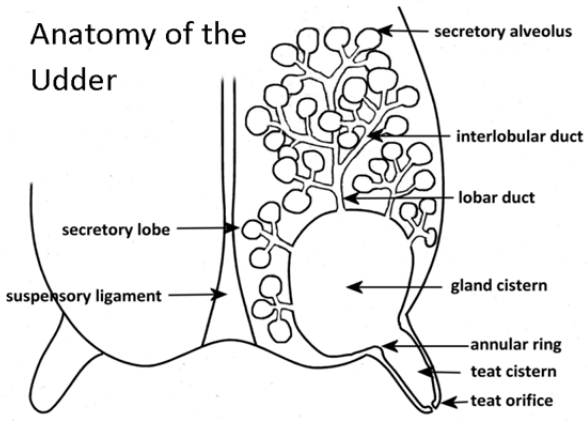
1. WHAT IS NORMAL?

To understand what is abnormal, we first need to understand how a healthy ewe produces milk.

1.1 THE NORMAL ANATOMY OF THE MAMMARY GLAND

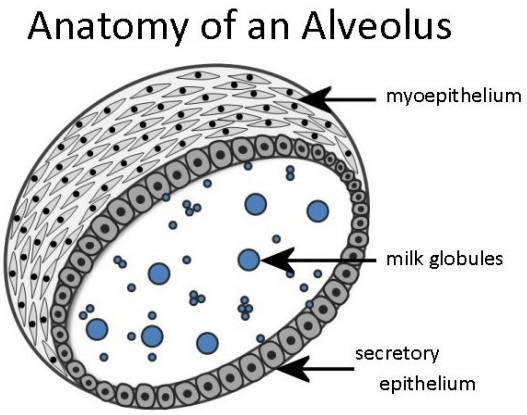
The mammary gland is composed of glandular tissue, which grows under the influence of hormones (see **Section I.1.2**). A diagram of the anatomy of the udder is provided in Fig. 1. This tissue produces milk, which is secreted into alveoli – small spaces shaped like balloons. There are millions of these alveoli in each mammary gland of a ewe. Milk produced in the alveoli travels into the ducts that connect the alveoli and eventually into the gland cistern and into the teat cistern.

Fig. 1.



Each alveolus is lined by secretory epithelial cells, which are responsible for secreting the various components of milk (casein, lactose, lipids, minerals, vitamins and water) (Fig. 2). The milk is actively forced out of the alveoli by the contraction of a layer of specialized cells (myoepithelial cells) which line the outside of each alveolus, and then through a series of ducts and into the gland cistern where it accumulates. This process is called "milk ejection". The alveoli are also surrounded by a network of small blood vessels, which bring nutrients to the cells for making the milk, as well as bring disease-fighting white blood cells (somatic cells) and antibodies. The lymphatics travel along with the blood vessels, also providing a means for white blood cells to travel. The tissue between the alveoli (known as the interstitium) provides a frame for these blood and lymphatic vessels – as well as nerves. The glands are supported to the body wall by suspensory ligaments.

Fig. 2.



Apocrine secretion is the process whereby the milk is excreted by the secretory cells that line the alveoli (Fig. 3). The milk particles collect in the cell towards the end closest to the lumen of the alveoli and then are "pinched-off" the cell and into the alveolar lumen. The globules not only contain the components of milk but also small cytoplasmic particles. They are encapsulated in a thin membrane that was part of the cellular structure. This is similar to goats but different from cows that produce milk by merocrine secretion. Because the cell is damaged slightly each time milk is excreted from it, factors of inflammation called cytokines are also released into the milk. This likely affects the normal level of somatic or inflammatory cells in the milk, as they are attracted to the presence of cytokines.

Fig. 3.

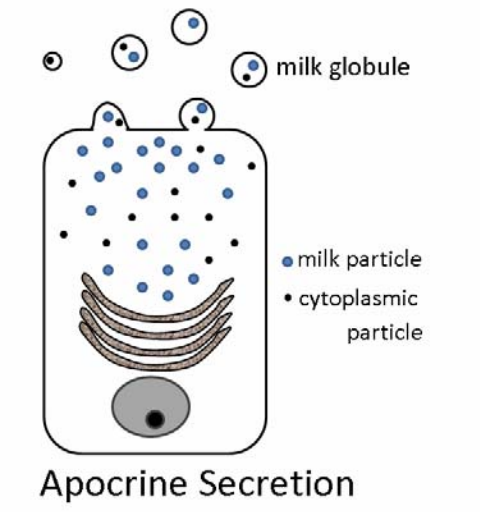
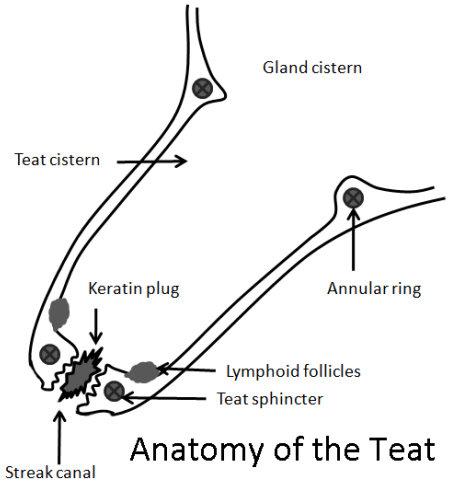


Fig. 4.



The teat is separated from the gland cistern by the annular ring at the top of the teat (Fig. 4). This ring contains many blood vessels and feeds the blood supply to the teat. The teat cistern is lined with a smooth mucous membrane. The teat sphincter is a strong muscle located at the bottom of the teat. The streak canal is located within the teat sphincter and connects to the teat cistern. The suckling action of the lamb's tongue allows trapping of the milk from the gland cistern into the teat cistern and then squeezes it down the streak canal through the teat sphincter. The actions of a milker's hand or of the milking machine, mimics this.

The health of the teat is very important in preventing mastitis. The end of the teat is constructed to prevent introduction of bacteria. The teat sphincter normally closes after milking. However, it may take up to 2 h for the teat sphincter to close properly after machine milking, allowing bacteria to invade in the meantime. As well, just inside the teat cistern above the streak canal are accumulations of lymphoid cells (lymphoid follicles), which help to fight bacteria that may invade the teat. When the ewe is dried-off at the end of lactation, a keratin plug consisting of a waxy material secreted by the cells of the sphincter forms a physical barrier in the streak canal. Damage – acute or chronic, mild or severe – to the health of the teat is a major predisposing factor in mastitis.

1.2 HOW IS MILK PRODUCED?

1.2.1 MAMMOGENESIS (MAMMARY GLAND DEVELOPMENT)

During pregnancy, the mammary gland structure develops. The number of blood vessels and milk secretory cells increase in preparation for lambing and milk production. New lobules of alveoli and the supporting ducts sprout as the mammary gland grows. This sprouting appears to continue for several weeks after lambing. The hormone progesterone is one of the main triggers for udder growth, in combination with the hormone estrogen. Progesterone is secreted by the ovary of the ewe (from the corpus luteum – a structure on the ovary which develops after the ovum or egg is ovulated), and after the first trimester of pregnancy – by the placenta of the developing foetuses.

1.2.2 LACTOGENESIS (PRODUCTION OF MILK)

This is the creation and secretion of milk, starting with colostrum prior to lambing and continuing through lactation. The number of secretory cells in the mammary gland determines the amount of

milk produced. Damage from mastitis will greatly reduce milk production. Damage may be temporary or permanent. During lactation, estrogen is still important in directing milk production but progesterone is not.

GALACTOPOESIS

This term refers to the maintenance of lactation once lactation has been established. Lactation is maintained by the secretion of galactopoietic hormones and the removal of milk (milking). Hormones of importance include growth hormone (likely most important) and prolactin. Removal of milk removes a protein called feedback inhibitor of lactation (FIL), which inhibits milk production. This protein is important for drying-off (see below).

MILK EJECTION REFLEX (MILK LET-DOWN)

When the teats are stimulated with touch (which mimics nursing behaviour), the nerve impulses from the teats to the brain cause release of the hormone oxytocin from the pituitary gland, a very important gland that sits just below the brain inside the skull. Oxytocin travels through the bloodstream to the mammary gland and causes contraction of the myoepithelial cells that coat the outside of each alveolus. This causes the alveolus to contract and expels the milk from the lumen, forcing it down the ducts and into the gland cistern. This milk ejection occurs very quickly, within a few minutes of stimulation.

Milk ejection does not always require touch as the sight and sounds associated with the milking parlour may cause oxytocin release once the ewe has learned that the parlour is associated with milking. This is called a "conditioned response". But proper stimulation is important to make sure that maximum milk-out occurs. If ewes are not properly prepped and the milking machine is put on without stimulation, milk-out time is longer and peak-milk flow rate is delayed. Without proper udder preparation the longer milking time damages the teat sphincter which may lead to invasion with mastitis-causing bacteria.

Stress, fear and pain will inhibit the action of oxytocin and therefore milk ejection. Release of the hormone epinephrine (produced by the adrenal gland) is part of this inhibition. Cortisol, another hormone produced by the adrenal gland in response to stress will also lower milk production. So it is very important to make sure that the milking procedure is as stress-free as possible to optimize milk ejection. This includes preventing loud noises or threats from other animals such as dogs or strangers.

RESIDUAL MILK

This term applies to the amount of milk left in the udder after milk ejection and milking. The volume tends to be less in young animals versus those that have had several lactations, but can be as much as 10 to 20% of total milk produced each day. Machine stripping will decrease this amount by about half but there are disadvantages to machine stripping with respect to udder health. Oxytocin injections before each milking may temporarily decrease the amount of residual milk but the ewe quickly becomes resistant to its effects.

1.2.3 INVOLUTION

When removal of milk ceases, the mammary gland will involute. However, even if the ewe continues to be milked, milk production will eventually decline and cease.

If milking ceases there is a build-up of FIL, which will reduce secretion of milk. Cells start to die (programmed cell death also called apoptosis) resulting in involution of the gland. This cellular debris is cleaned up by white blood cells (macrophages). Existing cells produce less milk. This state of active involution usually starts 24 to 48 h after milking stops.

The keratin plug forms in the streak canal of the teat, preventing bacteria from invading the udder. This usually happens within a few days of drying-off. The udder may enlarge but the milk is reabsorbed after a time. Milking off this secretion can be harmful to udder health as the keratin plug is removed thus allowing bacteria to enter.

Pregnancy will contribute to the decline in milk production, although ewes are often not bred until late in lactation (to lamb every 12 months, ewes would be bred at 210 days in milk), so it is unlikely to play a major role in lactation length.

1.2.4 THE DRY PERIOD

Ewes require a dry (non-lactating) period before they lamb again. Research in goats has shown that goats require at least 28 days or the next lactation milk production is lower. Cows require a minimum of 40 days. Without this quiet period, mammary cell proliferation is reduced at the next lambing and as much as 1/3 less milk is produced the following lactation. A ewe should have a dry period not shorter than 28 days and more appropriately a minimum of 60 days.

1.2.5 EFFECT OF SEASON AND DAY-LENGTH (PHOTOPERIOD) ON MILK PRODUCTION

Normally, sheep lactate during the spring and summer. However because milk is required year round for cheese production, there are financial pressures to have ewes' milk during all seasons.

Sheep milked when the photoperiod is long (i.e. spring and early summer), have a higher level of milk production than when milked when the photoperiod is short (i.e. late fall to early winter) or when the photoperiod is decreasing (e.g. in the fall). For this reason, there may be a financial benefit to expose ewes that lamb in the fall to long photoperiods using artificial light (e.g. 16 h of light per day). This could be combined with light programs that induce out of season breeding (See Section I.2.5.5).

The length of photoperiod also seems to be important pre-lambing. Ewes exposed to short photoperiods (8 h of light each day) for 6 weeks pre-lambing have higher milk yields than ewes exposed to long photoperiods (16 h of light each day).

There is evidence that milk produced during the winter months has a higher cheese yield but this may be because those ewes have lower milk volumes at that time of year.

1.2.6 EFFECT OF MILKING FREQUENCY

If milk is not removed frequently from the gland the following will happen:

- There is increased pressure in the mammary gland which causes decreased blood flow and thus nutrients resulting in decreased milk secretion
- The hormone prolactin is not released
- The level of the FIL protein will increase and inhibit milk secretion

When nursing lambs, ewes are milked-out every one to two h. Traditional milking systems are usually every 12 h or twice/day. But milking is very labour intensive and if the interval could be decreased without loss of milk yield, there could be tremendous savings.

Between milkings, milk is stored not only in the alveoli but also in the gland cistern. Up to 75%, but usually around 50%, of total milk production can be stored in the cistern of the ewe as opposed to dairy cattle, which is generally around 20%. Sheep selected for larger gland cisterns tend to be affected less by decreased milking frequency, likely because they have more capacity for storage in the cistern.

There is evidence that after 90 days in milk (i.e. mid-lactation) it is possible to milk ewes as infrequently as every 16 h without loss of milk yield but not as infrequent as once/day. However, early lactation ewes should still be milked at least every 12 h, as it would decrease milk yield (20 to 60%), lactation length and persistency.

Milking 3 times per day is done with dairy cows to increase production. Studies in dairy sheep have shown an increase in milk yield of between 15 to 35% but there are few studies and conflicting results.

1.2.7 LACTATION CURVE

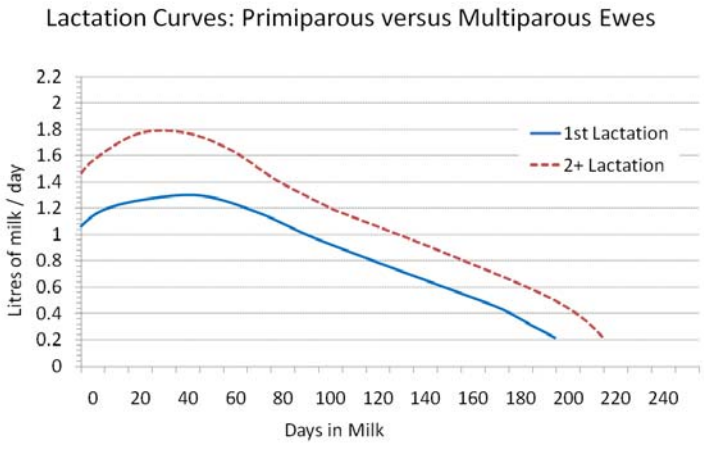
Total milk production of the ewe is dependent on the shape of the lactation curve, specifically time and height of peak milk (maximum daily milk yield in the lactation) and the persistency of the lactation (lactation length). More milk is obtained when the peak is high and the curve is flat and long.

