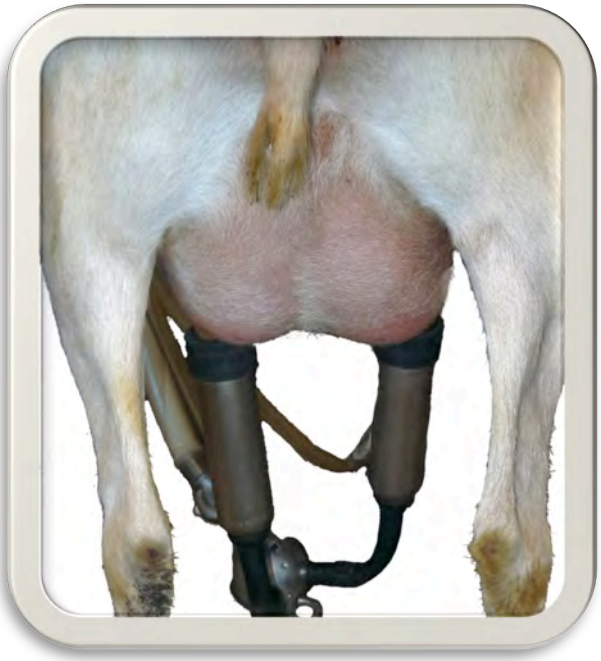
A Guide To

Udder Health For Dairy Goats



To assist producers, veterinarians, extension and dairy support personnel in the production of quality goat milk

Version 1.0 2016

Agri-Food and Rural Link
A program of the OMAFRA – U of G Partnership
Mobilizing Agri-Food and Rural Research Knowledge

University of Guelph
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THE DAIRY GOAT GUIDE HAS BEEN GENEROUSLY FUNDED BY

Knowledge Translation and Transfer (KTT) Program; University of Guelph / Ontario Ministry of Agriculture, Food & Rural Affairs Program; Ontario Goat; Hewitt's Dairy

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WHAT IS THE PURPOSE OF THIS GUIDE?

Dairy goat producers want to produce the highest quality product – specifically, milk – for their consumers. Part of the process of achieving this goal is to maintain the health of the animals that produce that milk, and in particular the health of the udder.

This guide is designed to help educate producers, veterinarians, and extension and dairy support personnel on how to best do that. The information in this guide has come from a number of sources but includes extension information from both the small ruminant and cow sectors, and new information from the latest research from around the world.

The self-assessment quiz is designed to help you determine if you understand the information and to remind you of the important points. To get the most out of this guide, we recommend that you complete all of the sections and assess your understanding as you go along.

WHAT IS MEANT BY THE TERM "QUALITY MILK"?

Quality milk is defined by its characteristics:

- The level of bacteria in the milk;
- The number of somatic cells (which are a measure of inflammation or mastitis);
- The freezing point if the milk is abnormal in composition;
- Presence of residues of veterinary drugs and other chemicals or toxin; and
- By its colour, flavour and odour.

Most processors have standards and provinces have legislation governing what is acceptable quality for goat milk. **None of the components of this guide are part of a regulatory process** but its contents will help you to understand how to produce better quality milk, with particular reference to the health of the udder. Please understand that regulations and guidelines can be regionally different and it is **your responsibility to know what the regulatory levels are for your region and markets**.

WHAT IS MEANT BY THE TERM "UDDER HEALTH"?

The term "udder health" refers to those measures which keep the udder healthy so that it can produce high quality milk. But of course, the udder is attached to the doe and the doe lives with other goats – so really "udder health" also refers to those practices designed to keep the herd healthy so that the does can produce healthy milk.

Mastitis is the number one reason for poor udder health and will be a major focus of this guide, but overall doe health also influences the ability for it to produce quality milk. Udder health is an integral component of producing quality milk – in terms of the level of somatic cells (a measure of mastitis), some aspects of bacterial counts, and of course residues of drugs in the milk. So in summary, this guide will emphasize milk quality within the context of udder health.

HOW THIS GUIDE IS ORGANIZED

The page number is colour-coordinated by section as above. Within each section there are many sub-sections that address the material in detail. Some words or phrases may be new to you so we have provided some definitions to help with understanding. The self-assessment quiz is provided in a separate section so that multiple persons can use the guide. References and additional reading suggestions are provided in an appendix so that you can understand where this information came from and find more detailed information if you wish.

NOTES

SECTION I
NORMAL LACTATION

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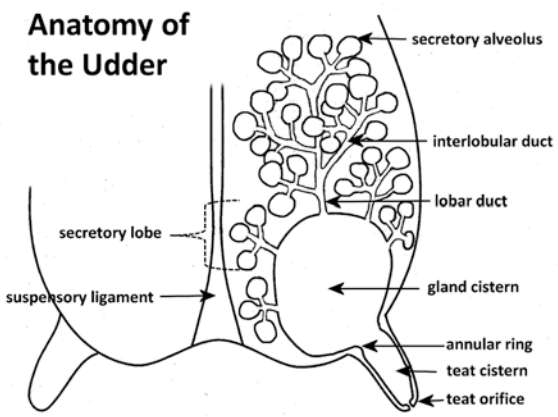
1. THE NORMAL MAMMARY GLAND SYSTEM OF A DOE

To understand what is abnormal, we first need to understand how a healthy doe 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 parts 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 doe. Milk produced in the alveoli travels into the ducts that connect the alveoli and eventually into the gland cistern and into the teat cistern.

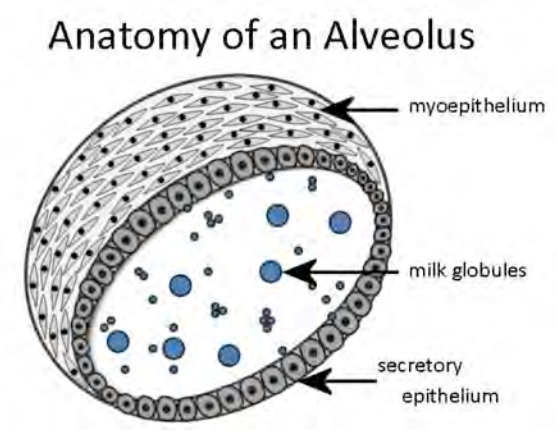
Fig. 1.



1.2 MILK ALVEOLI

Each alveolus is lined by special secretory epithelial cells, which are responsible for secreting the various components of milk (casein, lactose, lipids (milk fat), 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.

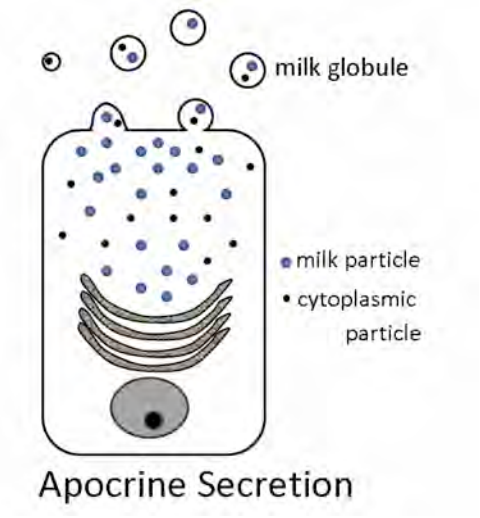


1.2.1 HOW MILK IS SECRETED

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 sheep 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.

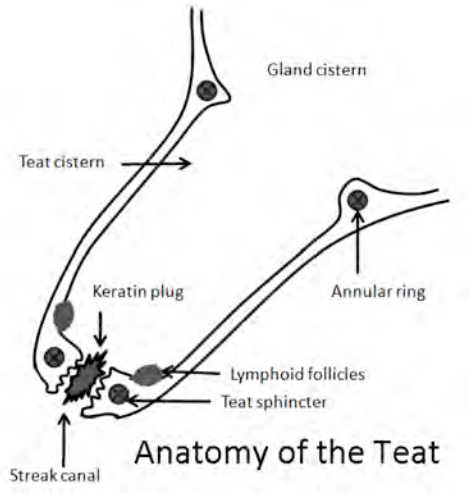
Fig. 3.



1.3 ANATOMY OF THE TEAT

The teat is separated from the gland cistern by a circular band of tissue (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 kid'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.

Fig. 4.



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 nursing. 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 doe 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.**

1.4 ECTOPIC MAMMARY TISSUE

Occasionally mammary tissue may grow in places other than in the mammary gland. This likely occurs before birth but may not be evident until the doe lactates for the first time. A common site is at the base of the teat. Another is around the vulva. Does coming into milk will develop swellings that are moderately painful – occasionally milk can be expressed from them. The recommendation is not to touch them and consider culling the doe if they interfere with proper milking.

2 HOW IS MILK PRODUCED?

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 kidding 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 kidding. 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 doe (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.

2.2 LACTOGENESIS (PRODUCTION OF MILK)

This is the creation and secretion of milk, starting with colostrum prior to kidding 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.

2.2.1 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 naturally produced protein called **Feedback Inhibitor of Lactation** (FIL). Build-up of this protein in the udder inhibits milk production. This protein is important for drying-off (see below).

2.2.2 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 doe 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 does 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.

2.3 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

3 INVOLUTION OF THE UDDER

When removal of milk ceases (e.g. at dry-off or weaning), the mammary gland will involute. However, even if the doe continues to be milked, milk production will eventually decline and cease. The speed of this decline is influenced by the doe's genetic make-up.

If milking ceases there is a build-up of FIL, which will reduce secretion of milk. Cells start to die naturally (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 does are often not bred until late in lactation (to kid every 12 months, does would be bred at 210 days in milk), so it is unlikely to play a major role in lactation length.

3.1 DO GOATS REQUIRE A DRY PERIOD?

The practice of continuous milking through to the next kidding appears to be common but that practice carries some risks. Research shows that goats require at least 28 days of dry period or the next lactation milk production is lower. Without this quiet period, mammary cell proliferation (i.e. the cells which produce milk) is reduced at the next kidding and the udder resembles that of a late lactation doe. One study found that ~ **30%** less milk is produced the following lactation in those animals. To fully understand the effects of this management practice, more research is needed.

At this time, it is recommended that the dry period not shorter than 28 days and more appropriately a minimum of 60 days to allow for proper colostrum production; appropriate doe nutrition; and proper dry period mastitis treatment (see Section VI).

4 MILK PRODUCTION

4.1 WHAT ARE NORMAL PRODUCTION LEVELS FOR DAIRY GOATS?

There is tremendous variability in milk production based on breed and parity. Table I.1 is adapted from information published by the American Dairy Goat Association of breed averages of dairy goat herds on milk recording programs. One kilogram is worth approximately 1 litre of milk

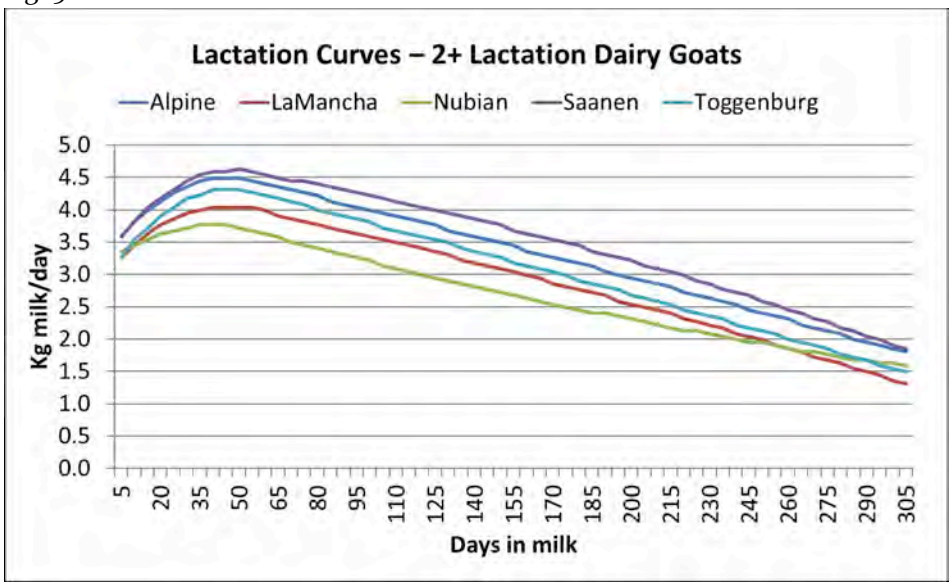
Table I.1 American Dairy Goat Association breed averages – 2013 lactations[1]

Breed	Avg Age	Milk (kg / lbs)	Range (kg)	Butter fat (%)	Protein (%)
Alpine	3 y 5m	1163 / 2559	405 - 2400	3.3	2.9
LaMancha	2y 6m	987 / 2171	318 - 1832	3.7	3.1
Nigerian Dwarf	3y 6m	327 / 719	123 - 741	6.3	4.3
Nubian	2y 6m	893 / 1964	241 - 1687	4.6	3.7
Saanen	3y 5m	1188 / 2631	386 - 2495	3.3	2.8
Toggenburg	3y 5m	983 / 2163	414 - 1891	3.1	2.7

4.2 LACTATION CURVE

Total milk production of the doe 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 for the common dairy breeds[2] if the doe is milked twice/day starting one day post-kidding.

Fig. 5



[1] ADGA http://www.adga.org/
[2] Adapted from data USDA Animal Improvement Program http://www.aipl.arsusda.gov/

4.3 FACTORS THAT AFFECT PEAK MILK AND PERSISTENCY

Genetic selection and breed have the most profound effect on milk production. But within breed on a given farm, other factors will also influence peak milk and persistency.

- Photoperiod (daylight length) during dry and lactation period, including season
- Milking frequency (number of times milked per day)
- Pregnancy
- Lactation number
- Length of lactation
- Nutritional supplementation
- Number of kids born – prolific does produce more
- Level of production – higher producing does have higher peaks
- Stress and pain at the time of milking
- Presence of mastitis and CAE virus (10% less milk in CAE test positive does)

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

Because they are seasonal breeders, normally goats lactate during the spring and summer and are dry during the winter. However because milk is required year round by the processors, there are financial pressures to have does milk during all seasons. Season of kidding and day-length appear to affect milk production. Does which are dry during short-days (i.e. late fall / early winter months) milk about ½ kg/day more their subsequent lactation than does dry during the long-days (i.e. late spring / early summer months). Some producers find that winter milk may have high fat percentage though. Does exposed to long-day photoperiod manipulation (see Section VIII) in the winter months, will milk as if it is summer.

4.3.2 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

Does nursing kids are normally milked-out every one to two hours. Traditional milking systems are usually every 12 h or twice/day. But milking is very labour intensive and if the interval between milkings could be increased without loss of milk yield, there could be tremendous savings on labour. Between milkings, milk is stored not only in the alveoli but also in the gland cistern. Up to 80% of total milk production can be stored in the cistern of the doe as opposed to dairy cattle, which is generally around 20 to 30%. So with this thought, researchers have wondered if goats could tolerate being milked once/day. Unfortunately research has found that for high producing dairy goats, milking once/day versus twice/day will cause a loss of 16% to 35% of milk production regardless of age. This difference appears to persist whether once/day milking is done in early, mid or late lactation. Once/day milking also increases somatic cell counts (SCC). Goats with large cisterns have similar production losses than goats with small cisterns.

Increased frequency of milking may increase production. One study in which goats were milked four times/day showed an increased milk production ~ 15 to 20% over twice/day.

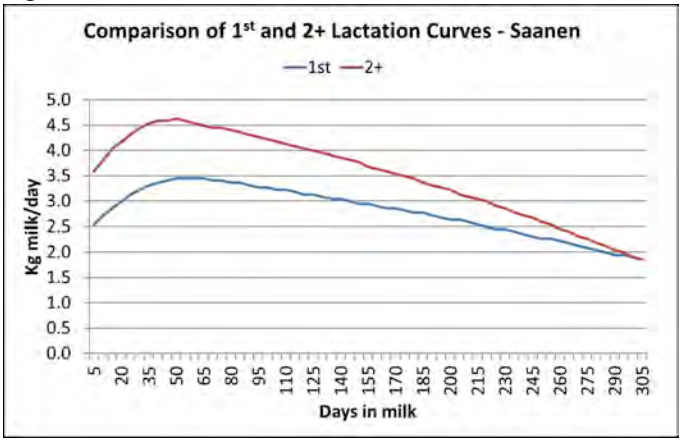
4.3.3 EFFECT OF PREGNANCY ON LACTATION

Does which are expected to kid every 12 months and have a dry period of 2 months, are usually bred in late lactation around the beginning of the 7th month of lactation. Research has shown that early pregnancy, i.e. first 2 months of gestation, has no detrimental effect on milk production. However, in the last month of lactation prior to dry-off, milk production is only 60% of that of an open doe at the same number of days in milk. This is due to hormonal changes and the natural tendency for an animal to cease lactating prior to giving birth again.

4.3.4 FIRST LACTATION VERSUS 2+ LACTATION

Doelings, i.e. first lactation goats have lower peak milk and more persistency in their lactation curves. Fig. 6 demonstrates the difference between a lactation curve of a multiparous Saanen doe and one lactating for the first time[3].

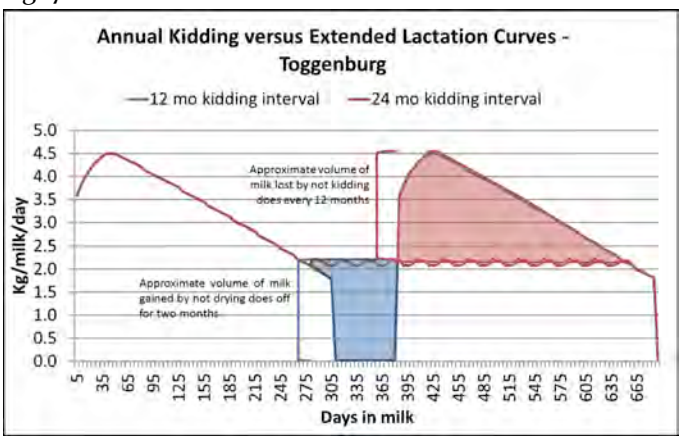
Fig. 6



4.3.5 EXTENDED LACTATIONS

There has always been considerable interest in milking goats longer than 10 months (305 days) in order to reduce the number of dry months and subsequently the number of freshenings (kiddings) in a doe's life. This is different than milking through kidding. There are pros and cons to this but in the end, it mustn't harm the health of the goat and must make economic sense in terms of value of milk produced, kid sales, genetic improvement, etc.

Fig. 7



Most does will dry off by 10 months of lactation, but a proportion has the genetic ability to keep milking. While milk production will persist in those animals – usually at the level of a late lactation doe without the drop associated with pregnancy, the lactation line is flat. Fig. 7 adapted from data provided in the research literature[3] attempts to show the trade-off in milk production between the two systems. Is the milk production gained by not drying off the doe worth the loss of the peak milk and the kid sales? This answer will differ by farm and by doe being milked. Regardless, it is commonly practiced with some does that are persistent milkers.

[3] Adapted from data USDA Animal Improvement Program http://www.aipl.arsusda.gov/

SECTION II
MASTITIS – WHAT CAUSES IT AND HOW IT IS DETECTED

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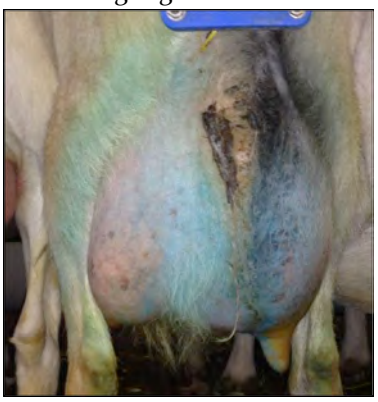
1. MASTITIS AND ITS COSTS

1.1 WHAT IS MEANT BY THE TERM "MASTITIS"?

Mastitis means inflammation of the mammary gland and change to the anatomy and / or physiology of the udder. Inflammation is the animal's response to a microorganism (e.g. bacteria, viruses) but may also be a response to injury or systemic illness. Inflammation can be seen because the udder will become **red, swollen and painful** – indications that the immune system is active in the udder (Fig. 1). Inflammatory cells are usually white blood cells, and when present in the milk, are called somatic cells.

"Intramammary infection" (IMI) is term often used instead of mastitis but is caused by a microorganism. In this guide, we will use the term **mastitis**.

Fig. 1 Udder with mastitis. Note swollen right gland.



Mastitis causes loss in milk production and the quality and yield of milk products (e.g. cheese, yoghurt, fluid milk).

It can be detected by:

- Clinical examination of the doe and its milk;
- Measuring the level of somatic cells present in the milk; as well as
- Culturing the milk to identify the microorganisms responsible for the infection

Because mastitis is so important when trying to produce quality milk, this guide will go into detail regarding the disease, how to detect it and how to treat and control it.

1.2 IMPORTANCE OF MASTITIS IN DAIRY GOATS

When you see an inflamed udder or abnormal milk in a doe, this means lost milk and therefore lost income. There are also losses associated with subclinical mastitis (See Section 2.2).

1.2.1 ECONOMIC IMPACT

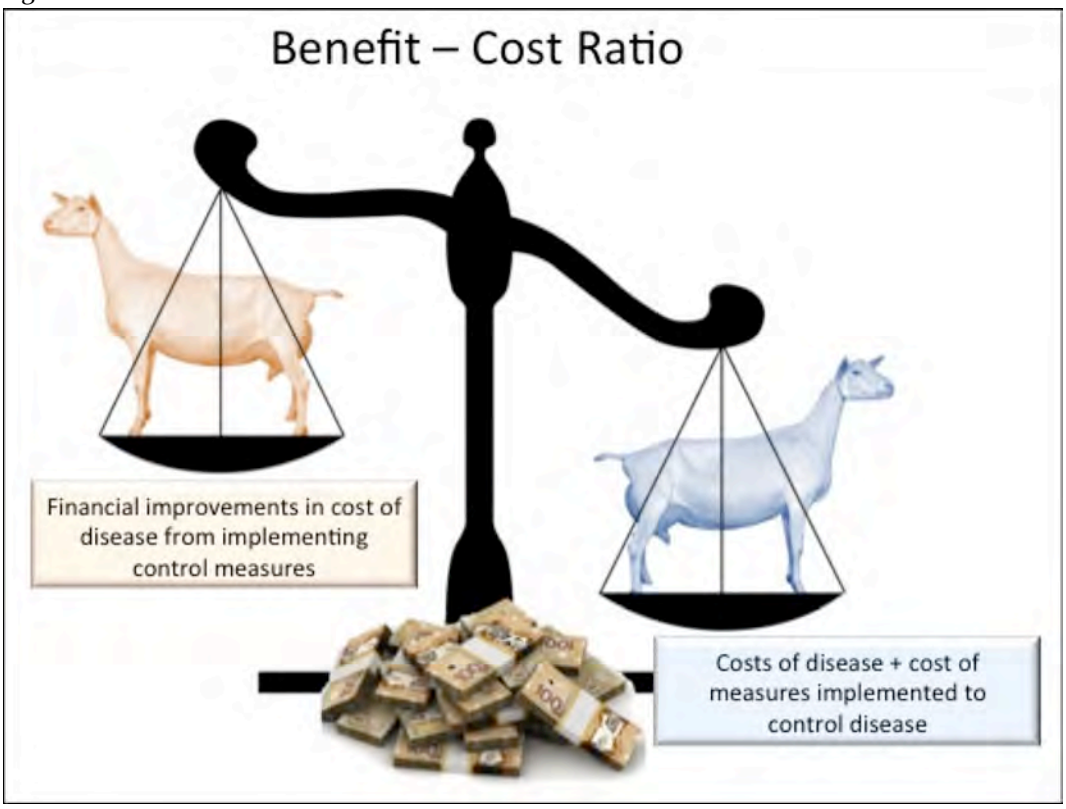
ESTIMATES OF THE ECONOMIC COST OF MASTITIS

To properly estimate the economic costs associated with mastitis, not only does a producer need information on how much the disease is costing – but also must determine what level of disease is acceptable and attainable (i.e. set a goal). Mastitis cannot be eradicated like some other diseases and so the control program must be designed to reduce losses so that a good benefit – cost ratio can be achieved. **Economists call this "Avoidable Loss", i.e. the difference between current losses and achievable losses given a good and affordable health management program**.

Calculating the benefit – cost requires considering both the costs of having the disease versus not having the disease, i.e. changes to level of mastitis if specific interventions are taken, and the costs of

lowering the incidence of mastitis (Fig. 2). Below are examples of the costs (benefits) that go into this analysis.

Fig. 2



COSTS ASSOCIATED WITH MASTITIS

Fig. 3 Cull does

- ✓ A doe with mastitis is often culled earlier in life (Fig. 3). This changes the turnover rate of the herd with lost opportunity sales of replacement stock. The doe is replaced in the herd with a doeling with lower milk production.
- ✓ If a doe is culled early, the difference between her slaughter price and that of a doe raised or purchased to replace her.
- ✓ The difference between the value of a dead doe and a replacement doe.
- ✓ A doe with mastitis will have lower milk production in terms of yield, and total solids multiplied by the value of that lost milk.
- ✓ Lost bonuses for producing high quality milk, or rejection of milk from processors if mastitis levels rise too high.
- ✓ Lost kid production in terms of differences in kid survival and poorer kid growth.
- ✓ Veterinary costs for treating clinical mastitis, which includes drugs, equipment and labour.
- ✓ The value of discarded milk from treatments, plus the risk of inhibitors (drug residues) being detected in the milk or meat (See Section VI).

- ✓ Increased feed costs associated with feeding less productive does.
- ✓ Increased management costs (labour and facilities) that are associated with having to separate treated does or does with contagious forms of mastitis when milking.

COSTS OF A HEALTH MANAGEMENT PROGRAM DESIGNED TO CONTROL MASTITIS

- ➢ Improvements in housing (e.g. stocking density, ventilation, cleanliness of bedding).
- ➢ Improvements in milking equipment and its maintenance.
- ➢ Products to improve hygiene at milking (e.g. gloves, disinfectants, paper towels)
- ➢ Therapies such as "dry-cow" intramammary antibiotics that may cure existing infections and reduce new ones.
- ➢ Detection of and monitoring for subclinical mastitis (SCC and/or CMT and culturing milk from suspect cases).
- ➢ Costs associated with culling chronically infected does.

BENEFITS OF AN UDDER HEALTH PROGRAM

The clearest benefits are the avoidance of the losses listed under "costs associated with mastitis" and the increased milk production, health and welfare of your animals. Additionally, the herd's reputation will be improved and recognized for its udder health status.

1.2.2 WELFARE COSTS

Mastitis is an illness that can cause permanent damage and sometimes death. It is also very painful to the doe, particularly severe clinical mastitis. The welfare implications can also apply to offspring, as kids nursing does with mastitis may starve to death. Mastitis must be properly treated and controlled to decrease the welfare costs to the farm.

1.2.3 PUBLIC HEALTH RISK

BACTERIA THAT CAUSE DISEASE IN PEOPLE

Many of the bacteria (e.g. *Staphylococcus aureus, Listeria monocytogenes*) that infect the udder of a doe can also cause disease in humans if consumed in raw milk and soft or semi-soft raw milk cheeses. Often these disease agents are shed in the milk with no signs of infection. Raw milk consumption should be avoided since it can carry bacteria that can lead to serious health conditions that range from illness to life-threatening kidney failure, miscarriage, and – in some cases – death. Specific bacteria that are risky will be covered in Section II.3. These microorganisms are killed by proper pasteurization.

CHEMICALS OR OTHER ADULTERANTS

Failure to withhold the milk after using antimicrobial drugs (antibiotics) may leave residues of these drugs in the milk – increasing the risk of allergy or toxic insult in humans. Overtreatment with antimicrobials may increase the risk of antimicrobial resistance. Residues from other drugs, e.g. dewormers, lice treatments, hormones, painkillers, can all make humans ill when they consume the milk. Consult Section VI for more detailed information on how to avoid this risk.

2. SIGNS OF MASTITIS

Mastitis as a disease can be categorized into three types depending on the severity of the disease and the signs that it causes.

2.1 CLINICAL MASTITIS

Clinical mastitis presents itself with visible signs of infection with abnormal milk, and may or may not be associated with systemic signs, depending on the severity of the infection (Fig. 4).

2.1.1 SEVERE CLINICAL MASTITIS

This term means that the doe has signs of illness. The incidence of severe clinical mastitis (number of cases/year) is generally ~ 1%, but the case fatality rate (proportion of does that die if they have the disease) is often 10 to 50%, making this not only economically important but also a welfare concern. Of those that survive, a very high percentage (as high as 70%) are culled either because the udder is irreversibly damaged or because of low milk production after recovery.

ACUTE SEVERE CLINICAL MASTITIS

Acute means sudden onset (as opposed to chronic where the disease has been present for weeks or months). Signs include: high fever, usually 40.5 °C (105 °F) or higher (normal ~ 39.5 °C or 103 °F); depression; partial or complete lack of appetite; dehydration which is usually noted as sunken, dull eyes; and grinding teeth from pain. The udder or individual gland is swollen, hot, and painful to touch and usually has an inflamed or red appearance. The doe may appear lame because of a reluctance to have the leg touch the udder. The milk may be watery in appearance or red-tinged from blood or appear like reddish serum - with or without clots of milk present.

GANGRENOUS MASTITIS

Gangrenous mastitis is often called "**blue bag**". Signs in the doe may be similar to acute severe clinical mastitis with the exception that the gland and / or teats are cold to the touch. About 8 to 10% of all cases of clinical mastitis are gangrenous. The onset of the disease is very acute, e.g. within a few hours. The skin is often bluish or purple in colour indicating that the blood supply to the skin and udder is damaged – usually from toxins released by the bacteria in the udder (Fig. 5). The secretion from the udder is usually scant, blood-tinged serum.

Fig. 4 Clinical mastitis

Fig. 5 Gangrenous mastitis
Courtesy N. East

Fig. 6 Sloughing gland lost from gangrenous mastitis. Courtesy G Zobel

Gas may also be felt in the udder. The changes to the skin may advance beyond the udder and can affect the abdomen and inside of the thighs. When this is the case, the likelihood for survival of the doe is poor.

Fig. 7 Firm gland

Gangrenous mastitis is most often seen within 1 to 4 weeks after kidding, and some cases occur after dry-off, but it can occur at any time of lactation. The bacteria usually responsible for this type of mastitis are either *Staphylococcus aureus* (most commonly) or *Mannheimia haemolytica*, but other organisms are less commonly responsible, such as *Escherichia coli* (*E. coli*) or *Pseudomonas* bacteria (See Section II.3.2 for more details). Bacterial spores from clostridial organisms which prefer tissue with low levels of oxygen, may invade into damaged tissue causing "gangrene". Usually by the time the gland becomes cold to the touch, it is too late to save it – but perhaps not too late to save the doe. However, does with gangrenous mastitis are usually very ill and in need of emergency treatment if they are to be saved.

Does that recover from gangrenous mastitis will lose the diseased gland (Fig. 6). The tissue dies and becomes purulent and the discharges from the decaying gland are teeming with bacteria – a source of infection to other does. These wounds can easily become fly struck and filled with maggots. These animals should be isolated and culled as soon as drug withdrawal times are over and the udder is healed.

Fig. 8 One gland is "light" suggesting mastitis

2.1.2 MODERATE CLINICAL MASTITIS

There are clinical changes to the udder and milk, but the doe appears healthy.

ACUTE

The onset is sudden, usually noticed from one milking to the next. The doe is not ill but the udder is abnormal, e.g. the udder is uneven because one of the glands is swollen; the skin of the gland may appear pink or red and warm to the touch; the gland is often firm on palpation (Fig. 7), or it may be lumpy or fibrotic. With moderate clinical mastitis, the doe will have a normal appetite, although milk production is reduced. The milk is likely discoloured, clots, flakes or strings – and sometimes purulent (i.e. pus).

Fig. 9 Abscessed udder

CHRONIC

It may be that the initial acute infection was missed, or the doe failed to recover completely from an acute case of mastitis. It is not uncommon for chronic mastitis to be noted at dry-off, or at kidding. The udder, one or both glands - may be larger because of the presence of scar tissue or abscesses, or shrunken (Fig. 8) because of the loss of functional tissue producing milk. It may

be hard or lumpy. If abscesses are present (Fig. 9), there may be pus draining from a hole in the gland. The udder may still be warm to the touch and painful. The milk is abnormal and decreased in amount. It may even be absent or replaced with a purulent (i.e. pus-like) secretion. These cases are impossible to cure and the doe should be culled.

2.1.3 MILD CLINICAL MASTITIS

The doe is not ill, the udder appears normal but the milk appears abnormal. It may have clots, be purulent and / or have an abnormal colour or sometimes odour or taste. These changes may be acute or chronic but it may be more difficult to tell how long the changes have been present based on the appearance of the milk.

2.2 SUBCLINICAL MASTITIS

This is by far the most common presentation of mastitis. There are no clinical changes to the doe and the milk has a normal appearance. However, mastitis may be present and be causing an increase in somatic cells and a decrease in milk production. Subclinical mastitis must be detected using tests that detect either the somatic cells or by culturing the milk. Because most mastitis in does is subclinical it is economically critical to detect and control.

2.3 AGALACTIA (NO MILK IN THE UDDER)

Agalactia means that one or both glands have no milk whatsoever. There are many causes of agalactia:

- The milk-producing tissue of the glands may be destroyed by an infection;
- The teats may have a blockage – either congenital (the teat wasn't formed correctly) or acquired from trauma, or scarring secondary to mastitis;
- The doe may not be producing milk either because she is ill, nutritionally starved, or she is at the end of her lactation;
- Apparent agalactia may occur if the milk let-down mechanism isn't working (e.g. stress or improper udder preparation), or the kids have nursed out all of her milk.

3. WHAT MICROORGANISMS CAUSE MASTITIS IN GOATS?

Most mastitis is caused by bacterial infection by a wide variety of bacteria. Viruses and yeasts may also be involved. Some of these bacteria are contagious, i.e. picked up from another animal – and some are from the environment. The important and common pathogens are summarized in Table II.1. There are many other organisms, which occur less commonly.

Table II.1. Classification of important udder pathogens of does

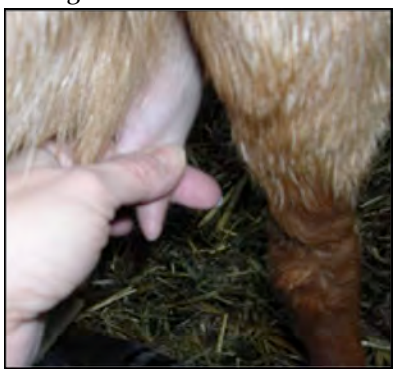
TYPE OF ORGANISM	NAME OF ORGANISM	CHARACTERISTICS
CONTAGIOUS (Goat –to-Goat)		
Bacteria	*Staphylococcus aureus*	A common cause of clinical mastitis in does. Very difficult to cure. Highly contagious from other does and milkers' hands.
Bacteria	*Mannheimia* species (Pasteurella)	Common cause of clinical mastitis in ewes, but not as common in does. May come from throat of nursing kids.

TYPE OF ORGANISM	NAME OF ORGANISM	CHARACTERISTICS
Bacteria	Coagulase negative staphylococcus (CNS)	A group of organisms that are the most common cause of mild clinical mastitis and subclinical mastitis. Also considered environmental.
Bacteria	*Streptococcus agalactiae*	Occurs more commonly in cattle. **Rare** in goats.
Mycoplasma	*Mycoplasma agalactiae*	Very rare in North America but common and important cause of mastitis in European sheep and goats. Incurable.
Mycoplasma	*Mycoplasma mycoides* subsp. *capri* (Mmc)	Common in some parts of North America. Occurs occasionally in Ontario. Causes septicaemia in kids as well as arthritis and mastitis. Also called *Mycoplasma mycoides* subsp. *mycoides* large colony type. Incurable.
Virus	Caprine Arthritis Encephalitis virus (CAEV)	Common infection in Canadian goats. Causes inflammation and scarring of the udder as well as arthritis in adult goats. Incurable.
Prion	Scrapie	Causes wasting and nervous signs. It is shed in the milk but cannot be detected by milk culture. Incurable.
ENVIRONMENTAL (Environment-to-Goat)		
Bacteria	*Streptococcus dysgalactiae* *Streptococcus uberis*	From dirty or wet environment and udder. Can also be transmitted doe to doe (contagious) and causes joint infections in kids. There are many other organisms in the same group, e.g. *Enterococcus faecalis.*
Bacteria	Coliforms (*E. coli*)	From dirty environment. Common in dairy cattle. Less common in goats.
Bacteria	*Pseudomonas aeroginosa*	From dirty or stagnant water. Also contagious doe to doe. Incurable.
Bacteria	*Listeria monocytogenes*	From wet conditions, bad silage. Can be shed in the milk without signs of mastitis. Important public health issue.
Yeast	*Candida albicans & Cryptococcus*	Usually from overtreatment with antibiotics.

3.1 CONTAGIOUS MASTITIS ORGANISMS

Contagious organisms are pathogens transferred from animal-to-animal. This transfer of bacteria is usually done at milking, from sources such as milker's hands (Fig. 10), towels that are used on multiple does, or from milk remaining in liners of the milk cups (inflations). These infections tend to be a problem on-farm, and it is difficult to eliminate the organisms which remain in the udder and cause loss of milk production.

Fig. 10 Hands may carry contagious bacteria



3.1.1 BACTERIA

STAPHYLOCOCCUS AUREUS

Staph. aureus is a contagious pathogen, which is **one of the most important threats** to udder health in many herds. It is generally transferred to does at milking from both the milk and teat skin of infected animals, to uninfected animals. This transfer is done through milking equipment, milker's hands and

from towels used to dry the udder if they are used on multiple does. Another possible method of transmission is feeding kids milk infected with *Staph. aureus*. At the initial stages of infection, *Staph. aureus* often causes clinical mastitis; however, most commonly it is a subclinical infection, often with elevated somatic cell counts. Additionally, the infections are chronic, causing lost milk production and are very resistant to treatment. The infection often results in the formation of microscopic abscesses in the udder tissue, making it difficult for antibiotics to reach the bacteria.

