Overview

• Sheep Reproductive Cycle
  – How the estrous cycle works

• Anatomy of Reproduction
  – Female Anatomy
  – Male Anatomy

• Egg + Sperm → Embryo → Lamb
  – The process of making a lamb/kid, start to finish

• Advances in Sheep Reproduction
  – LAI, ET, synchronization tools, etc.
Female Reproductive Cycle

• **Definitions:**
  – **Estrous**: adjective, “The length of the estrous cycle is _____ days.”
  – **Estrus**: noun, “The ewe is displaying estrus.”
  – **Hormones**: regulate reproductive organs of the ram and ewe, secreted from different places
  – **Follicle**: site on the ovary where the oocyte is housed
  – **Corpus luteum (CL)**: forms after the follicle ruptures and secretes progesterone
Hormones

- **Estrogen (E₂):** female sex hormone, development of the sex organs and 2° sex characteristics, causes ewe to display estrus or “heat”
- **Progesterone:** the hormone that maintains pregnancy
- **FSH:** follicle stimulating hormone, stimulates development of follicles
- **LH:** luteinizing hormone, causes ovulation, development of the corpus luteum
- **GnRH:** gonadotropin releasing hormone, tells the brain to release FSH and LH
- **PGF2α:** prostaglandin f-2α, causes regression of the corpus luteum
Estrous Cycle

Corpus Luteum

Image provided by Dr. Schrick
Female Reproductive Cycle

• Characteristics
  – Seasonally polyestrus: sheep/goats display multiple estrous cycles in one season
  – Short day breeders: sheep begin to cycle as day length decreases (autumn/fall)
  – Not all breeds have the same breeding season
    • Long- Rambouillet, Merino, Dorset, Exotics
    • Short- Southdown, Cheviot, Shropshire
    • Intermediate- Hampshire, Columbia, Corriedale
Female Reproductive Cycle

• **Numbers to Know**
  – **Puberty**: 5-8 months of age (bucks sooner)
  – **Estrous cycle length**: 14-19 days (Sheep)
    18-24 days (Goats)
  – **Estrus length**: 20-42 hrs. (Sheep)
    25-40 hrs. (Goats)
  – **Gestation**: 143-152 days (5 months)
Anatomy of Reproduction

• **Female anatomy**
  - External and internal
  - Functions of each part

• **Male anatomy**
  - External and internal
Anatomy of Reproduction

- **Female anatomy**
  - Ovaries
  - Oviduct
  - Uterus
  - Cervix
  - Vagina
  - Vulva

http://www.ansci.wisc.edu
Anatomy of Reproduction

- Male Anatomy
  - Accessory sex glands
  - Epididymis
  - Vas Deferens
  - Scrotum
  - Testicles
  - Urethra
  - Penis

http://kinne.net/fertbuck.htm
Anatomy of Reproduction

https://www.veterinary-online.blogspot.com
Hormones

• Estrogen and progesterone are very important

• Estrogen is responsible for:
  – Display of estrus!

• Progesterone is responsible for:
  – Maintenance of pregnancy!

• That’s why we can use these to manipulate the ewe’s cycle
Gametes

- Female gamete- oocyte, produced by ovary
- Male gamete- sperm, produced by testicles

Please visit [www2.dpi.qld.gov.au/sheep](http://www2.dpi.qld.gov.au/sheep) for more information.
Ovulation

• Oocyte is housed in the dominant follicle of the ovary
A Sperm Factory

1. High Speed Manufacturing
   - \(<1-25 \times 10^9\) spermatozoa/day (35,000-200,000 per second)
   - “Plant” must be air conditioned

2. Finishing Shops
   - Fluid absorption
   - 8-25x10^9 spermatozoa
     - Membrane changes
     - Nuclear & flagellar stabilization
     - Motility
     - Cytoplasmic droplet translocation

3. Warehouse and Shipping
   - Storage 10-50x10^9 spermatozoa
   - Spermatozoa for 5 to 10 ejaculations
   - Smooth muscle contractions upon sexual stimulation

4. Final Alterations and Packaging
   - Metabolic substrates
   - Surface coatings
   - Transport for spermatozoa

5. Delivery System
   - Erection
   - Protrusion
   - Emission
   - Ejaculation
A Look at Fertilization

- sperm fertilising ovum
- zygote dividing by mitosis
- morula (solid ball of cells)
- blastocyst (hollow ball of cells)
- ovum shed from ovary
- ovary
- wall of uterus
- blastocyst implanted in wall of uterus

http://en.wikibooks.org
Embryo Development

0-2
1-cell

1-3
2-cell

2-3
4-cell

3-5
8-cell

4-5
16-cell

5-6
Morula

5-7
Tight Morula

7-8
Early Blastocyst

7-9
Blastocyst

8-10
Expanded Blastocyst

9-11
Hatched

Image provided by Dr. Schrick
Blastocyst!