Fig. 5 demonstrates the pattern of milk production if the ewe is milked starting one day post-lambing. As outlined below, there are many producers that start to milk the ewe later in lactation (approximately 30 days post-lambing). So, for those farms, persistency is critical to achieving economic returns on their animals.

Factors that affect peak milk and persistency include:

- Genetic selection for these traits
- Photoperiod (daylight length)
- Lambing season – affected by available nutrition
- Nutritional supplementation
- Number of lambs born
- Lactation number
- Stress and pain at the time of milking
- Number of times milked per day
- Presence of mastitis

Fig. 5.



Based on published studies, ewes that lamb in the spring tend to have higher peak milk, but ewes that lamb in the fall are more persistent. Ewes with multiple lambs tend to have higher milk production, perhaps as a consequence of higher levels of progesterone during pregnancy and so more alveoli. For those farms that wean at one month of age, the amount of milk suckled by the lamb(s) will have a great effect on the milk production once the ewe goes into the milking string. Multiparous ewes have higher peak milk and more persistent production than first lactation ewes. First lactation ewes also have later peak milk, perhaps because the udder is slower to develop.

1.2.8 NORMAL MILK PRODUCTION VALUES FOR DAIRY SHEEP

There is tremendous variability in milk production between breeds of dairy sheep, length of lactation and milking systems. Meat breeds tend to have very short lactations (< 90 days), dairy breeds are quite variable – up to 300 days, again depending on a number of factors covered above, including nursing period, but usually less than 240 days.

The more common dairy breeds in North America – East Friesian (Germany), Lacaune (France) and much less common, Assaf (East Friesen X Awassi (Israel))–have higher milk production values than meat breeds and their crossbreeds. Quoted ranges include: East Friesian – 300 to 600 kg (litres) over as much as 10 months of lactation with some as high as 900 kg; Lacaune – 270 kg over 5 ½ months; Awassi – 440 to 550 kg over 8 – 10 months. British Milk Sheep is a composite breed combining dairy breeds with some maternal trait meat breeds. Milk production values are quoted as 300 to 400 kg of milk over 6 - 7 months. Meat breeds tend to produce less than 70 kg of milk and often much less. Other Mediterranean breeds not currently present in North America, also have notable milk production values: Manchega (Spain); Chios (Greece); and many, many more. To help understand the comparisons between how milk production is reported: 1 L of milk weighs 1.030 kg; 1 kg of milk = 2.2 lbs; 1 pint of milk = 1.044 lbs.

Sheep milk is markedly different in composition than milk from cattle or goats. Fat is most often reported as a proportion of the milk produced although stage of lactation can vary this percentage quite a bit. Sheep have values from as low at 5% to a high of 9% but most often reported in the 6 to 7% range. This compares to 3.5 to 4.5% for dairy cattle and goats. Protein values are similar but slightly lower, most often reported as 4.5 to 6%. Lactose percentages tend to be similar to cattle and goats with most values falling between 4.5 to 5%. Proportion of milk as water tends to be less than cattle and goats, 83% versus ~ 88% - reflective of higher total solids (fat and protein).

2. FLOCK HEALTH MANAGEMENT OF THE DAIRY EWE

2.1 MANAGEMENT OF THE EWES DURING THE TRANSITION PERIOD

The transition period is that time from late in pregnancy when the lambs are growing rapidly and the ewe is starting to produce its first milk – colostrum, lambing and a few weeks post-lambing when she is making milk and adjusted to her new ration and management.

2.1.1 VACCINATION PROGRAMS FOR THE ADULT FLOCK

CLOSTRIDIAL DISEASES

TETANUS

Tetanus, caused by *Clostridium tetani* can affect animals with wounds, lambs tail-docked with rubber rings, dirty tagging equipment, or ewes with damage from lambing. The bacterial spores can last for decades in the soil. If the spores enter a wound, the bacterial toxin (tetanus toxin) is absorbed by the body and causes the muscles to spasm. A sheep with tetanus has a stiff gait and cannot open its mouth (lockjaw), eventually suffocating due to paralysis of the breathing muscles. Very few animals with tetanus survive.

Fig. 6. Lamb with tetanus

PULPY KIDNEY / ENTEROTOXAEMIA

Fig. 8. Lamb died from pulpy kidney

These two names applied to the same disease caused by *Clostridium perfringens* type D, which causes sudden death in healthy lambs. There are many other types of *Cl perfringens* (A, B, C, and E) infections but "type D" is the most common and important type in sheep. The bacterial spores are passed in the manure and contaminate feed and pasture. When eaten, the spores develop into bacteria in the digestive tract but are usually killed by the digestive juices in the abomasum. But when lambs are eating a rich diet such as grain or lush pasture, the bacteria will grow and produce toxins that damage many tissues including blood vessels, the brain and the kidneys. Lambs will change from being very healthy and active to dead within a few hours. The most common age to be affected is 3 months to one year of age although adults can also get the disease.

GANGRENE

Fig. 7. Gangrenous mastitis

For dairy sheep, this disease is important if the flock has problems with gangrenous mastitis (Section II.2.1.1). Clostridial organisms will invade dead tissue and produce toxins, which cause very severe illness in the ewe. It is rare for a sheep with gangrene to survive.

SUGGESTED VACCINATION PROGRAM FOR CLOSTRIDIAL DISEASES

Clostridial vaccination programs should be done for all sheep in all flocks, as these diseases are very common. There are many vaccines on the market approved for sheep – some containing antigens to as many as 8 different clostridial organisms. Regardless of what product your veterinarian recommends, make sure it contains protection against both tetanus and pulpy kidney. Other organisms may be important on your particular flock and so seek advice from your flock veterinarian on which vaccine to use. When deciding when to vaccinate lambs and adults, first read the label and package insert. Below is an example vaccination program (Table I.1), but your veterinarian may adjust this depending on the vaccine used and other management factors.

Table I.1. Vaccination program to control clostridial diseases in dairy sheep

CLASS OF ANIMALS	TIMING OF ADMINISTRATION OF VACCINE
Nursing Lambs	No vaccination should be administered to nursing lambs, as the vaccine will not work if antibodies absorbed from colostrum are still present in the lamb.
Lambs: 12 weeks old	The initial vaccination of the primary series can be administered at this time.
Lambs: 16 weeks old	The booster of the primary series should be given 4 weeks after the initial vaccination.
Market lambs	Market lambs should not be vaccinated within 21 days of slaughter.
Ewes	Booster every 12 months or more frequently, ideally 4 to 2 weeks prior to expected lambing to optimize colostral antibody production for the lambs. This will protect the lambs until approximately 3 months of age.
Rams	Booster every 12 months.

REASONS FOR VACCINE FAILURE

- **Vaccine given too young**, i.e. interference from antibodies from the colostrum will inactivate the vaccine.
- **Vaccine not boostered**. The first dose primes the immune system; the second boosts it high enough to protect the lamb against disease.
- **Booster dose is not given at the correct time**. For the primary series, the two doses must be given ~ 4 weeks apart (read the label for company's recommendations). For the annual booster, the vaccine must be given every 12 months.
- **Dose given is too small**, i.e. not enough antigen to produce an immune response.
- **Vaccine not given by the correct route of administration**. Read the label to see if should be given under the skin (subcutaneous) or in the muscle (intramuscular).
- **Vaccine is contaminated**. Bacterial contamination of the vaccine will cause infection at the site of vaccination – harming the animal and making the vaccine useless. Inserting a used needle will inject bacteria right into the vaccine.
- **Vaccine is expired**. The vaccine is composed of inactivated bacteria and toxoids that stimulate a protective immune response. Over time, these degrade and lose their ability to cause an immune response. After the expiration date, the effectiveness of the vaccine is not sufficient to protect against disease.
- **Vaccine is not kept refrigerated**. Bacteria may grow in the vaccine, making it ineffective.

CASEOUS LYMPHADENITIS (CLA)

THE DISEASE

Caseous lymphadenitis, (CLA; CL; cheesy gland), is caused by the bacteria *Corynebacterium pseudotuberculosis*. The bacteria cause abscesses of the lymph nodes and internal organs of sheep and goats, and sometimes llamas and alpacas. The abscesses break and drain and contaminate equipment (e.g. shears), feed and water where the bacteria can survive for long periods. The bacteria easily invade the body through abrasions and small wounds on the skin or in the mouth.

Fig. 9. Abscess due to CLA

Abscesses are most often found in the lymph nodes located just under the skin. They also occur inside the body: lung liver, kidney, in the spine and brain. Internal abscesses can occasionally cause chronic wasting (the animal feels ill from the infection and eats poorly and so loses weight or the bacteria actually damages tissues) or death of the ewe or ram. If you see abscesses in your sheep, have your veterinarian culture the abscess to determine if this is CLA.

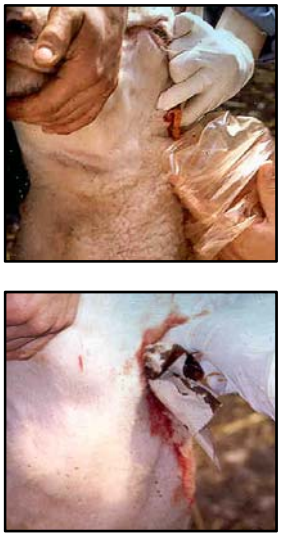
VACCINATION

At this time, there are only two CLA vaccines licensed in Canada and the USA[1]. The vaccine is given using the same schedule as outlined in Table I.1. The vaccines will not cure sheep already infected with the bacteria but will help to protect replacement stock. Consult your veterinarian for more details on how to best use it in your flock.

OTHER CONTROL MEASURES FOR CLA

To help the vaccine do its job, it is important to reduce the load of bacteria in the environment. This can be done through the following measures:

Fig. 10. Lance, clean and disinfect CLA abscesses



- Routinely palpate the external lymph nodes of sheep, e.g. every 4 to 6 weeks.
- If an abscess is found, isolate the sheep in a pen reserved only for sheep with CLA abscesses.
- When the abscess is ripe (hair or wool loss on the surface), first check to see if it is an abscess by withdrawing pus using a sterile needle and syringe.
  - Wearing disposable gloves, lance the abscess completely open with a clean sharp scalpel blade. Have your veterinarian teach you how.
  - Catch all the pus in a plastic bag for proper disposal.
  - Scrub the wound and surrounding skin with chlorhexadine or iodine (2 ½% tincture) to kill all bacteria.
  - Keep the sheep isolated until the wound in healed.
- Milk all sheep with abscesses last and then disinfect the milking stalls, including feeders before the next milking.
- Record all treatments so sheep with repeated abscesses are culled.
- Shearing protocols to reduce transmission
  - Shear young-stock first, then older sheep and finally sheep that have had an abscess in the past.
  - If an abscess breaks during shearing,
    - Disinfect the abscess.
    - Clean and disinfect the shearing blades, shearing piece (handle), hands and change clothing if contaminated with pus.
  - Spray all shearing wounds or abrasions with iodine or chlorhexadine solution.
- Feeders should be designed so that sheep do not need to put their heads through slats to reach the feed.

[1] Case-Bac (Colorado Serum / Bioniche); Caseous DT (Colorado Serum / Bioniche)

2.1.2 CONTROL OF ABORTION

The most common causes are *Chlamydia abortus*; *Toxoplasma gondii* (toxoplasmosis); *Coxiella burnetii* (Q Fever); *Campylobacter jejuni*; *Campylobacter fetus* subsp *foetus*; iodine deficiency; and Border Disease virus. However there are many, many causes of abortion and if your flock is experiencing losses, it is critical to have your veterinarian investigate and institute proper control measures.

Fig. 11. Mummified fetus and placenta

Fig. 12. Severe placentitis

FEATURES OF THE COMMON CAUSES OF ABORTION

Healthy sheep rarely abort, fewer than 2%. But an abortion "storm" of 15 to 30% it is not uncommon. When an infectious cause of abortion first enters the flock, initially losses are high. But if the abortion disease is enzootic, most losses are seen in the naive ewe-lambs. In that case abortion rates of 5 to 7 %, although not alarmingly high – indicate there is an abortion problem in the flock.

Abortions, i.e. premature delivery of lambs, usually start about 2 weeks prior to the first expected date of lambing. Lambs born before 142 days of gestation usually can't survive as they are too premature. Aborted foetuses may be aborted alive but die soon after; dead – fresh or rotten; macerated; or mummified (Fig. 11). The placenta may appear normal or may be thickened, reddened, or necrotic with purulent discharge (placentitis, Fig. 12). Lambs may also reach term – but are either stillborn or weak and alive but die soon after birth. The ewes may appear healthy or be very sick, depending on the disease agent.

INVESTIGATION OF AN ABORTION PROBLEM

If your flock is experiencing an abortion problem, it is very important to get a diagnosis so that appropriate action can be taken. Pathologists are well trained to investigate abortion in small ruminants and success rates are very good when both the placenta and fetus are submitted.

If you go to the barn and notice that a ewe has aborted, do the following:

- Put on protective clothing and double glove with disposable gloves – ideally shoulder gloves (e.g. rectal sleeves). If you have a mask, put that on as well.
- Pick up all the aborted materials you can find including all the placentas, gently remove the straw and bits of manure (don't wash) and place in a clean, heavy-duty plastic garbage bag.
- If the placenta is hanging out of the vulva, gently grasp and remove it. If it won't come, cut the bottom part off and leave a bit hanging out. Make sure you have at least 2 cotyledons (look like pink pepperoni slices) included in the piece of placenta.
- Identify and mark the aborted ewe. Move the pregnant healthy ewes out of that pen – which could be contaminated with the disease agent, and leave the aborted ewe there. She can be culled to slaughter once the birth fluids have dried up (usually 2 weeks).
- If the ewe aborts close to term and comes into milk, you should consult your veterinarian to determine if it is advisable to keep her in the flock.

- After lambing is done, that pen will need to be thoroughly cleaned and disinfected and the bedding burned or thoroughly composted for at least 5 months.
- Put your gloves in the bag with the foetuses and placentas, tie the bag off and put it where animals can't eat the contents and it will stay cool and not freeze.
- Leave your coveralls and boots (and hat and coat) in the barn, wash your hands and arms with disinfectant soap and call your veterinarian.
- Arrange to take the placentas and foetuses to the veterinary diagnostic lab as soon as you can (the AHL[2] is open in the early evening and weekends).
- Look up the ewe's records with respect to when she was bred and any other history.

Your veterinarian will assess the situation and decide what measures are most appropriate to take, both with that ewe and with the flock as a whole. Watch other ewes for signs of abortion and follow the procedures above again until you have a diagnosis. If you know the cause, aborted foetuses and placentas still must be properly disposed either with deep burial (not the manure pile!) or burning.

