs born co-twin to a male
  - Deformed reproductive tract & infertile

**EWE: Failure to Conceive or Maintain Pregnancy**
- Early Embryonic Death
  - <60 days gestation
  - Genetic defects
  - Abortion diseases
  - High urea nitrogen from feed
  - Stress

**Common Causes of Abortion in Sheep**

**Infectious**
- *Chlamydophila abortus*
- *Campylobacter spp*
- *C. jejuni*
- *C. fetus fetus*
- *Toxoplasma gondii*
- *Bordetella burnetii*

**Non-Infectious**
- Iodine deficiency
- Stress
- Trauma

**EWE: Poor Prolificacy**
- In the face of adequate number of rams
  - Any of above +
  - Genetics
    - Breed can’t meet producer goals
    - Nutritional deficiency in flushing period
    - Severe nutritional deficiency after breeding
    - Over-conditioned ewe lambs have lower ovulation rate
  - Poor fertility in ewe lambs raised in a feedlot

**EWE: Poor Prolificacy**
- Lower prolificacy at beginning and end of ovulatory season
- Lower prolificacy out of season
- Primiparous and older females are less prolific
- Inadequate # and fertility of males
Accelerated Breeding Programs

- 3 Lamb Crops in 2 Years
- Breed every 8 months.
- Lambs weaned at 50 days
- Breed in-season, out-of-season and transitional season.
- Allows for marketing of meat animals year round.

- Cornell Star
- Breed every 7.2 months
- 5 lamb crops in 3 years
- Minimal breeding / lambing period and early weaning

“Three in Two” Accelerated Lambing System

- 3 Lambings in 2 Years
- 3 Lambing periods per year:
  - Jan 1st, May 1st & Sep 1st
- Breeding < 30 days
- Lamming < 30 days
- Lactation < 60 days

CORNELL STAR Accelerated Lambing System

- 5 Lambings in 3 Years (36 months)
- One production cycle = 7.2 months
- 5 lambing periods per year starting:
  - Jan 1st, Mar 15th, May 27th, Aug 8th & Oct 20th
- Breeding < 30 days
- Lamming & Lactation = 66 days

Conclusions

- To optimize productivity from a sheep flock, it is important to understand normal reproduction and how to manipulate it.

Questions?