- Day 7-12 in bovine
- Day 4-10 in sheep

- **ICM** (Inner cell mass) this will become the fetus
- **Trophoblast** this will become the placenta

Pathways to Pregnancy and Parturition, P.L. Senger
Gestation Facts

• Gestation in the ewe lasts for 146-150 days (5 months), same for does
• Fetal age can be determined by crown-rump length and/or head diameter via ultrasound
• The CL produces progesterone for the first 55 days of pregnancy, after that the placenta takes over until day 146-150
• The fetus initiates parturition via cortisol
Parturition

• The process of giving birth to offspring

• Three stages (times are for the ewe)
  – Contractions & cervix dilation (2-6 hours)
  – Expulsion of fetus (30-120 minutes)
  – Expulsion of membranes (5-8 hours)
Parturition

• Parturition is induced by release of cortisol from the fetus (this is a “stress” hormone)
• Progesterone from placenta gets turned into estrogen
• This estrogen causes the uterus to contract
• Contraction continues and releases PGF2α, which causes more contractions, this cycle continues until birth
Parturition

• Pressure inside the uterus causes the fetus to position itself correctly, if not then dystocia will occur
Artificial Insemination

- Semen is deposited into the ewe’s uterus through the vagina or through use of a laparoscope
Laparoscopic AI

• Semen can be frozen or fresh
• What are some advantages of this technology?
• Success rates can be as high as 70-80%
  – Depends on technician
  – Synchronization
  – Seasonality
  – Age
  – Nutritional management
  – Stress
Laparoscopic AI

• Proper restraint is critical!
Cervical AI

- Not as widely used
- Success rates vary greatly
- Hard to pass a pipette through the ewe’s cervix

Pathways to Pregnancy and Parturition, P.L. Senger
Embryo Transfer

- Does for the female what AI does for the male
- Uterus is outside of body
- Embryos are flushed out and collected in a dish on day 6
- Use LAI (fresh semen preferred)
Embryo Transfer

• Optimal Candidates:
  – Young to middle aged females who are highly productive and more lambs are sought after each year.
  – Older females not able to care for their offspring but are still genetically desired.
  – You wouldn’t just flush “any old ewe”.
  – Need several recipients available per donor.
Embryo Transfer
Embryo Transfer
Semen Collection

- Provides insurance to the owner
- Useful for ET and LAI
- Use of more diverse group of males than with natural cover
- Collected via artificial vagina or with an electroejaculator
- Motility and morphology are both evaluated
Cryopreservation

• More breeding opportunities
• The ram might die and you need genetics
• Effective storage is essential with all frozen semen!
• Post-thaw motility must be evaluated
• High quality semen is important for LAI and ET
Synchronization

- Use of hormones to manipulate the estrous cycle and synchronize estrus in a group of ewes
- Allows for better lambing management
- More uniform lamb crop
- Fall born lambs?
- Make sure you have enough rams
Synchronization

-12 0 2

CIDR

IN OUT

-12

Estrus

PG600

$5 per CIDR (Pfizer) $10 per dose OUT

$10 per CIDR

(Pfizer)
CIDR’s

- CIDR- Controlled internal drug release
- Progesterone impregnated plastic
- Acts like a CL
Ultrasonography

- Used for pregnancy detection
- Echogenicity: works via sound waves
  - Fluid: black
  - Bone: white
  - Tissue: gray
- Can perform as early as 40 days abdominally, more typically done around day 45-50
Ultrasonography

• Used for fetal counting and sexing
• Can perform sexing around 45-60 days of age
  – Fetus must be in the correct position!
• Veterinarians usually charge a small fee for each service performed
Questions?

Unique Workshop Focuses on Small Ruminant Reproduction

By BECKY TALLEY
Sheep Industry News Associate Editor

From Nov. 10-12, North Dakota State University's (NDSU) Animal Sciences Department, in conjunction with a grant from the American Sheep and Goat Center and the Department of Animal and Food Sciences at the University of Wisconsin-River Falls, hosted a small ruminant reproductive management workshop for veterinarians.

The workshop provided hands-on experience in a wide variety of topics including sheep reproduction, estrus synchronization and superovulation, laproscopic artificial insemination (LAI) and embryo collection and transfer, to name a few.

While veterinarians are commonly schooled in a variety of reproduction techniques, it is less common for them to have experience with the type of sheep and goat reproduction that the workshop covered.

Because of the sheep's unique reproductive tract, common artificial techniques like cervical artificial insemination, do not have as high a success rate like it does in other species, so techniques like semen collection, embryo transfer and LAI are very important to make genetic advancements in ovines.

Jessy Harris, reproductive physiologist from University of Tennessee-Knoxville, participates in an embryo transfer during the small ruminant reproduction management workshop at North Dakota State University.

However, from a producer standpoint, many are not aware of these techniques or Small Ruminant Workshop, page 11