ABORTION DISEASES AND HUMAN HEALTH

Many of the causes of abortion in sheep are zoonotic. Because you may not know the cause, it is safest to assume the worst and protect you, your family and other farm workers. What follows are some general guidelines but your veterinarian may wish to make more specific recommendations. If abortion is occurring or has previously occurred in your flock:

- Wear protective clothing and disposable shoulder gloves when assisting lambings.
- Leave all protective clothing in the barn to keep the disease agents out of the house. Dedicate a set of protective clothing to lambing so that any disease agents are not spread to healthy animals.
- Frequently wash your hands and arms with disinfectant soap (chlorhexadine) to prevent accidentally contamination of your mouth, eyes or nose.
- It may be advisable to wear a mask (N95 fitted mask) when assisting an aborting ewe to prevent inhalation of disease agents.
- People that have weak immune systems (e.g. elderly people, or those with chronic illnesses); pregnant women; babies and toddlers should not enter the lambing area as they are at higher risk of becoming ill.
- The people listed above should also not handle very young or sick lambs. For other barn chores, they should wear protective clothing that stays in the barn.
- If anybody becomes ill – go to your physician armed with knowledge about the abortion disease in your barn so that proper and prompt treatment can be given.

2.1.3 LATE GESTATION AND EARLY LACTATION NUTRITION

Nutrition in the last trimester of pregnancy affects not only the ewe's ability to milk well, but also the survivability of her lambs and the quality and quantity of the colostrum she makes for those lambs.

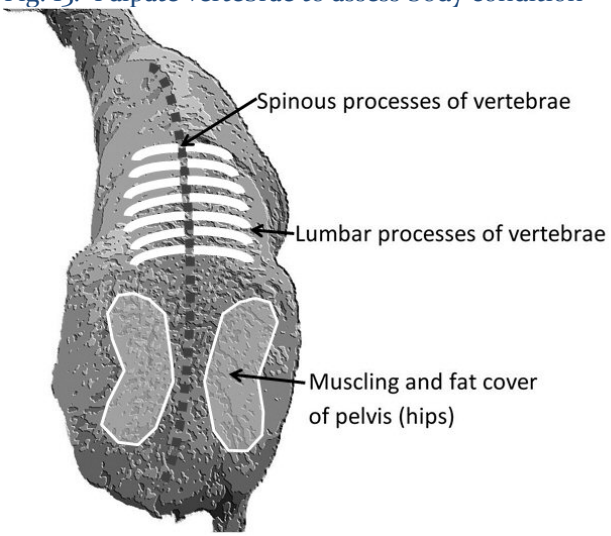
[2] University of Guelph Animal Health Laboratory is a diagnostic laboratory that has a service for performing post mortems on livestock. http://www.guelphlabservices.com/AHL/

Late gestation requires additional energy and protein. For ewes carrying singles, this may be provided by good quality forage – but usually some grain and perhaps a protein supplement must be supplied.

SORTING BY BODY CONDITION SCORE AND NUMBER OF LAMBS

Pregnancy scanning approximately 50 to 70 days of gestation, can determine the number of lambs that the ewe is carrying. Although it is preferable for ewes to carry multiple lambs as this will increase the size of the udder and increase milk production, they will also put an extra demand on the pregnant ewe, which must be compensated for in the late gestation ration.

Fig. 13. Palpate vertebrae to assess body condition



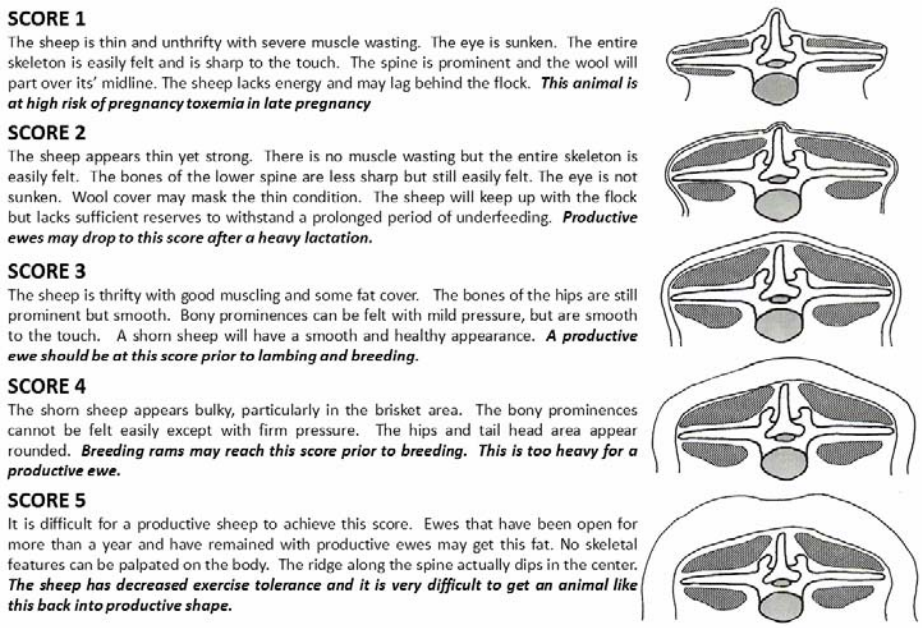
To properly perform condition scoring, have the ewe standing (e.g. in a chute) and firmly palpate to determine the amount of muscle and fat present in the following locations: the backbone in the region behind the ribs (spinous processes), the lumbar processes and the top of the pelvis. The brisket can also be assessed in a similar way. Body condition scoring at pregnancy scanning will allow feeding groups to be sorted as follows:

- Ewes carrying single lambs that are BCS 3.0 to 3.5.
- Ewes carrying multiples (twins and triplets) and ewe carrying singes that are thin (BCS 2.0 to 2.5)
- If facilities and numbers allow: Ewes carrying triplets and quads + ewes carrying twins that are thin.
- Ewe lambs should be fed differently as they are growing as well as carrying lambs. Body condition scoring is illustrated on the next page in Fig. 14. and the goals are described in Fig. 15.

PRODUCING QUALITY COLOSTRUM THROUGH PROPER VACCINATION

The lamb must get its initial immunity from the ewe's colostrum. If the quantity is sufficient but the quality is poor, the lamb may still not be protected. Make sure that the level of antibodies available for the lambs is provided through a proper vaccination program (Section I.2.1.1). The ewe is best given 4 to 2 weeks prior to the first expected lambing date, or approximately 120 days (4 months) after the ram is introduced to the flock for breeding purposes. Vaccinating later means that the colostrum is already in the udder and the vaccine will not improve the level of protective antibodies for the lamb.

Fig. 14



BODY CONDITION SCORING OF SHEEP

SCORE 1

The sheep is thin and unthrifty with severe muscle wasting. The eye is sunken. The entire skeleton is easily felt and is sharp to the touch. The spine is prominent and the wool will part over its' midline. The sheep lacks energy and may lag behind the flock. ***This animal is at high risk of pregnancy toxemia in late pregnancy***

SCORE 2

The sheep appears thin yet strong. There is no muscle wasting but the entire skeleton is easily felt. The bones of the lower spine are less sharp but still easily felt. The eye is not sunken. Wool cover may mask the thin condition. The sheep will keep up with the flock but lacks sufficient reserves to withstand a prolonged period of underfeeding. ***Productive ewes may drop to this score after a heavy lactation.***

SCORE 3

The sheep is thrifty with good muscling and some fat cover. The bones of the hips are still prominent but smooth. Bony prominences can be felt with mild pressure, but are smooth to the touch. A shorn sheep will have a smooth and healthy appearance. ***A productive ewe should be at this score prior to lambing and breeding.***

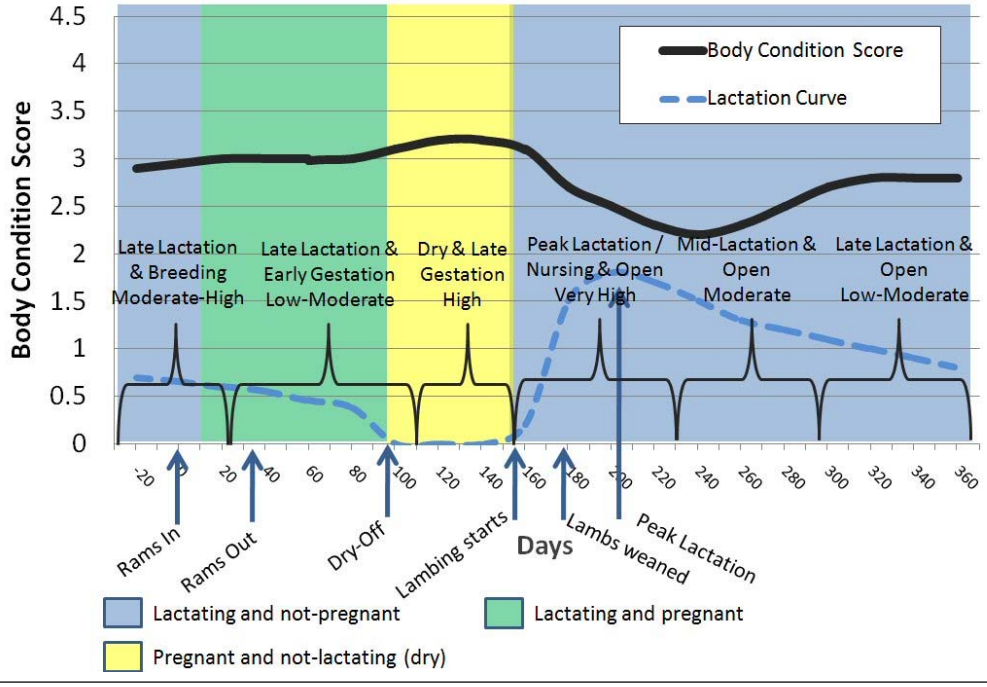
SCORE 4

The shorn sheep appears bulky, particularly in the brisket area. The bony prominences cannot be felt easily except with firm pressure. The hips and tail head area appear rounded. ***Breeding rams may reach this score prior to breeding. This is too heavy for a productive ewe.***

SCORE 5

It is difficult for a productive sheep to achieve this score. Ewes that have been open for more than a year and have remained with productive ewes may get this fat. No skeletal features can be palpated on the body. The ridge along the spine actually dips in the center. ***The sheep has decreased exercise tolerance and it is very difficult to get an animal like this back into productive shape.***

Fig. 15 BSC goals by stage of production (low, moderate, high or very high nutritional demands)



MINERAL / VITAMIN SUPPLEMENTATION

VITAMIN E AND SELENIUM

Most soils in Canada are deficient in selenium (Se). Vitamin E is plentiful in fresh forages (hay and haylage) as alpha-tocopherol, but declines sharply in stored forages and is very low in corn silage. Deficiency of selenium and vitamin E not only causes white muscle disease in lambs, but is also associated with early pregnancy loss and poorer immune performance, which shows up as, increased risk of mastitis and off-flavoured milk (cardboard). These diseases can be prevented by proper supplementation of the ewe during pregnancy and lactation, removing the need to inject lambs.

Work with your nutritionist to make sure the correct amounts are in the ewe's ration. Se supplementation to the ewe:

- 0.2 to 0.3 mg/day to the pregnant ewe;
- 0.7 to 1.0 mg/day to the early lactating ewe.

E.g. a mineral containing 60 ppm (parts per million or mg/kg) of selenium, fed free choice will be usually consumed at ~ 15 gm (1/2 ounce) / day of mineral. This means that the ewe will generally ingest 0.9 mg of selenium/ day. Vitamin E should be supplemented so that the ewe ingests 250 to 500 IU / day.

CALCIUM AND PHOSPHORUS

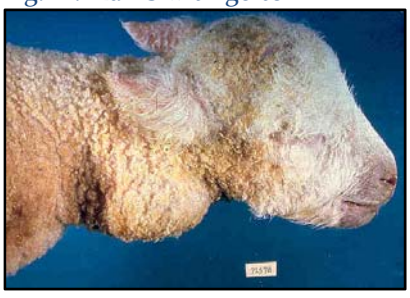
Ewes in late gestation need to be fed adequate calcium for the growing bones of the lambs. Adequate amounts are usually supplied by good quality, mixed grass forages – but diets composed mostly of corn silage may be short in calcium. Limestone is a good source of calcium as are legume forages (e.g. alfalfa). Phosphorus is usually supplied through the mineral and grains. It is important that the ratio of calcium to phosphorus be 1.5 – 2 to 1.

OTHER MACROMINERALS

Sodium (Na) and chlorine (Cl) (**salt**) are critical to proper metabolism at all times in the sheep. Sheep should always have access to a free-choice salt, ideally loose rather than as a block – or incorporating salt in the diet at 1-4% of the total dry matter of the ration. Potassium (K) deficiency is most commonly seen in animals on high grain and low forage diets. Magnesium (Mg) must be included in the diet to prevent a disease called "grass tetany", due to low magnesium. This is usually seen in lactating ewes being fed cereal forages (e.g. oat hay) or grazing green cereals (e.g. winter wheat pastures in the fall).

TRACE MINERALS

Fig. 16. Lamb with goiter



Ewes should have access to a balanced trace mineral feeding program either through loose feeding of a trace mineral premix, or through inclusion in a late gestation pellet including protein and grain. Trace minerals that are sometimes associated with disease in sheep:

- **Iodine** (I) – to prevent congenital goiter a cause of abortion and stillbirth in lambs. Lambs are aborted or born very weak and have enlarged thyroid glands. The

Great Lakes region and the Prairie Provinces are deficient in iodine and so this mineral must be supplemented to sheep at all ages and times of the year.

- **Cobalt** (Co) – necessary for the production of vitamin B12 by the rumen microflora. Much of Canadian soils are deficient in cobalt. Deficiency in cobalt results in sheep growing poorly - also called ill-thrift.
- **Copper** (Cu) – sheep require very little in comparison with cattle and goats, and if fed too much will store the extra copper in their liver. Eventually the copper damages the liver and destroys their red blood cells killing the sheep. Never feed sheep a mineral or ration not specifically formulated for sheep. Total level of copper in the diet should not exceed **10 ppm** dry weight (DW).

Fig. 17. Copper toxicity - jaundice mucous membranes and dark red urine

OTHER VITAMINS

- **Vitamin A** – this is consumed as beta-carotene, which is converted to vitamin A in the intestine. Green forages supply sufficient vitamin A to maintain ewe health. Deficiency can result in poor growth and milk production, blindness and sometimes nervous signs. If not present in the green feed, it must be supplemented to the ewe on a daily basis, particularly in lactation.
- **Vitamin B1** – also known as thiamine. This vitamin is produced in the rumen by rumen microflora. With some digestive upsets, an enzyme is produced which breaks down thiamine in the rumen. Thiamine deficiency results, causing brain damage called polioencephalomalacia, or more commonly "polio", not related to the human disease polioencephalitis. Animals with this disease need emergency attention by a veterinarian to diagnose and treat this deficiency before permanent brain damage is done.
- **Vitamin B12.** This vitamin is also produced in the rumen but requires the presence of cobalt to be made. Cobalt deficiency disease described above, is actually a deficiency of vitamin B12.
- **Vitamin D** –is produced when the skin is exposed to sunlight. Vitamin D aids in absorption of calcium from the intestine. If sheep are housed for long periods or if the sky is overcast for weeks at a time, and there is no supplementation, disease may be seen in growing lambs – as rickets, or in all animals as osteomalacia (soft bones). It may also increase the risk of hypocalcaemia (Section I – 2.1.4) in ewes in late pregnancy.