Staph. aureus is identified through culturing of milk from suspected cases. Antibiotic treatment **while milking has low success of curing the infection**; however, **treatment during the dry period is more effective**. The best way to control this pathogen on-farm is to take stringent prevention protocols when milking. These management practices include milking *Staph. aureus* infected animals in the group last, and thoroughly disinfecting the milking equipment after use on these animals, so the bacteria are not transmitted to uninfected does. In some cases, if *Staph. aureus* is a major issue in a herd, a separate milking unit can be reserved for milking these problem animals.

MANNHEIMIA SPECIES (PREVIOUSLY *PASTEURELLA*)

Mastitis caused by *Mannheimia* bacteria is less common in dairy goat herds and is more associated with meat sheep, but results in severe clinical cases of mastitis. In sheep, the strains of this pathogen that are isolated from the teat skin of infected udders are identical to those isolated from the throat area of lambs and the same strains which cause pneumonia. This suggests that nursing may be a risk factor for this type of mastitis.

COAGULASE-NEGATIVE STAPHYLOCOCCI

Coagulase-negative staphylococci (CNS) are a group of bacteria comprised of over 50 different bacterial species. They vary in level of ability to cause disease from most often subclinical mastitis to moderate or occasionally severe clinical mastitis. Coagulase-negative staphylococci may self-cure or be quite persistent in the udder. These bacteria have historically been considered as contagious but may also come from the environment.

Coagulase-negative staphylococci are identified by culturing milk from suspected cases. Currently the Animal Health Laboratory - University of Guelph (AHL) will determine the actual species of the bacteria routinely but this information tends not to change the approach to treatment. Research has shown that some of the more prevalent CNS species in herds are *Staph. epidermidis*, *Staph. caprae* (often found in human skin infections) and *Staph. simulans*. These may be more commonly found when improper post-milking teat dipping is performed.

STREPTOCOCCUS AGALACTIAE

Although a **very rare** infection in goats, *Streptococcus agalactiae* can be transferred to does during milking. If this infection is identified on-farm, it can be eradicated from the herd through treatment of affected does during lactation. *Strep. agalactiae* are identified through culturing milk from suspected cases. Antibiotic treatment can successfully kill *Strep. agalactiae*, and rid the infection from the udder.

3.1.2 MYCOPLASMA

MYCOPLASMA AGALACTIA

This particular bacterium, which causes a disease called "contagious agalactia", is considered not to occur in North America but is a very common and important cause of mastitis of sheep and goats in Europe which is why we have included its description. *M. agalactia* does not respond to treatment. Contagious agalactia syndrome can also cause arthritis and conjunctivitis; however, it is most importantly a cause of mastitis. In Europe, dairy sheep and goats are commonly vaccinated as part of the control program. This will reduce the severity of the disease but not eradicate it.

MYCOPLASMA MYCOIDES SUBSP CAPRI

Also called *Mycoplasma mycoides* subspecies *mycoides* large colony type, this infection is common in dairy goats in some parts of North America (e.g. California) and can be a devastating infection. Mastitis can be acute severe to subclinical. Does may be normal appearing carriers or develop severe illness and may die of the infection within a few hours. Kids drinking infected milk may develop septicaemia and die, or if they recover will develop septic arthritis (Fig. 11) or become carriers of the bacteria. The bacteria are highly contagious and spread easily at milking time on equipment and milkers' hands. There is no effective treatment and culture and cull is the only control method.

Fig. 11 Kid with mycoplasma arthritis and septicaemia (Courtesy N. East)

Routine milk culturing will not grow these bacteria. If mastitis in the herd is severe and other bacteria are not isolated from milk samples, your herd veterinarian may decide to culture the milk for mycoplasma, which requires special milk culturing methods.

3.1.3 CAPRINE ARTHRITIS ENCEPHALITIS VIRUS (CAEV)

CAE is a very common disease in dairy goats in Canada. It is caused by a slow virus (CAE virus). Animals can be infected at any age but infection as kids likely has the most effect on the doe later in life. The kid becomes infected through drinking the colostrum and milk, from respiratory secretions and sometimes while the kid is still in the uterus. The doe remains infected for life and there is no cure.

Fig. 12 Doe with CAE mastitis

The virus targets the joints, udder and lungs. As mastitis, it causes uniform hardening of the udder and loss of milk. The virus causes an influx of lymphocytes into the udder tissues, which causes severe inflammation, scarring and loss of milk producing alveoli (Fig. 12). Infected does produce less milk and have lower milk components than uninfected does. Additionally, the arthritis is responsible for pain and early culling due to lameness. At this point, there is no official CAE control program in Ontario although many veterinarians offer a method of test and eradication using a blood test (serology) to detect infected goats. A similar infection – maedi visna – in sheep has an Ontario

voluntary program designed to help producers eradicate this important and common infection, and remain low risk[1]

3.1.4 SCRAPIE

Scrapie infects both sheep and goats, resulting in severe disease for which there is no cure (Fig. 13). The agent of scrapie can be found in the milk, but does not cause mastitis. Prions, which are the infectious proteins that cause scrapie, have been isolated from the brain, tonsil and lymph nodes, as well as mastitic mammary glands. This could pose a problem with the transfer of these prions from a doe's milk or colostrum to her kids, which could increase the potential of scrapie infection. Heat-treating the colostrum will not kill the organism. Scrapie is not considered to be a zoonotic disease (i.e. doesn't infect humans) but milk processors may refuse to pick-up milk from infected herds. At this time, there is no genetic test for "scrapie resistance" in goats as there is for sheep but research is underway. Early results suggest that genetic selection in goats will be more complicated than it is in sheep. However, Canada has a voluntary scrapie certification program and concerned goat producers should enrol in order to protect their herd[2]. To assure that this disease is not allowed into the herd, only goats from certified herds should be purchased.

Fig. 13 Goat with scrapie, courtesy FAO Manual on Meat Inspection

3.2 ENVIRONMENTAL MASTITIS ORGANISMS

Environmental organisms are pathogens that are transmitted from the environment into the udder. These organisms are typically found where the animals are housed, and can be transmitted through manure, bedding, or even water sources. They tend to cause acute, and sometimes severe, cases of mastitis.

3.2.1 BACTERIA

STREPTOCOCCUS DYSGALACTIAE, STREPTOCOCCUS UBERIS & ENTEROCOCCUS SPP

Streptococcal and enterococcal bacterial infections are usually from poor environmental hygiene on the farm, e.g. dirty and wet bedding. Infection from these bacteria is not as common as those caused by CNS or *Staph. aureus* but are increasingly important on many goat dairies. Although they are classified as environmental pathogens, they have some contagious characteristics. Both have been isolated from the teat skin and the environment. The can be transmitted by flies, and infections tend to flare up during the warmer summer months.

These infections cause a very acute and sometimes severe case of clinical mastitis, with severe udder swelling and redness, and high body temperatures. Sometimes an animal will have repeated flare-ups of moderate to severe clinical mastitis. Prompt treatment with intramammary or systemic antibiotics may or may not cure these infections but without clean-up of the environment, cases will continue to occur.

[1] http://www.uoguelph.ca/~pmenzies/mv/OMVFSP_Index.html
[2] http://www.scrapiecanada.ca/certification.html

COLIFORM BACTERIA

Although usually not common in goat dairies, coliform infections can potentially cause severe cases of mastitis, with both local signs of inflammation in the udder, as well as systemic signs throughout the body. Common coliform bacteria include *E. coli* and *Klebsiella spp* and occasionally *Salmonella spp*. Coliform mastitis is a veterinary emergency. As these infections are extremely sudden and severe, antibiotic treatment of the intramammary infection may not be effective, however, treating the systemic signs of pain and dehydration are essential to lessening the adverse effects on the doe. Salmonella bacteria are an uncommon infection in goats and pose most risk because the bacteria can be transmitted through consumption of unpasteurized milk and cheeses.

PSEUDOMONAS AERUGINOSA

Pseudomonas aeruginosa bacteria are classified as environmental coliforms; however, they are also contagious. This pathogen is found in **contaminated water sources**, present anywhere on-farm, but can be isolated from wash water in the milking units. The mastitis can present as severe toxic mastitis, or chronic subclinical mastitis. Antibiotic treatment is rarely successful; therefore it is common to cull these animals from the herd, to decrease the potential for pathogens to be contagiously transferred to other does.

LISTERIA MONOCYTOGENES

Listeria monocytogenes causes severe illness in people most often due to consumption of contaminated cheeses. Contamination of the milk occurs from feeding poor quality ensiled forages or spoiled feed. The bacteria are shed into the milk with or without signs of mastitis. Most human cases occur when unpasteurized milk or pasteurized milk that has been improperly handled, is used to make soft and semi-soft cheeses. The bacteria can grow and survive up to 90 days at refrigerator temperatures in the product (see Section VIII.4.3). *Listeria* can cause mastitis in does as well as disease of the nervous system, abortion and septicaemia in young kids. *Listeria* bacteria are shed continually from the time of infection.

3.2.2 YEAST

Mastitis caused by yeast is very difficult to manage. Yeasts are environmental organisms, and are frequently found in water sources. They have an increased potential for causing an intramammary infection during milking if the teats are wet when the milking unit is put on. Overtreatment with antibiotics or poor hygiene when inserting mastitis ointment tubes is commonly associated with outbreaks of yeast mastitis. Yeast infections present as acute clinical infections, with high body temperatures in does. Yeast mastitis does not respond to standard antibiotic therapy and antibiotics should not be used to treat infections. However, the symptoms of these infections could be addressed with the use of pain management therapies and frequent stripping of the affected glands.

4. IMPORTANT RISK FACTORS FOR MASTITIS

There are many factors that predispose a doe to developing mastitis or influence how common mastitis is in a herd other than the presence of pathogenic microorganisms. These are summarized in Table II.2 and are covered in more detail in the following sections.

Table II.2. Risk factors for mastitis in dairy does

FACTOR	RISK
Kidding Time	Weakened immune system; number of kids born; difficult kidding.
Stage of Lactation	The prevalence of infection increases in late lactation.
Nursing Kids	The risk increases if kids are allowed to nurse. They can transmit bacteria and orf (soremouth) virus. Additionally they may damage the teat from biting.
Dry-Off	Timing and method of dry-off.
Lactation Number	Older does tend to be more at risk of mastitis.
Viral Infections	CAE virus; orf virus
Udder Shape and Size	Poor shape interferes with milk-out; poor size will reduce milk production; poor teat placement and teat size will interfere with milk-out. Worn out suspensory ligaments will cause the teats to be low and susceptible to damage.
Teats	Teat end calluses from over-milking or long milk-out times; warts.
Environment	High stocking densities; poor ventilation; wet and cold floor and dirty bedding; air temperature too hot or cold; high humidity; inclement weather; relocating and mixing does.
Milking Technique and Equipment	Poor udder preparation – cleanliness and milk let-down; dirty hands; cracked and worn teat liners; high vacuum levels; inadequate vacuum reserve; incorrect pulsation rate and ratio; over-milking; failure to properly teat dip.
Genetics	Resistance to mastitis.
Nutrition	Low energy; selenium and vitamin E.

4.1 STAGE OF LACTATION

4.1.1 KIDDING TIME

Research has shown that high producing dairy goats have more poorly performing immune systems around kidding. This may translate into increased susceptibility to mastitis or other diseases.

4.1.2. END OF LACTATION

The risk of infection increases with longer "days in milk". Somatic cell counts (SCC) also increase independent of risk of infection when milk production starts to decrease – partly due to volume and partly because the udder is starting to involute through apoptosis (see Section I.3).

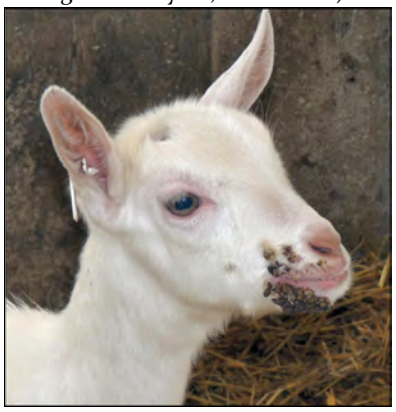
Fig. 14 Nursing kid

4.2 RISK FROM NURSING KIDS

4.2.1 TEAT BITING

The risk factors for mastitis from nursing kids are multiple (Fig. 14). Nursing kids may bite teats, sometimes breaking the skin or even penetrating the streak canal of the teat causing scarring of the teat and possibly occlusion of milk flow from the teat. The reason for this behaviour is not completely understood, but the damage may interfere with milking ease.

Fig. 15 Orf infection (also known as contagious ecthyma, soremouth)



4.2.2 ORAL INFECTIONS

Infections on the lips or mouth of the kid (e.g. *Staph. spp* bacteria, orf virus (also known as contagious ecthyma virus and soremouth (Fig. 15)) may cause teat infections, increasing the risk of mastitis. See Section II.4.5.2.

4.2.3 CROSS-SUCKING OR SELF-SUCKING

Kids being reared artificially may suck each other's teats after drinking (cross-sucking) or their own teats (self-sucking). They may infect their glands as kids with mastitis bacteria that will show up as a hard, mastitic gland when they first kid. This is particularly true if fed mastitic "waste" milk, e.g. from a doe with *Staph. aureus* mastitis.

4.3. DRY-OFF AT END OF LACTATION

Dry-off should be done when the doe is 4 to 8 weeks from kidding. The udder is undergoing a natural involution and the stress involved with milk cessation is mild. Dry-off should be done when milk production has dropped sufficiently and when done, the animal should not be milked again. Milking once/day for a period before dry-off will help to reduce milk production in a doe that is hard to dry-off. A keratin plug forms within a few days to a week of dry-off in the streak canal of the teat, which protects against mastitis bacteria from entering during the dry period. Removal of this plug because of milking out a "full" udder has been associated with dry-period mastitis in dairy cows.

4.4 LACTATION NUMBER / PARITY

First fresheners have lower risk of infection than older does. Older does are more likely to have mastitis because of longer exposure to risk factors and changes to the anatomy of the udder and teats. Older does are also more likely to be infected at freshening than first fresheners suggesting that the infections may have been carried over from the previous lactation or picked up during the dry period.

4.5 VIRAL INFECTIONS

4.5.1 CAPRINE ARTHRITIS ENCEPHALITIS VIRUS (CAEV)

As mentioned previously, CAEV causes mastitis in does without the presence of other bacteria. CAEV infection is an important source of lost revenue in milk production. Infected does produce 10% less milk than uninfected does and losses due to arthritis are common.

4.5.2 ORF VIRUS INFECTIONS

Orf infections have many names,(e.g. "contagious ecthyma", , "scabby mouth" and "sore mouth") and is a common viral infection of goats. Kids are most susceptible to disease but it can also be seen in adult goats, particularly if not previously exposed. The virus prefers to infect regions of the mouth and nose but can infect the teats (Fig. 16), coronary band above the hoofs, inside the mouth, around the eyes, tips of the ears, the poll region and around the vulva or penis. The lesions are raised, red and scabby, and last about 6 weeks. Although the infection is painful, usually kids handle it well.

Unfortunately the lesions almost always become infected with *Staph. spp* bacteria. This increases the risk of mastitis to the doe in one of two ways: either the kid nursing with infected lesions bathes the end of the teat with *Staph.* bacteria increasing the risk of mastitis, or the doe develops orf on her teat and then is at greatly increased risk of *Staph.* mastitis. Either is very dangerous to the doe.

4.6 UDDER SHAPE AND SIZE

Conformation of the udder means more efficient milk-out, allowing less residual milk and the need for machine-stripping. The following are important attributes of a good udder:

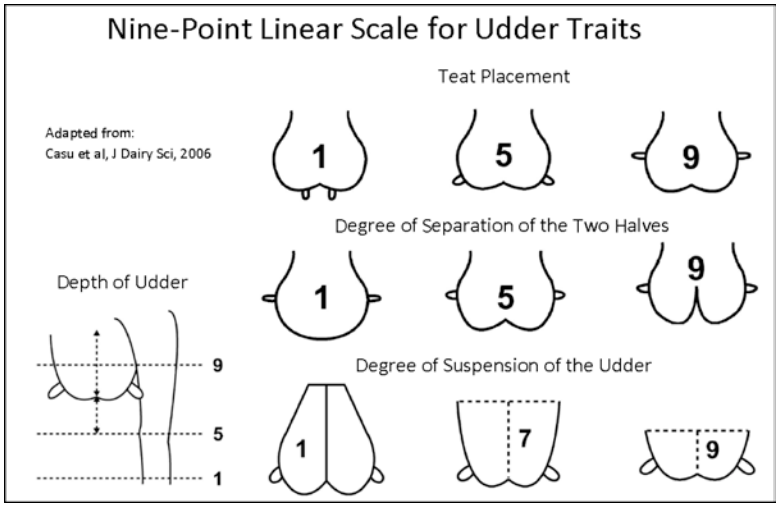
- Great volume, with globular shape and clearly defined teats (Fig. 17);
- Soft and elastic tissues, with palpable gland cisterns inside;
- Moderate height, not lower than the hock;
- Marked suspensory ligament.

Fig. 17 Well balanced udders

A nine-point scale for assessing proper udder and teat conformation has been developed for dairy sheep and goats and can be used to select goats to cull (those that score poorly) and those from who to select replacements (those that score well). This score has been related to ease and speed of milk-out and thus overall milk production.

Fig. 18 is adapted from one of the 9-point systems. Teat placement for machine milking should be closer to 1 in the scale of 1 to 9 – opposite of selecting for does nursing kids. Separation of the two glands should be closer to 9 on a scale of 1 to 9. Suspension and depth of the udder should be closer to 9 on a scale of 1 to 9. Degree of suspension and the depth of the udder appear to be highly correlated. Missing from this system is scoring of teat length (1 = short; 9 = long) where 4 to 5 would be preferable.

Fig. 18 9-point scales for selecting goats for udder conformation



4.7 TEATS

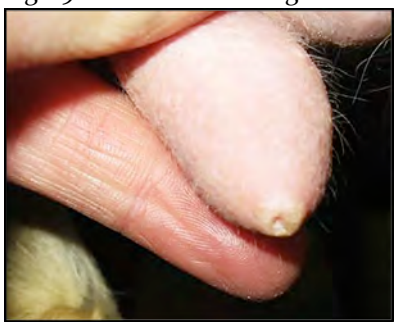
Teat damage caused by nursing kids, contagious ecthyma lesions and chapping has been discussed previously in Sections II.4.2 and II.4.5.2. The teat is an amazing structure – with the teat sphincter and lymphoid follicles just inside the teat cistern doing a great job keeping mastitis pathogens from invading further into the udder. Other important teat conditions are listed below.

4.7.1 TEAT END CALLUSES

Quite a bit of research has been done in dairy cows with respect to mastitis and presence of teat end calluses (Fig. 19) – but none yet in dairy goats. In cows, calluses are caused by:

- Teat shape. Pointed teats, as opposed to inverted or flat-ended are more prone to calluses;
- Longer machine-milking times (over-milking);
- Low milk-flow leading to over-milking;
- Irritating chemicals used for udder washing;
- High vacuum levels and;
- Factors associated with teat cup liners.

Fig. 19 Teat end callus - goat



These calluses can be seen around the teat orifice and vary from a smooth ring to a rough ring with severe proliferation of tissue (hyperkeratosis). In dairy cattle, presence of hyperkeratosis has been linked to an increase risk of *Staph. aureus* mastitis. More work needs to be done in dairy does and the relationship to milk-out time, but we can learn from work already done in cattle.

4.7.2 WARTS

Warts, caused by a papilloma virus are cauliflower-like growths on the teats (Fig. 20). These growths may interfere with proper function of the teat cups, and they may become infected with bacteria. If close to the teat orifice, they may increase the risk of mastitis. The virus is also contagious to other goats. Affected animals should be milked with a separate unit which is then cleaned and disinfected. Usually the infection disappears in 4 to 8 weeks.

Fig. 20 Warts on teats

4.7.3 ABNORMAL TEAT SHAPE AND SIZE

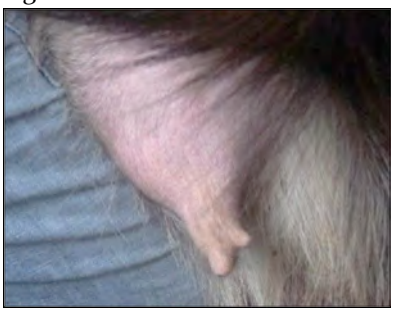
Goats appear to have a particular problem with extremely variable teat shape and size (Fig. 21). This may interfere with proper placement of the teat cups, which may be more prone to falling off and / or sucking air if teats that are too small or too large. Genetic selection for proper teat conformation will help.

Fig. 21 Extreme variability of teat size and shape

4.7.4 EXTRA TEATS

Extra teats and webbed teats, in which the extra teat is connected to the main teat (Fig. 22) are not common but goats with this malformation should be culled prior to breeding as it is a genetic problem and these animals cannot be milked properly.

Fig. 22 Webbed teat



4.8 ENVIRONMENT

The environment that the dairy doe is maintained in has a profound effect on milk quality and udder health. Poor environment increases the risk of environmental causes of mastitis, and increases the stress to the doe. The information is summarized in Section VIII Table VIII.3.

4.9 MILKING TECHNIQUE AND EQUIPMENT

4.9.1 UDDER PREPARATION

Regardless of how clean the environment is, there will be bacterial contamination of the udder and teats. Lack of or improper cleaning and drying will create opportunities for these bacteria to enter the teat during or after milking and cause mastitis. Long hair should be removed from the udder and teats to lower the risk of bacterial contamination (Fig. 23). Clipping allows for easy cleaning of the udder and remove the risk of manure tags contaminating the udder, hands and milking equipment.

Fig. 23 Hairy udder

4.9.2 HANDS AND HAND-MILKING

Hands are easily contaminated with bacteria which then can be transferred to the teats and milking equipment. These bacteria may be plentiful on the hands, even if they appear superficially clean. Wounds and cracks on the hands are often infected with mastitis causing bacteria, particularly *Staph. aureus* and CNS. Hand milking is unfortunately, a very efficient way to transfer mastitis pathogens from one doe to the next. Because it is sometimes impossible to remove all risky bacteria from the hands – even with frequent washing with disinfectant soaps, it is advisable to wear disposable gloves. If gloves become soiled, change gloves or wash in a disinfectant soap and then dry.

Fig. 24 Liner cracks with bacteria

4.9.3 MACHINE MILKING

Set-up and maintenance of milking equipment is covered in more detail in Section IV.3.

TEAT CUPS

Teat cups are well recognized as a common source of contamination with mastitis pathogens. Tiny cracks in the liners

can harbour a teeming population of bacteria, which will mix with milk and impact the teat sphincter with a soup of microorganisms (Fig. 24).

Fig. 25 Teat end edema (red) from over-milking or too high a vacuum level

VACUUM LEVELS

Overly high levels of vacuum can damage the teat end. Acutely this may cause problems with the return of blood flow back to the teat after milking, and for teat sphincter closure (Fig. 25). Chronically, it may cause damage to the teat end – rings of scar tissue (Fig. 19), which can harbour microorganisms that cause mastitis. However, too low vacuum levels may increase the risk of clusters dropping off and increase the risk of impacts of milk flowing backwards from the unit and spraying the teat ends, which are open and susceptible. If the milk is contaminated with contagious mastitis pathogens, the doe is at risk of infection. Recommended vacuum level for dairy does at the teat end is between 35 to 41 kPa (10 to 12 inches of mercury (Hg)) although recommendations vary depending on the type of system used, e.g. 35.5 kPa (10.5 inches Hg) for lowline systems and 39 kPa (11.5 inches Hg) for highline.

VACUUM RESERVE

Having sufficient vacuum reserve is critical to prevent changes in direction of milk flow. When milking units are removed incorrectly or fall-off and vacuum levels drop, the milk from another doe may flow backward to the teats as previously described. Squawks, which indicate sucking of air around the teat cup and into the milk-line, can have a similar effect. Crimped-over milk lines to accommodate milking of does with a blind gland or a gland with less milk (usually a doe that has mastitis), can also suck air – causing hits or impacts of milk on the teat end.

PULSATION RATE AND RATIO

The rate and ratio allows for efficient removal of milk from the teat and proper blood flow. If not set-up correctly this can cause damage to the teats and inefficient milking, increasing the risk of mastitis. The recommended pulsation rate for dairy goats is between 60 to 120 cycles / min with 90 most recommended, with a ratio of between 50 to 60%.

MILKING TIME

Goats milk out very quickly, often in less than 2 min. Over-milking will tire the teat sphincter and over time will damage it (Fig. 19, Fig. 25). If the teat sphincter doesn't close properly after milking, there is an increased risk of bacteria invading the udder and causing mastitis.

Reasons for over-milking include:

- Too many units per person milking so that they cannot manage udder preparation and unit management in a timely manner;
- Improper stimulation of the udder for optimal milk ejection (milk let-down) and;
- Issues in the parlour that interfere with milk ejection e.g. too noisy, yelling and pushing.

4.10 GENETICS

Milk production is related to udder and teat conformation as it relates to ease of milk-out (Fig. 18). The heritability of milking speed is high in dairy goats, estimated at 0.54 to 0.65. There is good evidence that by highly selecting udder and teat conformation, udder health will improve as will milk-out.

4.10.1 LEVELS OF SOMATIC CELLS

There is little published looking at the genetics of somatic cells, milk production and resistance to mastitis in goats. There is evidence that selection for αs 1-casein levels in milk (an important milk protein) may also increase somatic cell counts in goats. Other than that, estimates of heritability for SCC levels in goat are low (between 0.1 and 0.2 h^2). This means that selecting does for low SCC values would make for slow progress in "resistance" to mastitis. In comparison, heritability of milk yield is 0.34, milk fat – 0.50, and milk protein – 0.63, all quite high indicating their selection would make for fast genetic improvement.

A recent article has found that Polish dairy goats carrying a gene marker for high lactose production also had lower SCC values. More needs to be done to see if this gene is present in North American goats.

4.10.2 RESISTANCE TO CLINICAL MASTITIS

There is on-going research both in dairy cows and goats looking for genetic markers and other indications of resistance and susceptibility to episodes of clinical mastitis. Most are based on the animal's ability to fight infection.

4.11 NUTRITION

4.11.1 LOW ENERGY

In early lactation, does are often in a negative energy balance, which must be compensated for by improved quality and quantity of feed during this period and by having an adequate body condition score at the beginning of the period (covered in more detail in Section VIII.1.4). Underfed does in late gestation and early lactation have been shown to have increased SCC and changes to the fatty acid profile of the milk as well as changes to the freezing point of milk.

PREGNANCY AND NUTRITIONAL STRESSES

Being pregnant with multiple kids appears to increase risk – possibly because of increased nutritional needs but perhaps because of reduced function of the immune system and therefore the does are less able to ward off infection. Because does carrying multiple kids produce more milk, and the extra kids provide additional income – it is necessary to make sure the environmental hygiene is excellent for these animals. It is important to note that both overfeeding and underfeeding of pregnant does can have a negative effect on udder size, birth weights of the kids, and total levels of antibodies available in the colostrum.

4.11.2 SELENIUM & VITAMIN E

In areas where selenium is deficient – which is most of Canada, it is critical to supplement the does' diet during gestation as well as lactation. Vitamin E, while present in green pastures in large amounts, degrades quickly in stored feeds and so must be supplemented to does that are not on green pasture grazing. Both are important in prevention of mastitis and general udder health. This is covered in more detail in Section VIII.1.4.2.

5. HOW DO WE DETECT MASTITIS IN AN INDIVIDUAL GOAT?

5.1 EXAMINATION OF THE UDDER AND TEATS

5.1.1 UDDER

When a gland has a clinical mastitis infection, the signs are usually obvious; the affected gland or half is often enlarged and swollen (**Error! Reference source not found.**). If the infection is severe enough, the udder is red in colour (indicating that it is inflamed), and is hot to the touch. Does are susceptible to a condition called "blue bag" in which the toxins of the bacteria (usually *Staph. aureus* but sometimes *Mannheimia* or *Pseudomonas*) cause the tissues of the gland to die and become gangrenous; the gland is cold to the touch and blue and the doe is very ill (Fig. 5). If the infection is chronic, the udder can be shrunken, hard and may contain lumps or abscesses (Fig. 9).

Fig. 27 *Staph. spp.* impetigo.
Courtesy N. East

Staphylococcal impetigo is an udder skin condition that is associated with *Staph. aureus* or other *Staph.* bacteria. There is a rash with small bumps or small abscesses on the udder, which are a source of mastitis-causing bacteria (Fig. 26).

5.1.2 TEATS

Teat end health is very important to help control udder health in goats. The conditions of the teats are discussed in Section II.4.7. Poor vacuum and equipment function during milking can cause damage to the teat end. First evidence is a raised ring around the teat canal, leading to build-up of scar tissue around the teat opening – also known as hyperkeratosis (Fig. 19). This condition leads to the teat end being very rough, and often harbours mastitis-causing bacteria.

Fig. 26 Teat bite wound

Sometimes milkers encounter a situation when a build-up of scar tissue – called a **pea**, blocks milk from travelling down the teat canal. This scar tissue is caused by infection (mastitis) or trauma. It may be loose or attached to the teat wall. Sometimes it can be milked out if small or removed by a veterinarian but often the damage is permanent.

In does that are still nursing their kids, there is a risk of teat damage due to **teat biting** (Fig. 27). This is very painful to the

doe during milking, and can potentially harbour contagious bacteria. Does may develop orf on the teats, if nursed by infected kids (Fig. 16).

5.2 EXAMINATION OF THE MILK OF AN INDIVIDUAL GOAT

5.2.1 PHYSICAL INSPECTION OF MILK

APPEARANCE OF NORMAL MILK

Normal milk should be white in colour, but may range to a white-yellow. Milk should have a thin consistency, with no solid milk clots or flakes whatsoever.

APPEARANCE OF COLOSTRUM

Colostrum has a thicker consistency than regular lactation milk, and is generally yellow in colour. If no clots are present this is not abnormal. This appearance only lasts a few days after kidding, and then the milk returns to its normal colour and consistency.

Although colostrum may be considered 'normal' from a physiological aspect, it is not considered normal in terms of marketing (for human consumption). Ontario regulations consider colostrum to be 'abnormal' and therefore require that it not be mixed with milk in the bulk tank (milk for market).

APPEARANCE OF ABNORMAL MILK

For cattle and goats the Ontario Provincial Milk Act describes **abnormal milk** as that which:

a) comes from an animal 15 days prior to and 3 days after parturition, (or longer if it still contains colostrum);
b) contains blood or other foreign particles;
c) is watery or coagulated;
d) has odours that adversely affect its organoleptic characteristics or is;
e) contaminated by chemical, toxin, drug or any other foreign substance.

The characterization of abnormal milk can be quite subtle, from faint flakes in otherwise normal milk, to paste-like clots with no liquid present. The colour can range from white to white-yellow. In some cases, if there is an acute infection such as *E. coli*, milk is of thin consistency with little-to-no clots, but the liquid is yellow and clear. With severe gangrenous mastitis, the milk may look like red serum – with or without clots of milk (Fig. 28).

Fig. 28 Secretion with gangrenous mastitis (Courtesy N. East)

Sometimes, normal appearing milk may be contaminated with fresh blood, either giving a "strawberry" colour to the milk or presence of actual blood clots. This is due to trauma of the udder, however is not by infection, but from injury. This is quite common in early lactation animals after a difficult kidding, but can be caused by any injury to the udder, e.g. from horned does fighting.

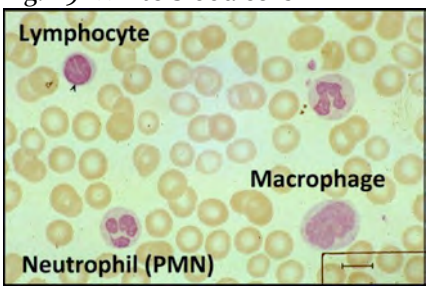
5.3 DETECTION OF INFLAMMATORY SOMATIC CELLS IN AN INDIVIDUAL GOAT

5.3.1 WHAT ARE SOMATIC CELLS?

Somatic cells, mostly comprised of white blood cells are defense cells of the immune system that are excreted into milk to kill infections in the udder. They also include cells sloughed from the alveoli (Section I.2). Somatic cells are always found in milk; however, the number and type of cells varies greatly during stage of lactation, with numbers rising in late lactation, but also when there is infection in the udder. The following are cells that are found in normal goat milk:

- Macrophages (means big eaters); Approximately 30% of all cells in normal milk
- Lymphocytes; Approximately 15% of all cells in normal milk
- Polymorphonuclear leucocytes (PMNs) (also called neutrophils); 50% of all cells in normal milk in early lactation – this increases to 70 to 80% by the end of lactation
- Epithielial duct cells; <5% of all cells in normal milk

Fig. 29 White blood cells



The primary role of macrophages and lymphocytes are to act as an alarm system in the udder, and signal when there are bacteria present in that gland. When this occurs, there is a huge influx of PMNs from the blood stream, and these cells destroy the bacteria in the tissue and the milk alveoli in the gland. Goats differ from sheep and cattle in that PMN's are present normally in greater levels in goats and may increase dramatically in late lactation in normal healthy udders, making it difficult to differentiate between infected and normal glands at that time.

5.3.2 SOMATIC CELL COUNT (SCC)

Somatic cell count (SCC) is a diagnostic measurement to determine the level of inflammation in the udder. As previously mentioned, there are always somatic cells present in the milk, so at no time will SCC be zero. So instead, we select an SCC value, above which we suspect mastitis may be present (see Table II.3).

When an infection occurs, the influx of PMNs into the gland will trigger an increase in SCC. This increase helps to detect subclinical cases of mastitis, where there are no visible changes in the milk to indicate an infection.

SCCs are measured by the number of somatic cells that are found in one millilitre (1/1,000 of a litre; mL) of milk. The unit of measurement is cells/mL of milk. A simplified way to understand these SCC is a linear score (also called somatic cell score or SCS), which is a mathematical conversion of SCC. This value is easy to interpret both on an individual doe level and herd level. Table II.3 shows the

Table II.3 Relationship between linear score (somatic cell score) and somatic cell counts

LINEAR SCORE	SOMATIC CELL COUNT (CELLS/ML)	
0	12,500	Healthy Udder
1	25,000	
2	50,000	
3	100,000	
4	200,000	Suspect
5	400,000	
6	800,000	
7	1,600,000	Mastitis
8	3,200,000	
9	6,400,000	

linear score, and its corresponding SCC value. Each doubling of the SCC results in an increase in linear score of 1. It also includes ranges for values for which it is more likely the udder is healthy and values for which it is more likely mastitis is present.

5.3.3 HOW ARE SOMATIC CELLS MEASURED?

SCC values can be determined at different levels: the individual gland, the individual doe (the average of both glands), and whole herd. Whole herd SCC values are either the average of all the milking does (when samples are taken from individual animals), or if the sample is taken from the bulk tank, the average of all the milking does adjusted by the volume of milk they contributed to the bulk tank.

To send samples for SCC determination, milk should be aseptically taken into milk vials. These samples don't require refrigeration for transportation; however, it is important that they are preserved properly. Bronopol tablets are used to preserve the milk. Vials with these tablets can be purchased from a number of sources on-line or usually obtained from a laboratory that offers SCC counting. These laboratories will have automated cell counters, which detect particles in the milk and are accurate for goat's milk. In Ontario, CanWest DHI[3] and the Agriculture and Food Laboratory, University of Guelph[4] offer this service.

Some goat dairies may wish to invest in on-farm cell counting techniques. There are portable cell counters that can be easily used before milking to determine SCC status of a gland. A milk sample is taken cleanly, and then drawn up immediately into a plastic cassette, which is then inserted into the cell counter. A SCC value is then determined based on the milk in the cassette. This information can also be transferred to a computer for easy record keeping.

5.3.4 WHAT IS A NORMAL SCC FOR DAIRY GOATS?

When measuring SCC for udder health, it is important to have a benchmark SCC level, to know if a gland is healthy. Any SCC over this benchmark can be an indication that there is an issue in the gland. Even though these benchmarks are a good guide, producers should strive for values under these levels for optimal udder health.

In dairy cattle, a normal udder health value to strive for is 200,000 cells/mL and dairy sheep are similar. In goats, we need to consider the following issues when interpreting SCC:

- The small particles released into the milk from apocrine secretion (see Section I.1.2.1) may be as numerous as 150,000 particles / mL of milk. Unlike with cattle, some automated somatic cell counting machines may count these particles as somatic cells, thus artificially elevating the SCC. However, this is less likely than in previous years as newer machines are calibrated better. Previously, it was deemed necessary to stain and count the somatic cells using a microscope – a very laborious and expensive activity!
- Older healthy does tend to have higher SCC values than 1st and 2nd lactation healthy does.
- Does in late lactation have a much higher SCC than in earlier, so much so that SCC cannot be used to accurately predict if subclinical infection is present in a gland. However, up to at least 90 days

[3] http://www.canwestdhi.com/; Tel: 1-800-549-4373
[4] http://www.guelphlabservices.com/AFL/raw.aspx; Tel: (519) 767-6299; Toll Free: 1-877-UofG-AFL (1-877-863-4235); Fax: (519) 767-6240; E-mail: aflinfo@uoguelph.ca

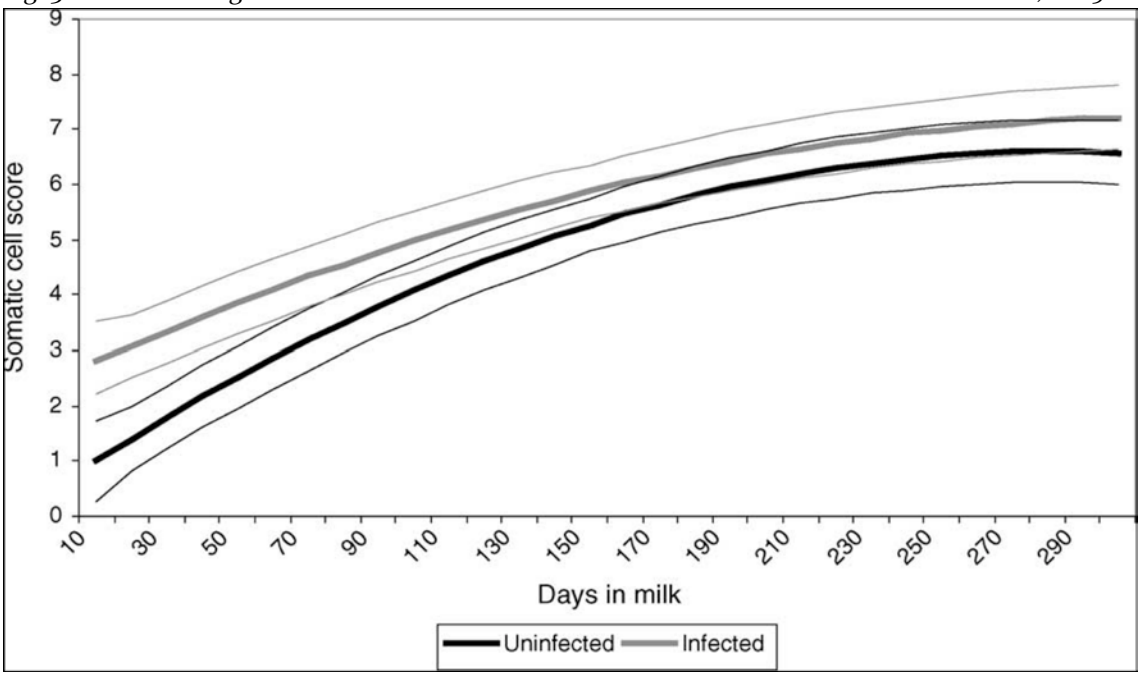
in milk, SCC is significantly lower in uninfected glands than in infected and can be used as a screening test for mastitis.