WATER

Without water, sheep will not eat. Within a short period of time, they will become severely dehydrated and die. Sufficient quantity and quality of water is critical to the survival of animals for even a short period of time. The following in Table 1.2 is adapted from the review article by Infascelli et al, 2004 but modified by information from the Fact Sheet 716/400 Water Requirements of Livestock – OMAFRA. Please note that these values are by kilogram of feed (dry-weight or DW) consumed. Lactating ewes will consume up to 3.5% of their body weight. So an 80 kg ewe in early lactation may eat 2.8 kg of feed (DM) and on a warm summer day may need almost 30 L of water per day.

Table I.2. Water requirements (litre of water per kilogram of dry matter intake of feed)

CLASS OF SHEEP	ENVIRONMENTAL TEMPERATURE (°C)		
	< 16	16 – 20	> 20
Lambs up to 4 weeks of age	4.0	5.0	6.0
Growing lambs and open and non-lactating adults	2.0	2.5	3.0
Mid-gestation ewes:			
Carrying 1 lamb	3.0	3.8	4.6
Carrying 2 to 3 lambs	3.3	4.1	4.9
Late-gestation ewes:			
Carrying 1 lamb	4.1	5.2	6.3
Carrying 2 to 3 lambs	4.4	5.5	6.6
Lactation:			
First month (OMAFRA Factsheet)	9.4	10.4	11.4
Second and following months	3.0	3.7	4.5

Water quality is also critical. Sheep are reported to tolerate up to 1.7% (17,000 mg/L) of total dissolved solids (also called TDS) but general livestock guidelines suggest up to only 3,000 mg/L without an impact on health. Sheep may need time to acclimate to above 3,000 mg/L but levels above 5,000 mg/L should not be used for pregnant or lactating animals. Table I.3 is a summary of information including the guidelines for Canadian water quality for livestock last updated in 2005 and information from other sources.

Table I.3. Recommended guidelines for water quality for livestock production

ITEM	MAXIMUM RECOMMENDED LIMIT (MG/L OF WATER)
Total Dissolved Solids (TDS)	< 5,000, with 10,000 as a maximum before seeing problems. Dairy sheep may tolerate lower levels before affecting milk production. Less than 1,000 is recommended for dairy cows.
Sodium	1000. < 200 recommended for humans.
Chlorine	1,000 but decreased water consumption at > 250.
Calcium	1,000
Nitrate & nitrite	100
Nitrite alone	10
Sulphate	1,000 (333 elemental sulphur).
Copper	< 0.1 for cattle.
Iron	< 0.1 for dairy animals or will cause oxidized flavour in milk. Human limit for taste is 0.3, and 10 lowers water palatability for cattle, but no toxic levels have been established for ruminants.
Lead	0.1
Selenium	0.5
Alkalinity (calcium carbonate)	pH between 6.0 and 8.5. 500 or lower if sulphate levels are elevated.

ITEM	MAXIMUM RECOMMENDED LIMIT (MG/L OF WATER)
Lipolytic/proteolytic bacteria	≤ 5/100 mL for dairy industry
Coliforms	Recommended: 1 coliform/100 mL water – lambs. < 20 coliforms/100 mL water – adults. No higher than 200/100 mL.
Enterococci	50/100 mL maximum.
E. coli	200/100 mL maximum.
Cyanobacteria (blue-green algae)	Up to 3.9 µg/L of toxin or 19,500 cells/mL water.

FEEDING MANAGEMENT OF THE LATE GESTATION EWE

Pregnant ewes require more feeder space than one that has lambed. Because it is critical that all sheep have an opportunity to eat grain, feeder space should be adjusted accordingly unless being fed a total mixed ration (TMR) with ad libitum access. Grain should be hand-fed twice per day to make sure that all ewes are eating. Amounts vary but the ration should be properly balanced for body condition score, number of foetuses and age (ewe-lambs versus adult ewes). This is best done by a nutritionist.

2.1.4 CONTROL OF NUTRITIONAL / METABOLIC DISEASES OF THE LATE GESTATION EWE

PREGNANCY TOXAEMIA

Also called "twin lamb" disease, this is caused by insufficient energy in the late gestation ration. Ewes carrying multiple lambs are more at risk because their needs are several times higher than a ewe carrying a single lamb. The pregnant ewe needs energy dense feed such as grain.

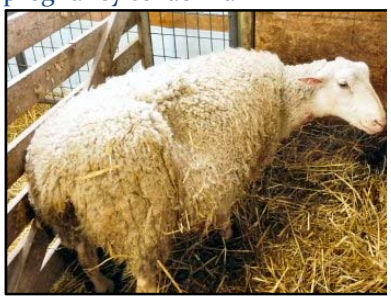
Ewes with pregnancy toxaemia stop eating grain or stop fighting for grain. The rumen is empty and they appear gaunt (Fig. 19). As the sugar levels decline in the blood and brain tissue causing brain damage, the ewe shows nervous signs: they press their head into walls (headache from brain swelling); and will hold their head high and may appear blind (Fig. 18). Soon they can no longer stand, and are totally off-feed. The low sugar levels cause the lambs to die in the uterus – then the ewe becomes toxic from the decaying lambs, and she dies soon afterwards in 2 to 3 days.

If ewes are at risk for pregnancy toxaemia, there are factors that may tip a ewe over the edge:

Factors affecting the flock: Bad weather without proper shelter; being held off feed or missing a meal for a procedure (e.g. shearing, vaccinating); problems with access to water (e.g. frozen water line) or very cold water reducing feed intake; insufficient space at the feeder; poor quality forage, etc.

Fig. 18. Head position with pregnancy toxaemia

Fig. 19. Gaunt ewe with pregnancy toxaemia



Individual animal factors: old age; poor teeth; lameness; thin body condition score (no reserves); over conditioned or fat; any chronic wasting disease; not able to compete at the feeder.

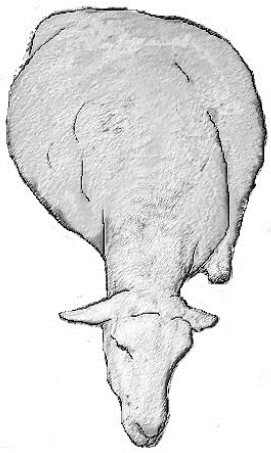
If a late pregnancy ewe goes off feed, it is important to call your veterinarian to determine the reason for this. Pregnancy toxaemia can sometimes be successfully treated if caught early but if you wait until the ewe is down, death is likely for both her and her lambs.

Prevention is the best approach - making sure that the ration contains sufficient energy and protein for the stage of pregnancy and the number of foetuses being carried. Analysing forages, sorting groups by body condition score and number of foetuses, and hand-feeding supplemental grain will help. Your veterinarian can also monitor the blood of your flock for levels of β-hydroxybutyrate (BHB), a ketone body produced when the sheep is in a negative energy balance, that is – the ewe is not getting enough energy from her feed. Blood BHB levels can detect pregnancy toxaemia in a flock before animals become ill.

HYPOCALCAEMIA (MILK FEVER)

Just like a dairy cow, sheep can get "milk fever"– a disease caused by low calcium in the blood (hypocalcaemia). But that is where the similarity ends. Cows usually develop hypocalcaemia at calving due to the demand for calcium in the milk. However, the biggest calcium need for sheep is in late gestation, when the skeletons of the foetal lambs are being mineralized. This happens 6 to 2 weeks before lambing and before there is any milk in the udder. Calcium in the ewe is necessary for proper muscle contraction. Ewes with low calcium levels in the blood become excited and stumble and hop around the pen and then become cold, bloated, and down. Their hind legs are stretched behind them and front legs tucked underneath. The head is stretched out in front and they often drool. Ears and skin are cold to touch. Hypocalcaemia can occur along with pregnancy toxaemia and a veterinary examination is necessary to determine which disease is present (or if both are).

Fig. 20. Hypocalcaemia



The risk factors for this disease include: forages with low calcium (oat hay, corn silage, grazing winter wheat) and no calcium supplementation in the mineral; transport – either by vehicle or being moved on foot long distances – both use up calcium; other disease that puts them off-feed when calcium levels are borderline; high phosphorus in the diet without additional calcium.

Hypocalcaemia is a medical emergency and requires immediate treatment by a veterinarian to save the ewe's life. Fortunately, unlike pregnancy toxaemia, response to proper treatment (calcium injections given in the vein) is fast and dramatic. However, giving calcium incorrectly can stop the heart – so diagnosis and treatment should be done by a veterinarian.

VAGINAL PROLAPSE

Vaginal prolapse (VP) is quite common in sheep and it is impossible to prevent all cases. However there are things that can be done to avert cases. VP occurs usually 2 to 3 weeks before lambing. The pressure from the lambs combined with looseness of the ligaments in the perineum pushes the wall of the vagina to the outside. It starts as a small pink protrusion, usually first observed when the ewe is lying down – when abdominal pressure is greatest. Once the tissue becomes irritated, the ewe will

start to strain increasing the size of the prolapse. When severe, the ewe's life and the life of her lambs is at risk.

FACTORS AFFECTING THE RISK OF VAGINAL PROLAPSE

Flock Level Factors

- Poor quality or poorly digestible forage is likely the # 1 cause of vaginal prolapses. Poor quality forage will increase rumen size and may cause the vagina to be pushed out when the heavily pregnant ewe lies down. This is worse in small ewe-lambs, or in over-conditioned (fat) ewes or ewe-lambs.
- Feeder design. If the ewe must stand on the feeder to reach the feed, the pressure of the uterus will force the vagina out. Cattle feeders that have not been height adjusted and grazing steep hillsides may increase risk.
- Feeder space. Crowding at the feeder will increase pressure on the abdomen.
- Feeds high in estrogens. Some plants (e.g. red clover) or diseased grains containing mould toxins (e.g. zearalenone), causing relaxation of the pelvic ligaments.

Individual Level Factors

- If a sheep had a vaginal prolapse the previous pregnancy it is almost certain it will prolapse the following year. Affected sheep should not be rebred but culled.
- Over-conditioning increases the risk due to abdominal fat.
- Having other pregnancy associated disease such as pregnancy toxaemia.
- Short tail-docking will weaken the ligaments and muscles in the pelvic region and greatly increase the risk of rectal prolapse – which occurs along with vaginal prolapse.
- There may be genetic component, but management and environment are more important.

Treatment of vaginal prolapses must be done promptly and a number of options can be used including vaginal spoons and harnesses. However, if several animals are affected, check the risk factor list and work with your flock veterinarian to determine how to avoid the problem.

2.1.5 PREPARING FOR LAMBING

BREEDING FOR LAMBING

LENGTH OF EXPOSURE TO THE RAM & LENGTH OF LAMBING PERIOD

Exposure to the ram for breeding must be a planned event. Rams should be introduced for a specific time period. Ewes are short-day seasonally polyestrous, that is they cycle only during the fall when daylight is decreasing – usually starting in late August to mid-September – and cycle every 17 days until early winter (e.g. January to early February). Seventy-five percent of ewes should become pregnant to the first cycle after exposed to the ram and 20% to the second. By having a breeding exposure of 35 days, ewes have at least 2 opportunities to breed and become pregnant. Normally the length of a lambing period is about one week longer (+/- 3 days) than the length of the breeding exposure. So, if the breeding exposure is 35 days, the length of the lambing period is 42 days.

TO KNOW WHEN THE EWES ARE DUE TO START LAMBING:

- Restricting the time the ram is exposed to the ewes.
- Using a ram marking harness and recording breedings (marks). Change the colour of the crayon every 2 weeks so can visually identify "re-marks".
- Having the ewes scanned and estimate foetal age.
- House the late pregnancy ewes together so appetite and behaviour can be monitored.
- Observe the ewes at least once / day for udder development starting ~ 1 week before first expected lambing date (~ 135 days after the day the ram is first introduced).

CONSIDERATIONS FOR EWE-LAMBS

It makes sense to breed ewe-lambs separately from the ewes as ewe lambs are still growing as well as being pregnant; and exposure to abortion diseases can be lessened. Ewe lambs need more attention to possible difficulty lambing and bonding with offspring.

They can be bred when they reach 70% of mature body weight, which should be by 7 months of age. In this way, they can join the milking string at one year of age. Ewe-lambs are less fertile if bred out-of-season before experiencing their first natural heat. These females may need to have breeding delayed until their first fall after achieving puberty.

ENVIRONMENTAL NEEDS FOR LAMBING

Close-up ewes need to be observed frequently so illness can be detected as well as lambing difficulties. Close-up pregnant ewes should be penned or pastured separately from those that have lambed or are far from lambing, and facilities should allow separation of individual ewes if necessary. The environment should contain fresh clean water, good quality forage and clean bedding or pasture. There should be good ventilation with minimal drafts and low humidity. If on pasture, there should also be protection from predators.

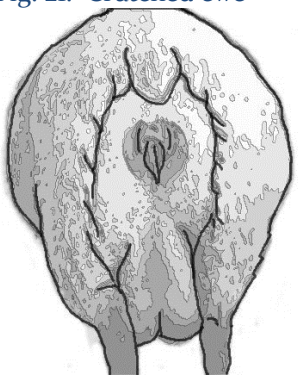
Ewes should be allowed to lamb undisturbed if making good progress. Once lambs are born, facilities should allow for easy separation of the ewe-lamb pairs into claiming pens, unless lambs are to be snatched at birth for specific disease control programs.

SHEARING

Shearing of the ewe can be done at the same time as vaccination against clostridial diseases as long as the ewe has protection from wind and cold for a few weeks until the fleece is 2 to 3 cm long (1 in). Shearing has many benefits:

- It increases the amount the ewe eats so that the lambs will be a better size when born;
- The udder and rear of the ewe are cleaner so that the lamb doesn't get a mouthful of manure-coated wool when nursing;
- It reduces the humidity in the barn; and
- It keeps the udder cleaner for milking later on.

Fig. 21. Crutched ewe



If shearing is not possible, the wool should be removed from the escutcheon and udder – a procedure called crutching (Fig. 21).