- Does infected with *Staph. aureus* tend to have a much higher SCC (> 1.5 million cells/mL milk) than those infected with CNS bacteria which can be as low as 500,000.

In research performed in Italy, the mean Linear Score of does with uninfected glands was 3.9 (slightly less than 200,000 cell/mL milk) and from infected glands was 5.6 (approximately 600,000 cells/mL milk). Fig. 30 shows the relationship of the SCC between infected and uninfected glands over the lactation. This suggests that we should be using different cut-points for differing stages of lactation. Goat mastitis workers in France have suggested that for **goats less than 90 DIM, SCC≥ 556,000 cells/mL milk be considered suggestive of infection but with goats in later lactation, that cut-point is increased to 1,200,000 cells/mL milk.**

While there is often no regulatory limit for SCC at the herd level, it is suggested based on available research that i**ndividual goat values of > 800,000 (linear score ≥6) should be strongly suspected of having mastitis.** (See Table II.3).

Fig. 30 SCC and stage of lactation - uninfected versus infected udder halves. Moroni et al, 2005.



5.3.5 WHAT SCC LEVELS ARE EXPECTED WHEN MASTITIS IS PRESENT?

With goats, this is not a straightforward decision. Because does in late lactation may have an SCC value greater than one million with no evidence of mastitis and a doe in early lactation may have an SCC of 500,000 with mastitis – using SCC alone is inadequate when deciding if a goat requires treating.

5.3.6 OTHER FACTORS THAT INFLUENCE SCC LEVEL

There are a variety of factors that can affect SCC levels in does other than mastitis.

- Stage of lactation: increased levels are generally found in late lactation. This is due to two factors: does in late lactation produce less milk so SCC values may be concentrated; the udder is attempting to involute and produces more somatic cells – this is most pronounced in goats.
- Age of does: older does generally have a higher SCC than younger animals.
- Some breeds tend to have higher levels than others.

5.3.7 CALIFORNIA MASTITIS TEST (CMT)

A CMT is a practical tool that is used on-farm to detect does that have an increased SCC. This method of monitoring udder health is simple, and producers can get almost instantaneous results, and allows them to pinpoint their high SCC animals, and those with subclinical infections in a very easy manner.

Fig. 31 CMT tools

HOW DOES A CMT WORK?

A CMT is a system that uses a paddle split into four wells to test individual glands for SCC level in an animal (Fig. 31). Initially designed for dairy cattle, it can be easily used for goats, by just using two of the wells. Milk is mixed with a CMT reagent (purple solution).

The CMT reagent reacts with the nucleic acid (e.g. nucleus) of the somatic cells. If somatic cells are present in high numbers, a thickening or gelling of the milk will occur. The higher the SCC, the more gelling that occurs. These reactions are categorized into five categories, from negative to a strong positive test. (Table II.4).

Fig. 32 Strip cup to inspect milk

The CMT reagent also indicates how acidic or alkaline (pH) the milk is. Normal milk is slightly acidic (pH 6.6 to 6.8). As SCC climbs, the milk becomes more alkaline and the reaction appears more intensely purple.

One of the main benefits of the CMT is that the reagents will not react with other substances such as blood or manure. Having said that, it is important to make sure that the paddle is as clean as, as excess debris could affect how the milk and reagent solution move.

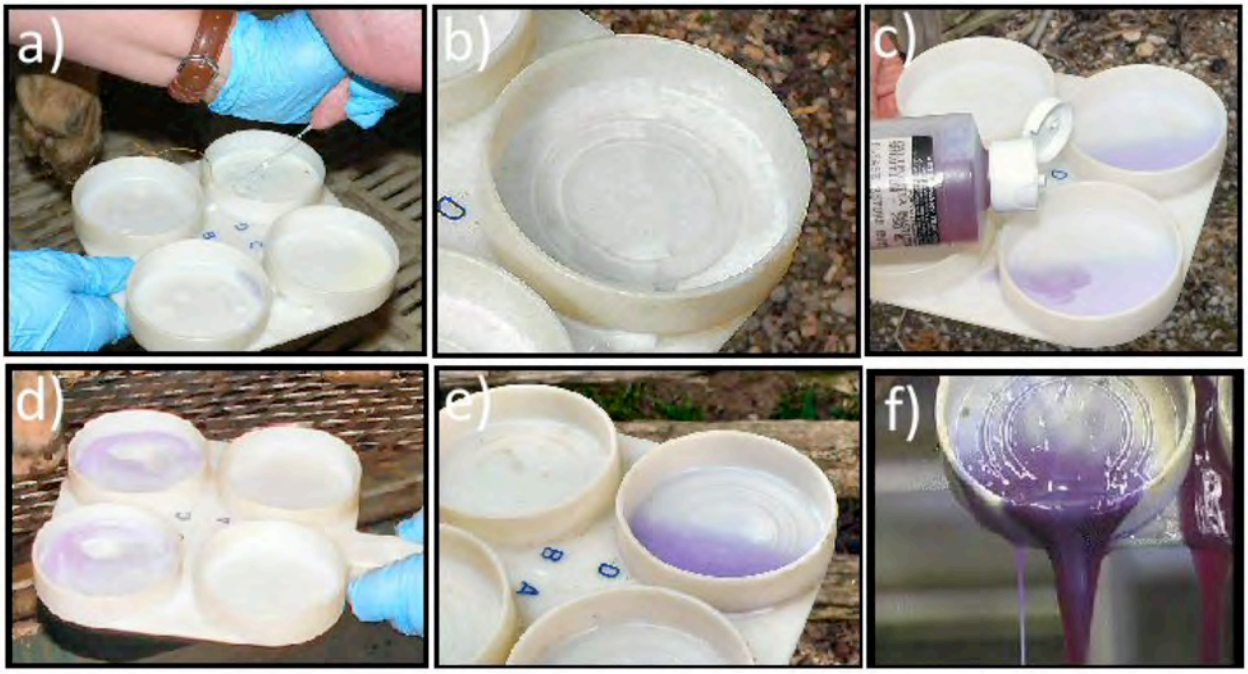
HOW TO PERFORM A CMT

- Gloves should be worn at all times
- The udder and teats should be clear of dirt before sampling
- The foremilk should be removed prior to testing (Fig. 32).
- Use a strip cup to allow visualization of the milk against a black background. If the milk appears abnormal with clots and discolouration, mastitis is present and the CMT is not necessary to perform (Fig. 33).
- Place the paddle underneath the doe, and sample milk into one well per gland (Fig. 34a).

Fig. 33 Clinical mastitis

- The paddle can be held in any direction, but be consistent so it is clear which gland corresponds to each well.
- At least 5 mL (1 teaspoon) of milk should be expressed into each well.
- Pour out excess milk by tilting the paddle, ensuring the right amount of milk (Fig. 34b).
- Keeping the paddle tipped, add an equal amount of reagent to the milk (i.e. 5 mL - a teaspoon), making sure that the total amount of liquid doesn't fill more than half of the well (Fig. 34c).
- Mix the milk and reagent together by moving the paddle gently in a circular motion and tipping back and forth, for approximately 10 – 30 sec (Fig. 34d)
- Observations of the consistency of milk can be done while swirling, to see if any gel is forming. Alternatively, the paddle can be tilted to observe the consistency of the liquid as it is pouring out (Fig. 34e and f).

Fig. 34 Performing a California Mastitis Test (CMT)



USING THE RESULTS OF A CMT

The CMT can be used for daily monitoring of udder health on-farm (Fig. 35). If you suspect that a doe

Fig. 35 CMT reaction

may have an udder infection, the milk can be tested immediately. **If the reaction is ≥ CMT 1+ in early lactation or ≥ 2+ in late lactation, a milk sample should be cultured.** CMT is a good screening process to ensure that only glands that are high in SCC levels are cultured.

However, this technique does have its limitations. Interpretation of the score is subjective. False positives can occur in does that are early or late in lactation. SCC is a more reliable test than CMT. Table II.4 is adapted from the Canadian Bovine Mastitis Research Network TACTIC Udder Health Veterinary Kit, and describes the visual identification of the range of CMT scores. A video can be viewed on-line showing the different CMT scores using sheep milk[5]

Table II.4. California Mastitis Test scoring system

SCORE	INTERPRETATION	VISUAL CHARACTERISTICS OF LIQUID	SCC RANGE (CELLS/ML)
N	Negative Sample (Fig. 35 #1)	The mixture does not change, and remains the same liquid consistency of milk with bluish/purple tinges.	0 – 200,000
T	Trace Sample	The mixture will thicken slightly like very thin porridge; however, it can revert back to its original state when moving the paddle.	150,000 – 500,000
1	Weak, but Positive Sample (Fig. 35 #2)	There is slight thickening of the milk like thin porridge; no gel forms; when swirled, the mixture will climb the walls of the well; and when poured out, the mixture flows a steady pace.	400,000 – 1,500,000
2	Distinctly Positive Sample	Gel is beginning to form; when swirled, the gel tends to clump in the middle of the well; when poured out, the gel will pour out first; leaving some liquid is remaining in the well.	800,000 – 5,000,000
3	Strongly Positive Sample (Fig. 35 #3 and #3a)	The entire mixture is gel; when swirled it clumps in the middle; and when poured out of the paddle, no liquid remains in the well.	> 5,000,000

5.4 DETECTION OF BACTERIA IN THE MILK OF AN INDIVIDUAL GOAT

Commonly, detection of pathogens in the udder involves culturing of the milk for presence of bacteria and mycoplasma. It is unusual that we choose to detect viruses from milk although tests have been developed for detection of CAE virus using a polymerase chain reaction (PCR), used to detect the DNA of the virus.

5.4.1 OBTAINING AN ASEPTIC MILK SAMPLE FROM AN INDIVIDUAL DOE FOR CULTURE

When taking a milk sample for submission for culture, it is important that preparation of the teats is done correctly to ensure that samples do not become contaminated. Ideally, these samples would be taken at the time of milking, as udder preparation and disinfection are being done at that time and milk let-down is maximized, which helps with manual teat sampling.

[5] How to perform a CMT in a dairy sheep. https://www.youtube.com/watch?v=5Mplg93MUz8&feature=youtu.be

MATERIALS REQUIRED

The following materials are required for aseptic milk sampling on goat herds:

- Sterile milk vials; ideally a snap-cap vial, which is easier to open, as compared to a twist top vial (Fig. 36);
- Disposable latex or nitrile (blue) gloves;
- Labels and markers for labelling the vials;
- Udder wash solution and cloths/towels to initially disinfect and dry the udder and teat;
- Sterile swabs that are soaked with 70% isopropyl alcohol to disinfect the teat and;
- Cooler with ice packs to put milk samples in when transporting from the farm.

Fig. 36 Materials for milk culture

PREPARING THE UDDER AND TEAT

1. Before doing any type of udder and teat preparation, it is important to remove any excess dirt or manure from the udder, as it could fall into the milk vial during milking, and contaminate the sample.
2. Gloves should be worn at all times during sampling
3. The udder and teats should be clean and dry, using udder wash or wipes and a single service cloth or towel (Fig. 37).
4. Four or five strips of fore-milk should be extracted from the teat before taking the sample. Use a strip cup to collect this milk.
5. Teats should be fully disinfected with sterile alcohol swabs.
6. Teat ends, particularly the sphincter, should be thoroughly wiped with a fresh swab. This is to remove dirt and kill any bacteria on the outside of the teat. Use fresh swabs until the swab appears clean (Fig. 38).

Fig. 37 Clean the udder

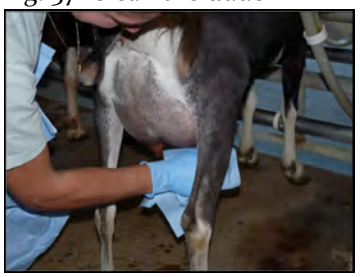


Fig. 38 Clean the teat end

TAKING THE SAMPLE

1. All sampling should be done in the same fashion as stripping foremilk during udder preparation or hand milking, by manually stripping the teat in a downward motion (Fig. 39).
2. When removing the cap of the milk vial, it is essential that the lid is held with the inside of the cap downwards, to prevent any debris from getting inside.
3. The vial itself should be held at a diagonal angle to ensure that no debris will get into the vial.
4. Ensuring that the teat end does not come in contact with the tube, begin stripping the milk into the tube.
5. Only fill the milk vial up to approximately ¾ of the full volume, as there is a chance of the vials to open when frozen if they are too full.

Fig. 39 Take a sterile milk sample

6. If composite samples are being taken instead of individual gland samples, ensure that equal amounts of milk are taken from each gland.
7. Teats should then be disinfected after sampling with post-milking teat dip.

HANDLING OF SAMPLE INCLUDING STORAGE AND SHIPPING TO LABORATORY

- It is important to properly label the milk samples to make sure that each sample is identified properly (Fig. 40). The following information should be included on the label:
  - Date
  - Farm name
  - Doe unique identification number
  - Gland sampled (left or right)
  - Reason for sampling (i.e. mastitis case, high SCC, positive CMT reaction)
- Samples should be placed in a cooler with frozen ice packs, and sent to a lab as soon as possible. If samples are being held at the farm for an extended period of time, they should be frozen immediately.
- For submitting samples, it is important that the herd veterinarian fill out the appropriate paperwork for laboratory submission.
- If milk samples are stored in a 4 °C fridge, they should remain there no longer than 24 h before culturing.
- If the sample is frozen in a -20 °C freezer (normal temperature of a home freezer), it should remain there no longer than 1 month before submitting for culture.
- If testing for mycoplasma rather than bacterial pathogens, it is essential that the milk samples remain unfrozen but they must be processed by the laboratory within 72 h of taking the sample.

Fig. 40 Labelled for submission

Fig. 41 Culturing milk on blood agar plate at the laboratory

5.4.2 HOW TO INTERPRET MILK CULTURE RESULTS

Results from the lab give information of what bacteria are found in each sample, and the number of each type of bacteria that are found on the milk culture (Fig. 41). Generally we can distinguish culture results into three categories:

- Positive
- No growth
- Contaminated

"POSITIVE" RESULT

One bacterial type (e.g. colony type) is prevalent on the plate, and is assumed to be the cause of the mastitis infection. If the plate has two different types of bacteria present, one being an important pathogen, it is considered the source for the mastitis infection.

Fig. 42 Positive culture results

Source: http://www.healthhype.com/

"NO GROWTH" RESULT

There are times that the samples will show no growth on the plates, despite a positive CMT or SCC result. There are a variety of reasons, including:

- Inadequate volume of milk submitted for culture;
- Non-bacterial infections, such as viruses (e.g. CAEV), yeast or mycoplasma;
- Acute and systemic infections that have already been cleared by the body at the time of milk sampling, such as *E. coli* infections. The SCC levels may still be very high but the bacterial infection has been cured;
- The doe has been recently treated with antibiotics and their presence in the milk is stopping the growth of bacteria on the plate or;
- Not drying the teats well enough and contaminating the milk with a disinfectant.
- In goats, CMT values may be high in late lactation and not reflective of presence of mastitis.

"CONTAMINATED" RESULT

Contaminated samples are generally defined as three or more bacterial species or colony types on a culture plate from a milk sample. Some of these bacteria could be found in the milk, but some could be from debris that fell into the vial while taking the sample, dirt still remaining on the teat end or from dirty hands contaminating the teat and/or lid of the vial.

NUMBER OF BACTERIA / COLONY FORMING UNITS

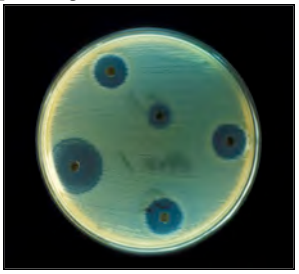
The number of **colony forming units** per millilitre of milk (CFU/mL) that are reported by the laboratory is important when interpreting results. In Fig. 42, each "dot" on the plate is one CFU. The CFU/mL is reported as the number of bacterial colonies that grow on culture plates, corrected for volume of the sample that was actually plated for culture. The significance of the culture result is tied to the type of pathogen, e.g. *Staph aureus* present in low numbers is likely the cause of the mastitis, whereas an environmental organism or CNS may be present in low numbers because of contamination of the sample. Mixed infections are suspect as likely being caused by contamination. Some laboratories report milk culture results as 1+, 2+, 3+ and 4+ depending on the number of CFU.

5.4.3 ANTIBIOTIC SENSITIVITY TESTING

This procedure is done to determine whether or not mastitis-causing bacteria are sensitive or resistant to a specific antibiotic (e.g. penicillin, tetracycline, etc.).

To do this test, a broth mixture containing the bacteria previously isolated from the milk sample, is poured over an agar plate. Small paper disks the size of a pencil end that have specific antibiotics added are placed on the plate. The antibiotic leaches out into the agar around the disk. Bacteria will grow in the agar where there are no antibiotics to retard their growth but not grow around the disks where the antibiotic is present – unless that bacteria are resistant to that antibiotic in which case they will grow right up to the disk. So a clear zone around the disk is good news – that antibiotic may be effective. No zone around the disk is bad news, that bacterial isolate is resistant to the antibiotic. This is called the Kirby-Bauer Disc Diffusion method. The lab report will come back that the bacterial isolate is either sensitive (S), resistant (R),

Fig. 43. Antibiotic sensitivity testing Source: By CDC / Provider: Don Stalons - phil.cdc.gov, Public Domain



or is moderate sensitive (I) to that antibiotic depending on how close the bacteria grow to the disk containing the antibiotic. This information can help when selecting the correct treatment for that case of mastitis.

5.4.4 ROUTINE HERD CULTURE

WHOLE HERD CULTURE

Routine culturing of lactating does will improve understanding of udder health in a herd. Culturing milk samples from all lactating does at once (whole herd culture) may be recommended for herds in which SCC levels at the herd level (e.g. bulk tank) are markedly elevated, when milk quality issues suggest the problem is mastitis (see Section V) or when there is a high incidence of clinical mastitis. In this case, culturing the entire lactating herd can identify problem animals. Whole herd cultures are done initially on composite samples (both glands in the same vial), and will identify does that may need to be treated, culled or identified and milked last.

TARGETED CULTURE OF INDIVIDUAL DOES

Certain animals or certain times of lactation may be targeted for culturing as part of a program to screen for mastitis cases. This routine sampling can be done when whole herd culturing is not required. Some key screening criteria to culture animals are as follows:

- Does with clinical mastitis;
- Does with abnormally high SCC's based on stage of lactation;
- Does with CMT reactions 1+ or higher;
- Does at kidding or at dry-off and;
- Purchased does.

5.4.5 DETECTING MASTITIS WITHOUT CULTURE

Cow-side tests have been developed to detect mastitis infections. Electrical conductivity of the milk (based on changes in level of chloride ions) can be measured at each milking using in-line systems and in cows, and helps to detect presence of inflammation due to subclinical mastitis. PCR, which detects the DNA of mastitis pathogens – both dead and alive, can be used to monitor bulk milk. Temperature of the cow using infra-red cameras or in-line systems to detect changes in milk temperature at the cow level, may detect onset of severe clinical mastitis earlier. There is also a number of rapid culture systems designed for on-farm or veterinary clinic use. They usually involve use of special culture media. The accuracy of some of these systems has not yet been evaluated in goat dairies – another area for research!

6. DETECTION OF MASTITIS USING POOLED MILK SAMPLES

Bulk tank or pooled milk can be used as an inexpensive screening test to detect prevalent pathogens in a herd. The main pathogen that is relevant in these samples is *Staph. aureus* in does. This method of detection is an ideal option for a screening program, with regular sampling (e.g. monthly) to monitor changes in bacterial populations in herds.

6.1 CULTURING POOLED MILK

6.1.1 OBTAINING AN ASEPTIC MILK SAMPLE FROM THE BULK TANK

Fig. 44 Bulk tank sampling

The best time to take a sample is just before the milk truck arrives so that the maximum number of milkings is represented. It is important that the milk is agitated properly before sampling to ensure a truly representative sample for the herd. Agitation should occur for approximately five minutes before sampling.

Milk samples should be taken from the top of the tank from the manhole. The outlet at the bottom of the tank should not be used for sampling, as there can be bacterial build-up in this pipe. A clean sanitized dipper should be used. After collection, milk is aseptically placed in a sterile milk vial (by pouring or use of a sanitary straw) (Fig. 44), as is used for individual doe culture, and refrigerated or frozen until it can be cultured as outlined in Section II.5.4.

When milking into buckets rather than a bulk tank, a sample should be taken from each bucket (Fig. 44) and then pooled in a single vial (Fig. 45). Prior to sampling, each bucket should be thoroughly mixed and sampled using a clean, sanitized dipper. This sample only represents one milking but is still a good way to monitor mastitis pathogens in the herd.

Fig. 45 Pooled sample

6.1.2 INTERPRETING RESULTS

Often an environmental pathogen is cultured (e.g. coliforms, streps, *Pseudomonas*). It may be from mastitic does. However, it is possible that these bacteria are from environment. This environmental population can be found anywhere from wet and dirty udders during milking preparation to faulty equipment in the parlour. These bacteria if present in high numbers may indicate a severe hygiene problem in the milking system. Please see Section V Quality Milk, for more information.

Any contagious pathogens that are present in a high enough prevalence should be detected in the bulk tank sample. For example, a pooled sample which is positive for *Staph. aureus*, strongly indicates that there are several does in the herd infected with this important contagious pathogen. See Section VI.8 for more information on how to manage this.

6.1.3 INTERPRETATION OF RESULTS FROM POOLED SAMPLES

Culture results from pooled milk can be reliable; however, they do not have the capacity to detect pathogens as efficiently as culturing individual does. If there is a high prevalence of a particular pathogen, e.g. *Staph. aureus*, pooled milk culturing should be able to detect it in the sample. However, if there is a low prevalence of a major pathogen, the culture results could give a false negative result. Pooled culture is not a substitute for monitoring SCC levels and culturing individual goats.

Culture results from bulk tanks or buckets may also reflect post-milking contamination, e.g. from the milking equipment, poor udder preparation or unsanitary bulk tank. This is particularly true with environmental organisms. Results must be interpreted with care.

SECTION III
MILKING MANAGEMENT

TABLE OF CONTENTS

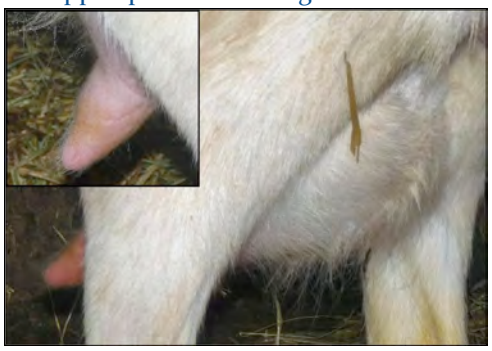
1. PREPARING FOR MILKING

It is important to ensure that each udder preparation step is performed consistently to get the best results. Udder preparation is especially important when trying to control udder infections due to environmental pathogens (see Section II.3.2).

1.1 CLIPPING THE UDDER AND TEATS

Udders and teats with excessive hair can harbour dirt and manure, which is difficult to remove during normal cleaning and next to impossible to dry effectively (Fig. 1). Dirty water on the teats and udder will cause bacterial contamination of the milk causing milk quality problems (See Section V), and is a risk for mastitis (See Section II.4). An example of a clipped udder can be seen in Fig. 2.

Fig. 1 Hairy udder and teat (inset) should be clipped prior to milking



1.2 CLEANING THE TEATS AND UDDER

Cleaning, disinfecting and drying the teats and udder prior to each milking is essential to minimize the amount of bacteria present on the teat. This not only helps minimize the chance of these bacteria from contaminating milk and equipment, but also minimizes risk of bacteria entering the teat and causing mastitis (Fig. 2).

Many Ontario dairy goat herds have problems with environmental mastitis (Section II.3.2). Proper cleaning and disinfection of the udder and teats is one of the important ways to control this problem.

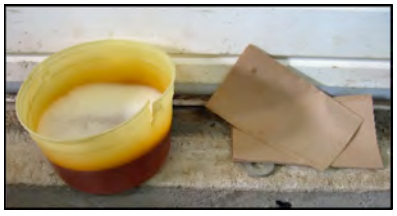
Fig. 2 Cleaning the udder and teats

1.2.1 WASHING THE TEATS AND UDDER

PROCEDURE

1. Strip out the foremilk into a strip cup (See Section III.1.4 for details).
2. Use a clean cloth or paper towel soaked with an approved udder wash solution.
3. Squeeze out excess moisture. It is important that the cloth not be too wet.
4. With the cloth fully open, wipe completely around each teat in a downwards direction with particular attention to wiping the teat end.
5. Use a clean part of the cloth / towel / wipe for each teat.
6. Then wash / wipe upwards on the udder if dirty.

Fig. 3 Udder wash and paper towels



UDDER WASH SOLUTION

When disinfecting the teats and udder, use an approved udder wash at the correct concentration. (Table III.1; Fig. 3). If the

water becomes dirty replace it immediately with fresh water and disinfectant.

MATERIALS USED TO WASH

Disposable towels minimize the chance of bacterial transfer from multiple uses, and they are easily discarded when dirty. The most common disposable towels are packages of brown paper towels, which are very inexpensive (Fig. 3). Regardless, the towels should be clean and discarded when they become dirty.

Commercially available udder wipes which are impregnated with a chlorhexidine sanitizer, may be used instead of udder washing and drying (Fig. 4). Again, the wipe should be approved for use in dairy animals to avoid dangerous disinfectants from contaminating milk intended for people (see Table III.1) and must be single-service.

Fig. 4 Commercial udder wipes approved for use in dairy

Reusable cloth towels may be used as long as changed frequently and properly washed and disinfected between uses (Fig. 5) (see Section III.1.2.2 for details).

Fig. 5. Clean laundered udder cloths

DRY PREPPING

Use of dry paper towels or other dry clothes alone (a.k.a. dry prepping the udder) is not sufficient to effectively remove debris and bacteria. A disinfectant wash solution MUST always be used first when prepping the udder and teats.

1.2.2 DRYING THE TEATS AND UDDER AFTER WASHING

Drying the udder, and especially the teat ends, is a key component in the udder prep procedures. It is important to maintain proper milking procedures, as this step in udder prep can have an effect on the udder of the doe, and the milk that travels to the tank.

PROCEDURE

1. Towels used must be clean and single-service.
2. The cloth should be fully open to get the maximum coverage when drying the teat (Fig. 6) and udder.
3. The towel should be completely wrapped around the teat, and should be pulled downwards in the natural direction of the teat.
4. If using a pre-dip (Section III.1.2.3), it is imperative that all teat dip is removed from the teat, with particular attention paid to the teat end, before the milking unit is attached (Fig. 7).
5. Then wipe up on the udder to remove all moisture that may trickle down to the teats.
6. Discard / launder when done each goat.

Fig. 6 Cleaning teats with commercial udder wipes. Note dirt on the wipe.

MATERIALS USED TO DRY

Most often individual paper towels are used and these work very well. Washable clothes may also be used (Fig. 5) however, they do have to be washed and disinfected thoroughly after each milking.

When washing the towels, it is **critical** that at least two of the following are being met to kill all bacteria on the cloths:

- Hot water, at least 70°C, for washing;
- High temperature for drying and;
- The addition of bleach at washing.

Water quality is important in terms of hardness and bacterial level. A high quality detergent is required. Towels should be dried properly using either a clothes dryer or clothes line, as wet environments promote the growth of bacteria.

Fig. 7 Teats have been pre-dipped and dried with a single-service paper towel prior to milking

RISKS FROM NOT DRYING PROPERLY

- Insufficient wiping the teats to dry may leave dirt and bacteria on the teat end, increasing risk of mastitis and high bacterial counts.
- Water on the udder will run down the teats bringing dirt and bacteria, particularly environmental pathogens, with it to the teat end and milk with risks as above.
- Improper removal of iodine-based teat dips applied at the previous milking will increase iodine concentration in the milk, which can have human health implications.

1.2.3 PRE-DIPPING TEATS

Pre-dipping teats is done to reduce the risk of transmission of environmental bacteria after the udder is cleaned and dried (see Section II.3.2) and so may not be recommended in all herds (Fig. 7). Only teat dips approved for use as a pre-dip should be used (see Table III.1). It is very important that if used, directions should be followed to prevent iodine residues in the milk – a human health hazard. This is done by proper drying of the teats prior to milking. For the procedure used for proper teat dipping, see Section III.6 below.

1.2.4 DISINFECTANTS USED ON TEATS AND UDDERS

Disinfectants used on the udder or teats of a dairy animal must be approved by Health Canada for such use[1]. The following products listed in Table III.1 are licensed for use in dairy cattle and should always be used according to label directions.

[1] Guidelines for approval of teat dips is found on the Health Canada website at: http://www.hc-sc.gc.ca/dhp-mps/vet/legislation/guide-ld/teat_guidelines_trayons_directives-eng.php

Table III.1. Udder and teat antiseptics approved for use in dairy cattle in Canada (partial list)

INGREDIENTS	PRODUCTS APPROVED IN CANADA FOR DAIRY COWS
	UDDER WASHES / WIPES
Accelerated Hydrogen Peroxide	DeLaval Prima™ (DeLaval)
Chlorhexidine	**WASHES:** Della Prep™ (DeLaval); Dihexamin ® Udder Wash (Divsersey); Professional Preference Udder Wash (Rafter 8); H-50 Udder Wash (Ostrem) **WIPES:** Dairy Prep Wipes (Agrisan); Kleen & Dri XL (Boumatic); La Lingette Hypre Towel (Matelvage Sarl); Marathon LC (Liberchem); Septicare (Matelvage Sarl)
Iodine	Della-Wash™ (DeLaval); Divosan (Diversey); Iodaphor Prep Udder Wash (Agrisan); Iodophor II (Ecolab); Iosan (West Pentone)
Lactic Acid, glycerin, alcohol	Lactofoam™ (DeLaval)
Linear Dodecyl Benzene Sulfonic Acid	Teat Kleen™ (Ecolab)
Nisin	Wipe Out Dairy Wipes
Quaternary Ammonium	Ultra Prep Udder Wash (Agrisan); Ster-Bac Udder Wash (Ecolab)
	TEAT DIPS
Chlorhexidine	**POST-DIP:** Dairyman's Defence™ Shield (Agrisan); Della-Blue™ Teat Dip (DeLaval); Dihexamin ® Teat Dip (Diversey); H-30 Teat Dip (Ostrem); Ultra Blue Teat Dip (Agrisan)
Glycerin & Sulfonic Acid	**POST-DIP:** Blu-Gard Teat Dip (Ecolab)
Hydrogen Peroxide	**POST-DIP:** Oxy-Gard™ Sanitizing Teat Dip
Iodine	**PRE- AND POST DIP:** Bovitec (Agrisan); Della-Pretech Plus™ (DeLaval); Della-Pro™ (DeLaval); Preodine (Agrisan) **POST-DIP:** Bovi-Kote 75 (Agrisan); Dairyman's Defence™ Premier (Agrisan); Dairyman's Defence ™ Ultra (Agrisan); Della-Soft ACT™ Teat Dip (DeLaval); Duo (Ecolab); I-Deal™ Teat Dip (Ecolab); Dairy Dine Germidical Teat Dip (Dominion); Iodaphor 110 Teat Dip (Agrisan); Iodaphor 110HV (Agrisan); Iodex (Agrisan); K-24 Germicidal Teat Dip (Ostrem); Mastmin® 50 (Diversey); Teat GuardTM (Ecolab): Tri-FenderTM (DeLaval)
Lactic Acid– activator Sodium Chlorite - base	**POST-DIP:** 4XLA Antiseptic Pre- & Post-Milking Teat Dip (Activator & Base) (Ecolab); Uddergold® Germicidal Barrier Teat Dip (Activator & Base) (Ecolab)

1.3 MILK LET-DOWN

Milk let-down is the process by which the maximum udder pressure is obtained in the udder after a release of oxytocin, which allows for optimal milk production at each milking. Milk let-down in goats is relatively short, so it is essential that udder cleaning and drying is done quickly, but efficiently and units are applied within 2 minutes of initial stimulation.

Milk let-down is stimulated during the udder preparation steps, which is why these steps are not only important for udder hygiene, but also to stimulate maximum milk let-down and reduce the need for long milking times and damage to the teat ends. Wiping is especially essential for this process.

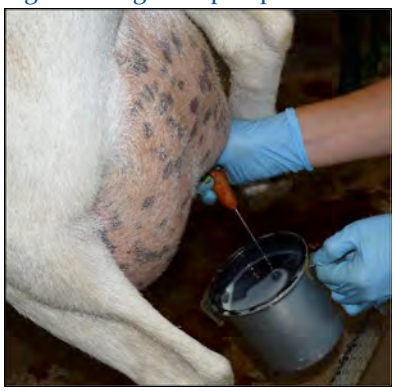
1.4 STRIPPING FOREMILK INTO STRIP CUP

As previously described, the foremilk should be removed prior to teat and udder preparation (see Section III.1.2.1). This is to:

1. Promote milk let down.
2. Remove milk in the teat cistern that may have high bacterial counts.
3. Examine the consistency and colour of the milk, to determine if there is clinical mastitis (Fig. 8).

The milk should always be squirted into a strip cup. There are different kinds: one type has a filter that allows normal liquid milk to pass through the filter into the cup, while the mastitic milk is caught in the filter; another has a black surface that, when the milk runs across it, will show up clots and changes in colour. A CMT can also be performed on the milk to determine milk culture should be done (see Section II.5.2).

Fig. 8 Using a strip cup



1.5 HYGIENE OF HANDS

As the hands are frequently in direct contact with teat ends, it is very important to make sure they remain clean during the milking process. As previously discussed in Section II 4.9, hands can be a risk factor for contagious mastitis. Cleaning and disinfecting hands before milking is essential to minimize the transfer of bacteria and milking facilities should include a hand-washing station (Fig. 9, Fig. 10), however, using disposable gloves is ideal when milking does, whether by hand or machine milking. Examples of gloves are found in Fig. 6 and Fig. 8. The use of gloves decreases the chance of bacteria often present in small cracks on the skin or under the fingernails are transferred to the doe's teat end.

Fig. 9. Wash and dry hands, both gloved and bare, frequently

Fig. 10. Hand washing facilities

1.5.1 *STAPHYLOCOCCUS AUREUS* HUMAN CARRIERS

People can be carriers of pathogens; of particular concern is *Staphylococcus aureus* including antibiotic-resistant strains of this important pathogen. It has also been shown that the coagulase-negative staphylococci species, *Staphylococcus epidermidis*, can be transmitted from the skin of humans to the mammary gland of does. These two organisms are two of the most important pathogens in mastitis of goats and so care must be taken to prevent transmission of these bacteria from the milking staff to the animals.

Once udder preparation is complete, milking can begin (Fig. 11).

Fig. 11 Clean and dry udders ready for milking

2. ATTACHING TEAT CUPS TO THE UDDER PROPERLY

Milking operators play an important role in maintaining vacuum stability by minimizing air admitted when they attach the milking units (Fig. 12). Air admission during teat cup attachment may cause slugging in the milk line, which will result in vacuum fluctuations. Frequent milk slugging can cause slow milking of does and increased liner slips. Proper unit adjustment will minimize liner squawks, which is particularly important toward the end of milking.

Fig. 12. Attaching teat cups

2.1 MILKING SINGLE GLAND ANIMALS

The situation may arise where milk can only be produced by a single gland because of loss of the other gland from mastitis or teat damage. A clean inflation plug can be used on the inflation that is not in use (Fig. 13), to allow for adequate suction, while preventing unwanted debris from being sucked into the unit. If the unit has a separate automatic shut-off, this may be used when milking single gland animals. Not advised is kinking over of the milk tube, as this is not a solid seal and air may leak by the kink leading to vacuum fluctuations.

Fig. 13. Inflation with plug

It is important to clearly identify which gland is not being milked to avoid accidental milking.

3. RECOMMENDATIONS DURING MILKING

3.1 TIME FROM UDDER PREPARATION TO MILKING

As mentioned in Section I.1.2, milk let-down is caused by release of oxytocin from the goat's pituitary gland. Oxytocin release is triggered by outside signals such as occur when cleaning the udder and teats. This happens very quickly, within less than a minute. **Twenty seconds** of stimulation is adequate for milk-let down. To make sure that this phenomenon is properly taken advantage of, milking should commence in **60 sec** (not more than 120 sec) after udder preparation.

3.2 TIME FOR MILK-OUT

Dairy goats milk-out relatively quickly when milked by machine. Studies performed in several dairies found that milking times average from 1 to a maximum of 3 minutes – even for high producing does, with peak milk flow starting ~ 30 seconds after the cups are attached. Over-milking causes damage to teat ends (Section II.4.7.1), slowing milking and increasing the risk of mastitis.

3.2.1 UNITS PER MILKER

The number of milking units per milker is dependent on the length of the parlour, the amount of time that is ideally allotted to milking, as well as the number of people milking. This is very herd dependent, but there are some general rules to follow.

- It takes ~ 30 sec to check the milk (stripping the foremilk) and clean and dry the teats and udder.
- It takes another 10-15 sec to apply the teat cups.
- If machine stripping is performed, this may take another 15 to 20 sec.
- It takes another 15-20 sec to remove the teat cups (if no automatic take-offs or ATOs are used) and effectively teat dip.

This means that each doe will occupy a milker's time for 55 to 85 sec. The average doe takes 120 sec to milk out. So it is likely that if a milker is responsible for more than 3 to 4 goats at a time, without the use of ATOs – goats may be over-milked and suffer increased risk of mastitis.

If ATOs are not be used, to make sure the does are not being over-milked, use a stopwatch to check how much time the milking unit is on. Do not skimp on time for proper udder preparation and post-dipping. These procedures are critical to udder health and milk quality.

3.3 STANDARD VALUES FOR MILKING EQUIPMENT

It is important to ensure that standard values for milking equipment are monitored on a regular basis. Although the equipment may appear to function correctly during milking, there could be an underlying issue affecting milk flow, or causing teat damage. The following chart demonstrates appropriate recommended equipment standards that are used for milking goat herds:

Table III.2. Standard values for milking equipment in dairy goat parlours

EQUIPMENT PARAMETER	STANDARD VALUE
Pulsation Speed	60 – 120 cycles/min – 90 most commonly recommended
Pulsation Ratio	50 – 60%
Vacuum at Peak Flow (kilopascals = kPa)	At the teat: 35 to 39 kPa (10 to 11.5 inches Hg) Low Line System: 35.5 kPa (10.5 inches Hg) High Line System: 39 kPa (11.5 inches Hg) 1 kPa = 0.295 inches of mercury (Hg)

As mentioned in Section II.4.9.2, improper set-up and maintenance of milking equipment will result in an increased problem with mastitis.

Basic information on the components of milking machines is available from the OMAFRA Factsheet "Understanding the Basics of Milk Machines"[2]

3.4 PREVENTING LINER SLIPS AND SQUAWKS AND IMPLICATIONS FOR MASTITIS

Squawks are a sign of liner slippage, when the teat cup liner loses contact with the teat skin and air enters the liner through the mouthpiece. Liner slips may cause reverse milk flow; milk droplets are forced at high speed towards the teat end. Liner slippage can be a significant cause of mastitis.

There are many reasons why liners slip in a milking parlour, including the following:

- Liners which are old and worn;
- The mouthpiece of the teat cup is misshapen;

[2] http://www.dairyweb.ca/Resources/USWebDocs/MilkingMachine.pdf

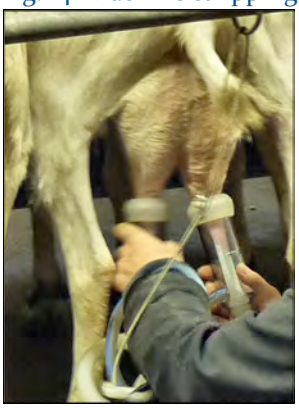
- Milking wet teats;
- Milking at low vacuum level or a high number of vacuum fluctuations;
- Blocked or partially blocked air vents and;
- Poor conformation of the udder and teats may increase risk (Section II.4.6).

3.5 MACHINE STRIPPING - IMPLICATIONS FOR MASTITIS

WHY MACHINE STRIP?

Machine stripping is where at the end of milking, the udder is massaged and/or teat cups manipulated while the teat cups are in place (Fig. 14). This is done to remove any residual milk that may be present in the cistern of the gland (Section I.1). In dairy goats, the cistern can hold as much as 60% of total milk yield, compared to 20% for cattle (Section I.2.3). If the conformation of the udder and teats in goats is poor, the residual milk may be trapped when the udder collapses at the end of the milking period (Section II.4.6). The advantage to machine-stripping is that it increases the amount of milk removed from the gland over-all. However, there are disadvantages to machine stripping and implications for udder health.

Fig. 14 Machine stripping



RISKS OF MACHINE STRIPPING

Machine stripping increases the length of milk-out, not just because of the time required to manipulate the udder (Section III.3.2), but the machine-stripped does also take longer to milk out in general than does that are not machine-stripped. Over milking causes teat-end damage (Section II.4.7), which slows milking and increases the risk of mastitis organisms getting into the udder. Through-put of the parlour is much slower when machine-stripping is practiced. The time spent machine-stripping should not interfere with the time spent in teat and udder preparation.

4. REMOVAL OF THE MILKING UNIT

4.1 SHUT-OFF VACUUM TO UNIT BEFORE REMOVING CLUSTER

Vacuum should always be shut off before teat cups are removed. This is accomplished by using a valve or clamp on the longer milk hose or a shut off valve on the claw (Fig. 15). When milk flow lessens at the end of milking, as visually detected by the milker, the vacuum is manually shut off before removing the unit from the udder. Pulling a unit off when it is still under vacuum needs to be avoided to minimize teat end damage.

Fig. 15 Using shut-off valve to remove unit

4.2 AUTOMATIC TAKE-OFFS

Automatic take-offs (ATOs) are becoming more popular in milk parlours as a labour-saving device. The ATO removes the milking unit from the goat once the milk flow is sensed to be below a certain threshold. The ATOs can range from simple vacuum operated units controlled by milk flow float sensors to sophisticated electronic devices (Fig. 16).

In general the ATOs should do the following:

- Sense the end of milk flow without over-milking;
- Shut off vacuum to the claw before starting to retract the unit;
- Have as little restriction to milk flow path from claw to pipeline as possible;
- Be easily cleaned in place and;
- Be regularly checked for efficiency of removal.

Some milking management points to consider when using ATOs are the following:

- A doe with only a single gland may not be milked out properly using the automatic take-off.
- Does must be prepared properly for good milk let down.

Fig. 16 Automatic take-off

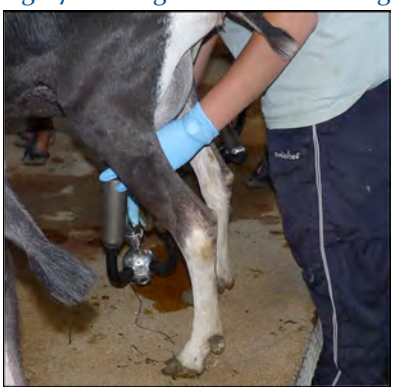
5. HAND MILKING

As an alternative to milking machines, hand milking does is a traditional method that can be very successful in certain herds. This milking method is generally used on smaller herds, and is extremely cost effective, as milking equipment is not required. Even though it is more time consuming than an automated system, a doe can be milked out in 2 to 4 min.

5.1 HOW TO MAINTAIN HYGIENE AND PREVENT CONTAGIOUS MASTITIS

The main principles of maintaining hygiene while milking are essentially the same as maintaining good hygiene when prepping the udder for milking. Hands should be cleaned and disinfected prior to milking (see Section III.1.5), and ideally, gloves should be worn to decrease the chance of transferring contagious bacteria to the udder of does. Latex gloves may cause an allergic response in some people; blue nitrile gloves can be used instead (Fig. 17).

Fig. 17 Wear gloves when milking



Teats and udder should be as dry as possible while milking, as any residual liquid from the udder wash, teat dips or disinfectants may drip into the milk. It will also contaminate your hands during milking allowing of transmission of bacteria between does. Because the teat ends are not protected when hand-milking, if there is splatter on the teats from urine or manure during milk, it is important to disinfect the teats before continuing.

6. POST-MILKING MANAGEMENT OF THE TEATS AND UDDER

Many new cases of mastitis occur soon after milking. There is a very strong body of evidence that preventing exposure of the teat end to a dirty environment is one of the most important facets of improved udder health. This includes teat dipping and environmental cleanliness.

6.1 POST-MILKING TEAT DIPPING

6.1.1 PRODUCTS

Approved teat dips for dairy cows are listed in Table III.1. Only products approved in Canada for dairy cows should be used in dairy goats. Teat dips must be handled properly to maintain their efficacy.

- Containers of dip must be closed at all times, and stored in an area, that does not expose the dip to extreme hot or cold temperatures, nor to sunlight (e.g. a cupboard with doors in the milk room).
- Pre- and post-dips, if not the same product, should be stored separately.
- Teat dips should not be diluted in any way, which can compromise the efficacy of the dip.
- After teat dip is removed from the storage container (e.g. into a teat dip cup or sprayer), it should NEVER be returned to that container.
- Expiry dates of these products should also be observed, as an expired product can drastically affect its strength as a teat disinfectant.

6.1.2 PROCEDURE

Immediately post-milking using either a teat dip cup or spray bottle, apply undiluted teat dip to the entire teat, including the teat end and up to the base of the teat where it meets the udder (Fig. 18).

Fig. 18 Proper teat coverage using a teat dip cup

6.1.3 DIP VS SPRAY

- If using a teat dip cup (Fig. 18), make sure there is sufficient dip in the cup to completely cover the teat up to the base of the udder.
- If using a spray system (Fig. 19), it is more difficult to correctly position the nozzle, risking insufficient coverage with solution. Extra care needs to be taken to make sure this doesn't happen.

Fig. 19 Teat spray. Uneven coverage.

Teats that have abnormal placement on the udder can be correctly dipped more easily than sprayed. Teat sprayers allow for easy and quick application of disinfectant on teats but require more care to ensure proper coverage.

6.1.4 RETURN VS NON-RETURN TEAT DIP CUPS

Return dip cups were the first containers developed for easy application of teat dips when milking. These are hand held cups that are shaped for easy application on teats (Fig. 18). The base of the container is a squeeze bottle that holds a reservoir of dip, which is squeezed up, into the cup as needed. This allows the milker to regulate the amount of teat dip being applied to the udder. The downside is that debris which may fall in the dip cup will be mixed with fresh dip – causing contamination.

Non-return dip cups are the same design as return dip cups, but the teat dip cannot return back to the original dip container, which decreases the chance of transferring debris and bacteria to the uncontaminated dip (Fig. 20). This type of dip cups is preferred, and they decrease the potential transfer of pathogens.

Fig. 20 Non-return cup

6.1.5 CLEANING THE DIP CUP

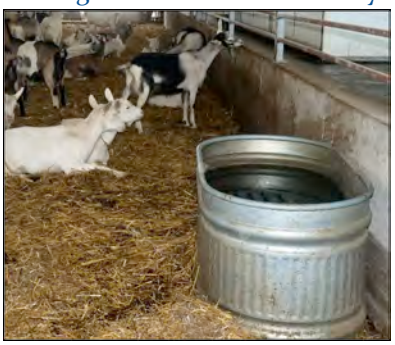
Cleaning the teat dip cups after each milking is important to decrease the spread of bacteria from milking to milking. Both the inside and outside of teat cups should be rinsed out at the end of each milking. If the dip cup is a return cup, all teat dip should be cleaned out after each milking, to decrease the chance of bacteria being transferred from milking to milking.

If manure or any debris falls in the teat dip cup during milking, any excess teat dip should be removed from the cup and rinsed. In addition, if any doe that has been confirmed as having a *Staph. aureus* mastitis, the teat dip cup should be emptied and rinsed before using it on the remainder of the herd.

6.2 ENVIRONMENT POST-MILKING

After milking, the teat sphincter is tired and does not close for approximately 30 to 120 min after milking, leaving it exposed to pathogens. Post-dipping the teats following milking helps decrease the chance of transferring pathogens into the udder, but by itself is insufficient protection.

Fig. 21 Water available after milking but environment is dirty



To prevent risk of environmental pathogens entering the teat sphincter, discourage lying down for at least 30 minutes following milking. Offering water and feed immediately after milking will help to do this. Fresh water should be freely available as soon as they leave the parlour, but it is critical that the area around the waterer be kept dry and clean (Fig. 21). If fresh feed is delivered to the feed bunk after the does leave the parlour, this entices them to stand and eat rather than lie down. While the does are in the holding area of the parlour prior to milking, this is an ideal time for wet bedding to be removed and fresh bedding to be laid down. If at pasture, make sure wet, swampy areas are kept fenced off. Dry lots or corrals should be similarly dry and clean.

FLY CONTROL

Flies have been shown to transmit mastitis causing bacteria as they are attracted to the teat ends. Fly bites on the teat ends will cause inflammation and possibly infection – risking mastitis. Fly control in the barn during the summer, particular biting-type flies is an important part of a mastitis control program. No fly repellent products are licensed for use on teats and udders of dairy animals.

6.3 IODINE RESIDUES IN THE MILK AND HUMAN HEALTH

High levels of iodine found in milk have been identified as a human health concern. Milk iodine levels can be affected by improper use of iodine-based teat dips as well as excess iodine in the doe's diet.

It is suggested that an appropriate iodine level in bulk tank milk should remain below 500 µg/kg,. This can be done by: proper cleaning of the teats prior to milking to remove residual teat dip solution; using only approved products for pre- and post-dipping; thoroughly drying teats prior to milking to remove residual pre-dip teat dip; assuring that dietary iodine levels be limited to requirements only (See Section VIII.1.4).

Children under the age of eight years old have a daily iodine requirement of approximately 90 µg (1 µg = one millionth of a gram), with a maximum iodine limit of 300 µg, and adults have a daily iodine requirement of approximately 150 µg per day, with a maximum iodine limit of 1100 µg. It is important that humans are not ingesting excess iodine from dietary sources.

7. MILKING ORDER

7.1 DOELINGS MILKED FIRST

There are several very good reasons to milk doelings first.

- To ensure that doelings become comfortable in a parlour setting, it is important to milk them first in the milking order to allow for more time to get accustomed to the milking system. If doelings are put into groups with older animals, there is a potential for them to get bullied out of being milked, and this will be associated as a negative experience.
- If doelings are milked together, the milking times will be more consistent between animals, as they are all producing a similar amount of milk.
- Does with more than one lactation, are more likely to carry infections with contagious mastitis pathogens. Milking doelings first reduces possible exposure to these infected does and their milk.

7.2 PHYSICALLY IDENTIFY CONTAGIOUS MASTITIS DOES

It is important to identify does with subclinical infections of contagious mastitis (e.g. *Staph. aureus, Mycoplasma mycoides capri*) and, if not able to be culled immediately, house and milk these animals separately from the rest of the herd to minimize the potential of transmitting these pathogens to healthy does. The identification should be visible from the rear of the animal at eye level, and be semi-permanent, i.e. should not wear off but should be able to be removed if the status of the animal changes. An example is to use leg bands such as shown in Fig. 22. Keep written records of all treatments, culture results and management decisions on each doe (Fig. 23).

Fig. 22 Leg band to identify udder health status

Use one of the following ways to manage these animals:

1. Have a separate milking unit that is used only for confirmed infected does. For example, a special bucket milker is used.
2. Milk with normal equipment but disinfect each milking unit separately after it has been used on an infected animal.

3. Identify does known to be infected with a contagious mastitis pathogen, and manage them as a **separate group**, i.e. keep in a separate pen (Fig. 24). Milk this group of animals last in the herd. By doing this, you eliminate the chance of infected milk being transferred to an uninfected doe through the teat cups of the milking unit. In addition, all milking units will be disinfected after the end of milking, which eliminates the need of disinfecting them separately after each infected doe is milked.

Fig. 24 Keep written records

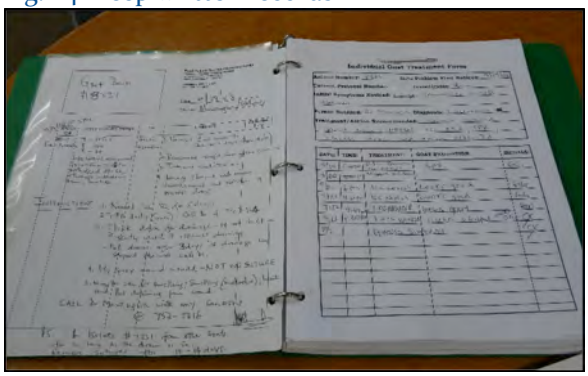
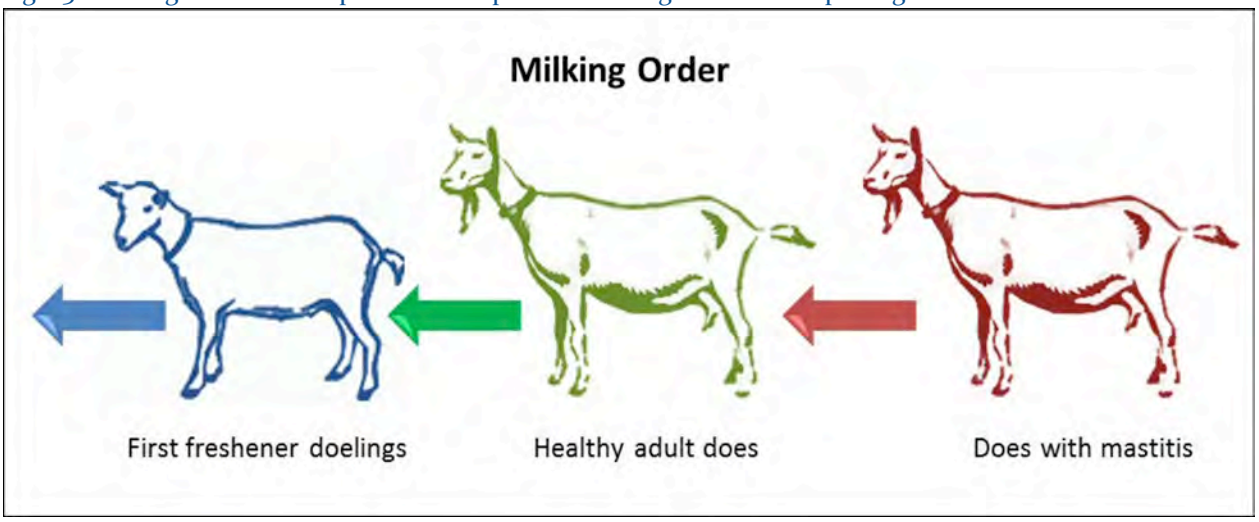


Fig. 23 Milking order will help to control spread of contagious mastitis pathogens



7.3 MILKING OF CAE-NEGATIVE ANIMALS

Some herds have put a great deal of effort into rearing CAE negative kids (see Section VIII.2). Milking time is a high risk time for infecting does. The virus is easily transmitted through respiratory secretions (e.g. coughing, nasal discharge) and through milk. When the kids are bred and freshen, they should never be mixed with the herd which contains infected does. The CAE-negative "herd" or group should always be milked first ahead of all others. After the milking is complete, the parlour should be washed and disinfected, including feeders in the parlour as the virus is spread through respiratory secretions. The virus present in the teat cups will be killed through the sanitation process post-milking. Water troughs should not be shared with potentially CAE-infected does.

SECTION IV
PROPER MAINTENANCE AND USE OF MILKING EQUIPMENT

TABLE OF CONTENTS

1. PARLOURS

Parlours are effective milking management systems on many dairy goat operations. The ability to milk a large number of does at one time allows for effective milking times, which is extremely beneficial for time management on-farm. In addition, with a parlour system, the animals are standing at a platform which is elevated from where the milkers stand, which avoids bending to apply milking machines.

Although these are very beneficial systems, it is important to understand the differences between parlours, how to manage each type properly, as well as how to manage does through these systems, from pre-milking to post-milking.

Fig. 1 Single-sided low-line parlour, milk from behind

1.1 TYPES OF PARLOURS

Although there are many similarities between parlour types, each system has to be managed in a specific way to ensure that all does are being handled properly, and that the utmost care is taken to ensure optimal udder health.

1.1.1 MILKING FROM BEHIND

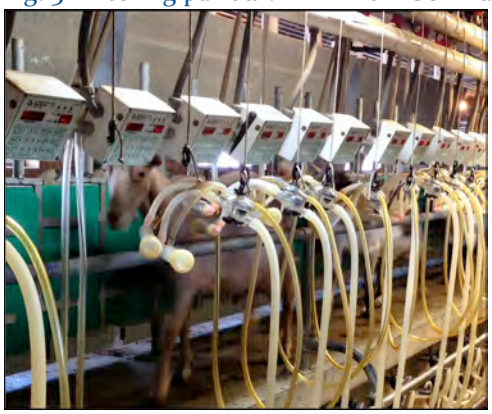
Parlours in which the does are milked from behind are called parallel parlours and are the most common type seen. A group of does go through a side of the parlour at one time, and are all milked at the same time, and released from the parlour at the same time. Parlours may be single-sided (Fig. 1) or double-sided (Fig. 2). With the latter, when one side of the parlour is milking, the other side is being prepped for milking, which increases parlour efficiency.

Fig. 2 Double-sided low-line parlour, milk from behind

When entering a parallel parlour, does walk straight into the parlour, and then when they reach their designated milking stall, they turn 90°, so they are standing away from the milker pit at a perpendicular angle (Fig. 3). These parlours allow for easy access to teats, as the doe's legs do not block the udder and teats.

One downside to parallel parlours is that the group must all be finished before leaving and allowing the next group to enter. This means that the speed is as slow as the slowest milking doe in the group.

Fig. 3 Entering parlour. Milk from behind



1.1.2 MILKING FROM THE SIDE

Parlour systems that allow milking from the side are called herringbone parlours and are not commonly used when milking goats (Fig. 5). They are essentially the same style of parlour as parallel parlours, except for the stall positions when being milked. The does enter the parlour, and they stop at stalls that are angled slightly outward from the parlour, with the does' head being

farther away from the milking pit then their hind ends. This positioning allows for faster entry into the milking parlour, which can decrease overall milking time. However, fewer does can be milking in the same space.

Fig. 5 Herringbone parlour

There are a few issues to consider when milking in a herringbone parlour. The first is the possibility of being kicked by the does during milking, as both milking prep and attachment of the milking unit have to be done around the back legs. When milking, it is also important to ensure that the teats are being stripped and wiped on the teat farthest from the milker pit first, following by the teat closest to the milking pit, and that the unit is placed on the teat closest to the milking pit first, followed by the teat farthest from the milking pit. By milking in this manner, it decreases the risk of contaminating teats when reaching over to wipe, or attach the milking unit, which in turn decreases the risk of transmitting pathogens to the teats.

1.1.3 ROTARY

Fig. 4 Rotary parlour for goats

Rotary parlours have become increasingly popular in the dairy industry, as these systems maximize milking efficiency on-farm. Does enter the parlour one animal at a time. Rotary parlours are circular, and rotate slowly, to allow for does to walk into their respective stalls (Fig. 4). The parlour rotates the animal almost 360°, finishing with exiting the parlour. Does may face head-in or head-out.

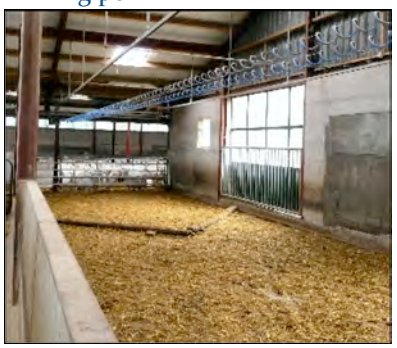
Animals are prepped and unit applied at the beginning of the parlour rotation, and then the does are milked for the majority of the parlour rotation. Once the parlour has almost finished its rotation, the doe is post-dipped, and ready to exit the parlour.

These systems should be used with automatic take-off units (ATOs) to assure over-milking does not occur; this is because rotation time, i.e. milking time is set by the speed of the rotation of the parlour and may be much longer than milk-out time. No machine stripping is done with this system.

Fig. 6 Pre-milking pen

1.2 PRE-MILKING PENS

Fig. 7 Hydraulic crowd gate in pre-milking pen



Before being milked, does are brought into a pre-milking pen, or holding area that is close to the parlour (Fig. 6). Generally, does from a whole pen are brought into the holding area at one time, so they can stay segregated into their respective groups. Some of these pens employ crowd gates (Fig. 7) to encourage does to enter the parlour.

Pre-milking pens should be regularly cleaned of manure build-up and should be well-drained so kept dry. This prevents splashing of manure onto the legs and udder of the does while they wait their turn to be milked.

1.3 BRINGING THE DOES INTO THE PARLOUR

Entry into the parlour should be encouraging and safe. Often parlours are elevated (Fig. 8). Footing should be dry and secure and the entrance well-lit. After the does exit the parlour (Fig. 9 shows dairy ewes exiting from the front), an entrance gate will be opened to allow a new group of does to enter the parlour side. Animals walk directly into the parlour, and after all stalls are filled, the entrance gate will be closed again, and milking procedures will commence.

For the majority of the time, does will walk directly into the parlour without issue, however with younger or problem does, a producer may need to help guide them to the parlour. This can be done manually, by walking behind the does, directing them into the parlour, or automatically with a crowd gate, which pushes the group towards the parlour. It is important that this be done by moving quietly and not shouting or using physical force. Any nervousness will inhibit milk let-down and reduce milk production (see Section I.1.2).

Fig. 8 Ramp to parlour is well-lit and secure

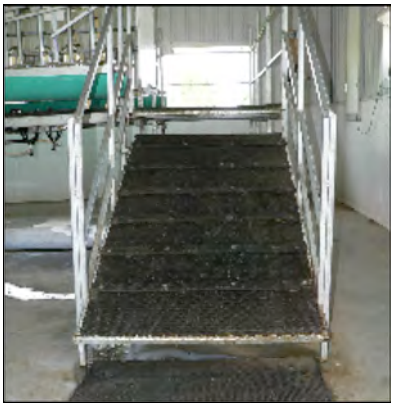


Fig. 9 Ewes exiting from the front

1.3.1 HEAD RESTRAINTS

When goats enter the parlour and go into their individual milking stanchions, there are two options for the head: the head is not restrained, or their head goes through a headlock system, so they are only allowed minimal movement during milking (Fig. 10). A locking head-gate prevents does from moving excessively during milking and encroaching on other animals.

Fig. 10 Head-gates. Does can't back out until released

1.3.2 FEEDING CONCENTRATES IN THE PARLOUR

Mangers are often placed on the other side of the head gate to offer a concentrate feed during milking (Fig. 11). While this occupies the does, assures that each doe has access to grain - and may help to bring nervous animals into the head gate readily, there are risks with this type of feeding that should be appreciated.

POOR RUMEN HEALTH

For optimal rumen health, the doe needs grain evenly through the day – balanced with forages, minerals and vitamins (see Section VIII.4.1). Feeding grain infrequently in the parlour will cause ruminal acidosis (grain overload when severe, or sub-acute ruminal acidosis (SARA) when mild). Does go off-feed, may develop laminitis, and the milk absorbs off flavours. Cud chewing is decreased and cud-dropping may be observed because of the digestive upset caused by this type of feeding.

Fig. 11 Does eating concentrate in parlour

DIETARY NEEDS ARE NOT PROPERLY MET

Relying on milking time to feed concentrate may mean that some does do not get enough and others too much. With the former, this can lower milk production and may harm reproductive performance if the does are too thin. The best way to feed concentrate is in a balanced ration as a total mixed ration (Section VIII.4.1.4) and to not feed it in the parlour.

1.4 TYPES OF MILKING SYSTEMS

The components of a pipeline milking system (Fig. 12) and a bucket milking system (Fig. 13) are provided in schematic diagrams below.

Fig. 12

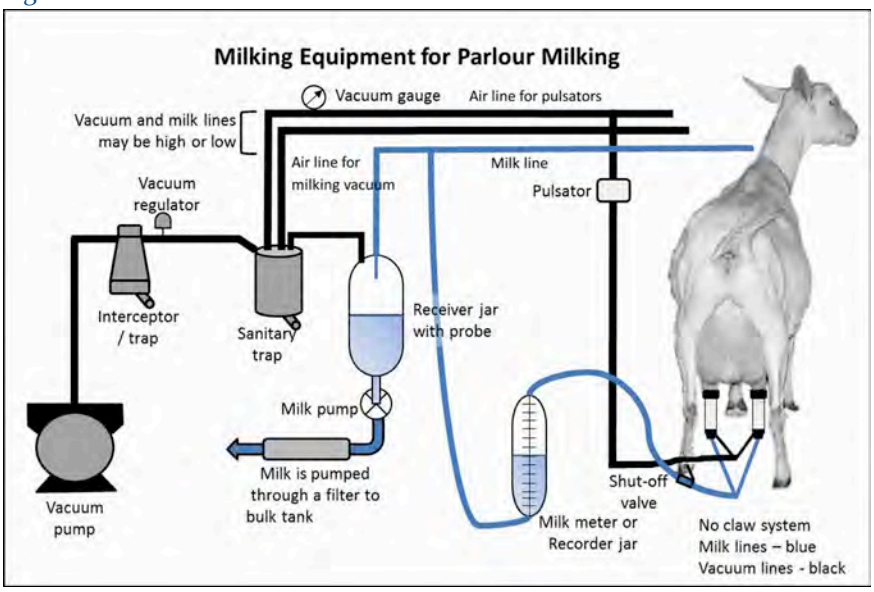
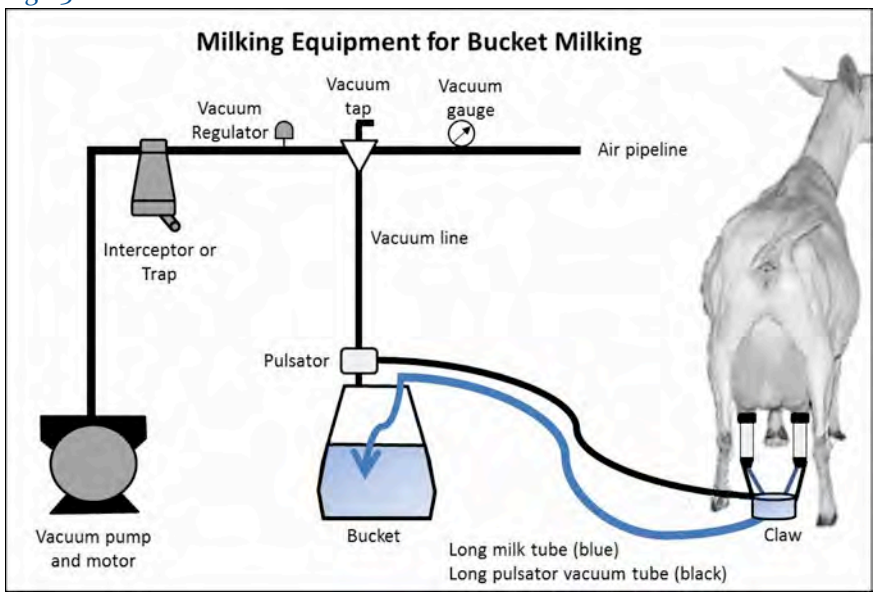


Fig. 13



1.4.1 PIPELINE

In new parlours, pipelines are generally installed as a low-line system (Fig. 14), which runs below the milking units. This system provides a consistent downwards flow of milk to the line, which allows for stable vacuum. There is an option of having the pipeline above the does, called a high-line system (Fig. 15), which helps to keep the line away from the animals, and potential damage. Ideally, the highline will be no more than 1.8 m (6 ft) above where the milker stands in the parlour.

Pipelines should be sloped (a minimum of 1%) towards the receiver to ensure proper drainage of fluids. They should also be properly sized so the milk flows through the pipe without blockages and that the slugging action during the wash cycle provides enough volume and force to adequately clean all interior surfaces of the pipeline and system.

Fig. 14 Low-line system.

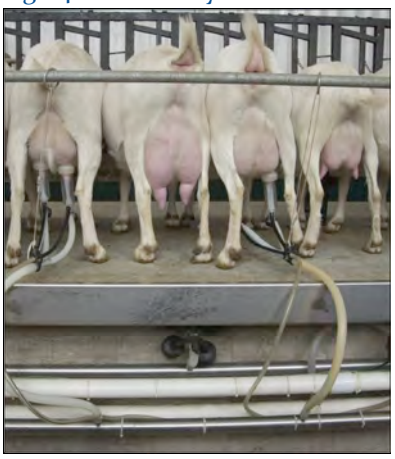


Fig. 15 High-line parlour.

1.4.2 BUCKET

A bucket system is commonly used with smaller dairies. It is also used to milk animals whose milk needs to be kept out of the tank (e.g. treated does, does with mastitis, fresh does) (Fig. 16). The milk storage unit is a sealed sanitary bucket so that vacuum can be used to pull the milk from the teats and hoses into the bucket (Fig. 13).

1.4.3 HAND-MILKING

In this system, each doe is milked into a pail with the milker sitting on a stool or raised platform beside or behind the doe. Does may be milked from the back or side. It is laborious but requires much lower financial input.

Fig. 16 Bucket milking

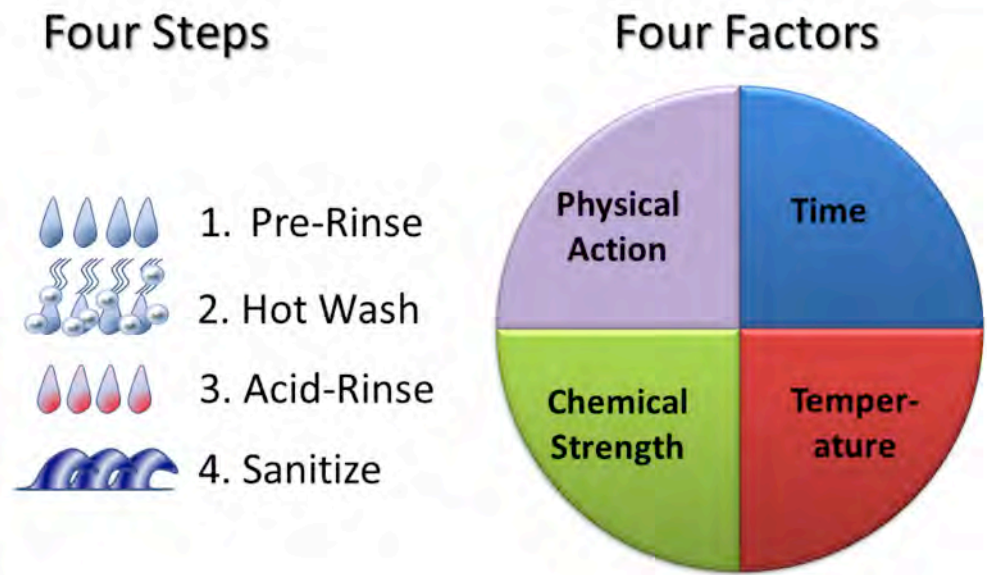
1.5 RELEASING THE GOATS

At the end of milking, goats can exit the parlour in a variety of ways. In a parallel parlour, a rapid exit system has a front gate which rises after milking, and all animals exit the parlour at the same time to the return lane to their housing pens (Fig. 9). This exit system can also be done in batch or gang exits, where only a portion of animals are released at each time. This type of system tends not to use head-gates. Exiting can also be done with the does backing up once released from the head-gates. The head-gate release is usually at one end of the parlour and all does are released at once. In a herringbone parlour, does exit the parlour when milking is completed and travel down the return lane back to their pens.

2. THE BASICS OF CLEANING MILKING EQUIPMENT

In order to provide high quality milk to the market place, the milking system must clean up perfectly after each milking. The four basics of cleaning are **Time**, **Temperature**, **Chemical Concentration** and **Physical Action** (Fig. 17). These factors are important in each cycle of a clean in place (CIP) system.

Fig. 17 **SANITATION 4X4.** The key steps and factors involved in the cleaning process for hand-milking, bucket-milking or pipeline milking are basically the same.



2.1 STEP 1 – RINSING MILKING EQUIPMENT SURFACES

Milking equipment should be rinsed and washed immediately after milking to avoid milk residues from drying on equipment. If not cleaned promptly, the residues will be very difficult to remove later.

2.1.1 PURPOSE

This step removes 90-95% of milk solids. It also removes residual milk and dirt and serves to warm up the milk line for Step 2.

2.1.2 TEMPERATURE RANGE

Water temperature should start at 43°C to 49°C (110°F to 120°F). If water temperature becomes too cool, i.e. drops below 38°C (100 °F) milk fat will solidify back onto the milk line. The temperature can also be too hot. A rinse temperature above 60°C (140 °F) may bake on milk protein.

2.1.3 MANAGEMENT TIPS

The pre-rinse should be an open cycle and not recirculate, i.e. open to the drain so only fresh water is used (Fig. 18). Otherwise a milk film may be redeposited in the system. Use of a pre-rinse divert valve will eliminate recirculation of milk soil and reduce the load that must be removed during the wash cycle.

To reduce the amount of milk in waste disposal systems, some producers save the first-rinse water-milk mixture and feed it to livestock. Note, it is not suitable to feed this water-milk mixture as a substitute for milk or milk replacer to nursing-age animals as the milk doesn't contain enough nutrients.

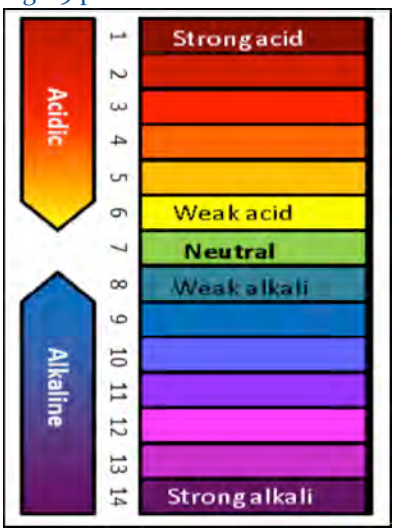
Fig. 18 Discard first rinse
Source: www.progressivedairy.com/

2.2 STEP 2 – HOT CHLORINATED ALKALINE DETERGENT WASH

2.2.1 PURPOSE

This cycle removes fat, protein and other organic materials including large numbers of bacteria.