EQUIPMENT FOR LAMBING

Prior to the start of lambing, make sure you have adequate supplies. A list of things to have on hand can include:

Fig. 22. Lamb equipment

- Lambing supplies: disinfectant soap; sterile lubricant; disposable shoulder gloves.
- Lambing equipment: lambing snare; soft ropes for legs; clean towels.
- Stomach tube for lamb; syringe or squeeze bottle for tubing colostrum; heat lamp
- Veterinary drugs and equipment – only to be used as directed by your veterinarian, e.g. written treatment protocol: injectable vitamin E selenium; tincture of 2.5% iodine for navels + disposable Dixie cups; short-acting penicillin; injectable oxytocin; non-steroidal anti-inflammatory drug (NSAID) for pain management; disposable sterile syringes (1 cc; 3 cc; 5 cc) and 1" needles (22 g; 20 g; 18 g; 16 g).
- All drugs must be stored properly, discarded if expired and used according to veterinary directions.
- All used needles (sharps) must be discarded immediately after use in a proper container (sharps container or empty plastic bottle with lid).

Fig. 23. Sharps container

2.1.6 LAMBING MANAGEMENT

ASSISTING AT LAMBING

It is important to provide proper assistance when needed. Keep lambing supplies on-hand as outlined above. Be clean and use a disinfectant soap, gloves and lots and lots of lubricant. Review management of dystocia with your veterinarian if you are not experienced.

After day 142 after the rams were introduced, observe ewes as frequently as can be managed, i.e. at least every 4 to 6 h.

INTERVENING IN A LAMBING

Some guidelines for when to intervene…

- Only part of the lamb appears, e.g. only the head, just the tail, just one leg.
- After the water breaks (amniotic sac), there is no progress for 30 min.
- The ewe has been straining to lamb for more than 90 min with no progress.

After washing up the vulva put on a glove and lubricate well. Have an assistant hold the ewe steady while she is standing. Insert your hand and identify the cervix. If it is closed, it feels similar to knuckles in a clenched fist but if open, you may not be able to identify it. Make sure that the cervix is

open enough to easily fit your hand through into the uterus. Once inside the uterus, you can feel the caruncles, which feel like prominent buttons. Be gentle! It's very easy to cause damage.

Malpresentations can be very daunting for the new producer. Here are a few tips to help you, keeping in mind that it is very easy to be too rough.

- Identify the legs and head of the lamb and which way it is positioned.
    - A front leg will have the first 2 joints bend the same way (fetlock and carpus or knee). The third joint will bend the opposite way (the elbow).
    - A hind leg will have the first two joints bend opposite ways (fetlock and the hock). The third joint (the stifle) will bend the opposite way of the hock.
    - The head can be identified by feeling the dome of the skull and the jaw. The teeth are sharp!
- A normal presentation has the lamb right sideup and forwards and both front feet and head are presented. Less optimal presentations are:
    - Backwards - no head to feel but can feel the tail and bottoms of feet are presented.
    - Upside down - check which way the legs bend.
    - The head bent back - may feel the front legs and neck, but no head.
    - Only one leg or no legs presented.
    - Twins can be tangled up so it is difficult to tell which leg belongs to which head.

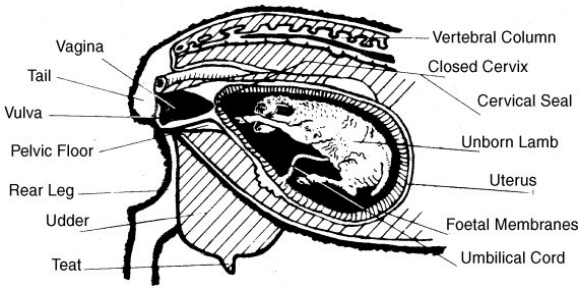
LAMBING-TIME EMERGENCIES

Difficult lambings that cannot be easily corrected are a veterinary emergency. If you wait, the placenta will separate from the uterine lining – interrupting the supply of oxygen and the lamb will suffocate.

Call your veterinarian immediately if:

- You cannot feel the lamb but the water has broken or labour is well advanced.
- Gentle manipulation after 15 min will not correct a malpresentation or produce a lamb.
- The lamb appears too large to fit easily through the pelvis.
- Things are just too confusing.

Fig. 24. Courtesy of Ontario Ministry of Agriculture and Food
Full Term Ewe with Lamb in Normal Presentation



A caesarean section (C-section) must be done in the following situations: the lamb is too large to come through the pelvis of the ewe or becomes stuck; a malpresentation cannot be corrected easily (e.g. head back, tangled twins); the cervix doesn't open sufficiently for the lamb to be easily delivered (e.g. ringwomb); the uterus is torsed inside the ewe; the ewe has pregnancy toxaemia and is down; the vaginal prolapse is severe and the cervix does not dilate enough to allow delivery of the lambs.

Other obstetrical emergencies include: prolapse of the uterus which most often occurs right after the lambs are delivered (differentiated from a vaginal prolapse because the ewe's caruncles can be seen); torn uterus, cervix or uterus; and excessive bleeding.

RESUSCITATING A NEWBORN LAMB

Resuscitation of the newly delivered lamb that is not breathing can be done by clearing the airway and reviving it. Swinging or hanging upside-down should be kept to a minimum as this put stress on the diaphragm and makes it difficult for the lamb to draw air into its lungs. Rub the lamb vigorously with a clean towel. Cold water in the ear stimulates it to shake its head and breathe in sharply. Do not perform mouth-to-mouth resuscitation in case of abortion diseases. A lamb delivered from a prolonged lambing or an assisted lambing is at HIGH RISK of dying from hypothermia / hypoglycaemia (chilling / starvation) and should receive special attention. These lambs may also not nurse enough to drink sufficient colostrum and will need to be supplemented by hand, either bottle or tube feeding.

STRAINING AFTER LAMBING

If the ewe continues to strain after lambing, it could be due to a few things. She may still have a lamb trapped in the pelvis – a simple examination will tell. If the lambing was difficult, the vagina or cervix may have been damaged and inflamed. Antibiotics and NSAIDS may help but contact your veterinarian. Sometimes a ewe will prolapse her vagina after lambing – even if she did not prolapse previously. Some ewes will strain with a retained placenta but usually there is another reason.

RETAINED PLACENTA

The placenta is usually passed within a few hours of lambing but is considered to be retained if it has not passed by 24 h. Reasons for this include: a difficult lambing; a lamb is still inside; abortion. If the ewe doesn't "clean" by 24 h, wash her vulva with disinfectant soap, put on a clean glove with lubricant and check for lambs. If no lamb can be felt leave the end hanging out and don't trim it. Monitor the ewe for fever and appetite. If the ewe stops eating, contact your veterinarian.

More information is available from OMAF Factsheet Assisting the Ewe at Lambing, which can be found at: http://www.omafra.gov.on.ca/english/livestock/sheep/facts/98-091.htm

2.1.7 COLOSTRUM MANAGEMENT

IMPROVING TRANSFER OF ANTIBODIES FROM THE COLOSTRUM TO THE LAMB

Lambs, unlike human infants, are born without protective antibodies and must obtain these from the first-milking colostrum of the dam. The colostral antibodies are absorbed through the gut lining for only a brief time in the first day of life. This transfer of antibodies is critical to the lamb for the first few months of life.

LAMB TEAT-SEEKING BEHAVIOUR

Normally, the lamb will be on its feet in a few minutes, attracted to the smell of the waxy gland in the inguinal region next to the udder, and to the curve of the ewe's abdomen. These are cues the lamb uses to locate the teat. The ewe assists this process by licking and nudging the hind end of the lamb towards the teat. This stimulates a sucking response. Ideally the lamb should be ingesting colostrum within an hour of being born. To assist this behaviour:

- Putting the ewe and her lambs in a claiming pen to assist with bonding.
- Make sure the ewe's udder is clean and dry. Crutching or shearing will help this.

- Checking the ewe's udder to detect mastitis and to strip the plugs from her teats.

With a weak lamb or a nervous ewe that won't allow suckling, strip the colostrum and hand-feed the lamb. Oxytocin can be used to help let milk down. Consult your vet for recommendations on its use. Hand-feeding can be done by bottle, or by stomach tube.

HOW MUCH COLOSTRUM DOES A LAMB NEED?

The lamb needs to consume 20% of its body weight in colostrum over the first day but 5% of that (i.e. 50 mL/kg body weight) within an hour of birth. E.g. a 4 kg lamb (~ 10 lbs.) needs 200 mL (~ 6 ½ ounces) immediately, and a total of 800 mL (27 ounces) in the first 24 h (1 ounce ~ 30 mL). If the lamb is too weak to nurse effectively, it needs to be hand-fed or tube fed.

TIMING IS CRITICAL FOR COLOSTRUM FEEDING!

Make sure that in the first 24 h, the source of colostrum is the *first milking colostrum only*. Colostrum from a ewe that lambed yesterday contains insufficient antibodies because as soon as she begins to lactate, the colostrum will be diluted with milk. The longer you wait to milk out the newly lambed ewe, the more dilute and less effective the colostrum will be.

Issues of concern are:

- If the lamb first ingests bacteria or viruses from the environment or dirty udder, then the colostrum it ingests later won't protect it.
- The ability of a lamb to absorb colostrum decreases over time so that waiting even a few hours will impair the lamb's ability to absorb antibodies.
- Hand feeding a weak lamb may make the difference between success and failure. Be clean about how you hand feed the lamb.

WHICH EWES SHOULD BE SELECTED FOR STORING COLOSTRUM?

Sometimes ewes have insufficient colostrum, either because of illness, mastitis or because she has multiple lambs. Older healthy ewes usually provide the best colostrum in terms of concentration of antibodies. Make sure all collected colostrum is clearly labelled with ewe ID, date collected, other issues about that ewe (e.g. disease status), age of ewe, etc. But be careful of the following:

- Higher producing ewes may have a lower concentration of antibodies due to dilution with large quantities of milk.
- The health status of the "donor" ewe is important (see heat treating below).
- Selected ewes should have up-to-date vaccination programs.

CAN COW COLOSTRUM BE USED INSTEAD OF SHEEP COLOSTRUM?

The short answer is yes. However, there are some issues to note.

- It must be first milking colostrum as well.
- Use only colostrum from a healthy, older cow without mastitis.
- Many diseases that can infect cows can also infect sheep and can be transferred in the colostrum, e.g. Johne's disease, bovine leucosis virus (BLV).

- Donor cows should be properly vaccinated against clostridial diseases.
- Occasionally, but rarely cow colostrum contains antibodies that attack the lambs' bone marrow causing the lambs to become very anaemic within a few weeks of birth.
- When freezing cow colostrum, label the cow ID and don't use if disease is seen later in lambs, or pool colostrum from several cows to dilute any potential issue.

CAN GOAT COLOSTRUM BE USED INSTEAD OF SHEEP COLOSTRUM?

Ideally you shouldn't use colostrum from goats. Goats carry so many diseases that can be shed in the milk (e.g. infectious causes of abortion, caprine arthritis encephalitis, Johne's disease) that can infect sheep. However, it can be heat treated (see below) to lower risk.

HEAT TREATING COLOSTRUM

Bacteria and viruses can be killed or reduced in number by heating the colostrum prior to feeding. While milk pasteurization temperatures may destroy the antibodies, lower temperatures for longer periods of time can be used to make the colostrum safer without harming the antibodies.

The general recommendations are to heat the colostrum either **to 56 °C or 60 °C** and hold the colostrum at that temperature for **60 min**. Over-heating it will destroy the antibodies. Under-heating will allow survival of disease agents. If stirring, the utensil must be cleaned between stirrings so that the colostrum is not recontaminated. Water baths – with accurate thermostats – are best for holding the temperature (must be heated prior to putting in the bath). Slow cookers are not regulated enough. Stove top can work but requires constant attention. Never use a microwave, as heating is too uneven.

USING COLOSTRUM REPLACEMENT PRODUCTS

The commercial product must be labeled as a "replacement" product rather than "supplement". It should use serum or colostrum (not whey) as a source and have listed that it contains at least 100 g/L of IgG (antibodies). Some of these products have specific instructions on how much to feed for different sized lambs – follow the directions! Any substitute without antibodies may keep the lamb alive for a day or 2, but they generally die of disease within a week or two.

REFRIGERATING COLOSTRUM

No matter how clean you are when milking the ewe, bacteria will contaminate the colostrum. If the colostrum is not used promptly – those bacteria will grow and degrade the quality of the colostrum quickly. If you intend to refrigerate it for a few days, the colostrum should be heat treated as described above.

FREEZING COLOSTRUM

It is best done immediately after milking or heat treating. Freeze in an ice cube tray and then transfer to a labelled freezer bag. Or freeze in zip-lock freezer bags – 2 bags is preferred, one inside the other. Freeze while lying flat. Use a warm water bath to thaw – never a microwave. Temperatures too hot will destroy the antibodies. It is best used within 6 months but can be used up to a year. If older, you will have to increase the volume to overcome the loss of antibodies.

2.1.8 PROCESSING NEWBORN LAMBS

Once the lambs are born, there are measures that can reduce the risk of disease later on.

- Dip the navel (umbilical cord) in a 2.5% tincture of iodine solution (alcohol-based rather than water-based) at birth. Don't use teat dips or udder wash products. Make sure the whole navel up to belly is included. A non-return teat dipper can be used (label for lamb navels only) or a disposable paper cup (Dixie cup). Use fresh dip on each lamb. This will help to prevent navel ill and joint ill.
- Identify the lamb by ear tag or paint branding and record.
- Weigh the lamb and record. Record any particulars with regards to difficulty of lambing, health of ewe, status of litter-mates.
- If the ewe has not been properly supplemented with selenium and vitamin E in the feed during pregnancy, the lamb can be injected at birth with a suitable product. Do not inject in the muscles of the hind leg at this may damage the nerve. Inject in the muscle of the neck with a sterile needle. Read the label directions and only use if indicates it is appropriate for newborn lambs. Use the label dose only (e.g. ¼ cc of 3 mg Se / mL product)! There have been several cases of over-dosing newborn lambs at birth with selenium and vitamin E. This may result in rapid death of the lamb.
- After 24 h when the lamb has consumed adequate colostrum and only if it is strong and healthy: tail dock breeds with long, woolly tails; castrate if males are to be raised for meat and kept over 5 months of age into the fall.

More information is available from the OMAF Factsheet Care of the Newborn Lamb available at: http://www.omafra.gov.on.ca/english/livestock/sheep/facts/98-087.htm

2.1.9 PREVENTION AND TREATMENT OF HYPOTHERMIA/HYPOGLYCAEMIA

This information is available from the OMAF factsheet Hypothermia in Newborn Lambs available at http://www.omafra.gov.on.ca/english/livestock/sheep/facts/98-089.htm. Talk to your veterinarian before lambing season begins. Discuss and review any techniques used to revive chilled lambs.