Fig. 19 pH scale



WHY HOT WATER?

Dairy detergents require hot water to work effectively. To be removed milk fat needs to be heated to be in a more liquid state so it can be dissolved. End of rinse temperature should not drop below 100°F (38°C). If water temperature becomes too cool milk fat will solidify back onto the milk line.

WHY A HIGH PH?

The alkali in the cleaner reacts with milk fat breaking it down and suspending it in the cleaning solution. The chlorine chemical breaks up the milk proteins, which are then also suspended in the wash solution. See Fig. 19 for range of pH numbers.

WHY DAIRY DETERGENTS?

Dairy detergents contain sequestering agents or chelating agents, which tie up hard water minerals such as calcium and magnesium. Chelating agents prevent minerals from precipitating out of solution and forming films on the milk contact surfaces (milk stone). Dairy detergents also contain surfactants, which decrease the surface tension of the solution and assist in penetrating the milk soils. Use only approved dairy cleaners. Non-dairy cleaners are less effective and over time will lead to the development of films and residues, which leads to high bacterial counts in the milk.

Fig. 20 Hot enough at the end of the cycle?

2.2.2 TEMPERATURE RANGE

Start temperature should be 74 °C (165 °F). Water temperature at the end of the cycle must be **absolutely no less than 49 °C (120 °F)** (Fig. 20). Circulation time is usually 6 – 10 min. An adequate end temperature is more important than precise wash solution contact time.

2.2.3 MANAGEMENT TIPS

WATER QUALITY

The wash solution is mostly water - 99% or higher. All water used for cleaning should meet potable (drinking) standards[1].

The amount of detergent used depends on volume of water and water hardness. Hard water can reduce the effectiveness of dairy cleaning products. A water softener is recommended for hardness over 20 grains.

Most labels will specify amounts to use per quantity of water, taking into account the grains of water hardness. Your chemical supplier should provide a wash procedure chart (in Ontario this is a MUST), which reflects the types and amounts of cleaners required for each cycle. Follow the recommendations!

ALKALINITY OF THE CLEANING SOLUTION

The pH of the caustic cleaning solution should be between 12 and 13 (Fig. 19). This pH will cause burning to unprotected skin and eyes. Handle using gloves and goggles to protect from splashing. The active alkalinity needs to be in the 600 - 900 ppm range, in the higher range for bulk tank and milk meter cleaning.

INVESTIGATE WATER TEMPERATURE IF CLEANING AND BACTERIAL PROBLEMS

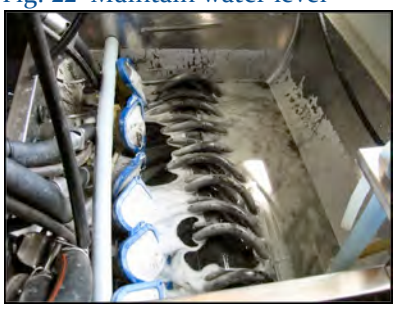
The water heater needs to be adequately sized for your requirements. The actual amount of hot water available from a tank is about 70% of its capacity (Fig. 21). For example, a 40 gallon tank only provides (40 X 0.7) 28 gallons of hot water!

Fig. 21 Hot water tank in good repair

Using hot water for other uses (e.g. mixing milk replacer) can reduce the availability of hot water for pipeline washing. Recovery rates will vary depending on your specific heater. The time between a pipeline wash and a bulk tank wash needs to be long enough to allow the water heater to recover.

Water heater problems can go undetected for a long time if you do not monitor wash temperatures. Calcium and magnesium salts can accumulate in water heaters and reduce heating capacity to below adequate. A burnt out bottom element is a frequent problem. Buildup of mineral in water pipes and screens can restrict the flow of water to the wash control box causing improper temperatures at the wash sink.

Fig. 22 Maintain water level



[1] Ontario Drinking Water Standards: https://dr6j45jk9xcmk.cloudfront.net/documents/1140/81-drinking-water-standards-objectives-and.pdf

Unplanned admissions of air into the milking system cools wash water very rapidly and may cause poor slugging. Maintain water level in wash sink so that suction lines never draw air (Fig. 22). The pipeline must be free of air leaks at joints and milk inlets.

PHYSICAL ACTION / SLUGGING OF CLEANING SOLUTION

Most modern pipeline systems rely on slugs of cleaning solution to provide scrubbing action. If your system has an air injector, proper adjustment is essential.

Fig. 23 Receiver jar wash-up

Keep filters clean; a blocked air injector results in a poor slug. The air injector open time determines slug travel distance. The open time should be just long enough to cause the slug to travel to the receiver jar before it breaks up. The air injector closed time determines the amount of water drawn in and initial slug length.

- Slug volume should be about 1/3rd the volume of the receiver (Fig. 23).
- Slug velocity needs to be 7-10 m/sec (23 to 33 ft. per sec).
- Minimum of 15 slugs per wash.

The following indicates there may be an issue with air injector location or timing[2]:

- The water level in the receiver does not change during the cleaning cycle;
- The milk pump never shuts off during the cleaning cycle;
- The system "traps out" (the ball valve in the sanitary trap shuts off system vacuum during one or more wash cycles);
- A large volume of water drains from the distribution tank when the vacuum pump is shut off after cleaning or;
- Air is drawn into the system at the wash sink.

Automatic bulk tank wash systems clean by covering the inner surfaces of the tank with a sprayed sheet of cleaning solution. The large surface area of a bulk tank and spray action of automatic tank washers can make it hard to maintain the required 49°C (120°F) end temperature on the hot wash cycle. Only a small surface area of a bulk tank receives the force of the spray jet leaving much of the cleaning to the cascading action of the solution as it flows down the tank sides. Therefore the mechanical cleaning action is significantly reduced in a bulk tank compared to circulation cleaning of pipelines.

Fig. 24 Manually clean bulk tank

You may need to manually clean your tank to be sure all surfaces are adequately scrubbed (Fig. 24).

[2] Douglas J. Reinemann Trouble Shooting High Bacteria Counts in Farm Milk 1997

DRAINAGE IS IMPORTANT!

Wash temperatures as well as chemical concentrations can be adversely affected by residual water from previous cycles. All secondary drains, especially from the receiver must be large enough to drain completely before the next cycle. All milk lines and wash lines need adequate and continuous slope to allow for complete drainage between cycles. Inadequate drainage in the system results in mixing / neutralizing of cleaning chemicals. This can affect solution temperatures and strength. Poorly drained equipment allows bacterial growth between milkings.

2.3 STEP 3 - ACID RINSE

2.3.1 PURPOSE

This cycle removes detergent residues, neutralizes alkali residues and prevents mineral deposits. The acid rinse leaves the inside of the pipeline with an acid pH, (pH 4.0 or less, see Fig. 19) which suppresses bacteria growth. An acid rinse also increases the life of inflations and gaskets. If an acid rinse is not completed, rubber ware starts to ink (leaves black smudges on equipment) indicating that the rubber is deteriorating and not doing its job of providing a water-tight seal.

2.3.2 TEMPERATURE RANGE

Water temperature is not critical in this cycle but should comply with label recommendation as posted on wash chart.

2.3.3 MANAGEMENT TIPS

The acid rinse pH should be between 2.5 and 3.5 and is very corrosive to skin and eyes. Handle using gloves and goggles to prevent injury from splashing. **NEVER mix an acid detergent with a chlorine-based product.** This produces a highly lethal chlorine gas which, when inhaled can with only one or two breaths, rapidly destroy the lungs of animals and people. There is no treatment once the lungs are damaged.

2.4 STEP 4 – SANITIZE

2.4.1 PURPOSE

This cycle is completed to eliminate bacteria that may grow on equipment surfaces between milkings even when well cleaned and acid rinsed. It is performed before milking.

2.4.2 TEMPERATURE RANGE

Use warm water 43°C – 60°C (110°F – 140°F)

2.4.3 MANAGEMENT TIPS

Use a solution containing 100-200 parts per million (ppm which is the same as mg/litre) chlorine. The sanitize cycle should be completed just prior to milking – no more than 30 min - and should circulate for 3 to 4 min. It should be run before installation of an inline milk filter.

2.4.4 TYPES OF SANITIZERS

CHLORINE

Chlorine is the most popular dairy sanitizer. It has activity at low temperatures, is relatively inexpensive, and leaves minimal residue or film. It is a broad spectrum bactericidal chemical (kills many forms of bacteria). It is minimally affected by hard water but is corrosive if present in too high concentration. A maximum of 200 ppm chlorine should be used just prior to milking.

The major disadvantage to chlorine is corrosiveness (especially at high temperatures). Avoid using hot water in the sanitize cycle, cold or tepid is acceptable. The activity of chlorine is reduced by organic load and by alkaline pH. **Chlorine sanitizers must not be mixed with acid cleaners because at low pH deadly chlorine gas can be formed**.

IODINE

Iodine also has broad spectrum microbial activity. Iodine sanitizers mixed with a surfactant are termed iodophores. Organic matter interferes less with the action of iodophores than with that of chlorine. Iodophores also have more residual activity than chorine. A concentration of 12.5 to 25 ppm is recommended for iodophore sanitizers.

The major disadvantage is that iodine can cause staining, particularly on plastics. Iodine vaporizes at temperatures above 120ºF / 49ºC. Loss of activity occurs at high pH values.

PEROXYACETIC ACID

Peroxyacetic acid (PAA) is stable at 100 to 200 ppm. These sanitizers are non-corrosive and tolerate hard water. PAA solutions have been shown to be useful in removing biofilms – important when troubleshooting high bacterial counts in the milk. However, PAA solutions have a pungent odour.

2.5 CLEANING MILK CONTAINERS

2.5.1 CLEANING THE BULK TANK

Bulk tank cleaning involves the same cycles and temperatures as pipeline cleaning. Often bulk tanks are a more difficult vessel to clean than a pipeline. Achieving a 120 °F / 49 °C end temperature of the hot wash can be challenging. Automatic bulk tank washers deliver a spray of cleaning solution which sheets over the surface. There is much less shear force or physical action as compared to pipeline slugging. The spray-ball or jet tube must deliver cleaning solutions to all interior parts of the bulk tank. Watch for plugged spray heads and incomplete drainage between cycles. When in doubt, best to also clean using manual labour (Fig. 24). Visually inspect the interior surfaces of the tank when dry to detect films of protein, fat or milk stone buildup. A strong flashlight may be needed to conduct an effective examination.

Listed below are areas where cleaning problems frequently occur in bulk tanks.

- Outlet and valve
- Plug and plunger rod
- Under the bridge and lid
- Dipstick and dipstick socket
- The corners of a square tank
- Agitator paddles

2.5.2 CLEANING BUCKET MILKERS

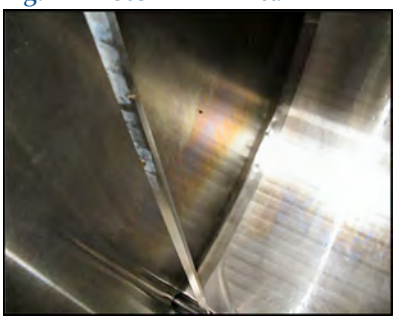
The cleaning procedure should be done with the same rigour and attention and CIP systems for pipeline milkers: first warm rinse, followed by brush cleaning each bucket with a hot chlorinated alkaline dairy detergent. Then rinse with dairy acid. Invert to let dry with bottom open to air (Fig. 25). If they are stacked wet, moulds and bacteria may grow causing later milk contamination and off-flavours.

Fig. 25 Buckets need to be cleaned between uses

2.6 RESIDUAL FILMS ON MILKING EQUIPMENT

Cleaning failures usually result in a visual buildup or residual film in some part of the milking equipment. Films can often be diagnosed by scrubbing a small area with concentrated acid or detergent solutions. There are two categories of residual films:

Fig. 26 Protein film in tank



2.6.1 ORGANIC FILMS

Organic films are usually composed of fat or protein. Protein films can appear as a blue rainbow colour (Fig. 26) or a brownish slime (applesauce-coloured). Beads of water hanging on the top side of the pipeline or receiver jar may indicate a fat film (Fig. 27). Fat films are alkaline soluble. Protein films are soluble in chlorine.

Fig. 27 Water beads from fat deposits

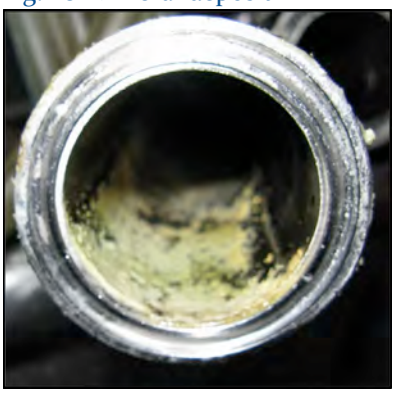
BIOFILMS

Microbiological films, a type of organic film, can form under certain conditions. These films are called biofilms and can be very difficult to remove. Often there is no obvious residue but the stainless lacks the sheen of a clean surface and may appear a dull grey colour. A group of bacteria known as pseudomonads are often linked to biofilms. These biofilms shed billions of bacteria and cause a significant increase in standard plate counts (see Section V.3.1). Cleaners and sanitizers with strong oxidizing properties (such as peroxyacetic acid) have proven to be effective in biofilm removal.

2.6.2 INORGANIC FILMS

Inorganic films are typically hard water minerals such as calcium, magnesium and iron (Fig. 28). Mineral films have a rough porous texture and are invisible when wet. Inorganic films are usually acid soluble.

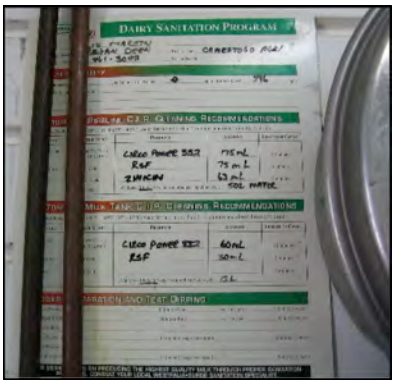
Fig. 28 Mineral deposit



2.7 TROUBLESHOOTING CLEANING

If a cleaning problem is suspected, begin troubleshooting the simplest things first. Observe one complete cleaning cycle (pipeline and bulk tank). Make sure that the manufacturer's cleaning instructions are being properly followed (Fig. 29). Note times and temperatures of each cycle. Verify amounts of cleaners used (Fig. 30-left) and if possible chemical concentration (e.g. pH, Fig. 19; Fig. 30-middle).

Fig. 29 Posted cleaning instructions



A hand held thermometer is essential (Fig. 30-right). A visual inspection of the milk contact surfaces requires a strong flashlight. This is particularly important for bulk tank examination. Mineral deposits and biofilms are difficult to detect when stainless steel is wet. Allow surfaces to dry prior to visual inspection. For more information, see Section V.3.7.

EXAMPLES OF PROBLEMS EASILY DETECTED

- Low end temperature of wash water
- Improper temperature at beginning, middle of cycle
- Wash draw line in the sink is sucking air
- The system "traps out" or sanitary trap floods causing shut-down of the wash system
- The hot wash circulates only once and then drains
- The sink drain is leaking and losing cleaner down the drain
- Poor washing action in one or more claws or hoses due to a plugged jetter
- Incomplete drainage from pipes etc. between the cycles

Fig. 30 Left - verify cleaners used correctly; Middle - pH paper to check acidity / alkalinity; Right - thermometer and strong flashlight

2.8 PLANNING A PARLOUR FOR CLEANING

2.8.1 KEEP IT COMPACT

Parlour design should minimize milkline, wash-line and airline lengths. Every extra foot of pipeline adds complication for cleaning. The length of pipeline from the milk-house to the parlour needs to be minimized. This will reduce heat loss during cleaning and reduce water volume requirements.

Fig. 31 Milk meters need extra cleaning

2.8.2 KEEP IT SIMPLE

Additional components such as milk meters can be difficult to clean. If you use these components as a management tool to both monitor production and improve genetic selection (both very valuable for every dairy), be prepared to do some extra cleaning (Fig. 31)!

2.8.3 DESIGN IT SO IT CAN BE KEPT CLEAN

Traffic through the parlour will inevitably cause a build-up of manure and urine, spilled milk, teat dip and feed (Fig. 32 left). It is critical for udder health that the parlour be set-up for routine washing down and sanitizing. It will also prevent a build-up of flies (which cause mastitis) and be a much more pleasant working area.

Fig. 32 Dirty parlour (left) and clean parlour (right)

Plan for managing wastewater, either through a buried septic system, a lagoon system or a storage / settling tank. More information on estimating storage needs and planning solutions can be found in the OMAFRA Factsheet Handling Milk Centre Washwater[3].

3. SET-UP AND INSPECTION OF MILKING EQUIPMENT

Having a standardized inspection of milking equipment on a regular basis is important to make sure that the system is functioning properly. For an excellent overview of the components of a milking machine system, visit the Food and Agriculture Organization of the United Nations (FAO) website[4]. Proper inspection should be done by an equipment dealer representative on an annual basis, and if particular issues arise. However, the producer should inspect equipment and function daily.

3.1 PROPER SET-UP OF MILKING EQUIPMENT FOR DAIRY GOATS

Goats are different from cows in that they have lower milk production, higher fat levels, smaller teat orifices and larger cisterns as a proportion of daily milk production. For all of these reasons, set-up of

[3] Handling Milk Centre Washwater: http://www.omafra.gov.on.ca/english/engineer/facts/14-047.htm
[4] FAO United Nations: http://www.fao.org/docrep/004/t0218e/t0218e02.htm

equipment may be different than the dairy cow. The following recommendations come from the International Dairy Federation (IDF)[5] and the Dairy Practices Council ® (USA) (DPC)[6].

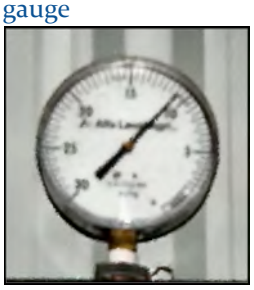
3.1.1 VACUUM

VACUUM LEVEL

As covered in more detail in Section III, the recommended claw vacuum at peak flow is 10 to 12 inches of mercury (in Hg) or 35 to 41 kilopascals (kPa) (Fig. 33). More details are covered in Table III.2.

Higher values may lead to teat-end damage and slower milking. Lower values may lead to units dropping off during milking.

Fig. 33 Vacuum gauge



VACUUM LINES

The materials used for the vacuum lines should be able to withstand vacuum levels of 85 kPa (25″ Hg). For the main vacuum line length and diameter recommendations, consult the "Dairy Practices Council® Guideline for the Design, Installation and Cleaning of Small Ruminant Milking Systems" (DPC 70, 2000).

VACUUM PUMP

Vacuum pumps need to be located close to the parlour but in a clean and dry location, free of dust and extremes of heat and cold. The document DPC 70, 2000 – provides recommendations of the air flow requirements needed for milking and washing – both for bucket systems and pipeline systems. It also provides recommendations on changes needed if the farm is located above 300 m (1000 ft) sea level, as more vacuum is required to compensate for the thinner air.

VACUUM RESERVE

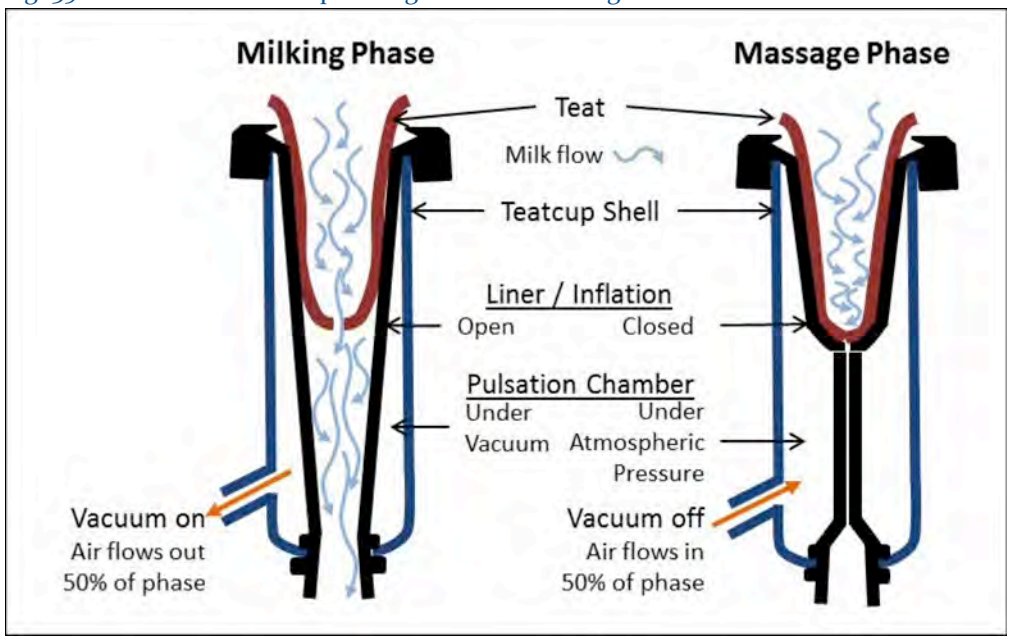
Sufficient vacuum reserve is necessary to prevent liner slips and squawks, drop-off of inflations and drop in vacuum resulting in fluctuations and milk impacts. Information that is used to calculate this amount includes: type of milking system (pipeline versus bucket); number of units; whether conventional clusters or those with automatic teat cup valves; and whether an automatic shut-off valve is used with the cluster. Elevation is also important as more reserve is needed at higher elevations above 300 m (1000 ft) sea level. Tables are available in the IDF Bulletin 370 (2002) so that a specific recommendation can be made for your facility.

3.1.2 PULSATIONS

The pulsations allow for vacuum changes in the teat liner / inflation to gently squeeze the teat sphincter to open and shut, allowing for removal of milk (Fig. 35). During the milking phase, the vacuum removes the air from the pulsation chamber – the space between the liner and the shell of the teat cup. This forces the teat sphincter open and allows milk to be pulled from the teat. When the

[5] International Dairy Federation: http://www.fil-idf.org/Public/ColumnsPage.php?ID=23077
[6] Dairy Practices Council: http://www.dairypc.org/

Fig. 35 Action of the teat cup during machine milking



vacuum is shut off, air enters the pulsation chamber, collapsing the liner and allowing the teat sphincter to close. Milk does not flow and the teat relaxes. Changes from the milking phase to the massage phase must be rapid to allow blood to flow back into the teat during the massage phase.

PULSATION RATE

For dairy goats, the recommended rate is 60 to 120 cycles / min, with 90 cycles being most commonly recommended (Fig. 34). There must be adequate rest time between each cycle to allow for blood flow back into the teat. If not, then teat damage may occur. For this reason, adapted pulsators designed for use in dairy cows should not be used as the change from open to closed and open again may not be fast enough given how rapid the pulsations are.

Fig. 34 Pulsator

PULSATOR RATIO

Pulsator ratios are the milk phase-to-rest phase, and are usually between 50% and 60%, with 60% most commonly recommended. The pulsator ratios should not vary between units by more than 5%.

PULSATION LINES

The vacuum line to the pulsators should be 2 inches (48 mm) in diameter. If using more than 36 milking units, the diameter should be 3 inches (73 mm). The slope should be 0.4% (4 mm per metre of line length) to the vacuum distribution tank. An alternative is to have auto drains installed at low points.

3.1.3 MILKLINES

SLOPE OF THE MILKLINE

Milklines should have a continuous and even fall towards the receiver jar, with a minimum of 10 mm (1 cm) of drop for every metre of pipe. This translates into a minimum decline of 1%. For example, if the distance from the furthest goat being milked to the receiver jar is 20 metres (66 ft.), then the drop is 20 cm (~ 6″). The maximum recommended drop is 2.5%. Steeper drops allow for slugging of milk and possible flooding of the milkline. Systems should be designed with a minimum number of elbows and dead-ends.

COMPOSITION OF THE MILKLINE

The inside of the milkline should be as smooth as a Number 4 mill finish in stainless steel sheet. It needs to be free of any marring of the inside surface, e.g. pitting, cracks, crevices. All welds of joints, ferrules and gaskets should also be smooth with no pits. There should be inspection ports to allow for visual inspection of the inside of the milkline.

FLOW OF MILK THROUGH THE MILKLINE

The flow of milk inside the milkline should be at a level of less than 50%, i.e. there should be more air above the level of milk than milk below. This is called "stratified flow" (Fig. 36). Slugs of milk flowing through the milkline, where the level of milk fills the milkline, will cause a drop in vacuum (usually greater than 2 kPa) and result in longer milking times, and more liner slips.

Fig. 36 Milk flow through line

Flow rates of milk will vary between breeds of goats and perhaps between stage of lactation. The following milk flow rates have been suggested by the IDF:

- Low milk flow animals = a maximum of 0.8 L of milk/ min
- Medium milk flow animals = a maximum of 1.3 L of milk / min
- High milk flow animals = a maximum of 2.7 L of milk / min

If flooding occurs during peak milk times (e.g. when does are in early lactation), you may need to decrease the number of units on at any one time to prevent "seasonal" flooding.

Based on research, does tend to either milk-out quickly (75 to 100 sec), or slowly (125 to 200 sec), with most milking out in less than 2 min (120 sec). High milk flow animals tend to milk out more quickly than low milk flow animals.

Milk flow rates and volumes will vary by number of units being used and type of animal being milked (flow rate and length of time for milk-out). Udder stimulation and subsequent milk-let down will also impact milk flow.

To calculate the minimum diameter of the milkline needed to keep a stratified milk flow, consult the IDF Bulletin 370 (2002), using information on expected maximum milk flow, number of units, type of milk-line (dead-end versus looped) and slope.

3.1.4 MILKING CLUSTER

CLAW

Milking clusters may or may not use a claw. If used, the claw of the cluster should be large enough so no flooding occurs during maximum milk-out (Fig. 37). If flooding occurs, milk may move from one teat cup to the other and transfer mastitis bacteria to the other gland.

Fig. 37 Claw size large enough?

INFLATIONS

The size of the inflation opening should be adequate for the teat size of the goat. Recommendations on inflation maintenance are provided in Section IV.3.2.1.

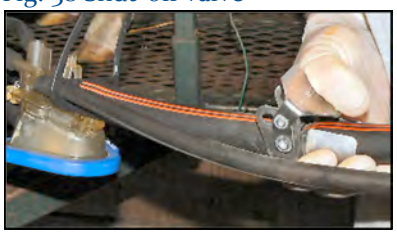
AIR VENTS

The milking cluster requires air vents so that the milklines do not become flooded. The air vents are located either in or near the claw or in the tube close to the teat cup inflation. They should be as small as needed to allow milk to move without flooding.

SHUT-OFF VALVE

There should be a shut-off valve installed to break the flow of milk between the milk line and the inflation (Fig. 38). This should be used every time a milking unit is removed. Automatic shut-off valves are recommended but must be properly calibrated so that goats are not over or under-milked.

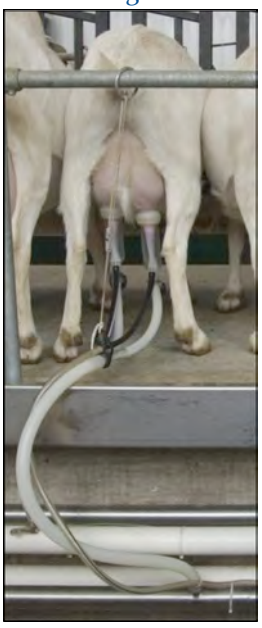
Fig. 38 Shut-off valve



MILK HOSES FROM TEAT CUP TO MILKLINE

If no claw, the milk hoses from each teat cup to the bucket or milkline should extend long enough (1 m) to prevent milk flow back to the other gland (Fig. 39). However, they should not be longer than 3 m (9 ft). They should enter the pipeline perpendicular and at the top half of the line.

Fig. 39 Milk hoses correct length?



3.1.5 RECEIVER TO MILK TANK

RECEIVER

The receiver jar should be located in the milk-room or parlour. From the receiver jar, one line goes from the top of the jar to the trap - preventing milk or cleaning solution from entering the vacuum distribution tank (Fig. 40). Another line goes to the bulk tank. A probe within the jar when triggered by the rising milk level will start the milk pump to move the milk from the jar to the bulk tank. Flooring should be impervious, washable and with an adequate and well-maintained drain. Souring milk will also cause bad odours which may be absorbed by the saleable milk.

MILK FILTERS

All milk (whether going through a pipeline or strainer) must be filtered prior to storage. Use only filters designed for use with milk and replace after each milking. Milk filters (in-line and strainer-type) should be replaced before or after each cleaning as determined by milking equipment manufacturer's recommendations. The filter will screen out debris and sediment (such as straw and large dirt particles) and some mastitic milk (i.e. clots). Checking the filter for signs of mastitis and other debris can help you to identify problems (e.g. adequate udder preparation (Fig. 42). The filter is not a replacement for proper udder and teat preparation (see Section III.1.2). Filters should also be used for hand-milking or bucket milking before the milk enters the bulk tank for storage (Fig. 42).

Fig. 40 Receiver jar with milk pump and trap

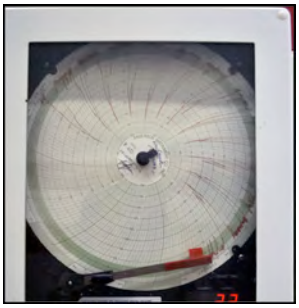
Fig. 42 Cleanliness of milk filter reflects udder preparation and health. Left – filter containing feed material and manure. Right –little dirt indicating good udder prep in this herd.

Fig. 42 Milk poured through strainer fitted with filter. System used with hand-milking or bucket.

3.2 MAINTENANCE OF EQUIPMENT

It is important to monitor milking equipment on a regular basis to determine if maintenance needs to be performed. Daily monitoring of the bulk tank temperature to identify inconsistencies is important to the maintenance of milk quality. Monitoring can be done using a hand thermometer with a stainless steel stem or with a time temperature recorder (TTR) (Fig. 43). Weekly monitoring of pre-rinse or wash water, as well as inspection of problem areas in the milking equipment should be done to monitor build-ups, cracks and leaks. If there are any issues at these weekly inspections, maintenance should be done by producers, or by equipment dealers as soon as possible after the problem is detected.

Fig. 43 Monitor temp of bulk tank



The system should have a thorough evaluation completed by an equipment dealer annually to make sure the equipment is functioning properly. In addition, oil for the vacuum pump should be monitored and changed when needed. The vacuum pump, as well as the valves and

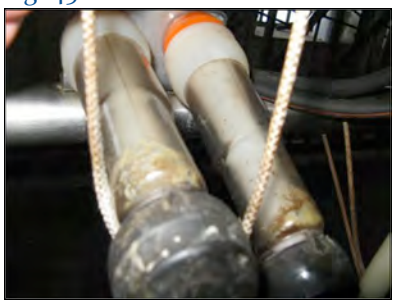
screens need to be cleaned twice a year. Inflations should be changed as required, as set by the equipment dealer, or if there is a leak.

Fig. 44 Worn inflation

3.2.1 REPLACE MILK INFLATIONS (LINERS)

Milk inflations need to be replaced when worn (Fig. 44). Rough inking and porous inflations can harbour bacteria and negatively impact milk quality. Worn inflations can harm teat end health predisposing does to mastitis. Breakdown of silicon will allow milk fat and solids to migrate into shells (the outer portion of the teat cup) (Fig. 45).

Fig. 45 Milk solids inside shell



GUIDELINE FOR REPLACEMENT

This can be calculated based on the rated life of the inflations and how often they are used.

1. Daily use of an inflation = (# milking goats / # of milking units) X # of milkings per day (Note – most everyone milks 2X per day but some dairies only 1X day)
2. Number of days to change inflations = rated life inflation / daily use of an inflation

An example how to calculate:
Daily use of an inflation = (200 does milking in a 24 unit parlour, being milked twice day = (200/24) X 2) = approximately 17 times per day.
If using silicone inflations with a rated life of 6500 milkings, then inflations should be changed every (6500/17) = 390 days. If using rubber inflations, the rated life is much lower, e.g. ~ 1500 milkings which in this example would be (1500/17) = 88 days.

Sometimes the inflations need to be replaced more often than manufacturer's recommendations. Things that can influence this:

- If the animals are being milked at a pulsation rate > 60 cycles/min. Since goats are milked at 60-120 cycles/minute, this may shorten the interval for replacement;
- If the ratio of washings to milking is higher (e.g. smaller dairy with same number of units used), the inflations may also wear out with fewer milkings or;
- Excessive chlorine use.

3.2.2 MONITOR AND REPLACE HOSES AND GASKETS

Fig. 46 Inking from rubber breakdown

As with milk inflations, rubber ware on gaskets and hoses breaks down with time, use, exposure to heat, cold and chemicals. Worn parts can harbour bacteria and leak milk. Rubber, which is breaking down, leaves a black residue called "inking" on surfaces (Fig. 46). This is a sign that the rubber part needs replacement.

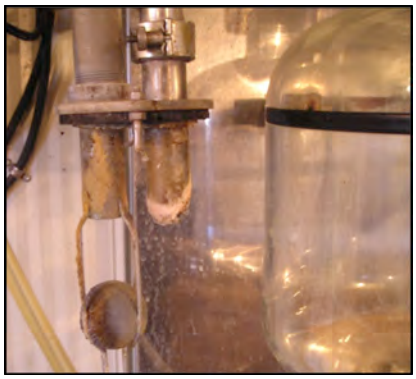
GUIDELINES FOR REPLACEMENT

- Replace silicone milk hoses every 2 years
- Replace plastic milk hoses every year
- Replace black gaskets every year
- Replace silicone gaskets every year
- Follow guidelines of dealer unless worn rubber indicates more frequent replacement is needed

3.2.3 CHECK FOR RESIDUES AND WEAR ON EQUIPMENT

- Manual cleaning of the jetter cups will increase their life expectancy.
- Inspect the bulk tank washer pump hose for debris which may plug the spray ball. A cap on the hose that connects to the bulk tank is one way of preventing debris and pests from entering the wash pump and bulk tank between washes.
- Check the milk wash plug for inking. Check it also for cleanliness. If a short plug is used for milking, make sure it is manually cleaned after each milking.
- If a jet tube tank washer is used, clean the outlet valve routinely. Keep the tip of the jet tube up off the floor to keep cleaner. Check for wear on the impeller – remove to inspect.
- Periodically inspect and clean shut-off valves and sanitary trap (Fig. 47).

Fig. 47 Check sanitary trap for cleanliness



3.2.4 BULK TANK MAINTENANCE

VISUALLY INSPECT THE TANK AFTER WASHING

Open the hatch after washing and let the surfaces dry before inspecting (Fig. 48). Wet stainless steel will appear clean. Water beading may indicate a fat film. A blue rainbow haze may indicate a protein film (Fig. 26). A greyish film (lack of shininess to surface) may indicate a biofilm. It is very important to remove any films from equipment to prevent high bacteria counts that may affect the milk.

Fig. 48 Left-milk stone in tank; centre-biofilm on agitator paddle; right-clean tank

Fig. 49 Milk tank equipment needs to be inspected and cleaned after every pick-up

INSPECT TANK HATCH AND OUTLET VALVES

Residues can build up around the tank hatch. The lid gasket, breather and exterior need frequent inspection and cleaning. The tank outlet valve should be cleaned after every milk collection / tank wash day (Fig. 50).

3.2.5 WASH CONTROL BOX MAINTENANCE

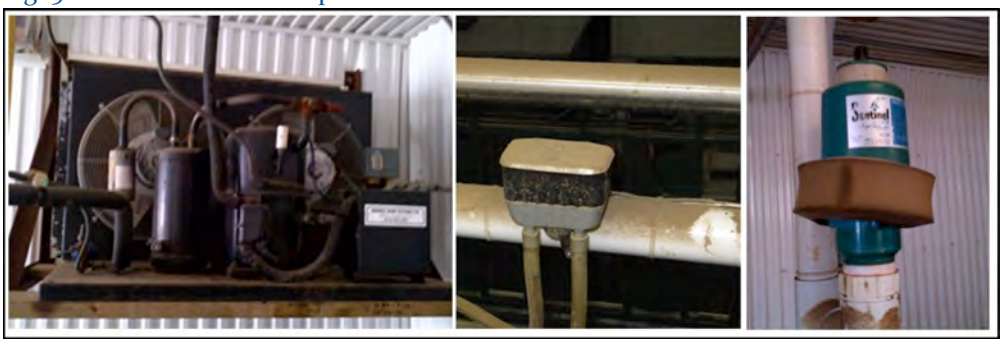
Check and clean the screens on the hot and cold inlet hoses. If the water is hard, calcium deposits can build up (Fig. 49). Repair any leaks at the chemical dispensing jars promptly. Leaks will result in a loss of the cleaning chemicals.

Fig. 50 Wash control box in good repair

3.2.6 CLEAN DUST AND DIRT FROM EQUIPMENT AND HOUSING

Equipment, particularly those with electronic components (e.g. pulsators, vacuum regulator pumps, air injectors, heaters), should be kept dust-free to assure proper operation. It is very important to keep the radiator of the condenser unit free of dust and dirt (Fig. 51) to ensure effective and efficient milk cooling. Parlours can be a dirty place, which means that regular cleaning is necessary to keep things working right. Use of screens on the windows, regular fly control in the parlour and milk house, air filters on intake fans will all help – but attention to maintaining and cleaning delicate equipment is also necessary.

Fig. 51 Dust and dirt can impair function



FLY CONTROL

Flies are attracted to organic material and carry bacteria that spoil milk and cause mastitis. The parlour should be kept free of manure, urine, spilled milk and residual feed. Areas in the milk house that may attract flies include the garbage (e.g. soiled milk filters), drain areas, dirty buckets, etc. Keep all areas clean and sanitized and remove garbage frequently. Keep flies out by having intact screens on all windows and doors. Fly bait – approved for use in livestock premises, can be used if fly build-up becomes a problem. Keep window sills free of debris and moisture. Floors should be kept swept and clean, particularly around drains that should also be cleaned frequently. Other fly sources to consider include manure storage facilities and dead-stock composting areas. Locate those away from the milking area and milk house.