2.2 LAMB REARING METHODS

Approximately 25% of the total milk yield of a dairy ewe is produced in the first 30 days of lactation, based on a 180 day lactation (McKusick et al, 1999). This means that allowing the lambs to nurse until weaning before moving into the milking string can be a very costly thing for a producer. However, length of lactation and milk production after 30 days appears to be similar between the 3 systems as are lamb weights at 30 days. Whichever system is used, there must be a balance between lamb health and survival, ewe udder health and income. Below describes three systems currently in common use in North American dairy sheep flocks.

2.2.1 REMOVAL OF LAMB AT BIRTH (DY-1)

This system has been shown to allow for 61% more milk to be available for commercial sale than weaning at 30 days when length of lactation is 180 days (McKusick et al, 1999). Remove the lamb from the ewe and hand feed colostrum as described above or allow nursing for 24 h and then remove (if no disease issues). There is no need for the ewe and lamb to bond.

Hand feed the lamb milk replacer product 3 to 4 times per day for the first few days of life. Each feeding should be at 50 mL/kg body weight. Keep in a warm, draft-free location in the barn that can be frequently disinfected if diarrhoea should develop. Although a heat lamp is great to help dry off lambs after birth, do not use later as this will encourage piling of lambs and may lead to pneumonia.

ARTIFICIAL REARING ON MILK SUBSTITUTE PRODUCTS

If strong at 3 days, move to a lamb bar but continue to pay close attention to the lambs' feeding behaviour. The care you take now to make sure the lamb gets up and suckles from the lamb bar will pay back in improved lamb survival and growth. Only use high quality milk replacer products developed specifically for lambs. Cow milk and calf milk replacer doesn't have enough energy for lambs.

Acidification of milk can be done. This allows ad lib feeding at warmer temperatures without spoilage of milk. The directions are available in the Dairy Goat Digest Issue #9, 2006 or on-line at http://www.oabp.ca/Ceptor/2009/September2.pdf#page=2

The method of delivering milk replacer is varied, from individual bottles, to lamb bars, to use of automated milk dispensing systems. The important aspects of any delivery system to avoid digestive upsets: the milk replacer must be mixed according to directions and be kept fresh; all milk feeding equipment including nipples and lines must be thoroughly cleaned with soap and warm water every day to prevent a build-up of bacteria; milk replacer should be fed either ad lib at cool temperatures (15-20^{0}C) or limit fed but offered several times per day. Common diseases include abomasal bloat – which can results in sudden death, diarrhoea and clostridial infections from dirty feeding equipment.

MOVING THE EWE TO MILKING STRING – CONSIDERATIONS

When first introduced to the milking parlour, the ewe may be nervous and not let milk down properly. Make sure that the ewe is allowed to enter by following an experienced animal, and that noises are kept to a minimum. The first time through will establish a comfort level that will make it easier in subsequent milkings. Additionally, assure that the milk is free of residues of veterinary drugs including antibiotics. Consult the flock veterinarian if any questions. See Section VI for more information.

2.2.2 WEAN LAMBS AT 30 DAYS (DY-30)

Lambs are allowed to nurse ewes. Ewes enter the milking string at weaning at one month and are not milked before that. Under this system, approximately 25% of salable milk is consumed by the lamb – but no milk replacer is purchased and labour requirements are much lower. This system is less suitable for ewes nursing only one lamb because the udder is not evacuated sufficiently to maintain milk production.

CONSIDERATIONS FOR EARLY-WEANED LAMBS

Early weaning can be done with lambs at 30 days of age but not without some risks. Lambs must be offered a highly digestible energy and protein rich diet to replace the lost milk, otherwise they will lose weight and may be at more risk of disease. Offering a good quality creep of 16% protein from at least 14 days of age is necessary to reduce this risk. Ewes should be removed from the lambs so that the lambs do not need to also adapt to the stress of acclimating to a new environment. Lambs should be 10 kg at this age.

MASTITIS AND LOST MILK RISKS FROM NURSING

In Section II of this course, risks of mastitis are described, including risks associated with nursing lambs. Lambs may favour drinking from one gland over another so that this system is not recommended for ewes nursing single lambs. The neglected gland may involute and so future milk production is lost. It is also at a greater risk of developing mastitis due to poor emptying. Other risks from nursing include risk of contagious ecthyma (orf); teat damage from aggressive nursing; stealing milk and transmitting bacteria from other sheep.

2.2.3 MILK ONCE/DAY WITH RESTRICTED NURSING (MIX)

Under this system, the ewe is milked in the morning only – and the lambs allowed to nurse unrestricted until evening when they are locked away for the night. The advantages are that there is salable milk for a longer period but access to milk replacer may be necessary to make sure lambs don't starve. Ewes milked under this system have about 38% more milk available for sale (McKusick et al, 1999). The disadvantage might be the extra labour and facilities needed to lock the lambs away at night.

RISKS /BENEFITS TO EWE

While there is stress to the ewe at having the lamb locked away for 8 to 12 h per day, it will still be able to nurse the lamb and express its normal mothering behaviour. Mastitis risks from nursing are the same as with weaning at 30 days.

RISKS / BENEFITS TO LAMBS

Some lambs may need access to milk replacer if they are not gaining well. It is stressful to a lamb to not nurse for 8 to 12 h per day.

2.3 ENVIRONMENTAL MANAGEMENT OF THE EWE

Below is a summary of recommendations for environmental management of the dairy ewe (Table I.4).

Table I.4. Environmental factors affecting udder health and recommendations for dairy ewes

ENVIRONMENTAL FACTOR	RECOMMENDATION FOR DAIRY EWES
Stocking Density	2 m^2 per ewe as a minimum. (1 m^2 = ~ 1.2 square yards.) 3 m^2 with access to exercise yard during day is preferred.
Air Space	7 m^3 per ewe as a minimum. (1 m^3 = ~ 1.3 cubic yards.)
Ventilation – Summer	70 m^3/ hr / ewe is moderate.
Ventilation – Winter	47 m^3/ hr / ewe.
Flooring	Slatted flooring require stocking densities of < 1 m^2 / ewe and is cold. Solid flooring should be slanting, well drained and able to scrape. Raised platforms (0.9 m X 0.6 m with a 5% slope) can provide comfort.
Bedding	Most preferable = clean sand; long-stemmed clean straw. < 15 % moisture in any bedding pack.

ENVIRONMENTAL FACTOR	RECOMMENDATION FOR DAIRY EWES
Air Temperature	Minimal optimal temperature is 9 to 12 °C. Mean optimal temperature is 15 to 18 °C.
Sunlight	Avoid high levels of UV without offering shade opportunities.
Humidity	Optimal humidity is 65 to 70%.
Grazing	Outdoor grazing is associated with improved udder health but dry and clean shelter from rain and hot sunlight must be offered.
Relocation and Mixing	Aggression associated with mixing and moving increases risk of mastitis.

2.3.1 HOUSING VERSUS PASTURE

Grazing ewes on pasture has many benefits with respect to controlling the environmental risks for mastitis – as long as the ewes have shelter from inclement weather, extreme heat and sunshine. However, the nutritional needs of the heavily lactating ewe must be considered.

2.3.2 BEDDING AND FLOORING

Different types of bedding have not been well evaluated in dairy sheep but much research has been done in dairy cows. It is critical is to make sure the bedding is dry, the flooring allows for drainage of excess moisture and that the ewe can rest comfortably and warm. Slatted flooring systems allow for many advantages for labour savings, but are cold and ewes should be provided with a platform – bedded and dry – to rest on, if that system is used.

2.4 FEEDING MANAGEMENT OF THE DAIRY EWE

The nutritional needs of the dairy ewe cannot be extrapolated from those published for dairy cows or goats. Proper formulation of rations is beyond the scope of this course. An excellent overview of dairy sheep nutrition can be found in the document Berger Y, Billon P, Bocquier F et al. Principles of sheep dairying in North America. Publication A3767 Cooperative Extension of the University of Wisconsin-Extension. 2004. An additional publication that may help with development of rations is Nutrient requirements of Small Ruminants. National Research Council Animal Nutrition Series. The National Academies Press, Washington D.C. 2007.

2.4.1 FEEDING THE LACTATING EWE

FIRST 2 MONTHS OF LACTATION

This encompasses the period just after lambing when the ewe's digestive system is adjusting to feed changes and she has been under tremendous stress from lambing and up to peak milk production. Dry matter intakes tend to be too low to meet her nutritional needs and may vary from 2.5% of body weight in late gestation to 3.5% in early lactation. The ewe must mobilize body fat to meet her lactation output and so must lamb with a body condition score of 3 to 3.5 as she will often drop to 2.5 or lower by peak milk. Without this fat reserve, peak milk production is compromised. For this period, the ewe requires highly digestible feedstuffs balanced for energy, protein and fibre to maintain rumen health. Ewes on pasture must be supplemented if high milk production is expected.

LATER LACTATION

From mid to late lactation, the ewe's dry matter intake is higher but milk production will drop. This means she will tend to put on condition. This is advisable to make sure that she is in optimal condition for breeding (about 200 days post-lambing) and should enter dry-off having recovered to BCS of 3.0 or 3.5. Again, high quality forage (stored feed or pasture) must be offered and usually some concentrate in order to allow ewes to have a persistent lactation. However concentrate will not substitute for poor quality pasture or hay.

2.4.2 TOTAL MIXED RATION

Total mixed rations (TMR) can be an excellent way to deliver nutrients to dairy sheep on an ad libitum method. Dairy cow rations are most often offered as a TMR in which forages are chopped and evenly mixed with concentrate, protein supplements and minerals and salt. Cows tend to be indiscriminate eaters and do little selection. However sheep are excellent at sorting feed. Particle size should be smaller than that chopped for a cow TMR so that sheep are less likely to sort although not extremely fine as fibre is very important for rumen health. TMR must be offered fresh and free choice and should be inspected to make sure that all parts are palatable. Sorting can cause grain overload (Sub-Acute Ruminal Acidosis also known as SARA) and put sheep off feed and cause off-flavours in milk.

2.4.3 PARLOUR FEEDING GRAIN

Grain or concentrate is often fed in the milking parlour as it may encourage ewes to come in. However, there are some problems with only offering grain in this manner:

- Total amounts cannot be controlled as ewes with big appetites may eat leftovers from ewes that are less aggressive eaters;
- A sudden "dump" of carbohydrates in the rumen can cause SARA and the ewe may go off-feed for half a day or more;
- The amount of grain that needs to be consumed by the ewe cannot be eaten in the time she is in the parlour, slowing down the flow through the parlour;
- Grains need to offered more frequently than twice per day to optimize rumen health;
- Grains should be fed after the ewes have a good source of fibre in the rumen;
- Energy from grain and protein from forages and supplements must be balanced in the rumen to more properly feed the ewe.

2.4.4 MINERAL AND VITAMIN FEEDING

Mineral and vitamin deficiencies and toxicities have been covered previously in Section I. It is important that minerals and vitamins be offered daily. If fed a TMR or grain-protein supplement, it is advisable to blend the mineral and vitamins supplement so that each ewe receives her daily intake. If no grain is offered, a palatable loose premix should be offered free-choice, kept fresh and protected from contamination and moisture.

2.4.5 OFF-FLAVOURS AND ODOURS IN MILK ASSOCIATED WITH FEEDS AND FEEDING

There are many different aspects to feed that influence the flavour of the milk. The compounds that influence the odour and flavour of milk are many – such as alkylphenols, rumen microbe produced compounds such as acetone, butanone, ethanol and propanol. These compounds can come from the

plant itself, and vary depending on the maturity of the plant – or from the fermentation process in the rumen. These chemicals are absorbed into the blood stream from the digestive system and then secreted into the milk. Corn silage may influence the flavour of the milk because of the fermentation products. Some pasture weeds can result in poorly flavoured milk and this effect may vary week to week as the pasture composition and maturity varies. Some minerals may cause oxidation of the milk. Low vitamin E in the ration is associated with a cardboard taste (oxidation). Feed strong-flavoured feeds after milking. Make sure ventilation is adequate to prevent absorption of bad odours.

2.4.6 FEEDING AND BACTERIA IN THE MILK

LISTERIA

Listeria monocytogenes is an important cause of neurological disease and abortion in small ruminants and of intestinal illness in humans. The bacteria are commonly found in the soil and manure and contamination of the feed with either of these may result in illness. *Listeria* will grow in cool temperatures in poor quality silage, i.e. silage with a pH >5. But it also can cause subclinical mastitis in sheep and thus contaminate milk and raw cheeses. The route of infection of the udder is most likely through the teats, which means that contaminated bedding or poor cleanliness of the udder is responsible for the infection. *Listeria* is killed by proper pasteurization but may survive heat treating at lower temperatures.

BACILLUS SPORES

Bacillus spp bacteria are found everywhere in the environment. These types of bacteria produce spores that can survive severe environmental conditions. These spores are found in the feed; contaminate the bedding or soil and then the teats and the udder of the ewe. If the udder and teats are not properly prepped and sanitized, these spores contaminate the milk. The spores are not destroyed by pasteurization and may cause food poisoning in people. These bacteria may also cause "blowing" of cheeses during the aging process – indicating the importance of proper cleaning of the udder and teats prior to milking.

2.5 REPRODUCTIVE MANAGEMENT OF THE DAIRY EWE

2.5.1 LAMBING FREQUENCY, LACTATION LENGTH AND LAMBING SEASON

Generally, because lactation lengths average 240 days (8 months) and the length of the dry period is not less than 2 months – dairy ewes do not lamb more than once/year. However, processing plants often demand milk for cheese making year round so there is a need to have ewes lambing at different times of the year. Proper management of the reproductive cycle is very important.

2.5.2 RAM MANAGEMENT

Here are some points to implement to improve ram performance.

- Approximately 6 weeks prior to breeding, have the rams checked for breeding soundness by your veterinarian. This is particularly important when using any kind of synchronization or estrus induction program where the ratio of rams to ewes is very low – and one infertile ram can lower pregnancy rates precipitously.

- Prior to breeding, rams should be in a body condition score of 4 out of 5. Rams will lose weight during breeding and if not in top fit, may not perform well.
- When not being used for breeding, rams should be kept well away from the breeding flock, ideally not only sight but also sound and smell. Not only will this reduce the risk of unwanted pregnancies, it will improve fertility if breeding early in the breeding season.
- Have a very specific breeding exposure. This was covered earlier.
- Plan purchases of rams well ahead of when they are needed. Make sure they come from flocks with good health status. Many important diseases can be carried by an apparently healthy ram. Avoiding sharing or purchasing a "used" ram. Not only can it introduce some abortion diseases (e.g. chlamydia) but also foot rot, Johne's disease, maedi visna – the list is long!