3.2.7 WASH SINK

Keep non-essential items out of the sink (e.g. milk bottles and nipples). Ideally, a cover should be in place over the sink (Fig. 52). This will help to maintain water temperatures as well as keep debris out.

For systems that are Clean In Place (CIP), the suck pipe should not draw air during the cleaning cycles. A coarse screen should be put on the end of the suck pipe to prevent debris from being sucked up. This debris can accumulate in the wash line and restrict flow to the jetters. Corrective actions should include consulting with your equipment dealer. Make sure drains stay clear and clean as well to allow for dirty water to get away quickly.

Fig. 52 Covered wash sink helps maintain temperature of wash water

SECTION V
MILK QUALITY

TABLE OF CONTENTS

1. WHAT IS MILK QUALITY?

The quality of the milk produced by goats is measured by several aspects:

- The level of bacteria in the milk;
- The number of somatic cells (as a measure of inflammation or mastitis) (see Section II.5);
- The freezing point as affected by water contamination, animal health and dietary factors;
- Presence of residues of veterinary drugs and other chemicals or toxins, and
- By its colour, flavour and odour.

All of these aspects influence the milk's shelf life; its taste and palatability; its safety for the public; the quality and quantity of the cheese and other daily products that can be made from the milk; and the nutritional value of the product.

The factors that determine milk quality are within the power of the producer to influence positively. Milk quality standards and the authority to enforce them are contained in provincial legislation (in Ontario this is authorized under the Milk Act). Some milk quality aspects are measured and enforced by regulators (such as farm premise standards), while others are monitored and controlled by dairy plants when purchasing the milk for processing (such as grading, testing and acceptance or rejection of tank-trucks of milk). For these reasons – and because we all want to produce the best milk possible – the production of high quality milk has to be the number one goal of all dairy goats producers, veterinarians, businesses and extension personnel who work with the producers.

1.1 REGULATING MILK QUALITY IN ONTARIO

The Ontario Ministry of Agriculture, Food and Rural Affairs' (OMAFRA) Dairy Food Safety Program is responsible for inspection of dairy goat farm premises and monitoring raw goat milk quality in Ontario according to regulations. Goat farm premise standards must be met (Grade A) prior to shipping milk[1]. Raw goat milk can only be marketed to licensed dairy plants. Milk may only be collected on the farm by certified bulk tank milk graders. Milk transport vehicles must be inspected and approved by OMAFRA. Raw milk quality standards (below) are provided in regulations under the Milk Act. Milk processors also have the right to reject milk if it does not meet their "in-house" standards. Regulations specific to milk quality are quoted below:

1.1.1 GOAT MILK QUALITY STANDARDS (GRADE A MILK)

In addition to meeting premises standards, the following standards for milk quality must be met:

- contain less than 321,000 individual bacteria cells (IBC) per millilitre using the Bactoscan method or less than 50,000 bacteria per millilitre by the Standard Plate Count method;
- be inhibitor free;
- be normal as indicated by a maximum freezing point of -0.564° Hortvet (-0.545°C) when tested on the cryoscope;
- be sweet and clean;
- be free from objectionable flavour or odour;
- be from healthy goats and;

[1] OMAFRA Dairy Goat Farm Production Requirements
http://www.omafra.gov.on.ca/english/food/inspection/dairy/page-1.htm

- be free from adulteration and from contaminants.

The Bulk Tank Milk Grader grades every bulk tank of milk prior to emptying. If they determine that milk is not Grade A they will reject the milk. It is the responsibility of the producer to dispose of rejected milk. Never dispose of milk through a sediment tank and treatment trench system as it can lead to blockage.

2 SOMATIC CELL COUNT (SCC)

Somatic cell counts and interpretation are covered in Section II.5.3. As they are a measure of the level of mastitis, they are important in milk quality. Mastitic milk has a reduced shelf life, decreased cheese-making ability and a disagreeable taste.

The bacteria responsible for mastitis may also pose a risk to the consumer's health. Raw milk, raw milk soft and semi-soft cheeses and cheeses contaminated post-pasteurization contain these pathogens which can cause disease in people – from mild gastrointestinal illness to septicaemia and death in rare cases.

2.1 REGULATORY LEVELS OF SCC

While in Canada, there is no federal regulatory allowable limit for SCCs in goats, in the USA, the acceptable SCC regulatory levels of raw milk set for dairy goats is 1,500,000 cells/mL milk.

In Canada, regulatory levels for dairy cattle are low, i.e. 400,000 cells/mL milk. However it is rare that goat dairies can maintain SCC levels that low. Dairy cattle produce milk through a merocrine system, so there is less damage to secretory cells in the udder, while goats produce through an apocrine system (see Section I.1.2.1), so that there are inflammatory factors in the milk that contribute to increasing SCC levels even when mastitis is not present. With goats, this back-ground level is estimated to be 150,000 cells/mL although may be higher when milk production is low or when goats are late in lactation. See Section II.5.3 for a more in-depth discussion of somatic cell counts and goats and how to interpret levels.

3 BACTERIAL CONTAMINATION OF MILK

In Ontario, bacterial contamination of milk can be measured by Standard Plate Count or by Bactoscan.

3.1 STANDARD PLATE COUNT

Standard Plate Count (SPC) is a standardized measurement of bacterial contamination of milk. A milk sample is collected on-farm at each bulk milk pickup for analysis and SPC of that raw milk sample is determined. This quality standard is the same whether dairy cattle, sheep or goats. It does not reflect what types of bacteria are contaminating the milk, or where the bacteria are coming from, but it does give a good indication that there is an issue with milk quality on-farm.

3.1.1 HOW IS SPC MEASURED?

SPC is a measure of the number of live, aerobic bacteria present in a milk sample. After the pooled milk is aseptically sampled (with no preservative), it is chilled and sent to a designated laboratory for testing. A measured milk sample is diluted with sterile water and measured into a petri dish and then mixed with agar which is a nutrient mixture which allows bacteria to grow. This agar is poured into

plates and then is incubated aerobically for 48 hours in a warm environment (incubator). Each bacterium or clump of bacteria in the milk forms a colony on the plate, which can be seen and counted with the naked eye (Fig. 1). SPC is measured as a colony-forming unit (CFU) per mL of milk (also covered in Section II.5.4.2). The number of colonies on the plate = the number of live bacterial colonies which can grow in air (aerobic) in that volume of milk. This is then arithmetically calculated so that the number of bacteria per mL/milk is obtained.

While regulatory limits in different jurisdictions vary, it is possible and preferable to keep bacterial counts less than 10,000 CFU/mL. High bacterial counts cause the milk to spoil more quickly, interfere with cheese making and can pose a public health risk.

Fig. 1. Standard Plate Count

Source: http://healthyeasttx.org/

3.1.2 ASSOCIATION BETWEEN SPC AND MASTITIS

SPC is not usually a measure of mastitis but rather associated with both poor milking and equipment hygiene. However, there are times both SPC and SCC increase at the same time, such as when the herd has a higher prevalence of subclinical mastitis, caused by some types of bacteria (see Section II.3.2). This has been shown to occur occasionally in goat dairies and so for that reason, good udder health is a critical component to keeping bacterial counts low.

3.1.3 BACTERIA NOT MEASURED BY SPC

SPC does not measure all bacteria in milk, i.e. it does not measure the number of dead bacteria; bacteria which grow only anaerobically (without oxygen); nor other organisms such as algae (prototheca) which is associated with dirty water, and yeasts which are associated with improper use of intramammary antibiotic treatment. Also since bacteria often stick together in 'clumps', each colony forming unit may represent more than one live bacteria.

3.2 BACTOSCAN

In dairy cattle and dairy goats, bacterial numbers in milk are measured using a system called Bactoscan (Fig. 2). This is an automated counter similar to an SCC counter, and counts individual bacteria thus giving a more accurate and less labour intensive measure of bacterial contamination of milk. It measures all bacteria whether alive or dead or anaerobic or aerobic. It also measures prototheca and yeast. It gives a much more accurate figure on the contamination of the milk than SPC.

Fig. 2 Bactoscan

Source: http://www.agentek.co.il

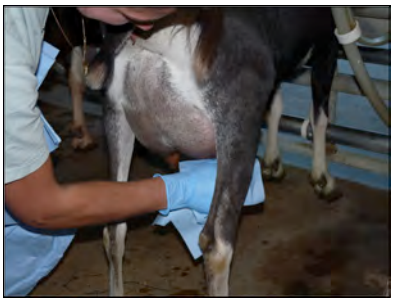
3.3 PLATE LOOP COUNT

In some cases SPC is not performed by a laboratory but rather the less accurate plate loop count (PLC) or the spiral plate count (SPL). Although these tests are effective in monitoring relative trends in bacterial counts in milk, they are not as accurate at counting bacteria as the SPC or Bactoscan. Whenever possible, SPC should be performed rather than PLC or SPL.

3.4 LABORATORY PASTEURIZED COUNT

The laboratory pasteurized count (LPC) (not used in Ontario but may be elsewhere) is essentially the same test as the SPC, but the milk is first pasteurized (72 °C (161 °F) for 15 sec). Generally, this test is done on samples if the SPC levels are high, e.g. > 50,000 CFU/mL. In some cases, the LPC levels are normal, as all bacteria have been killed at the time of pasteurization, however often the LPC is elevated suggesting milk quality issues. If the SPC is high, LPC also tends to be high. Pasteurization is not a complete fix for poor milk quality.

Fig. 3 Udder and teat preparation is critical in keeping bacterial levels down in the milk



3.5 PRELIMINARY INCUBATION COUNT

Preliminary Incubation Count (PIC) is a milk quality measurement on raw milk that attempts to mimic what happens to milk if it is not refrigerated properly. This test is similar to SPC; however, the milk is only incubated for 18 hours, and at a lower temperature. It is rarely used to assess milk quality.

3.6 USUAL SOURCES OF HIGH BACTERIAL COUNTS IN MILK

High bacterial counts in pooled milk are correlated with poor milking hygiene, inadequate maintenance of milking equipment, and udders with intramammary infections. If there are residues or films of milk or milk stone on any milking equipment, bacteria can grow and affect the bacterial levels in a bulk tank. Specifically, the following are more common sources of high bacterial counts:

- Poor udder preparation prior to milking, including dirty udders and wet teats (Fig. 3);
- Unsanitary milk handling equipment including milk claws, pipelines, hoses, buckets and bulk tank;
- Inflations that are overused, and cracked, causing bacteria to become trapped (Fig. 4; Fig. 5);
- Bulk tanks or buckets that are unsanitary, and not maintained at the proper temperature for cooling milk (1° - 4°C) can drastically increase the bacterial count in tanks;
- Water heaters in the sanitation system that do not reach optimal temperature or that have insufficient capacity for the entire cleaning process;
- Udder infections primarily caused by bacteria such as *Streptococcus uberis* and *Streptococcus dysgalactiae* as well as CNS – all important causes of clinical and subclinical mastitis in goats and;
- Increased external temperature and humidity.

Fig. 4. Bacteria in cracks in liner

Fig. 5 Worn inflation

3.7 TROUBLE-SHOOTING HIGH BACTERIAL COUNTS IN MILK

There are many potential sources of high bacteria counts, however most often they are associated with milking equipment

cleanliness, milking procedures or milk storage temperatures. It is important to monitor these areas closely to minimize bacterial contamination of goat milk.

Fig. 6 Protein film inside bulk tank

3.7.1 TEAT CUP INFLATIONS (LINERS)

Inflation quality can have an effect on bacterial counts in milk. If there is significant wear over time, the inflation can harbour pathogens that can be transferred to the teat end (Fig. 4). Cracks or rough surfaces in the inflations and short milking tubes are common sources of bacteria. All inflations should be changed on a regular basis to ensure that they are always in optimal condition (Fig. 5). See Section IV.3.2.1 for details.

3.7.2 EQUIPMENT CLEANLINESS

It is important to keep milking units as clean as possible during milking to ensure that manure or debris do not enter the claws, and into the milk line. Proper udder cleanliness before milking will decrease the chance of bacteria entering the milking units. In addition, water hoses should be installed in the milking parlour to rinse milking units if they become excessively dirty.

BIOFILMS, MILKSTONE AND OTHER DEPOSITS

Fig. 7 Milkstone in line

Biofilms and deposits are build-ups that occur in the milking system due to improper cleaning and can increase bacteria counts in the bulk tank (Fig. 6). Specific cleaning procedures are required to remove biofilms and deposits. Biofilms, although visually difficult to detect in the milking lines, can be successfully removed with oxidizing cleaning solutions. Mineral deposits are inorganic salts of minerals, and can increase significantly if the water in the wash system is particularly hard, or if the cleaning solutions are not being used as directed. If these mineral deposits are not removed, and interact with the milk components, milkstones may begin to form (Fig. 7). The acid-rinse portion of the cleaning process helps to properly remove these deposits from the milking system. This is covered in detail in Section IV.2.

PROPER DRAINAGE FROM LINES

When cleaning and sanitizing the milking system, is is important that all areas of the milking equipment are washed correctly and thoroughly drained after each cycle of the wash. Any pooled liquids can result in mixing of cleaning solutions making each cycle less effective and leading to residue buildup. Residues allow bacteria to become trapped and to multiply resulting in increased bacteria counts in the milk. Any liquid left in the milking equipment after cleaning and sanitizing could contaminate the next milking. Check your milking system for possible low spots (such as poorly sloped pipelines) and adjust them to ensure thorough drainage of liquids after each cycle of cleaning and milking.

MILK IN VACUUM LINES

Operators of bucket milking systems need to check and clean the vacuum line regularly. Over-filling a bucket milker may cause milk residue to enter the vacuum line (Fig. 8). Bucket milk pulsator check valves may still allow milk residue to enter the vacuum line. In pipeline systems a split liner may also result in vacuum line residues.

Fig. 8 Milk in vacuum line

PAILS FOR HAND-MILKING

Ensuring that pails are sanitized properly before milking is critical to keep bacterial counts low. This is especially true with pails for hand-milking, as these are open systems that are constantly exposed to the environment.

Hand milking pails must be thoroughly cleaned and properly stored after milking. First perform a warm rinse. Then use hot chlorinated alkaline dairy detergent with vigorous brush cleaning, followed by a rinse with dairy acid. Store pails upside down on clean racks to allow thorough drying and to prevent debris and flies from falling into pails (Fig. 9). Never 'nest' (stack) pails between milking. Ensure pails are properly sanitized before next milking.

Fig. 9 Pails for hand-milking must be cleaned and stored after use

Only use milking pails that are made of stainless steel. Plastic can easily become scratched or indented and allow bacteria to harbour in these areas. Plastic is also more absorbent than stainless steel making it more difficult to properly clean.

Fig. 10 Wash water hot enough?

3.7.3 WATER TEMPERATURE FOR CLEAN-UP

Water temperature during the cleaning process must be hot enough to ensure cleaning chemicals work effectively (Fig. 10). As a rule, wash water should not drop below **49 °C (120 °F).** Tank capacity should be sufficient that water is still hot at the end of the wash cycle (Fig. 11). See Section IV.2 for details.

Fig. 11 Tank big enough?

It is important that automatic cleaning systems are properly programmed by the equipment installer to ensure that each cycle is operating at the correct temperature and for an appropriate length of time."

3.7.4 WATER QUALITY

It is important to ensure that the water that is used for cleaning and sanitizing milk handling equipment has low bacteria and coliform counts (i.e. must be potable water). Abnormally high counts can be common with well water on farms, and this can lead to high bacteria counts in the bulk tank (Fig. 12).

Additionally, hard water will cause a bulk-up of mineral deposits (scale) inside equipment making cleaning more difficult. Hard water also requires the use of

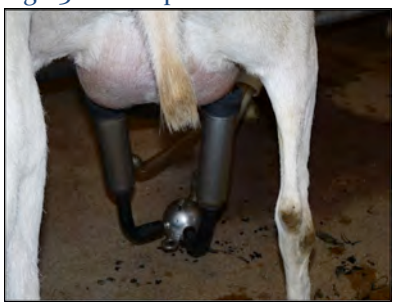
higher concentrations of cleaning solutions to clean effectively. Mineral buildups inside of water heaters also decrease their efficiency and effectiveness. For these reasons you should consider installing a water softener if the water is too hard (more than 30 grains of hardness per gallon).

Fig. 12 Clean water?

3.7.5 MILKING UNITS FALLING OFF DURING MILKING

In milking parlours, there is a chance that the teat cups will fall off during milking, primarily with agitated does kicking them off (Fig. 13). It is important to ensure that does, especially those in their first lactation, are milked in a calm environment to minimize nervousness and stress. This will decrease the chance of milking units falling to the floor of the parlour stall. If the units do fall off during milking, it is important to spray them completely and try and remove any debris before reattaching them. As covered in Section III.2.1, when milking animals with only one functioning gland, use a milk plug in the unused teat cup to prevent dirt, straw or manure from being sucked in, or allowing air in which may cause a drop in vacuum.

Fig. 13 Teat cups should be secure



3.7.6 AIR INJECTOR SETTINGS

Air injectors are used to force the wash solution slug out to reach all milk contact surfaces of the entire milking system. Milk residues may buildup on surfaces that do not receive sufficient contact with solutions, allowing bacteria to grow.

Fig. 14 Keep air injectors clean

Any variations to air injector settings will affect how solution is circulated through the system so it is essential that air injectors are cleaned routinely and properly adjusted by equipment installers (Fig. 14). The cleaning solution slug should have a velocity of approximately 25-30 ft/sec, (7.6 – 9.2 m/sec) and if it is not at the level, the air injector should be adjusted by a qualified technician.

3.7.7 COOLING OF THE MILK IN THE TANK

Ensuring that the bulk tank is cooling milk properly is essential to maintain the milk quality. Maintaining the appropriate cooling temperature also lowers the chance of increasing bacterial counts in the milk. The goal is to rapidly cool milk during milking and maintain a consistent low temperature (between 1° and 4°C) during storage time to minimize the growth of bacteria (Fig. 15).

Fig. 15 Temperature of bulk tank

SPEED OF ACHIEVING AND MAINTAINING THE PROPER TEMPERATURE

The bulk tank cooling should be programmed to cool the first milking to between 1° and 4°C within two hours after milking. For subsequent milkings the blend temperature should not rise above 10°C and should reach between 1 - 4°C within one hour

after milking. Temperature in a bulk tank should remain between 1 - 4 °C (34-40 °F) at all times, with temperatures in the lower range for extended storage times. Ideally, temperature should not be consistently over this temperature, or bacterial counts will begin to rise (Fig. 16).

Fig. 16 Time temperature recording of bulk tank

FLUCTUATIONS IN TEMPERATURE

Although the bulk tank should be maintained below 4 °C (40 °F), there will be some fluctuations when new milkings are added to the bulk tank. During milking times, it is common for this blended milk to be held at approximately 7 °C (45 °F). Once it has been agitated properly, milk temperature should drop to the 4 °C (40 °F) benchmark.

Freezing of milk in the bulk tank is detrimental to milk quality. Frozen or partially frozen milk is more difficult to agitate and pooling of warm milk improperly mixed will allow bacteria to grow. Freezing will also cause separation of milk and possible raising of freezing point that could lead to fines or rejection of milk.

EFFECTS OF STORAGE OVER LONG PERIODS

Although milk is generally picked up every third day on-farm, there could be times where milk is stored for an extended period of time (four days or longer). Even though this milk will be kept below 4 °C (40 °F), there is still a chance that bacterial counts will rise. For example, Pseudomonades have the capability of growing at relatively low temperatures as will Listeria – a very important zoonotic pathogen. If milk is stored for an extended period of time in a cooled environment, there is a chance for bacterial growth. Storing milk as close to 1° C will help keep bacterial counts low.

3.7.8 UDDER AND TEAT CLEANLINESS

Udder and teat cleanliness is not only critical to preventing mastitis (see Section III.1), it is also very important in controlling bacterial levels in the milk. Even when the teats appear clean, dirt and manure picked up from bedding or pasture, covers the sides and ends (Fig. 17). Wet or hairy udders are particularly an issue. Hairy udders and teats cannot be easily cleaned. Moisture left on the udder and teats – either from a wet environment or from improper drying of the udder – will wick bacteria into the milk during the milking process. Time spent properly cleaning and sanitizing the udder and teats will more than pay back in terms of improved udder health, milk quality and – naturally – more salable healthy milk.

Fig. 17 Carefully clean and sanitize the udder and teats before each milking

3.7.9 HAND-MILKING CLEANLINESS

Latex (Fig. 17) or nitrile (blue) (Fig. 3) gloves should be worn when hand-milking to prevent transfer of bacteria to the teats and possible contamination of the milk. Gloves should either be washed in a disinfectant soap or changed when dirty.

3.7.10 MASTITIS AS A CAUSE OF HIGH BACTERIAL COUNTS IN THE MILK

Mastitis is not commonly a cause of high bacterial counts, but there are instances in which it can occur (Fig. 18). Generally, mastitis bacteria contribute only low numbers to the total bacterial count and are rarely responsible for levels in violation. Exceptions to this are infections with some environmental bacteria, specifically *Strep. uberis* and *Strep. dysgalactiae*. These bacteria are explained in Section II.3.2. There is also evidence that CNS may play a role.

Fig. 18 Mastitic milk

Wet and dirty pens or pastures, failure to properly clean and disinfect udders and teats prior to milking, and failure to effectively teat dip post-milking contribute to the risk of goats contracting *Strep. spp* mastitis. Failure to properly identify infected udders and treat or cull the responsible does will increase this problem in the herd as well. Screening for mastitis of all causes should be part of your udder health program and will also identify these animals.

3.7.11 FLY CONTROL

Flies are attracted to organic material, e.g. milk and manure – and can transfer bacteria between these two materials. They will bite teat ends and transmit mastitis pathogens.

Care should be taken to keep flies out of milk pails (Fig. 19) and bulk tanks. Reduce fly populations by trapping, using premise sprays for use in livestock facilities and keeping the barn clean should be done routinely in the warm months (Fig. 20).

Fig. 19 Hand-milking pail with flies

Dead stock composting facilities and manure storage areas should be kept well-away from the parlour and livestock rearing areas.

Fig. 20 Fly control is important to udder health.
Left – dead flies in corner of milk house; Centre – flies on wall of milk house; Right – screen in milk house window to prevent flies from entering and fly trap.

3.8 OTHER BACTERIAL MEASURES OF MILK QUALITY

3.8.1 COLIFORM COUNTS

Coliform counts are a measure of the number of coliform bacteria that grow on either MacConkey's agar, or violet red bile agar after being incubated for 48 hours. These bacteria originate from environmental sources, particularly manure and may be *Escherichia coli* – i.e. *E. coli, Salmonella*, *Klebsiella* (found in dirty sawdust and shavings), *Enterobacter* and *Pseudomonas*. While these bacteria do cause mastitis, the number of bacteria shed in the milk from this source tends to be low as most are killed by the inflammatory process in the udder. Rather, these counts are usually indicative of unsanitary issues during milking, such as udders or milking units contaminated with manure.

There are no regulatory standards for coliform counts in raw milk in Ontario. However some processors and buyers will use the standard of under 100 CFU/mL.

4. FREEZING POINT

Milk has a very consistent freezing point directly related to the composition of milk. Abnormal freezing point test results occur if:

- Water has been added to the milk (e.g. malfunction of the cleaning system and water not properly drained, buckets or pails not properly dried before filling with milk),
- Milk is frozen in the bulk tank,
- Milk has not been mixed properly before sampling, or
- Milk is abnormal in composition for any other reason.
- Changes in the concentration of solids will cause milk to freeze at different temperatures.

Dilution of milk with water progressively gives a freezing point closer to that of water. In Ontario any goat milk freezing point equal to or greater than -0.535°C (-0.554°H) is considered abnormal.

5. DETECTION OF INHIBITORS AND OTHER CHEMICALS

From each truck load, milk samples are tested for presence of chemicals in the milk, which inhibit the growth of bacteria. These "inhibitors" are usually antibiotics but may also be disinfectants. Other chemicals include veterinary treatments, e.g. dewormers (anthelmintics), treatments for external parasites, NSAIDS (non-steroidal anti-inflammatory drugs). Use of veterinary drugs, the rules, regulations and risks are covered in more detail in Section VI.3.

Presence of inhibitors is very damaging to milk quality. It may prevent cheese making, and presence of some drugs may cause an allergic response in people consuming contaminated milk products. Usually the tank is discarded but if transported by milk truck, the entire contents of the truck may need to be discarded. Often fines are assessed by the processor to recoup losses from presence of inhibitors.

Below is a table modified from the OMAFRA Factsheet "Troubleshooting Antibiotic Residues in Goat Milk"[2]. More information on treatment and detecting antibiotic residues is covered in Section VI.

Table V.1. Troubleshooting antibiotic residues in milk

CAUSES	SOLUTIONS
A) Milk from treated does enters the bulk tank before the end of the milk withdrawal period	
No permanent written records of treatments	Keep a permanent record of treatments. Use the On-Farm Food Safety Program[3] and recording system (Fig. 21). Keep the records in or close to the milking parlour so that information can be easily checked.
Forgetting the doe was treated **Poor identification of the treated doe**	Mark all treated does in an easily recognized manner. The identification should be clearly seen while milking the doe (e.g. leg band) (Fig. 21), be semi-permanent and removable once the withdrawal period has ended. Livestock crayon is not ideal for these reasons.
Poor communication between the person who administers treatments and the person who milks	Information on all treated animals should be written on a blackboard or posted on a bulletin board near the milking parlour so all people can easily find the information (Fig. 21).
Milking one half when the other half was treated with an intramammary product	Because the antibiotics are absorbed into the body, they may also be present in the untreated gland. Keep both halves out of the tank.
The milk line is used as a vacuum source to milk the treated doe, when using a trap bucket to withhold the milk	Check with the equipment supplier to see whether the pulsator on the bucket can be adapted to provide vacuum to the trap bucket.
Separate milker unit not used for treated does	Milk the treated does last, or with separate equipment to ensure no contaminated milk can enter the milk supply (Fig. 22Fig. 21).
Milker unit not cleaned properly between treated and untreated does	Thoroughly clean the milking unit between treated and untreated does.
Treated dry does not managed separately from milking does (Fig. 22)	Keep dry does in a separate pen from milking does so they don't accidently enter the parlour (Fig. 23). Identify dry does (e.g. leg band) as soon as dry treated so not accidently milked.
B) Prolonged drug withdrawal time because antibiotics used improperly or without appropriate guidance	
Antibiotics are used at an increased dose, frequency or duration of treatment, different route of administration than indicated on the drug label	Use antibiotics in lactating dairy does only with a veterinary prescription from your herd veterinarian and with a valid veterinary client patient relationship (VCPR). Keep lactating and dry products in different cupboards to avoid mix-ups (Fig. 23).
Using antibiotic drugs not approved for lactating dairy does[4]	Only use antibiotics within a valid VCPR. If not sure if withdrawal time is sufficient, request milk testing for inhibitors

[2] Troubleshooting Antibiotic Residues in Goat Milk
http://www.omafra.gov.on.ca/english/livestock/goat/facts/info_trshtaresgtm.htm
[3] Canadian Goat On-Farm Food Safety Program http://www.cangoats.com/index.php?pageid=467

CAUSES	SOLUTIONS
	using an approved test (see Section VI).
Purchase does that were previously treated	Purchase goats only from farms on the Canadian Goat On-Farm Food Safety Program. Ask vendor for treatment records. Test the milk of does with an unknown treatment history.
Dry does which have been "dry treated", kid earlier than withdrawal time for product	Keep and consult records of all withdrawal dates for dry-treated does and dates of "safe to go in the tank". Consult herd veterinarian if this occurs.
Feeding medicated feeds	Medicated feeds should be clearly labelled and stored away from milking herd feeds. Feed handling equipment should be cleaned between types of feeds.
Inadequate udder preparation when topical antibiotic products are used	Follow proper protocols for udder preparation. Only use topical antibiotics on the advice of the herd veterinarian.

Fig. 21 Treatment record from the Canadian Goat On-Farm Food Safety Program (left). Identify treated animals (centre). Communicate with milkers (right)

6. MILK ODOUR AND FLAVOUR

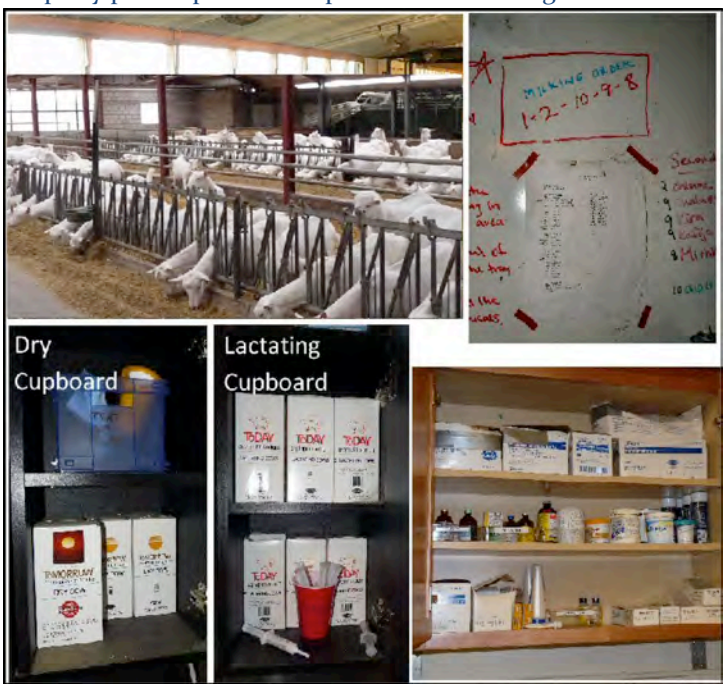
While mastitis does cause off-flavours, other natural compounds found in goat milk are also responsible for a "barny" taste to the milk. Goat milk tends to have higher levels of certain "smelly" compounds – in particular ethylphenols and cresols, than cattle.

Feeds may influence the level of these compounds in the milk. Other factors that can influence flavour in a negative manner are high grain diets, which result in ruminal acidosis (grain overload), corn silage, close proximity to bucks – particularly in breeding season, weeds and poor air quality. Low vitamin E will result in an oxidized "cardboard" flavour to the milk. Aggressive agitation of the milk and / or age will cause break-down of the fatty acids, in particular capreolic acid which will give the milk a "goaty" taste.

[4] No antibiotics are licensed for use in lactating dairy does in Canada. Extrapolation of withdrawal times for products licensed for dairy cows must be done on the written instructions by the herd veterinarian with a valid Veterinary-Client-Patient relationship.

Fig. 22 Milk treated animals separately by hand or by bucket

Fig. 23 Separate dry does from milking. Use strict milking order. Keep dry period products separate from milking.



7. ADDITIONAL RESOURCES FROM OMAFRA FOR MILK QUALITY

OMAFRA has put together many excellent factsheets which have additional information on milking goats and milk quality. Below is list of articles found at the OMAFRA web site http://www.omafra.gov.on.ca/english/livestock/index.html

Dairy Goat Digest Articles

- Dairy Goat Farm Expansion – Thorough Planning is Essential
- New Antibiotic Residue Testing for Goat Milk
- Preventing Antibiotics in Your Milk
- What the Inspector Sees
- Raw Milk – Not Worth the Risk
- Troubleshooting Milk Quality Problems – Step by Step Protocol
- Biofilms in Milking Systems
- Milking Equipment Maintenance
- Somatic Cell Counting in Goat Milk
- When to Contact your OMAFRA Raw Milk Specialist
- A Few Pointers for New Entrants
- Impact of Stage of Production, Nutrition and Cold Weather on Body Condition
- Hoof Trimming 101
- Fly Control Strategies on Dairy Goat Farms
- Procedures for Using and Maintaining Dippers

Milk Quality

- Keeping Milk Bacteria Counts Low
- California Mastitis Test
- Milking Procedure Tips
- Improving Milk Quality with Udder Preparation for Goats (Order No. 03-061)
- The Importance of Water Quality to Your Bottom Line
- Storage and Handling of Livestock Medicines on the Dairy Farm (Order No. 92-055)
- Troubleshooting Antibiotic Residues in Goat Milk
- The Science Behind the Smell
- Troubleshooting High Bacteria Counts

Equipment Maintenance and Cleaning

- Attention Bucket Milkers
- Goat Milk Cooling
- Heat Recovery from Milk Cooling Systems (Order No. 88-032)
- Maintain Milk Quality By Decreasing Biofilm In The Pipeline (Order No. 06-089)
- Maintenance of Milking and Milk Handling Equipment (Order No. 85-001)
- Pipeline Cleaning System Guidelines
- Replacing Rubberware
- Troubleshooting tips for bulk tank washers
- Checking temperatures to stay out of hot water
- Troubleshooting Films and Deposits on Dairy Goat Milking Equipment
- Biofilms in Milking Systems
- Milking Equipment Maintenance

Milk Sampling and Testing

- Regulating Sampling and Testing under the Raw Goat Milk Quality Program
- California Mastitis Test
- Somatic Cell Counting in Goat Milk

SECTION VI
TREATMENT AND CONTROL OF MASTITIS IN DAIRY GOATS

TABLE OF CONTENTS

1. VETERINARY DRUGS APPROVED FOR USE IN LACTATING DAIRY GOATS

There are <u>no</u> veterinary medicines in Canada that are approved for use in lactating dairy goats, where the milk is intended for food. This means that all drug use is "extra label" and that there are no published withdrawal times for milk. This presents a dilemma to goat producers and their veterinarians who wish to effectively treat and control infections in their does and yet be assured that appropriate withdrawals for milk and meat are followed so that no residues enter the food chain (see Section V.5). Along with working closely with your herd veterinarian with whom you have a valid veterinary-client-patient relationship (VCPR) (Section VI.1.2), this section will help to give you advice on how to best accomplish this goal.

1.1 WHAT IS EXTRA LABEL DRUG USE (ELDU)?

1.1.1 DEFINITION

As defined by Health Canada[1], Extra-Label Drug Use (ELDU), or "off-label use" is:

> *"The use or intended use of a drug approved by Health Canada in an animal in a manner not in accordance with the label or package insert. It also includes the use of all unapproved drugs, including unapproved bulk active pharmaceutical ingredients (APIs) and compounded drugs."*

While we traditionally think of ELDU in terms of using a drug not approved for use in goats as a species (e.g. approved for cattle but not goats), it also includes using it differently than the directions on the label, i.e.:

- Different dose (*e.g. using a drug at 3 mL/45 kg when it is labelled at 2.5 mL/45 kg*)
- Different frequency (*e.g. giving a drug twice per day when it is labelled at once per day*)
- Different route of administration (*e.g. giving the drug under the skin when it should go in the muscle*)
- Different duration (*e.g. if the label says only to give for 3 days and it is administered for 5 days*)
- Different indication (*e.g. when labelled to treat pneumonia and it is used to treat mastitis*).
- Different class of animal (*e.g. when labelled for use in a kid and it is used in a lactating dairy doe*)

1.1.2 REGULATORY ISSUES

Prescription veterinary medicines can only be purchased from a veterinarian and with a valid veterinary-client-patient relationship (see Section VI.1.2). Written instructions for ELDU need to be provided by your veterinarian when the drug is dispensed when different from the label. The veterinarian and producer are responsible for making sure the drug is used correctly and drug residues do not enter the food chain.

If the drug is purchased at a Livestock Medicines Outlet (i.e. over-the-counter medications, also called OTC), and it is to be used extra-label, it is strongly advised to use only with a written veterinary prescription (required by those on the Canadian National Goat Federation Goat On-Farm Food Safety Program). However, in Quebec, all livestock medicines are purchased from a licensed veterinarian.

[1] http://www.hc-sc.gc.ca/dhp-mps/vet/label-etiquet/index-eng.php

Inappropriate ELDU may result in:

- Residues in the milk which is dangerous for people and will harm cheese production
- Residues in the meat, which is dangerous for people
- Inappropriate treatment of animals resulting in treatment failure and/or adverse reactions in the goats
- Risk of development of antimicrobial resistance (AMR) because of failure to treat the infection correctly or over-treatment resulting in AMR in other bacteria in the animals.

1.1.3 HOW ARE WITHDRAWAL TIMES DETERMINED WITH ELDU?

It is insufficient to assume that because a withdrawal for meat or milk is "X" for cattle or sheep, that it will be the same for goats. Goats metabolize drugs very differently than other species. So, how are withdrawal times determine and how can a veterinarian safely determine withdrawals for dairy goats? Some background…

MAXIMUM RESIDUE LIMIT (MRL)

As defined by Health Canada[2], Maximum Residue Limit (MRL) for a drug in meat or milk is:

> "*The amount of residue that could remain in the tissue or food product derived from a food producing animal that has been treated with a veterinary drug*."

The MRL for a drug or chemical is usually measured in very tiny amounts, e.g. ppm (parts per million), and is determined through scientific experiments as being the highest level of a drug or chemical that is safe for a person to consume daily over their life-time with no risk to their health.

Withdrawal times are calculated as the amount of time that it takes for that drug to leave the body of a treated animal to at least as low as the MRL established for that drug and animal.

MINIMUM DETECTION LIMIT (MDL)

This is a property of the test used to detect presence of a drug in the milk. The test can detect presence of a drug down to a certain limit – again usually measured in ppm. Usually this level is lower (i.e. less) than the MRL established for drugs approved for use in lactating dairy animals (in Canada – this is limited to dairy cows).

ESTABLISHING A REASONABLE WITHDRAWAL TIME

As no drugs are approved for lactating dairy goats, the processor will use the MDL as the MRL. This value is likely lower than the published MRL for dairy cows. Because of this, **withdrawals approved for dairy cows may result in a positive test for dairy goats**. When selecting a milk test to use at home, make sure its MDL is as low as that which is used by the processor.