RAM TO EWE RATIO

Making sure that there is sufficient ram power when implementing any breeding program, is critical for optimizing fertility and prolificacy. Below (Table I.5) are suggested ratios to use under different circumstances. All numbers assume that all rams are fertile.

Table I.5. Recommended ram to ewe ratios for various breeding situations

BREEDING SITUATION	RAM : EWE RATIO
Mature - breeding paddock (ovulatory season)	1:40 to 1:80, depending on breed
Yearling - breeding paddock (ovulatory season)	1:20 to 1:25
Mature - rough terrain (hills, forested)	1:20 to 1:30
Mature - synchronized in the transition season using ram effect	1:20 to 1:25
Mature - synchronized in season using CIDR's or MGA or PgF2α	1:15
Mature - synchronized in the anovulatory season - any method	1:5 to 1:7

2.5.3 EWE MANAGEMENT

As with the ram, the ewe must be prepared for breeding well ahead of the event. This includes appropriate body condition score and health prior to breeding.

CULLING EWES

Culling decisions should be made at the end of the lactation and ideally before rebreeding a ewe. Reasons to select ewes for culling include:

- Chronic issues with mastitis, including
  - Infection with *Staphylococcus aureus* or *Pseudomonas aeruginosa*.
  - Loss of a gland.
  - Teat damage that slows milking.
  - Abscesses in the udder.
  - Chronically elevated somatic cell counts despite treatment.

- Test positive for maedi-visna infection or Johne's disease.
- History of a vaginal prolapse.
- Low body condition score and failure to gain weight in later lactation.
- Dental disease.
- Chronic lameness.
- Repeated abscesses due to caseous lymphadenitis.
- Low milk production.

There are many other reasons to cull a ewe as well including old age, reproductive failure, abortion, failure to give birth to viable lambs, etc.

PREPARING THE EWE FOR BREEDING

The ewe may be still lactating when asked to breed again. It is important that it be in a body condition score of 3.0 to 3.5. If thinner, increasing energy (maintaining a protein of ~ 12 to 14%) will help to gain weight. This is called "flushing" and depending on milk production, can be done on good quality forage or by feeding increased grain. This should be done about 3 weeks prior to ram exposure and continued through the breeding to 3 weeks after the ram is removed.

PREPARING THE EWE LAMB FOR BREEDING

Ewe lambs reach puberty usually at 60% of their mature body weight, but breeding should be done when they reach 70% of mature body weight. So if the average dairy ewe is 75 kg (165 lbs.), then the ewe lamb can be bred when it reaches ~ 50 kg (110 lbs.). Usually this is at 7 months of age, with the expectation that they will lamb at 12 months of age.

Ewe lambs that are fed to reach this weight too quickly, i.e. fed as if a market lamb, will put on fat. This is very detrimental for two reasons:

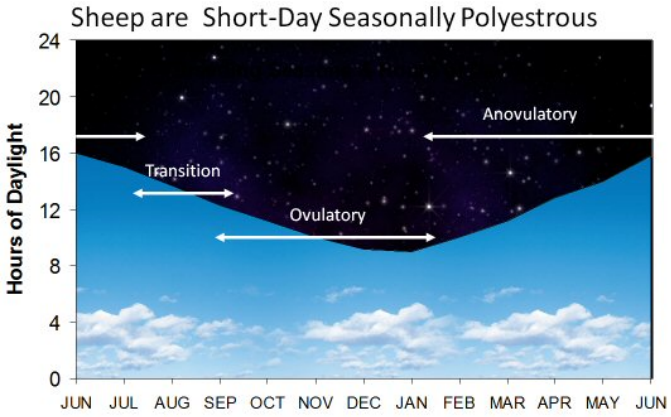
- Fat ewe lambs will produce less milk as adults as the fat will replace udder tissue.
- Fat ewe lambs are less fertile and may give birth to deformed lambs.

NORMAL REPRODUCTIVE CHARACTERISTICS OF THE EWE

SEASONALITY OF BREEDING

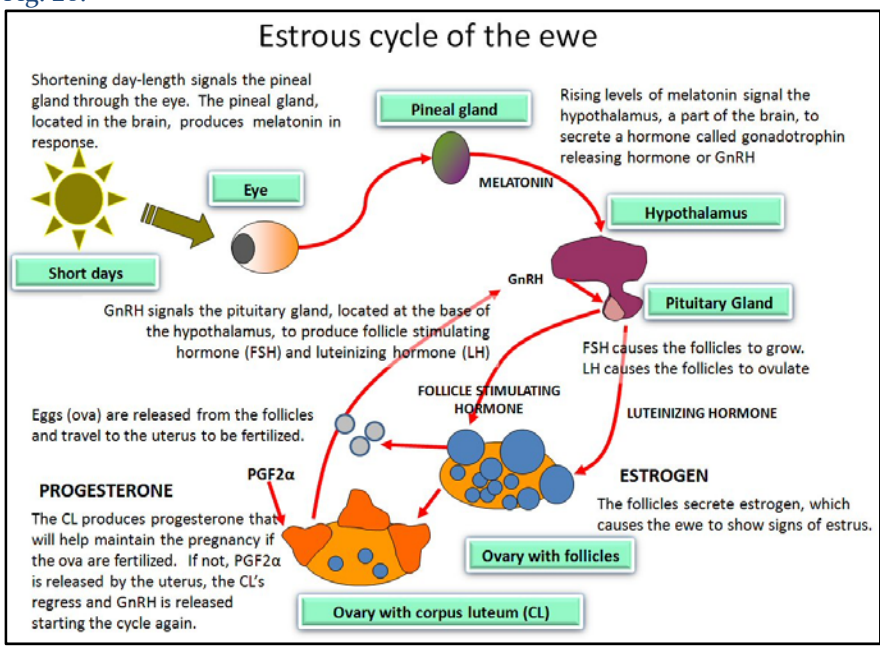
Sheep cycle in response to shortening daylight that starts after June 21st (summer solstice), and usually start fertile heats in September or October depending on breed and age. They will come into estrus (heat) every 17 days until early winter. This period is called the ovulatory season (Fig. 25). Ewes do not cycle from late winter through to about 8 to 10 weeks after the summer solstice. Most of this period is called the anovulatory season. A short period between the anovulatory and ovulatory season – usually late July and August, is

Fig. 25.



called the transition season. The ewes are not yet cycling but their hormone levels are starting to rise. Ewe lambs tend to have shorter ovulatory seasons than mature ewes.

Fig. 26.



The first cycle of the ovulatory season is silent. Ewes will cycle but are not receptive to the ram. The next cycle is fertile and of normal length and fertility. Ewes are in heat for about 30 h and are most fertile about 18 to 24 h after estrus starts. During a normal breeding exposure, all ewes should be bred at the first heat and about 75% or more should conceive to that breeding. Over three cycles, over 95% of ewes should conceive.

As illustrated in Fig. 26, the trigger for ewes to start cycling is the shortening day-length. This releases melatonin from the pineal gland, also called the 3rd eye because it detects light. The melatonin kick starts the brain into producing hormones. During the ovulatory season, this hormone cascade will continue every 17 days until the ewe becomes pregnant. Pregnancy inhibits the release of prostaglandin F2α (PgF2α) from the lining of the uterus and so the corpus luteum (yellow body) will stay on the ovary, producing the hormone of pregnancy, progesterone.

2.5.4 SYNCHRONIZATION OF ESTRUS IN-SEASON

Synchronization of estrus in the ovulatory season when sheep are normally cycling can optimize your planning for milk production. It may be that you wish to have groups lamb over the normal lambing season in order to spread out milk production, or to have your entire flock lamb within a very short time, to optimize labour and limit the number of months you need to milk the ewes. Work with your veterinarian to develop these products, particularly to preserve the safety of milk (see Section VI).

METHODS OF SYNCHRONIZATION

PROSTAGLANDIN (PGF2A)

This drug will induce estrus by causing the corpus luteum (CL) to regress, dropping the level of progesterone – which then brings the ewe into estrus about 24-72 h later. Normally the CL will last about 14 days before it starts to regress.

Approximately 60 to 70% of ewes at any time are responsive to an injection of PgF2α. If one injection is given, those ewes will respond and be bred. The 30 to 40% that didn't respond were either too late in the cycle and will be in heat anyway, or too early in the cycle and will be in heat in about 12 to 14

days. If two injections of PgF2α are given 10 days apart, all ewes will be synchronized after the second injection.

If the ewes are not cycling, this product will not work. A CL must be present to bring the ewe into heat. It should also be noted that fertility using this method is not as good as with methods using progesterone type products mentioned below.

No prostaglandin products are approved for use in sheep in Canada and you should only use them under the guidance of a licensed veterinarian with whom you have a valid veterinary-client-patient relationship. Two products are licensed for use in dairy cattle:

Dinoprost ®(Lutalyse, Zoetis Animal Health Canada; 5 mg/mL); dose for sheep - 10 mg i.m.

Cloprostenol ® (Estrumate, Intervet Schering-Plough Animal Health; 250 µg / mL); dose for sheep - 125 µg i.m. (or 75 µg/45 kg bw).

CIDR®

A CIDR® (CIDR® 330, Zoetis Canada) is an intravaginal device made of silicone and containing natural progesterone which, when used as directed, will slowly release the drug into the circulation of the ewe. The silicone device is inserted into the vagina of an open ewe and left there for several days. If left in long enough, withdrawal of the CIDR® will cause the progesterone to fall, and signal the release of GnRH, starting the estrous cycle. If removed too early, the CL will still be active and the ewe will not cycle.

Fig. 27. Ram marker harness

Recently one product was approved for use in Canada – CIDR® 330 (Zoetis Canada). It is not licensed for use in sheep during the ovulatory season, nor is it licensed in this country for use in lactating ewes that are milked for human consumption. Its use must be under the guidance of a licensed veterinarian with whom you have a valid veterinary-client-patient relationship.

A recommended program for use of CIDR®'s during the ovulatory season would be to insert them for 12 to 14 days, withdraw the CIDR® and join with the ram no later than 24 h after pulling the CIDR®. If left in for a shorter time, e.g. 7 days – an injection of PgF2α on the day of withdrawal will be required to induce estrus. If the ewes are being milked at this time, seek advice from your veterinarian on a proper milk withholding period.

It is important to not have the ram in the pen with the ewes while the CIDR® is inserted, as this will lower fertility. Put the ram to the ewe 18 to 24 h after pulling the CIDR®. Make sure there is an adequate number of rams per ewe in the group (1 ram per 15 ewes) and that breeding is occurring. A ram marker harness can be used to detect mounting behaviour (Fig. 27).

MGA (MELENGESTROL ACETATE)

MGA or melengestrol acetate (MGA 100 Premix, Zoetis Canada; 220 mg/kg of premix) is a synthetic hormone similar to progesterone. It is a feed additive used to suppress estrus in feedlot heifers. It is not approved for use in sheep regardless if they are lactating or not and **should never be used in**

lactating dairy ewes. For this reason, it must be under the guidance of a licensed veterinarian with whom you have a valid veterinary-client-patient relationship.

When used in sheep, its action is similar to CIDR's but it is delivered in the feed. Because it is important that the level of progesterone not vary during the day, the best way to feed it is by delivering the same amount twice/day as close to every 12 h as possible. The total daily dose is 0.25 mg / head /day or 0.125 mg / head every 12 h. It is fed for 12 to 14 days and the ram is introduced 24 h after the MGA is withdrawn. Ram management is the same as for CIDR's and PgF2α. One of the biggest reasons for failure is that the MGA is not offered at equal intervals through the day and that all ewes don't have equal opportunity to consume it.

MILK WITHHOLD WHEN USING HORMONES

As mentioned under each of these drugs, none of these products is approved for use in dairy sheep. Only CIDR's are licensed for use in sheep – and then only during the anovulatory season and not for lactating dairy ewes. For use of these products, you require a prescription from your flock veterinarian who may need to consult CgFARAD. MGA, which is a biologically active synthetic progesterone, should never be used in lactating dairy ewes as it is passed in the milk. When consumed by a woman, it can affect her reproductive cycle.

2.5.5 INDUCTION OF ESTRUS OUT OF SEASON

Ewes best produce milk in the late winter and spring seasons. While breeding in the ovulatory season produces spring milk, it is more difficult to produce milk in the fall and winter. Processing plants may rely on a steady supply of milk to make product so there is additional reason to breed ewes out of their normal breeding season. Below are methods to induce estrus in ewes that are not cycling, i.e. their ovaries are inactive and there are no hormones being secreted.

METHODS

CIDR®

CIDR® 330 (Zoetis Canada) is licensed for use in sheep during the anovulatory season but not for lactating dairy ewes. The label claim is for use in anestrous ewes. It is as follows:

*"**INDICATIONS:***

CIDR 330 intravaginal insert is indicated for the induction of estrus in ewes (sheep) during seasonal anestrus.*

**Note: Seasonal anestrus is when ewes do not have regular estrous cycles outside the natural breeding season.*

DOSAGE AND ADMINISTRATION:

Administer one CIDR 330 intravaginal insert into the vagina of each ewe to be treated for 5 days. After insert removal, use standard flock breeding procedures to breed ewes at induced estrus. In ewes responding to treatment, the onset of estrus generally occurs within 1 to 3 days after removal of the CIDR 330 intravaginal insert.

Make sure to have sufficient number of rams to adequately breed all ewes with an induced estrus. Breeds of rams may vary in libido in the non-breeding season. Therefore, a ewe to ram ratio up to 18:1 is recommended for multi-sire situations. For single sire situations, 12:1 for ram lambs and up to 18:1 for yearling rams are recommended"

Unfortunately, use of the product as labelled may not work in Canadian conditions. The following recommendation must be approved by your flock veterinarian. The CIDR should be inserted not less than 5 days and can be left in up to 14 days. In the anovulatory or transition season, at the time of CIDR withdrawal, another product called Pregnant Mare Serum Gonadotrophin (PMSG), also called Equine Chorionic Gonadotrophin (eCG) must be administered by intramuscular injection. PMSG mimics the activity of FSH and LH, both necessary to cause follicles to ovulate when estrus is induced out of season. There are several PMSG products licensed for meat sheep in Canada (Folligon® (Intervet Schering Plough; 5000 IU in 25 mL of diluent = 200 IU/mL); Pregnecol® (Bioniche Animal Health; 6000 IU in 20 mL of diluent = 300 IU/mL); and Novormon 5000® (Partnar Animal Health; 5000 IU in 25 mL of diluent =200 IU/ mL). A dose of 500 IU is usually recommended when breeding during the anovulatory season. Failure to use PMSG may result in no induction of estrus. Rams are introduced at a ratio of 1:5 to 1:7, 18 to 24 h after the CIDR is removed.

If there is concern that some of the ewes might be cycling, and you wish to have the CIDR's in for less than 14 days, it is recommended to give an injection of PgF2α either at the day of CIDR removal, or one day prior. This is in addition to administering PMSG.

MGA

The program to use MGA in the anovulatory season is identical to using it in the ovulatory season, with one exception – PMSG must be used or ovulation will not occur, resulting in no pregnancies. It is injected intramuscular 8 h after the last feeding of MGA, usually at a dose of 500 IU. Again, this program cannot be used in lactating dairy ewes but, with a veterinary prescription, it is a good program to use in dry ewes or in ewe lambs for their first breeding, particularly when you have many sheep to breed out of season. Ram:ewe ratio is also 1:5 to 1:7 and rams are introduced about 24 h after the last feeding.

PHOTOPERIOD (LIGHTS)

Because cycling is normally stimulated by the shortening day-length, it makes sense to attempt to convince ewes that it is late summer, i.e. when days are becoming shorter when it is actually late winter, i.e. when days are becoming longer. This is done by exposing the ewe to lights to mimic long days or spring, usually starting soon after the winter solstice (Dec 21), continuing for several weeks and then abruptly shutting down the lights to mimic fall day-length. This stimulates production of melatonin by the pineal gland. The melatonin acts on the hypothalamus as is depicted in Fig. 26.

The program usually starts in late December or early January to get ewes to cycle in April to May so it is ideal for dairy sheep that are group housed in the winter as no hormones are required. Facilities needed include:

- A mechanism to control the lights in the barn, e.g. a timer
- Sufficient artificial light for the *Long-Day* period (12 to 15 foot-candles at the animal level or approximately 150 lux or foot-meters)
- Either standard or fluorescent lights can be used
- Ability to block natural light for the *Short-Day* period, e.g. shutters on windows

For the *Long-Day* period, usually the lights are left on for 16 h per day but as long as 20 or 22 h, this while normal day-length is 9 to 11 h for southern Ontario. The lights are usually left on for 8 weeks (54 days). The process can be started as early as late November to early January, but most start at the winter solstice. For the *Short-Day* period, lights are only on for 8 h per day; this while day-length is 11 to 14 h. This means that to have an optimal effect, daylight must be blocked out. Ewes will start to cycle about 8 weeks after the *Short-Day* regime is started, usually late April to early May, but there is variation between breeds and farms.

Rams also need light treatment to improve their fertility. Two months prior to when they are needed, the rams need to be exposed to the Long-Day regime for one month, followed by the *Short-Day* regime for one month. This increases semen quantity by up to 40% over untreated males. To do this to optimal effect, have the rams in another barn and start the *Long-Day* regime two months before the rams are needed. After the rams have been *Long-Day* and *Short-Day* "prepped", move the rams to a pen near the ewes (not in with the ewes though!) about 30 days after the ewes have started their *Short-Day* regime (e.g. late March). This will help to bring the ewes into estrus, using the ram effect (see below). Once the ewes start to cycle, put the rams in with the ewes. Use a ram marking harness so that you can see if ewes are being bred. Vary the colour between rams, and you can see which of the rams is most active.

RAM EFFECT

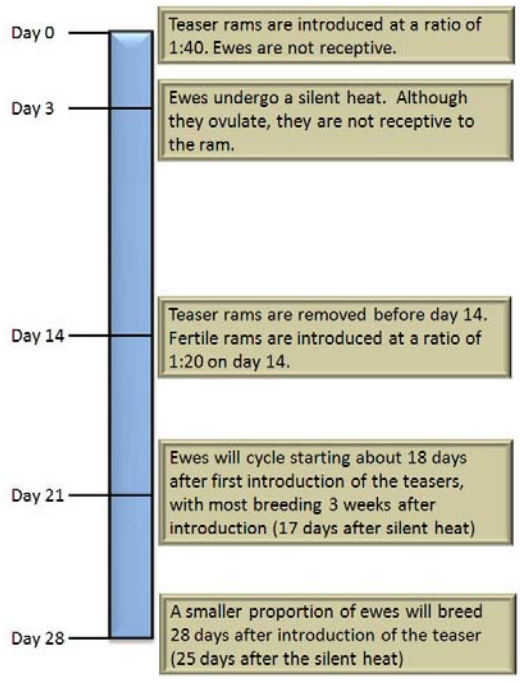
Ram effect is used to advance the normal ovulatory season, usually no more than 4-6 weeks. So if your ewes normally start to cycle in mid-September, proper use of the ram effect will bring the ewes into estrus usually early to mid-August. As with photoperiod, no hormones are required, making it perfect to use when ewes are being milked.

The important aspect for any ram effect program to work is that the rams that stimulate the ewes to come into estrus, must be new to the ewes, i.e. the ewes cannot have seen, smelt or heard the rams for 30 days prior to being used. The rams only need to be exposed to the ewes for 24 h to work, but are usually left around for a few days. Teaser rams, usually vasectomised and so infertile while still keeping their libido – will induce the ewes to come into heat.

The best rams to have the teaser surgery are mature, experienced, healthy rams that cannot be used anymore because they have too many daughters in the flock. They will know how to "work" the ewes. Don't use ram lambs or rams with temperament or health problems. Ask your veterinarian about performing a teaser surgery – it should be done at least 60 days prior to needing the teaser.

While the ram effect program works best using teaser rams to induce estrus, it can be done without teasers. In that case, you will need good gates and fences. Fertile rams, again new to the ewes, should be placed in an adjacent pen or

Fig. 28. Use of ram effect



pasture. They will run back and forth along the fence line and may try their best to jump over.

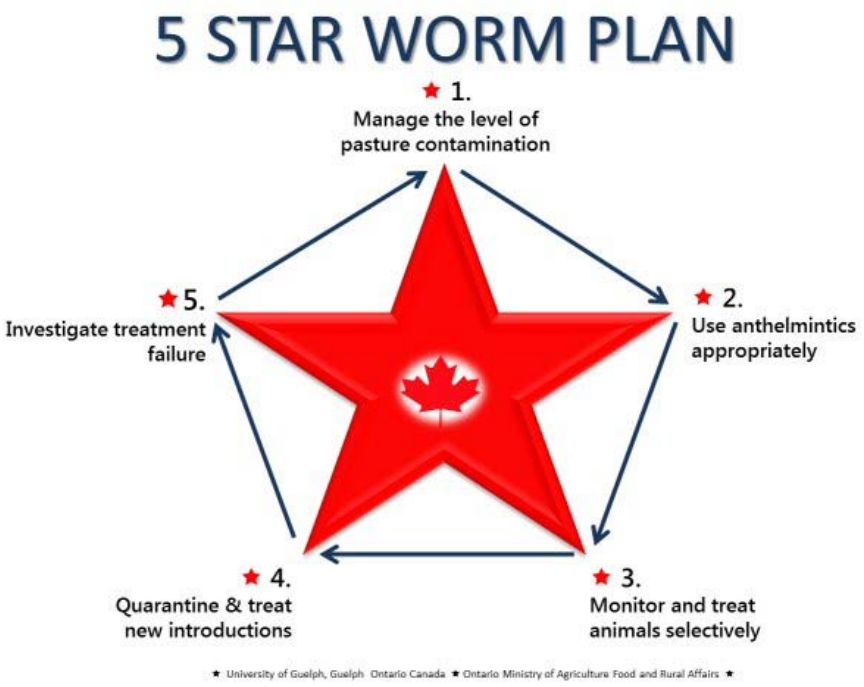
Regardless of whether you use teasers or fertile rams to tease the ewes, make sure that the rams you wish to use for breeding are put with the ewes no later than 14 days after the start of teasing. Ewes will synchronize into two groups with most in the early breeding group and a smaller group in the later breeding group.

This program will not synchronize estrus if ewes are already cycling, i.e. in the ovulatory season. If used in the anovulatory season, it may induce some ewes to cycle but generally fertility is poor.

2.6 CONTROL OF PARASITES

2.6.1 GASTROINTESTINAL PARASITES

Fig. 29



A handbook "Handbook for the Control of Internal Parasites of Sheep and Goats" has been written which contains detailed information on the control of gastrointestinal nematode (GIN) parasites in sheep and goats. The program called the "5 Star Worm Program" details how to control these infections in sheep and to prevent the formation of parasite resistance to anthelmintics (dewormers) (Fig. 29). Adult sheep usually do not have problems with GIN with the exception of Haemonchus contortus, a blood-sucking parasite that resides in the abomasum of the sheep – possibly at lambing as what is called Type II haemonchosis. The handbook is free to download and is located at

http://www.uoguelph.ca/~pmenzies/Handbook_Home.html

It can also be purchased as a book from the Ontario Sheep Marketing Agency.

MILK WITHDRAWAL ISSUES

There are no anthelmintics (dewormers) approved for use in lactating dairy sheep and any treatment will require your veterinarian to advise on an appropriate milk withdrawal or if that particular drug can be used at all. Do not use any anthelmintic without first consulting your veterinarian.

2.6.2 COCCIDIOSIS

Coccidiosis is a disease of lambs and not adult sheep. Its control is also covered in detail in the Handbook for Control of Internal Parasites of Sheep and Goats. As with treatment with an anthelmintic, there are no drugs (coccidiostats) that can be used in lactating dairy sheep.

2.6.3 EXTERNAL PARASITES

LICE AND KEDS

CHEWING LICE

Bovicola ovis are chewing lice that are mostly found in the head and neck region but can crawl quickly over the animals. They chew on the wool but the excrement of the lice causes itchiness. The sheep rub and break off the wool. Treatment must always be done twice, once to kill the louse and 14 days later to kill the lice that have hatched from the nits (eggs) of the louse. There are products approved for use in sheep but not lactating dairy sheep. Consult your veterinarian for advice on their control.

SUCKING LICE

Linognathus ovillus is a sucking louse found mainly on the face. It is very small and dark blue as it is filled with blood. As with biting lice, it causes itchiness. And as with biting lice, consult your veterinarian on how best to control it.

KEDS

These are not lice or ticks but wingless parasitic flies. *Melophagus ovinus*. They can easily be seen with the naked eye and chew and suck blood. Their excrement stains the wool yellow and their bites can leave scars on the skin. Shearing will greatly decrease their numbers. Consult your veterinarian on the best way to manage these parasites.

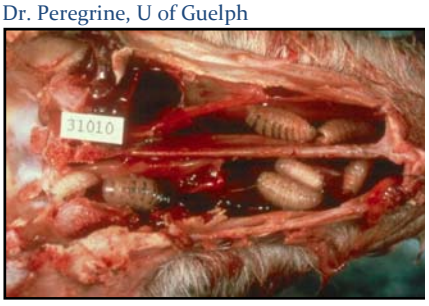
NOSE BOTS

Oestrus ovis is the larval (maggot) stage of the bot fly that lays its eggs just inside the nostrils of the sheep. When a bot fly is around, the sheep are very agitated: they will stomp their feet,

Fig. 30. Sheep keds
Dr. Peregrine, U of Guelph

Fig. 32. Chorioptic mange
Dr. Peregrine, U of Guelph

Fig. 31. Nose bots
Dr. Peregrine, U of Guelph



push their nose into the ground and not eat. For this reason, nose bots should be properly controlled. The larvae hatch and migrate up into the sinuses of the sheep causing mild distress and a nasal discharge. Ivermectin is very effective at killing the bot larvae but cannot be used in lactating dairy sheep without withholding the milk for a long period. Consult your flock veterinarian for advice on how to control this parasite.

CHORIOPTIC MANGE

Chorioptic mange caused by *Chorioptes bovis* – sheep adapted strain, is a very common infection. The mites are generally found on the pasterns of the legs and sometimes on the udder and escutcheon of the ewes, and the scrotum of the ram. The lesions are red, scabby, irritating and itchy. Again, consult your veterinarian on how best to treat them in lactating dairy ewes.

2.7 DISEASES WHICH CAUSE CHRONIC WASTING OF DAIRY EWES

There are many infectious and non-infectious diseases that can cause weight loss, other clinical signs, early culling and death in adult dairy sheep. Some of these infections are quite common in Canada, and their control is important to the overall health of the flock. The diseases, signs and control are listed in Table I.6. Complete discussion of these diseases is beyond the scope of this course.

Table I.6. Important conditions which cause chronic weight loss in dairy sheep in North America

DISEASE	SIGNS	CONTROL
Dental disease Common	Slow eating, not chewing cud, swellings on jaw or face.	There is not treatment. Forages and pastures should be free of weeds, stones and gravel.
Maedi visna Common	Decreased milk production, hard udder, respiratory distress.	It is caused by a slow virus. The **Ontario Maedi Visna Flock Status Program** is available at http://www.ontariosheep.org/PROGRAMSANDSERVICES/MaediVisna.aspx.
Johne's disease Common	Weight loss, sometimes diarrhea. Always fatal.	Control is difficult but relies on prevention of transmission of the bacteria Mycobacterium paratuberculosis to young lambs. More information is available at http://www.johnesdisease.org/index.html.
Scrapie Reportable	Weight loss, sometimes nervous signs and itching.	Suspected cases must be reported to the Canadian Food Inspection Agency. A scrapie program is available at http://www.scrapiecanada.ca/home.html.
Caseous lymphadenitis Common	External and internal abscesses, weight loss, sudden death.	Vaccination, isolation of animals with abscesses, culling, shearing biosecurity.
Competition Common	Weight loss, fighting.	When animals of different sizes, classes are housed together and there is insufficient feeder space.

2.8 BIOSECURITY OF THE SHEEP FLOCK

Biosecurity means those measures to prevent disease from entering a flock, spreading within a flock and being released from a flock. Risk to the flock comes from animals – both sheep, other livestock, vermin and wildlife; equipment; and people. Recently the Canadian Food Inspection Agency, sheep producer groups and veterinarians composed a Biosecurity Standard as well as a guide for sheep producers. All producers in Canada should have each received a copy. It can also be found "on-line":

http://www.inspection.gc.ca/animals/terrestrial-animals/biosecurity/standards-and-principles/sheep-on-farm/eng/1368456677456/1368456778304

2.9 ONTARIO SHEEP HEALTH PROGRAM

A program exists to help producers and veterinarians design and implement a flock health program. It is administered by the Ontario Sheep Marketing Agency and can be found at

http://www.ontariosheep.org/PROGRAMSANDSERVICES/OntarioSheepHealthProgram.aspx

It can also be found at

http://www.uoguelph.ca/~pmenzies/OSHP_Home.htm

2.10 FOOD SAFE FARM PRACTICES

This is the Canadian sheep industry's on-farm food safety program. Its goal is to protect people against biological, chemical and physical hazards in food derived from sheep, i.e. meat and milk. All dairy sheep producers should be enrolled and certified through this program as part of good management practices. The information on the program can be found at

http://www.cansheep.ca/cms/en/Programs/FoodSafeFarmPractices/FoodSafetyFarmPractices.aspx