THINGS THAT MAY PROLONG A WITHDRAWAL PERIOD FOR MILK

- The goat may metabolize the drug differently than a dairy cow – perhaps more slowly;

[2] http://www.hc-sc.gc.ca/dhp-mps/vet/mrl-lmr/index-eng.php

- If the goat is milked once/day versus twice/day thus slowing elimination of the drug from the animal;
- Milk volume per day is low, e.g. at the end of lactation resulting in concentration of a drug in the milk;
- The drug is administered incorrectly (e.g. subcutaneous versus intramuscular) resulting in the drug being poorly absorbed and eliminated;
- Too large a volume is administered in one spot, again resulting in the drug being poorly absorbed and eliminated;
- Injections are given in the same place on the animal, again resulting in the drug being poorly absorbed and eliminated;
- The doe is ill which might harm its ability to properly metabolize and eliminate the drug or;
- Too high a dose, increasing the frequency of treatment, prolonged administration, etc.

CANADIAN GFARAD

Fig. 1

The Canadian gFARAD[3] (global Food Animal Residue Avoidance Database) is an initiative based at both the University of Saskatchewan (Saskatoon, Saskatchewan) and the University of Guelph (Guelph, Ontario). CgFARAD provides information to Canadian veterinarians on food animal residues from drugs and other chemicals used in the food production industry. In order to help determine an appropriate withdrawal for meat or milk from a food animal species, veterinarians can submit a request to CgFARAD, and then relay this valuable information onto their respective clients, to ensure that all appropriate withdrawal times are being taken before milk or meat is put into the food chain.

Issues with CgFARAD include: turnaround time may be days to several weeks depending on availability of information; limitations of available information, i.e. sometimes they are unable to determine a withdrawal based on information published; and the potential cost. Currently the service is not charged but a lack of government funding for this program is a threat.

1.1.4 IS THIS DRUG SAFE TO USE?

Despite the fact that there are no drugs approved for use in lactating dairy goats in Canada, we must be sure that any drug which is used can be 1) administered safely to the animal; 2) it is effective for the disease being treated; and 3) that we can properly estimate a safe and reasonable withdrawal for milk and meat. Not all veterinary drugs available for dairy cattle can be assumed to fit these three criteria.

DRUG IDENTIFICATION NUMBER (DIN)

A drug identification number (DIN) is a specific number that is allocated to each drug that is approved for use through the Veterinary Drug Directorate, Health Canada[4]. This code is located on the label of each approved drug, with the three letters "DIN", followed by an eight-digit number. DIN codes can be used in many cases, such as recall of drug products, and quality monitoring of drug products.

[3] http://www.cgfarad.usask.ca/
[4] http://www.hc-sc.gc.ca/dhp-mps/prodpharma/activit/fs-fi/dinfs_fd-eng.php

If you have purchased a drug and it does not have a DIN on the label, then it does not meet the legal requirements of being used as a drug in Canada. This applies to both human and veterinary drugs.

THE LABEL OF A VETERINARY DRUG IN CANADA

A drug sold in Canada must have a label attached to it and is accompanied by a package insert or box containing additional required information. When you purchase a drug, save all the inserts and boxes and do not "repackage" drugs into other containers.

The following information should be kept where it can be readily consulted. A good practice is to keep a binder of labels, inserts etc. where you store your livestock medicines. This information can also be readily found through accessing the Canadian Compendium of Veterinary Products website[5]. This website includes all information for veterinary drugs licensed in Canada.

In addition to the requirement of a DIN – which must appear on the drug label, clear and up-front, the label must contain:

1) The words "**Veterinary Use Only**", i.e. not to be used in humans.
2) "***Pr***" means that it is by veterinary prescription only i.e. must be prescribed by a veterinarian licensed to practice in the province in which the animal resides. If no "*Pr*" is present on the label, then no prescription is required if used as directed on the label.
3) **Brand name** of the product – registered with the Veterinary Drug Directorate, Health Canada. It is accompanied by the name of the **manufacturer** and its Canadian address.
4) A list of **medicinal (active) ingredients** and their **concentration** in the product (e.g. milligrams (mg) of drug "X" per millilitre (mL) of product). Often preservatives, diluents and other non-medicinal ingredients are included – although some are proprietary and not be explained in full.
5) Instructions for administration:
   a) **Dosage** - usually in mL or mg of product per measure of the animal's body weight; e.g. 3 mL per 45 kg body weight (bw) or 2 mg/kg bw;
   b) **Route of administration** (e.g. oral, in feed or water, topical, intramammary, intravenous, intramuscular or subcutaneous);
   c) **Frequency of treatment** (e.g. once every 12 h; once/day; once every 48 h);
   d) **Duration of treatment** (e.g. for 3 days; once only);
   e) **Animal species** (e.g. cattle, swine) and **class of animal** if restricted to a class (e.g. kids);
   f) **Indication** (e.g. for the treatment of pneumonia).
6) Warnings and cautions about:
   a) **Health hazards** for humans and animals either through direct contact (e.g. may burn if get the drug in your eyes);
   b) **Adverse reactions** in animals (e.g. may be harmful to the fetus of pregnant animals, e.g. do not administer to horses), or through residues in food products;
   c) **Withdrawals for meat;**
   d) **Withdrawals for milk** if allowed for use in lactating dairy animals;
   e) **Restrictions,** e.g. do not use in lactating dairy animals. Some drugs cannot be used in lactating dairy animals because of long withdrawals or risk to human health;
7) **Production lot and batch number** (important for recalls or if an adverse reaction occurs);
8) **Expiry date** (important because the drug won't work if too old);
9) **Storage information** (e.g. must be refrigerated at < 4°C; do not freeze; do not expose to sunlight).

[5] http://cdmv.naccvp.com/?u=country&p=msds

USING DRUGS NOT APPROVED FOR USE IN CANADA

At this point, it is legal for producers to purchase drugs from outside Canada for "own use", i.e. to use in the treatment of their own animals[6]. Veterinarians may not do so. **This is not in compliance with the Canadian Goat On-Farm Food Safety Program.** Because there is no guarantee as to how they are manufactured, possible issues arising from using these drugs include:

- The product does not contain the level of drug indicated on the label;
- The product contains adulterants which may be harmful to the animal or to people;
- The product is expired and has been repackaged;
- The product has not been shown by properly conducted science to be effective or safe in animals and humans;
- The quality of the manufacturing process of the product is poor or unregulated.

It is strongly recommended NOT to use drugs that do not have a DIN.

1.2 WHAT IS A VETERINARY – CLIENT – PATIENT RELATIONSHIP (VCPR)?

The Veterinary-Client-Patient Relationship[7] (VCPR) is a key component of ELDU, and is outlined by Health Canada as:

- *"The client (owner or owner's agent of the animal [s]) has given the responsibility of medical care to the veterinarian and has agreed to follow the instructions of the veterinarian, and;*
- *The veterinarian has assumed the responsibility from the client for making clinical judgment regarding the health of the animal(s), the need for medical treatment, and for ensuring the provision of ongoing medical care for the animal(s), and;*
- *The veterinarian has sufficient knowledge of the health status of the animal(s) and the care received or to be received. The knowledge has been obtained through a recent examination of the animal(s) and the premises where they are (it is) kept or through a history of medically appropriate and timely examinations and interventions, and;*
- *The veterinarian is readily available, or has made the necessary arrangements with another veterinarian, for ongoing medical care in case of adverse reactions or therapy failure."*

Without having a reliable VCPR, the prescription of ELDU could pose potential health issues for both treated animals, and subsequent human health from consumption of these food products.

2. DETECTING RESIDUES OF DRUGS AND CHEMICALS IN MILK

For product safety, it is important to test milk for drug and chemical residues in milk before it is sent for processing for human consumption. In addition to regulatory standards, which require milk to be tested before processing, testing milk on-farm can be a good screening method to avoid shipping potentially contaminated milk.

[6] http://www.hc-sc.gc.ca/dhp-mps/vet/faq/faq_unapproved-nonapprouves_drugs-medicaments-eng.php
[7] http://www.hc-sc.gc.ca/dhp-mps/vet/label-etiquet/pol_eldu-umdde-eng.php#fnb3-ref

2.1 REGULATORY TESTING VERSUS ON-FARM USE OF KITS

By law, milk must go through regulatory testing before it is accepted for milk processing. These samples are sent to an accredited laboratory[8] so residue results are as accurate as possible. Bulk-tank milk samples are taken on-farm at milk pick-up by a certified bulk tank milk grader. When the tank trucks arrive at a processing plant, a milk sample is taken from the truck which represents a sample from all the farms picked up on that route that day. The milk will not be processed if the truck sample tests positive for any drug residues. If the milk from the truck is positive, the milk samples collected on-farm from all the farms picked up on that load, will be tested. The farm that is positive for drug residues will be financially penalized. For Ontario producers, the exact protocols are available on the Ontario Ministry of Agriculture, Food and Rural Affairs website[9].

2.1.1 ON-FARM TESTING OF MILK

There are many easy-to-use test kits available for purchase to test milk on-farm for presence of inhibitors. Most veterinarians also offer a service to their dairy clients using these tests. These kits allow sampling of both individual animals, and bulk tank samples to test for drug residues. However, these tests are not 100% accurate and may not be in agreement with the tests run by the processor or regulator. They can provide guidance, however should be used with caution.

Fig. 2

Kits currently available for use in dairy cows in Canada include:

- Charm ROSA[10] milk tests. There are several tests to detect many different antimicrobials at different MRL's.
    - The Rosa Charm SLBL test is US NCIMS approved for use in both sheep and goat milk. This is the only one recommended for use in dairy goats at this time (Fig. 2).
    - Common beta-lactam antibiotics include penicillin, ceftiofur (e.g. Excenel), cephapirin (e.g. Cefalak, Cefadri), cloxacillin (e.g. DryClox), and amoxicillin.
- IDEXX SNAP Antibiotic Residue test[11]
- Delvotest SP, DSM[12]
- Neogen BETASTAR PLUS[13]

These tests will detect milk at varying MDL's, some of which may be higher or lower than the dairy cattle MRL for milk. Because not all tests will detect all classes of antibiotics, consult your herd veterinarian to discuss which test(s) to use for routine screening for inhibitors (antibiotics) in goat milk.

[8] For Ontario, this is the AFL, University of Guelph: http://www.guelphlabservices.com/AFL/raw.aspx
[9] http://www.omafra.gov.on.ca/english/livestock/goat/facts/info_regsampling.htm
[10] http://www.charm.com/products/antibiotics
[11] https://www.idexx.com/dairy/dairy-testing.html
[12] http://www.dsm.com/markets/foodandbeverages/en_US/products/tests/delvotest.html
[13] http://www.neogen.com/FoodSafety/BS_Index.asp

2.2 TESTING A BULK TANK VERSUS AN INDIVIDUAL ANIMAL SAMPLE

An on-farm kit has the ability to sample both bulk tank milk, milk from a smaller volume such as a bucket, and milk from individual does. Testing of milk in the tank or bucket is very useful if a treated animal has accidentally been milked and that milk commingled (mixed) with milk from other does. If the milk sample tests positive for drug residue, the producer has the option to discard the milk from the tank and clean the milking equipment before milking the rest of the herd, not only to prevent treated milk from being shipped, but to not lose the milk from the rest of the does in the herd or suffer a financial penalty.

Individual animal testing can be used for a variety of common instances on-farm. The following are situations where testing milk from individual goats is beneficial:

- When does are added to the herd and the treatment history of the herd of origin is unknown;
- If a doe kids earlier than expected, and has been dry treated;
- With any extra label drug use;
- If a treated animal loses its treated identification, or record or;
- If an animal is treated with multiple drugs at once.

2.3 ACCURACY OF TESTING

Laboratory testing has the highest level of accuracy testing drug residues. When using an on-farm kit, the accuracy is not 100%, i.e. a test may be positive when the milk is OK – or of more concern, the test may be negative when the milk contains antibiotics. Additionally, kits cannot test all drugs used in livestock, so it is important to identify which drugs are being screened for to select the kit that is most appropriate for each herd. You should also remember that kits for purchase cannot detect dewormers, pain killers, or hormones in the milk but the regulatory testing body has that ability.

3. AVOIDING RESIDUES OF DRUGS AND CHEMICALS IN MILK

There are many ways to avoid residues in milk, and the main factor is proper communication on-farm. It is important to ensure that all identification protocols are done correctly, and all farm workers are aware of these protocols so the milk is safe for human consumption.

3.1 VETERINARY PRESCRIPTION ONLY

Treat dairy does using only drugs that are prescribed by a licensed veterinarian with an appropriate VCPR. This is especially important for dairy goat producers, as all drugs are used through ELDU.

With a prescription, veterinarians are required to indicate proper milk and meat withdrawal for each drug prescribed. This is also a requirement for the Canadian National Goat Federation Goat On-Farm Food Safety Program.

3.2 ANIMAL IDENTIFICATION

3.2.1 IDENTIFY ANIMALS FOR MANAGEMENT PURPOSES

Animals should have permanent IDs to identify them in the herd at any time, not only to distinguish between treated animals, but also to help in day-to-day herd management (Fig. 3). The identification should be:

- Unique within the herd (e.g. no instance of 2 does with the same tag and colour);
- Useful for managing that animal and accurate recording keeping;
- Avoid using names only unless written on the permanent tag;
- Easy to read from a distance – front, side and ideally back of the animal, or electronically;
- Have longevity, i.e. not fade, not break and become unreadable.
- Be redundant, e.g. if one tag falls out, there should be another ID on that animal that will allow accurate identification and retagging (e.g. tattoo, another ear tag).

Fig. 3. Readable unique ID but not consider permanent

TYPES OF PERMANENT AND UNIQUE ID SYSTEMS

The National Goat Identification program[14] (NGIP) will eventually be mandated as mandatory. Producers are encouraged to start using tags now before that time.

The NGIP is currently recommending three types of tags (Fig. 4). The following tags are available but have not been formally tested:

1. Small tags: For kids and tail tagging (La Mancha)
2. Small panels: For more visual identification
3. RFID: Used for electronic management systems

Fig. 4. Recommended NGIP tags

Similar panel tags can be purchased from agricultural stores, and each animal's unique ID can be written on the tag, and inserted in the ear. This is not compliant with NGIP requirements, but is a good tool for managing a herd.

Neck chain tags allow for easy visual ID but should be accompanied by another form of ID (Fig. 3).

3.2.2 IDENTIFYING TREATED AND INFECTED ANIMALS

Treated animals should also be identified so that the person milking can quickly and accurately distinguish them prior to milking. The ID should be:

1. Readable from the back / side of the doe depending on how milked;
2. Not be obscured with manure, mud, or milking equipment;
3. Be semi-permanent, i.e. should be readable for at least 2 months but should be removable after the withdrawal period has ended and;
4. Be easy to interpret as indicating a treated animal.

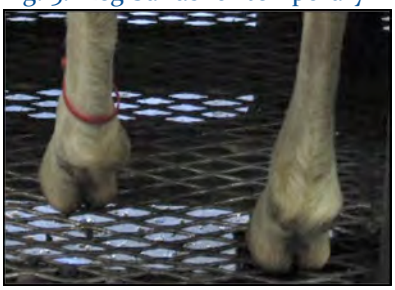
Additionally, treated animals should have a unique management tag so that written or electronic treatment records can be kept. Animals with chronic infections, e.g. *Staph. aureus* should also be

[14] http://cangoats.ca/index.php?pageid=539#videos

identified in a semi-permanent way (e.g. leg band) so that they can be milked differently to avoid risk of transmission of infection.

LEG BANDS

Fig. 5. Leg bands for temporary ID



Leg bands are ideal systems in milking parlours, as milkers can easily identify animals when they arrive to be milked (Fig. 5). These bands should be colour coded to minimize confusion about why this animal is being flagged as a concern. E.g. red can mean treated as a lactating doe; yellow can mean dry-treated; blue can mean a doe infected with the contagious bacteria *Staphylococcus aureus* (i.e. a "staph" doe).

This system is very useful; however backup recording in the parlour is essential to make sure treated animals are not being milked in the tank.

PAINT / LIVESTOCK MARKER

Fig. 6 Livestock paint

Another efficient way to identify treated does is using livestock markers or paint, easily seen by the person milking (Fig. 6). However, livestock marker is not an ideal option as it cannot be readily removed when the withdrawal period is over or may wash off prior to the withdrawal period being over.

3.3 KEEPING GOOD RECORDS

When treating animals, it is imperative that good records are maintained to inform all employees of drug use on-farm. The type of record may vary for each herd; however the important component is to make them consistent and easily understood by all employees. There are many reasons that record keeping is imperative, i.e. to ensure that:

- Treated milk does not enter the milk tank;
- Milking equipment is washed properly so that no residues remain in the milking claw and;
- Animals receive subsequent treatment after milking, if required.

For all treatments, it is important that all records contain the following:

- Animal name or number;
- Drug administered;
- Date of first administration, and any additional administrations, if required;
- Date that the milk can return to the bulk tank, after the milk withdrawal is met and;
- Date that the animal may be shipped to slaughter, after the meat withdrawal is met.

There are a variety of ways that drug use can be recorded, and should be consistent on-farm:

- Binder containing up-to-date treatment records. The treatment records provided through the Canadian National Goat Federation Goat On-Farm Food Safety Program are ideal for this purpose and can be downloaded from the website (Fig. 7);
- Electronic record management software to easily record treatments, and allows for monitoring previous health records in one animal or;
- A whiteboard or chalkboard that is placed in the parlour (Fig. 8).

Fig. 7. Animal Health Product Treatment Record. Canadian National Goat Federation Goat On-Farm Food Safety Program

Record 2: Animal Health Product Treatment **Must Do**

Dairy producers please use Record 3: Animal Health Product Treatment for Dairy Operations

Treatment Date (d/m/y)	Animal or Pen Identification	Condition Treated	Product Name	Prescription (P) or Non-prescription (NP)	Dose	Estimated Animal Weight/Number of Animals Treated	*Route (See abbreviation codes below)	Withdrawal (Date safe to ship to slaughter or auction)	Treated by (Initials)
05/02/03	*Pen #2*	*Pneumonia*	*Drug A*	*NP*	*700*	*170 lbs (8 does)*	*IM*	*19/05/03 (d/m/y)*	*JD*

MUST DO

*Route Codes: IW – In the water; SQ – Subcutaneous; IF – In the feed; IM – Intramuscular; TT – Topical treatment (pour-on); IV – Intravenous; OR – Oral

Note: If a needle breaks in an animal during an injection, record the animal's identification number, location of the needle and date it occurred in the comments section.

Comments: _____

Producer's Signature: _____ Date: _____

Producers are to review each record before signing.

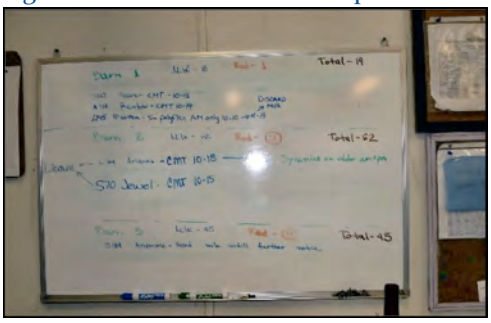
Auditor's Initials: _____ Audit Date: _____

CANADIAN NATIONAL GOAT FEDERATION Goat On-Farm Food Safety Program **B3**

3.4 COMMUNICATING THE INFORMATION TO PREVENT ACCIDENTS

One of the primary reasons to have good communication between employees during milking is to avoid accidents, i.e. milking a treated animal into the bulk tank. There are a variety of ways to improve communication between employees, and it is imperative that they are consistent.

Fig. 8. Communication in the parlour



3.4.1 COMMUNICATING IN THE MILKING PARLOUR

Many treatment decisions are made in the parlour, whether to treat mastitis or dry a doe off. Ways to make sure these decisions are properly recorded and communicated in the parlour:

- A whiteboard / chalkboard in the parlour can be used to quickly write down treatment events as they are done (Fig. 8);
- The permanent treatment records (written or on the computer) should be kept near-by (e.g. barn office) so they can be kept up-to-date at the end of each milking and can be quickly referenced if there is a question about an animal during milking;

- Veterinary prescriptions which include information on how and when to administer a drug, and on withdrawal times – should be stored with the treatment records for quick reference and;
- The methods of identifying a treated doe (e.g. leg bands) should be kept in the parlour and information on what each colour means.

3.4.2 MILKING TREATED ANIMALS SEPARATELY

Treated animals can be housed in a separate pen so they can be milked after the rest of the herd. The pipelines should be first removed from the bulk tank, and treated milk can be emptied directly down a drain. This group should be milked last in the herd to avoid contamination of the milking units and the pipeline with treated milk. Separate teat cups should be used as well as extra protection against residues.

Fig. 9 Rinse teat cups and claw after milking treated animal

3.4.3 MILKING TREATED ANIMALS USING A BUCKET MILKER OR INTO A PAIL

If separate housing for treated does is not an option, treated animals can be milked into a bucket milker. When doing this, the milking units are unhooked from the main pipeline, and hooked into the bucket, which prevents treated milk from being mixed in the bulk tank.

When an identified doe is found in the parlour, the unit should be changed over to the bucket milker, and all routine milking procedures should remain consistent, e.g. pre- and post-milking management.

After milking the treated doe is complete, the milking claws should be rinsed thoroughly, to make sure any residue is removed from the unit (Fig. 9). There is debate, however as to how effective this procedure is. Rather, keeping a spare claw reserved just for treated animals is recommended. The milking unit should be reattached to the main pipeline after it has been completely rinsed for the next doe. Treated milk from the bucket should be poured out, and the bucket rinsed thoroughly.

Fig. 10 Hand or bucket milk treated animals

Treated does can also be hand-milked into a pail (Fig. 10). Wash hands before and after milking.

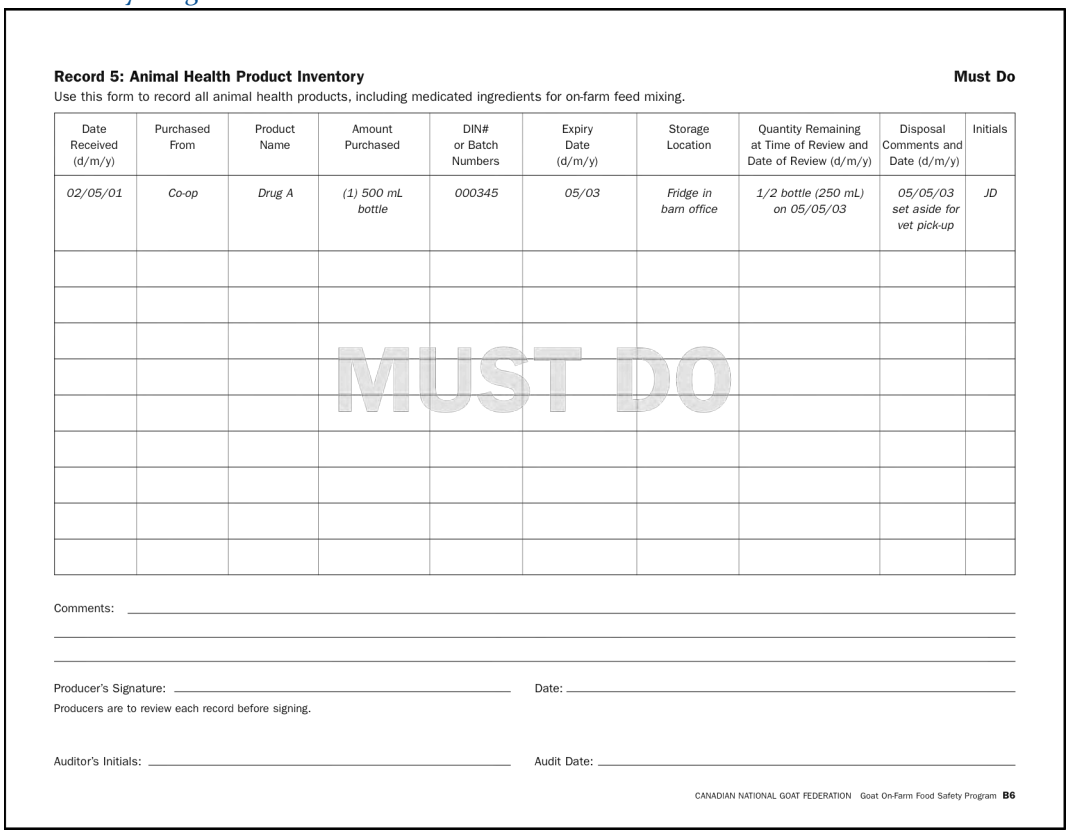
3.5 STORAGE OF LIVESTOCK MEDICINES

The storage of drugs is imperative to maintain the efficacy of these treatments. If they are damaged in any way due to poor storage, these drugs may not treat the animal properly, and will not cure the disease, as intended.

Fig. 11 Store medicines correctly

Livestock medicines should be stored in an accessible place such as the office or milk house (Fig. 11). Ideally, use a shelving unit to keep them organized, with a door to keep them protected from dust and sunlight. A log of these drugs should be used to maintain a proper drug inventory. Canadian National Goat Federation Goat

Fig. 12 Animal Health Product Inventory. Canadian National Goat Federation Goat On-Farm Food Safety Program



Record 5: Animal Health Product Inventory **Must Do**

Use this form to record all animal health products, including medicated ingredients for on-farm feed mixing.

Date Received (d/m/y)	Purchased From	Product Name	Amount Purchased	DIN# or Batch Numbers	Expiry Date (d/m/y)	Storage Location	Quantity Remaining at Time of Review and Date of Review (d/m/y)	Disposal Comments and Date (d/m/y)	Initials
02/05/01	*Co-op*	*Drug A*	*(1) 500 mL bottle*	*000345*	*05/03*	*Fridge in barn office*	*1/2 bottle (250 mL) on 05/05/03*	*05/05/03 set aside for vet pick-up*	*JD*

MUST DO

Comments: _____

Producer's Signature: _____ Date: _____

Producers are to review each record before signing.

Auditor's Initials: _____ Audit Date: _____

CANADIAN NATIONAL GOAT FEDERATION Goat On-Farm Food Safety Program **B6**

On-Farm Food Safety Program provides these records (Fig. 12) and guidelines for drug storage.

3.5.1 LACTATING VERSUS DRY

Drugs that cannot be used in lactating dairy does should be stored separately from those for which a veterinary prescription exists for use in lactating does. They should be stored in a separate cupboard which is clearly marked on the outside as to which class of medicine it contains (See Section V.5; Fig. 20). It is not uncommon (for example) for a lactating animal to be accidently treated with an intramammary "dry cow" product, i.e. a product which should only be used during the animal's dry period. If this happens, the milk may need to be discarded for a month or more!

3.5.2 BOXES, INSERTS AND LABELS

As outlined in Section VI.1.1.4, there is very important information required by law present on the label, box or insert in which the drug was purchased. That information should be kept in the binder with the treatment records where it can be quickly referenced and not discarded.

Never use a drug that is not properly labelled. Never "repackage" a drug into an unmarked or inadequately marked container.

3.5.3 STORING DRUGS PROPERLY

STORE AT THE PROPER TEMPERATURE

Drugs are required to either be at room temperature (e.g. 15 to 28° C), or refrigerated at approximately 4°C. Check the label to determine which is required and follow it! Do not keep drugs in the door of the refrigerator, as it can be much warmer than the rest of the fridge. If the drug must be frozen (e.g. reconstituted PMSG, see Section VIII.5.5), make sure the freezer temperature is not warmer than -20° C.

Fig. 13. Refrigerate drugs properly

The refrigerator should be kept in an accessible room, such as the office or milk house of a barn, and only drugs should be stored in this refrigerator, not food or drink. Keep a thermometer in the fridge and routinely check the temperature. Keep the refrigerator in a clean environment, e.g. not in a livestock rearing area. Dust and dirt may harm its operation. The refrigerator should be defrosted and cleaned regularly.

AVOID HEAT EXPOSURE

Much like freezing, excessive heat exposure to a drug can affect its overall efficacy. This is a common concern with drugs that are maintained at room temperature, especially during the summer months. It is important that drugs are stored in a cool area, such as an enclosed shelving unit, to shield the drug from heat. NEVER keep drugs on a window shelf or car dashboard!

PREVENT LIGHT EXPOSURE

For many medications, it is important to keep them away from direct light or sunlight, as this could damage the drug. Either keep in the cardboard package with the lid closed or, preferably store in a storage unit equipped with a door, so they can be shut out from the sun (Fig. 11). This type of exposure will also protect from flies, dust, and excessive moisture.

3.5.4 EXPIRY DATE AND DRUG INVENTORY LOG

All drugs have an expiry date indicated on the label, and must not be used passed this time point. All drugs will degrade with time. An expired drug may not contain sufficient active ingredient to be effective. It may also contain toxic breakdown-products which may be harmful to your animal. A log with an inventory of drugs and their corresponding expiry dates should be updated regularly so expired products can be disposed of and replaced with newer products (available from the Canadian National Goat Federation Goat On-Farm Food Safety Program) (Fig. 12). This log should include **batch and lot number** as well in case of recall.

3.5.7 AVOID CONTAMINATION OF THE DRUG WITH BACTERIA

Drugs containing bacteria will not work and can be harmful to the animal. For injectable drugs in particular, it is critical to keep the drug sterile. **DO NOT EVER**:

- Insert a used needle into the bottle –use only sterile needles to withdraw;
- Leave a needle in the bottle between uses – it allows bacteria to enter (Fig. 14);

- Insert a syringe top into the rubber stopper of the bottle, the hole it makes is large and allows bacteria to enter;
- Leave the bottle where flies and dust can contaminate the rubber stopper – next time you put the needle in, you will push bacteria in with it ;
- Remove the rubber stopper to withdraw the drug – the stopper is important in keeping the drug sterile or;
- Return unused drug in a syringe to the bottle – you cannot be sure that drug is still sterile.

Fig. 14 Never leave a needle in the bottle.

An open bottle should be stored properly. A clean cotton swab with isopropyl alcohol (same as you use to disinfect the teat to take milk samples) can be used to disinfect the rubber stopper. Some vaccines indicate to discard after opening. This is because bacteria readily grow in the vaccine. Follow directions!

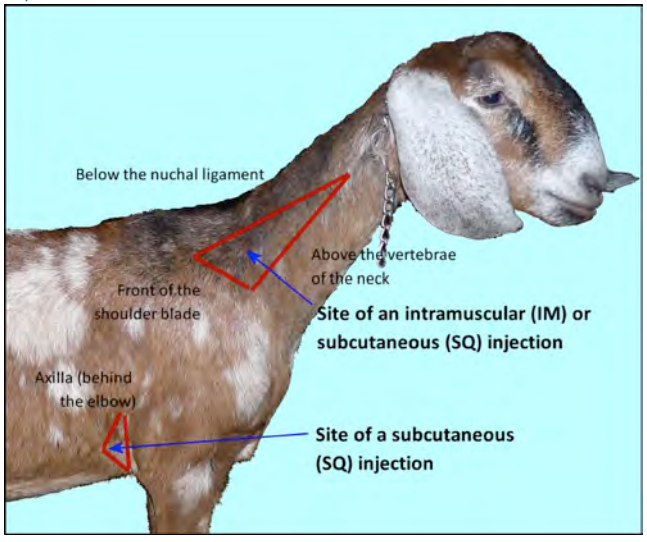
3.6 ADMINISTRATION OF DRUGS

3.6.1 ROUTE OF ADMINISTRATION

It is important to follow labelled directions of each drug to ensure that it is being administered properly. For treating pathogens in the udder specifically, antibiotics can be administered by the intramammary route.

- **Intramammary (IMM):** Only drugs labelled for IMM should be administered this way. See Section VI.4.2 for instructions on how to do this.
- **Intramuscular injections (IM):** For meat quality purposes, this injection is primarily done in an area of lesser value, such as in the neck (Fig. 15). Volume per injection site shouldn't exceed 5 mL.
- **Subcutaneous injections (SQ):** The drug is injected underneath the skin, in the neck or axilla (behind the elbow) of the doe (Fig. 15). Skin can be tented prior to injection to reduce risk of injecting too shallow or deep. If both SQ and IM are offered as choices to deliver the drug, generally select SQ as it is less damaging. Again, do not exceed 5 mL per injection site.
- **Intravenous injections (IV):** It is rarely necessary to give a medication intravenously. It is important to be trained on how to give IV injections by a veterinarian to ensure that the drug is being administered properly.

Fig. 15. Site of intramuscular and subcutaneous injections



3.6.2 EQUIPMENT USED FOR ADMINISTRATION

SINGLE – USE SYRINGES

Single-use syringes should always be used for treatments, unless treating a large number of animals at one time (e.g. vaccinating the herd against clostridial

diseases, see Section VIII.1.1). By using a syringe only once, the chance of contamination of the drug and infection of the doe, is decreased. Syringes come in many sizes: 1 mL; 3 mL; 6 mL; 12 mL; 20 mL; 35 mL; 60 mL. The size of the syringe used should match the volume to be administered. E.g. don't use a 12 mL syringe to administer 2 mL of a drug – it can't be done accurately.

Two different syringe tips are available; a regular tip syringe and a luer-lock syringe. Needles are placed directly onto the regular tip syringes, while with luer-lock syringes needles are twisted onto the tip of the syringe to lock it in place so there is less chance the needle will fall off.

AUTOMATIC SYRINGES

This type of syringe is used when injecting a large number of animals with the same amount of drug or vaccine, within a short time-period (e.g. an hour). It is set up to deliver the same volume each time you squeeze the trigger (Fig. 16). For this reason, it is difficult to change the volume easily between animals. The same needle is often used for several goats in a row. Discard immediately in a sharps container (Fig. 17) if the needle becomes contaminated, bent or dull. Automatic syringes require careful washing, disinfection and rinsing after use, and proper storage where it is dry and dust free. Regular maintenance and lubrication is required to replace worn out parts.

Fig. 16. Automatic syringe

Fig. 17 Sharps container

SINGLE – USE NEEDLES

The type of needle used on a goat depends on the size of the animal, and the viscosity (thickness) of the drug being injected. Higher gauge number = small bore size of the needle. For kids, needles should be a gauge of 20 to 22, and a length of ½ to 1 inch. For adult goats, a gauge of 18 to 20 and a length of ¾ to 1 inch is generally used. If treating IM, the needle should be 1 inch to properly penetrate the muscle, and for SQ (e.g. for vaccinating), the needle can be shorter. Using a longer needle than 1 inch increases the risk of breakage if the animal should move. Do not use needles with plastic hubs as they easily break if the animal jumps.

Usually the cap on the needle and sometimes its hub are colour coded but the colours may vary with the manufacturer. It is best to read the label on the box, or right on the cap to make sure you are using the correct gauge and length.

Fig. 18. Single-use needle

<u>Don't reuse needles.</u> You can't effectively clean the inside of a needle of residual drug and bacteria. Resterilizing the needles will cause them to become dull and increases the risk of breakage. In the scheme of things, a sterile needle is a cheap investment.

Fig. 19. Injection site abscess

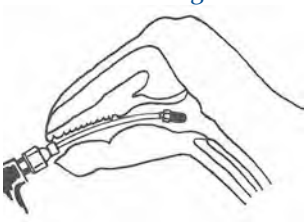
HOW TO AVOID INJECTION SITE ABSCESSES

- Prevent contamination of the drug with bacteria as covered in Section VI.3.5.7.
- <u>Always</u> use sterile needles and syringes.

DRENCH GUNS

Drench guns are used to administer treatment orally to goats. Only small amounts of treatment can be used with a drench gun, with volumes of less than 30 mL. This liquid is inserted into the animal's mouth over the back of the tongue, and is then swallowed into the rumen (Fig. 20).

Fig. 20. Tip of drench gun over back of tongue

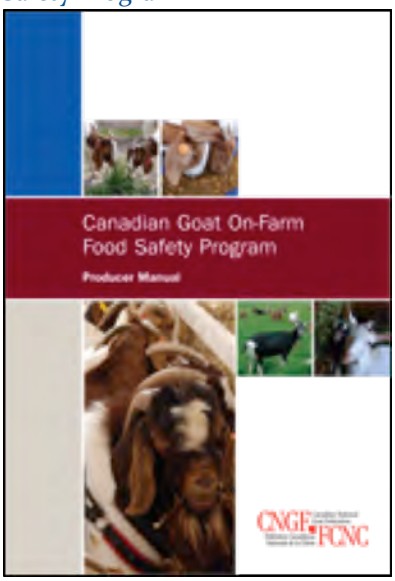


- Injectable products should never be administered as a drench!
- Generally anthelmintics (dewormers) are formulated as an oral medication and are administered as a drench (not in feed). Do not use anthelmintics formulated as a pour-on or as an injection. More information is available on-line[15].
- Oral antibiotics are NOT recommended for the treatment of mastitis or other bacterial infections in goats. Oral antibiotics are poorly absorbed in ruminants and so are not available to fight the infection. Additionally they may cause digestive upsets. Use of oral antibiotics has been associated with the development of antimicrobial resistant bacteria.

3.7 THE CANADIAN NATIONAL GOAT FEDERATION GOAT ON-FARM FOOD SAFETY PROGRAM

The Canadian National Goat Federation Goat On-Farm Food Safety (GOFFS) Program which has been mentioned many times in the document, provides rules and guidance for goat producers to assure animals and their products are safe for the public. All documents are available for download from the web[16] or ordered from the office of the Canadian National Goat Federation[17].

Fig. 21. Canadian National Goat Federation Goat On-Farm Food Safety Program



This program identifies good production practices (GPPs) either as "must do's" or "recommended". To help with implementing these practices, record keeping is required to ensure that all GPPs are being conducted properly. The program includes dairy goat production.

3.7.1 ADVANTAGES

One of the major benefits of this program is improvement of consumer confidence in the product that they are buying. It can increase confidence between producers and processors, and product sales can be expanded within agricultural sectors, and internationally. In addition, herd management can improve dramatically with accurate record keeping of animal health events.

[15] http://www.uoguelph.ca/~pmenzies/Handbook_Home.html
[16] http://cangoats.ca/index.php?pageid=467
[17] Canadian National Goat Federation. info@cangoats.com. Phone: 1-888-839-4271.

3.8 IF TREATED MILK GETS INTO THE BULK TANK

There are some things that producers can do to avoid the chance of this milk being transported for processing.

- The most prudent action is to stop milking the remainder of the herd, take a sample for testing at the laboratory, and dump the suspect milk. Once the tank and equipment have been cleaned and sanitized, proceed with milking the rest of the herd.
- Using an on-farm milk testing kit may help make decisions as to whether the milk is safe, but these kits are only moderately accurate and so the risk is that the result may be a false negative (i.e. the milk is positive when the test kit result is negative).

4. TREATING MASTITIS IN A LACTATING DAIRY DOE

4.1 SELECTING AN ANIMAL FOR TREATMENT

4.1.1 SEVERE CLINICAL MASTITIS

Does with severe cases of clinical mastitis should always be treated, as the doe is systemically ill (See Section II.2.1). Systemic antibiotics (e.g. injected rather than infused into the udder) and supportive therapy, such as pain management therapies and intravenous fluids should be administered as prescribed or performed by the herd veterinarian. If not treated, it should be humanely euthanized.

4.1.2 MILD TO MODERATE CLINICAL MASTITIS

Does with mild to moderate clinical mastitis generally show changes in their milk composition due to infection, and sometimes have heat and hardness in their udder, but have no systemic signs (See Section II.2.1). Intramammary antibiotics can be administered to help clear the infection; however, supportive therapy is generally not administered.

4.1.3 SUBCLINICAL MASTITIS

Subclinical mastitis is usually treated with an intramammary product after diagnosis using laboratory culture (See Section II.5.4). Some forms of subclinical mastitis respond well to intramammary treatment during lactation and others are better cured during the dry period.

4.2 ADMINISTERING AN INTRAMAMMARY TREATMENT

Intramammary treatments come in pre-packaged "mastitis tubes" which are sterile. The mastitis ointment is a combination of antibiotics and pastes specially formulated not irritate the udder tissues. Each tube has a tip (teat cannula) designed to fit into the teat orifice of a dairy cow; with care, they generally work for goats. The teat cannula has a cover to keep the end sterile. A plunger at the other end of the tube allows the ointment to be squeezed into the teat and udder cistern.

Some products are intended for use in lactating animals and do not persist in the udder more than a few milkings. Others are specially formulated to be administered at the end of lactation and the antibiotic persists in the udder while the doe is dry. Do not use a lactating product at dry off (it won't work as well). Never use a dry product in a lactating animal – it will persist for possibly weeks in the milk and lead to antibiotic residues.

4.2.1 PREPARING THE TEAT

Before administering an intramammary treatment, it is important that the teat is cleaned and disinfected properly so potential pathogens do not enter the teat canal. After milking the doe (i.e. evacuating the udder as much as possible of milk), teats should be dried with clean clothes or towels and the teat end and orifice disinfected with a sterile gauze wipe soaked in isopropyl alcohol (See Section II.5.4 on how to do this). This is very important if there is damage or scar tissue on the end of the teat – teeming with billions of bacteria if not properly cleaned. If after scrubbing the teat end, the swab is dirty, repeat with a new swab until it appears clean. Then you are ready to treat the gland.

4.2.2 INSERTING THE TIP OF THE MASTITIS TUBE INTO THE TEAT

When inserting the tip of the mastitis tube into the teat end, it is important that the cap remains on the tube for as long as possible to avoid contamination. The end of the teat should be gently held using clean, gloved fingers, stabilizing the teat end. The tip should be **partially** inserted into the teat opening only 1/8 inch (5 mm), to decrease the chance of more bacteria being pushed up the streak canal and into the udder (Fig. 22). Use only the short insertion tip. The teat opening of a dairy doe is smaller than a dairy cow and so more prone to damage, so insertion should be done very gently. The gland can be gently massaged after treatment – although this is not necessary.

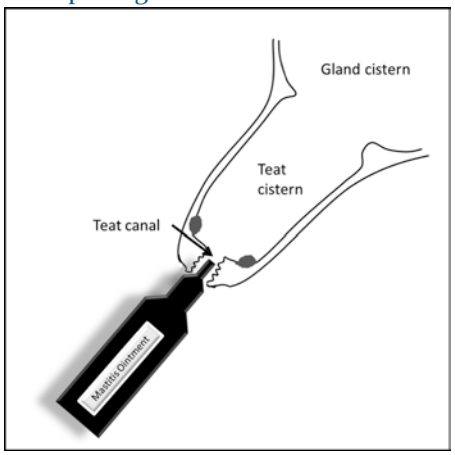
RESTRAINT OF THE DOE WHILE TREATING

Restraint of the doe is very important. Some does will get upset, moving and jumping around when treated – risking contamination of the teat cannula and teat end. Restraint can be done while the doe is in the milking stall – have an assistant push the doe against the side of the stall while you immobilize the teat end and insert. This will stop her from jumping. Or if preferred, when the doe leaves the milking parlour, have an assistant tip her onto her rump exposing the udder. She will struggle less while you disinfect the teat and insert the tube.

4.2.3 ALWAYS ADMINISTER THE WHOLE TUBE INTO THE GLAND

Even though the doe's udder is generally smaller than that of a dairy cow it is important to use the entire contents of the mastitis tube into one gland. The tube is intended to be used in its complete form and only delivering 50% of the antibiotic will decrease its efficacy. Additionally, splitting tubes between two glands or two does should **never be done** as it greatly increases the risk of transmitting pathogens or contaminants from one gland to another, quickly erasing any imagined savings.

Fig. 22. Insert tip of mastitis tube into teat opening but no further



4.2.4 TREAT BOTH GLANDS OR ONE?

Although both glands from a treated animal cannot be milked into the tank when one is treated, it is not necessary to treat both if only one has mastitis. Treating uninfected glands is an additional cost. In addition, it is important not to over-treat animals if not required. Overuse of antibiotics can cause yeast infections in the gland (Section II.3.2).

Antimicrobial resistance (AMR) occurs when a bacterial species has become resistant to the effects of a specific antibiotic. The most common reason for AMR to develop is prolonged use of an antibiotic, usually when the antibiotic is not needed; or prolonged use at a dosage that is too low. Resistant bacteria can be transmitted between people and animals. Antimicrobial resistance has been documented in mastitis organisms (e.g. methacillin resistant *Staph. aureus* or MRSA which is an important human pathogen), so being selective with antimicrobial treatment and not over or under-treating is strongly recommended.

4.2.5 REPEATING INTRAMAMMARY TREATMENTS

Follow the advice of the herd veterinarian as to how frequently an intramammary treatment should be administered and do not exceed this as it will affect milk withdrawal times. For example, if the treatment regime is for infusion at both the a.m. and p.m milking, do not repeat this the following day without specific guidance on milk withdrawal times from the herd veterinarian.

4.3 ADMINISTERING A PRODUCT SYSTEMICALLY

To treat systemic effects of mastitis infections, such as symptoms found with gangrenous mastitis, treatment with systemic antibiotics, e.g. by intramuscular or subcutaneous injection can be beneficial but should only be done on the advice of the herd veterinarian. Administration of antibiotics both intramammary and systemically will increase milk withdrawal times. Again, only do this on the advice of the herd veterinarian.

5. DRY PERIOD MANAGEMENT OF MASTITIS

5.1 DRYING DOES OFF

The dry-off period for does should be four to eight weeks long to allow for the doe's udder to rest and prepare for kidding (Section I.3) and perhaps longer to assure no antimicrobial residues at freshening. To dry a goat off, milk production should be minimized, either by natural progression of the lactation or manually, by altering feeding management and/or milking once/day for a period of time. This allows for build-up of the protein FIL (Feedback of Inhibition of Lactation) in the gland that causes the milk producing cells to naturally die (apoptosis). Once milking has ceased, never evacuate the udder unless clinical mastitis has occurred. It is important to not disturb formation of the keratin plug, which naturally forms in the teat during the drying procedure (see Section I.1.3) and protects the udder against new mastitis infections. Dry does should be penned in a separate housing environment than the lactating herd. This will allow for different nutrition and will prevent accidental milking of treated animals.

5.2 DRY PERIOD TREATMENT OF DOES

It has been shown in dairy goats that the use of a dry period mastitis treatment product (one tube per gland as with lactating products) can cure existing mastitis infections and prevent new infections acquired during the dry period and increase milk production in the following lactation.

5.2.1 CURING EXISTING AND PREVENTING NEW INFECTIONS IN THE DRY PERIOD

When does are treated with antibiotics at dry-off, there is a strong likelihood this treatment will rid the mammary gland of any existing infections. This is because the antibiotic will be in contact with the

bacteria for weeks, rather than – as in the case of treating during lactation – only for a few hours. The antibiotic will also not be diluted with milk so will be more concentrated. The dry mastitis ointments also have special carriers that will make the antibiotic more persistent in the udder.

Dry treatment can also help to prevent new infections from occurring during the dry period. The biggest risk periods are a) the few days after milking stops – when the keratin plug in the teat is still forming, and b) as the udder fills just before kidding. Most infections picked up at this time are from the environment, e.g. dirty bedding, wet and muddy pastures – especially around watering troughs, standing water (e.g. ponds and puddles), fly bites etc.

TEAT SEALANTS

Teat sealants can prevent bacteria from entering the teat during these high-risk times. External sealants coat the teat and act as a barrier to bacteria until the keratin plug is fully formed in the teat (See Section III - Table III.1). However, there is a chance that the sealant may rub off as the does lie down, lessening its barrier function. A more effective method is an internal teat sealant (OrbeSeal®, Zoetis Canada), which essentially acts as an artificial keratin plug until it is fully formed. Consult your herd veterinarian before using any of these products.

5.2.2 SELECTIVE VS BLANKET TREATMENT AT DRY-OFF

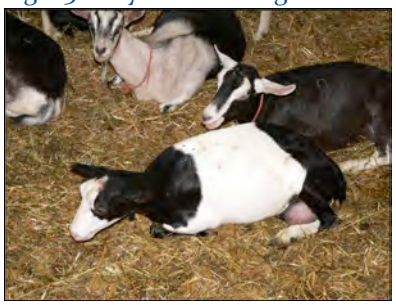
With **selective treatment**, only does that have been identified as having udder problems are treated with antibiotics at dry-off. This dry-off technique is beneficial in herds with a very low prevalence of mastitis and good environmental management of mastitis. Not only does this save on the cost of antimicrobials, but it also decreases unnecessary antimicrobial treatments.

Blanket treatment refers to the treatment of every doe at dry-off. This type of dry-off practice is beneficial for herds with more prevalent and chronic infections as well as increased SCC. Although this method is more expensive, there is a greater chance that these treated does will have improved udder health in their subsequent lactation.

5.3 ENVIRONMENT FOR DRY DOES

Although does do not have exposure to contagious pathogens during the dry period, there is still a great chance that animals can be exposed to multiple environmental pathogens. It is important to maintain a clean and dry environment for does so they are not exposed to increased bacterial counts due to manure, urine and excess water. To decrease stress amongst these dry does, housing them in a separate pen than the lactating string will minimize disruptions in their daily routine, allowing them to rest in preparation for kidding.

Fig. 23. Dry doe housing



6. ERADICATION OF CAPRINE ARTHRITIS ENCEPHALITIS FROM THE HERD

Caprine arthritis encephalitis (CAE) virus targets the udder, causing inflammation and scarring which can't be cured by antibiotic treatment. It also causes arthritis – eventually the doe is so lame it is reluctant to walk, leading to decreased production and culling. CAE is very common in North American dairy herds. At this time there is no official disease status program in Ontario for CAE as

there is for a related virus disease of sheep, maedi visna (MV)[18]. The protocols for the eradication of MV can be used for CAE, although the test used at the diagnostic lab is more specific for goat CAE.

There are a few methods that have shown to be successful in trying to eradicate CAE in dairy goat herds.

- Cull all goats that have tested positive for CAE (a blood test which detects antibodies).
- Only allow kids that are CAE-negative to be used as replacements in the herd.
    - It may take over a year for an animal infected at birth to test positive.
    - For this reason, we recommend repeated testing of stock greater than 4 to 6 months of age until the herd is completely test negative on at least 2 consecutive herd tests at least 6 months apart.
- In high prevalence herds where culling is difficult economically, kids intended to be kept as replacement animals should be snatched at birth (i.e. don't allow to nurse or be cleaned by the doe) and reared in an isolation facility so that there is no chance of transmission of the virus.
- Colostrum and milk are the most important source of infection to a kid (along with respiratory secretions passed by close contact from the dam or other infected animals in the pen), so feed either colostrum from a doe residing in a test-negative herd, heat-treated colostrum[19] or a commercial colostrum replacement product. Cow colostrum can also be used but should be from Johne's negative herds and also heat-treated. This is covered in more detail in Section VIII.

Consult your herd veterinarian for a more detailed CAE control program suited for your herd.

7. ENVIRONMENTAL CONTROL OF MASTITIS

Environmental mastitis appears to be a common problem in dairy goat herds in Ontario (See Section II.3.2). Environmental management is imperative on-farm to control mastitis caused by environmental pathogens. Manure and urine should be cleaned from the housing area regularly, so udders are not exposed to potentially harmful pathogens. Does should have adequate bedding in their pens as well, not only for increased comfort, but to ensure that they are not lying on the barn floor, which can be a breeding ground for pathogens (Fig. 24).

Fig. 24. Bright and airy pen - but high stocking densities make bedding management difficult

Pens should not be over-crowded, as it is imperative that each animal has adequate space to lie down. If they don't, there is a greater chance that the animal will have to lie in excess manure, which will increase their chance of acquiring an infection. Recommendations for environment and housing are provided in Section VIII Table VIII.3.

[18] http://www.ontariosheep.org/PROGRAMSANDSERVICES/MaediVisna.aspx

[19] Heat treating colostrum to kill viruses and bacteria, is done by bringing the temperature of colostrum up to 56 – 60° C, holding the colostrum at that temperature for 1 hour. The temperature should never be higher than this or the immunoglobulins (antibodies) will be denatured and not be absorbed by the kid. The colostrum should be stirred frequently with a clean and sanitizing implement. After heating, the colostrum should be labelled (date, doe ID) and frozen at < -20° C. Volumes should be small (50 to 200 mL) so that when thawed (slowly at room temperature), all of the colostrum is used at once. Frozen, it is good for up to 6 months. Thawed colostrum should not be refrozen.

If does are housed outdoors, particularly during the summer months, keeping them away from areas filled with excess mud is very important to control environmental mastitis. If does spend a large amount of time in these mud-filled areas, they are at risk for environmental infections. The heat of the summer increases the number of pathogens present, so this is an important thing to address in a pasture. Flies can bite teat ends and transmit these bacteria as well.

Fig. 25 Fence goats away from wet areas.

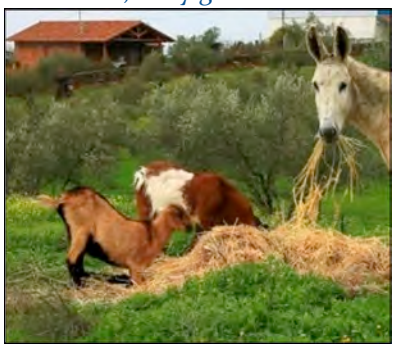
7.1 PSEUDOMONAS

Pseudomonas aeruginosa, an important cause of severe mastitis in does (see Section II.3.2) is found in water sources around a barn. It is commonly seen in contaminated wash water in a milking system, in the water trough, ponds, etc. Anywhere there is standing water that may contact your does' udders may be a source of infection. This bacterium is usually resistant to most antibiotics and so treatment will not cure these infections.

7.2 LISTERIA

Listeria monocytogenes is discussed as related to feeding (Section VIII.4.3.1) but does may also become infected from the environment. Listeria causes mastitis but is also commonly shed in the milk without signs of mastitis or any issue of listeriosis in the herd. More importantly, outbreaks of human listeriosis in Canada with severe gastrointestinal illness, meningitis, miscarriage and even death have been linked to eating contaminated cheeses made from milk of sheep and goats.

Fig. 26. Listeria may grow in hay fed on wet, dirty ground



Listeria prefers dirty, wet conditions and readily grows in feed and manure even at refrigerator-level temperatures. The bacteria will continue to grow in unpasteurized refrigerated milk – even in the bulk tank. The bacteria may be present in the milk either from an udder infection or contamination of the milk if the udder is not properly cleaned and disinfected (Section III.1.2).

8. CONTROLLING A *STAPHYLOCOCCUS AUREUS* MASTITIS PROBLEM IN THE HERD

Staphylococcus aureus has been mentioned many times in this guide and it is the most common cause of clinical mastitis, and one of the most important mastitis pathogens overall in goats. *Staph. aureus* is the most common cause of **gangrenous mastitis**. If your herd is experiencing cases of this – even one or two per year - it is likely that many more does in the herd are actually infected.

Fig. 27

Because it is contagious from doe-to-doe and from people-to-doe, identifying infected does, preventing transmission and appropriate treatment and culling of infected animals are all crucial to its control. Infected does are often called "staph"

does. The following measures are recommended with input from the herd veterinarian:

- Culture all does with clinical and sub-clinical mastitis to detect "staph" does;
- Identify "staph" does (Section VI 3.2.2) and milk separately, either by bucket milker if the does are not segregated from the healthy herd, or preferably segregated from herd (e.g. as a "staph string") and milked last in the parlour;
- Aggressively treat on the advice of your veterinarian - newly identified "staph" does, particularly if they are recently fresh doelings;
- Treatment is more effective if the doe is dried-up and dry-treated rather than treated while still milking;
- Perform follow-up culturing to determine if cured;
- Blanket dry treat all does as not all "staph" does can be identified by culture;
- Always wear gloves to milk does to prevent transmission from people to does;
- Do not allow kids to nurse does, particularly if infected with contagious ecthyma (orf, soremouth) (Section II.4.5);
- Prep the udder and teats carefully as outlined in Section III.1.2 using single-service towels;
- Make sure milking equipment is properly calibrated and maintained to prevent vacuum fluctuations and back-jetting of the milk from doe-to-doe;
- If new cases of "staph" continue to happen, consider culturing the entire milking herd to detect all "staph" does;
- Culture all "staph" does at kidding to determine if dry treatment has cured the infection;
- Cull does with a history of clinical mastitis due to "staph", particularly if udder damage remains. This includes does with a history of gangrenous mastitis;
- Cull does which do not respond to treatment, i.e. are still culture positive for "staph" and;
- Monitor the herd using bulk tank culture (See Section II.6)

9. WHEN SHOULD DOES BE CULLED BECAUSE OF MASTITIS?

Mastitis is one of the most common reasons for a doe to be culled from the herd while still a potentially profitable doe.

9.1 INCURABLE INFECTIONS

When does are infected with incurable contagious infections, particularly *Staph. aureus*, culling these animals may be an option to improve udder health for the entire herd. *Pseudomonas* infected does should also be culled.

Does with incurable environmental infections and udder abscesses should also be culled because of risk to the healthy herd and lost milk production.

Does which have lost a gland to mastitis and / or teat injury – but that have a healthy gland, may also be good candidates for culling. Even though the other gland will compensate somewhat in milk production – it is difficult for that doe to be as productive as a doe with two healthy glands. Be aware that blind glands may contain abscesses, which may break and drain.

9.2 REDUCED MILK PRODUCTION

Ideally, most culls in a herd are because of low production rather than disease such as mastitis. Culling based on milk production is herd-dependent and is based on the number of profitable does in the herd, as well as the cost of production per doe. If milk production is less than the cost of

production for each doe, it is in the producer's benefit to cull her from the herd. If milking numbers are to remain stable in the herd, room needs to be made for new doelings to enter the herd.

10 ORGANIC MILK PRODUCTION

The organic food industry has become a growing interest for consumers. The premise of this industry is described by the Government of Canada Organic Production Systems General Principles and Management Standards (CAN/CGSB-32.310-2006)[20]:

"*Organic production is a holistic system designed to optimize the productivity and fitness of diverse communities within the agro-ecosystem, including soil organisms, plants, livestock and people. The principal goal of organic production is to develop enterprises that are sustainable and harmonious with the environment*."

Organic production requires that practices are being done to ensure that animals are able to perform their natural behavioural processes, while still ensuring their health and animal welfare. There are many specific practices that must be adhered by, and are listed below as outlined in the document referenced above:

- *"Goats must have access to an appropriate amount of outdoor pasture, with 2.5 m^2/head, and 0.5 m^2/head for kids, and indoors, does must have 1.5 m^2/head, and 0.35 m^2/head for kids.*
- *In addition to pasture, does must be supplemented with organically grown feed as their form of nutrition. Sixty-percent of their diet must be hay, fresh/dried fodder or silage-based, with 15% of the total feed having a forage length of over 10 cm (~ 4 inches).*
- *Organic animals should not be given synthetically made allopathic (i.e. conventional) veterinary drugs or feed additives, such as antibiotics or parasiticides. However, vaccines can be administered, if required. In addition, phytotherapeutic (i.e. herbal or botanical) or homeopathic treatment can be used if they are deemed necessary.*
- *If physical changes are required in a herd, such as ear tagging, they should be accompanied by anaesthetics or pain mitigation drugs.*
- *Goats that are used for milk production must be milked in a continuous organic system for one year before they are considered for use in organic milk products. Any breeding stock that is purchased must also be confirmed organic.*
- *Record-keeping is very important on organic farms, and all information, such as feed records and disease treatments must be logged in detail."*

Please Note: Some of these recommendations are difficult to adhere to when you have a goat that is ill. It is advised that you do not withhold appropriate treatment of an animal in order to adhere to these organic standards. Any compound used as a treatment should have first been scientifically proven to be effective for the treatment and safe for both the animal and those consuming its products.

If you are considering changing to an organic dairy operation, it is strongly advised that you read the document in full as there are many restrictions that must be adhered to.

[20] http://www.tpsgc-pwgsc.gc.ca/ongc-cgsb/programme-program/normes-standards/comm/32-20-agriculture-eng.html

Table VII.1. Form to record culture results and treatments of individual does

DATE	DOE I.D.	GLAND (L / R)	SIGNS OF MASTITIS?[2]	TREATMENT HISTORY			SCC / CMT RESULTS	CULTURE RESULT[3]			TREATMENT PLAN	
				DATE	PRODUCT USED	# OF TIMES		BACTERIAL TYPE	GROWTH	ANTIBIOTIC SENSITIVITY	DATE	PRODUCT USED

[2] Record if doe was ill (e.g. fever), the gland was abnormal (e.g. swollen, hot), the milk was abnormal (colour, consistency), or if mastitis was sub-clinical.

[3] Results as provided from the diagnostic laboratory. Usually bacteria isolated are identified, the amount of growth (e.g. # colonies or 1+, 2+, etc.) and if requested, which antibiotics appear to kill the bacteria.

Table VII.2. Assessment of udder health in dairy goats

DATE OF ASSESSMENT	MILKING SYSTEM	FARM NAME				HERD VETERINARIAN
Average # does milked in previous 12 months		Avg. # days post-kidding does put into milk-line				Avg. length of lactation (milked)
MEASUREMENT OF PERFORMANCE		**PREVIOUS LEVEL**	**GOAL FOR HERD**	**CURRENT LEVEL**	**ACTION NEEDED?**	**ADDITIONAL ASSESSMENT**
ASSESSMENT OF CLINICAL MASTITIS						
Annual incidence of clinical mastitis[i] (%) *Calculate: (# does with 1 or more cases of clinical mastitis[ii] in last 12 months / average # does milked in last 12 months) X 100*			**< 5%**		☐YES ☐NO	• Investigate stage of lactation, season, parity of animals with clinical mastitis • Culture cases before treating to determine if contagious or environmental organisms • Review milking management, milking equipment
Annual incidence of repeat cases of clinical mastitis (%) *Calculate: (Total # cases of clinical mastitis in last 12 months / average # does milked in last 12 months) X 100*			**<1.5 X above**		☐YES ☐NO	• Culture cases to determine organism. • Investigate reasons for failure to manage clinical cases (e.g. treatment protocols)
Prevalence of does with a blind gland (%) *Calculate: (Total # of glands that did not produce milk in the last 12 months/total # of does milked in last 12 months) X 100*			**< 5%**		☐YES ☐NO	• Examine history of does with blind glands to determine reason. E.g. mastitis, teat damage. • Review culling policy.
ASSESSMENT OF SUB-CLINICAL MASTITIS						
Proportion of does with SCC level > 800,000[iii] (linear score 6) each test (%) *Calculate: (# does with SCC > 800,000 at last milk test/# does tested) X 100*			**< 20%**		☐YES ☐NO	• Investigate stage of lactation, season, parity etc. of animals with subclinical mastitis • Review milking hygiene and maintenance of milking equipment • Review management of does with contagious mastitis • Review hygiene of environment • Determine prevalence of teat end lesions and their cause (e.g. over-milking, high vacuum) • Review biosecurity protocol when purchasing animals • Investigate risk from nursing kids of teat damage
Incidence of new infections during lactation (%) *Calculate: (# does with SCC > 800,000 at last milk test and ≤ 800,000 at previous milk test/# does ≤ 800,000 at previous milk test) X 100*			**< 5%**		☐YES ☐NO	

MEASUREMENT OF PERFORMANCE	PREVIOUS LEVEL	GOAL FOR HERD	CURRENT LEVEL	ACTION NEEDED?	ADDITIONAL ASSESSMENT
Prevalence of chronic infections (%) *Calculate: (# does with SCC > 800,000 at 3 or more tests this lactation / total # lactations assessed) X 100*		**< 5%**		☐YES ☐NO	• Determine period of onset of chronic mastitis cases with respect to stage of lactation, parity, season • Culture to determine pathogen type • Investigate status of CAE infection in the herd
Prevalence of infections at first test post-kidding (%) *Calculate: (# does with SCC > 400,000 at first test post-kidding/total # first tests) X 100*		**< 10 %**		☐YES ☐NO	• Determine parity of affected animals • Investigate whether due to damage from nursing kids prior to placing in milk line • Review dry-period mastitis treatment protocols and hygiene at treatment • Investigate dry-off management • Review environment of dry does
ANIMAL LOSS DUE TO MASTITIS					
Turnover rate due to mastitis (%) *Calculate: (# does culled and died due to mastitis/average # milked in last 12 months) X 100*		**< 5%**		☐YES ☐NO	• Review treatment protocols, including methods of detection of does with clinical mastitis • Investigate causative agents causing death (e.g. *Staphylococcus aureus*) • Investigate and review as outlined above under clinical and subclinical mastitis • Review culling policies as well as areas above
Incidence of does dying of mastitis annually (%) *Calculate: (# does dying of mastitis / avg. # milked in last 12 months) x 100*		**< 0.5%**		☐YES ☐NO	
Proportion of does culled due to mastitis (%) *Calculate: (# does culled due to mastitis / avg. # milked in last 12 months) X 100*		**< 5%**		☐YES ☐NO	
Proportion of does culled that were culled due to mastitis (%) *Calculate: (# does culled due to mastitis / total # does culled[iv] in last 12 months)*		**< 20%**		☐YES ☐NO	

[i] A case of clinical mastitis is one in which there is a change to the udder and / or milk of one or more glands as detected by visual inspection.
[ii] Count does with multiple cases of clinical mastitis only once.
[iii] You may wish to lower this cut-point as udder health improves and average herd SCC drops. A goal would be to use SCC > 600,000 (linear score 5.5).
[iv] Do not include does that were sold for dairy, i.e. into another herd to be milked, but only those does sent to slaughter.

SECTION VII
MONITORING AND GOAL SETTING

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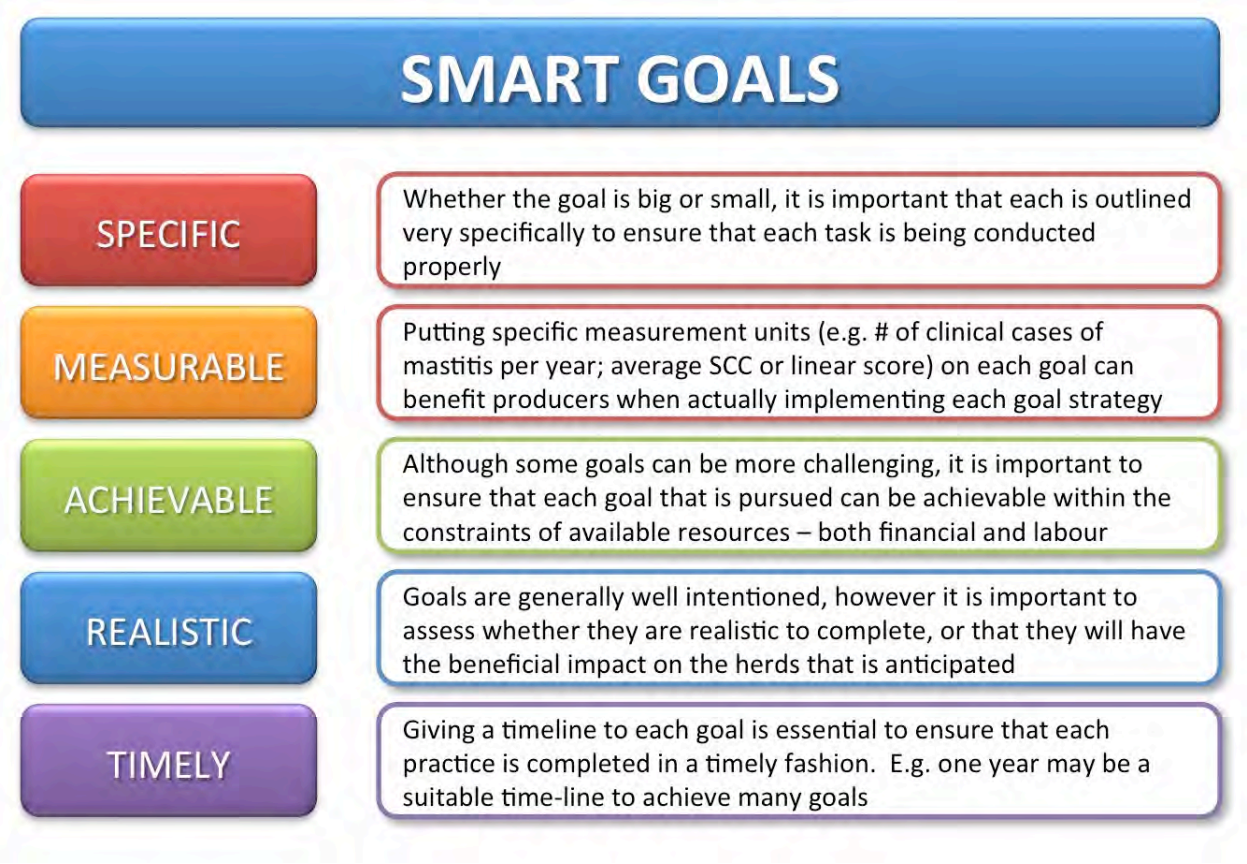
1. SMART - FARM SPECIFIC AND ACHIEVABLE

When developing goals on-farm, it is important to take step-by-step approaches and plan carefully to ensure that each goal will be done correctly, and that these methods will be implemented into routine management practices. Whether the goal is big or small, producers can benefit from using the "SMART" system when dealing with specific practices on-farm. The SMART system is outlined below:



1.1 EXAMPLE OF A GOAL OUTLINE USING THE SMART SYSTEM

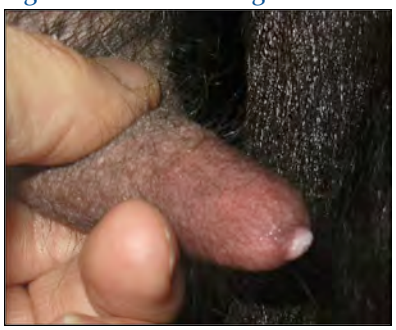
The following example could be a common goal for producers to help improve udder heath in their herds. Teat end damage is a known risk factor for clinical and sub-clinical mastitis. Over-milking is one of the most important causes of teat-end damage.

Goal: ***To reduce over-milking of does and prevalence of teat-end damage***

Specific Remove the milking units from the doe when milk flow ceases.

Measurable Fewer than 10% of units are on for longer than 20 sec when milk flow ceases. Prevalence of teat end damage as evidenced by scabbing, scarring

Fig. 1. Teat end damage



and raised rings around the teat end is less than 1 in 20 (5%) of teats.

Achievable Requires operating fewer milking units per milker (an investment in labour), or the implementation of automatic take-offs (a financial investment).

Realistic This requires knowing the current level of over-milking (measure where currently at – have an assistant use a stop-watch and record level of over-milking) and level of teat end damage from over-milking (again measure where currently at- at the end of one milking, have an assistant score the teat end lesions).

Timely Changes to proportion of goats being over-milked can be done quite quickly with increased attention to unit removal and/or employing more labour in the parlour. Purchasing automatic take-offs may be delayed until sufficient funds can be found. Set a time-line for their purchase and installation. Regular monitoring of prevalence and severity of teat end lesions can be done once/month to track trends.

2. FREQUENCY OF MONITORING

2.1 DETECTION OF INFLAMMATION (SCC AND CMT)

As mentioned in Section II.5.3, detection of inflammation caused by mastitis pathogens is a useful way of monitoring for mastitis in the herd. Monitoring monthly for herd-level SCC values as part of the general milk-quality monitoring done by processors, usually will give the producer sufficient information on whether important changes have occurred. Stage of lactation of the individual goat and the herd should also be taken into account. If this information is not provided by the processor, private laboratories or enrolment in the Can-West Dairy Herd Improvement program[1] can provide this information at the herd-level and individual animal level. CMT can be done at the same frequency or if clinical changes are noted and will provide immediate information at the individual goat and gland level (Section II.5.3).

2.2 DETECTION OF MASTITIS PATHOGENS

Use of CMT or evidence of abnormal milk by strip cup and gland by inspection will provide animals to culture for presence of mastitis pathogens. Bulk tank monitoring as covered in Section II.6 can be done monthly – although it is not as sensitive (i.e. finding all the infected goats) as individual culture, but is more affordable.

3. GOALS FOR BULK TANK SCC

The assessment of appropriate SCC levels in herds is generally variable, as the range of SCC values can be drastic between herds. On goat herds, bulk tank SCC (BTSCC) and bulk tank total bacterial counts have been highly correlated, with increases or decreases occurring at the same time. Therefore, it is important that along with monitoring infection status in herds, good udder hygiene is an important goal on-farm.

Although it has been shown that SCC values for does can be significantly high, sometimes reaching 1,500,000 cells/mL, does have the capability of maintaining a healthy SCC level of approximately

[1] http://www.canwestdhi.com/

600,000-800,000 cells/mL even in late lactation. Although SCC is goats is variable, this general threshold on-farm is certainly attainable, and something to strive for on-farm to aid in udder health, and overall milk production.

4. IDEAL NUMBER OF CLINICAL CASES

In an ideal world, there would be no cases of clinical mastitis in dairy herds; however, this is not a realistic goal on-farm, as there are many environmental and contagious factors that can affect udder health. As a rule, producers should aim for 5% or less of their herd that have cases of clinical mastitis on an annual basis. In terms of subclinical infections, less than 20-30% is a general goal to strive for, however, as previously mentioned, these infections are difficult to monitor on-farm without the use of monitoring either by CMT or SCC combined with milk culture.

5. FREQUENCY OF INSPECTION OF EQUIPMENT

Maintenance of milking equipment is essential for ensuring that a quality milk product is being distributed for human consumption. Bulk tank temperature should be monitored after each milking to ensure that the tank is reaching its optimal temperature. On a weekly basis, areas of the milking equipment that are prone to residue build-up, such as the receiver jar or milking claws should be checked. This regular monitoring will decrease the chance of excessive amounts of residues, which could affect the bacterial counts in in the bulk tank. In addition, pre-rinse or wash water temperature should be monitored once a week to see if it is reaching the required temperature. On an annual basis, the entire milking system should be evaluated by a milking equipment dealer to see that all components are functioning properly.

6. TRACKING UDDER HEALTH AND SETTING GOALS

A form (Table VII.1) can be used to record cases of mastitis, findings from cultures and response to treatment. It should be kept in the office / records room in a binder. A form (Table VII.2) can be used to track udder health monitoring and record goal setting. It should be posted in the milk house or parlour and consulted often, particularly when SCC reports are received.

Suggested goals are in shaded areas. You may set your own goals and own cut-points of udder health higher than these but as your herd makes progress towards better udder health, consider revising them downwards.

SECTION VIII
DAIRY GOAT HEALTH MANAGEMENT

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Health management includes those activities and procedures that prevent animals from becoming ill, e.g. vaccination, and improve productivity, e.g. reproductive management. This section is not meant to be comprehensive but should contribute to the health of the dairy doe – above and beyond her ability to produce high quality milk. **Health management programs are farm specific and need to be designed and implemented with the herd veterinarian.**

1 MANAGEMENT OF THE DOE DURING THE TRANSITION PERIOD

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

1.1 CLOSTRIDIAL VACCINATION PROGRAM FOR THE HERD

There are many different clostridial organisms. This group of bacteria grow only when there are low levels of oxygen but secrete dangerous toxins which are absorbed by the animal. This group also produces spores which allow the bacteria to survive years or even decades in the environment. Fortunately, a sound vaccination program will control most of the diseases these bacteria cause.

1.1.1 TETANUS

Tetanus, caused by *Clostridium tetani* can affect animals with wounds, kids castrated with rubber rings, dirty tagging equipment, or does with trauma secondary to kidding. 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 goat with tetanus has a stiff gait and cannot open its mouth (lockjaw), eventually suffocating due to paralysis of the breathing muscles (Fig. 1). Very few animals with tetanus survive.

Fig. 1 Nubian doe with tetanus. Notice erect ears and tense facial expression. Courtesy N. East

1.1.2 ENTEROTOXAEMIA

Known more commonly as pulpy kidney when lambs are affected, this disease of adult goats is caused by *Clostridium perfringens* type D. 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 the does are eating a rich diet such as grain or lush pasture, the bacteria will grow and produce toxins that damage blood vessels of the intestine, the brain and the kidneys.

Affected does will acutely develop severe diarrhea, often bloody (dysentery) (Fig. 2), severe dehydration, and will be in great pain. This is a medical emergency requiring immediate treatment or the animal is likely to die. Case fatality rates vary from 10% to 50% or more. Kids may also be affected and are more likely to die suddenly with no signs of diarrhea.

Fig. 2 Doe recovering from enterotoxaemia

1.1.3 GANGRENE

This disease is important if the herd 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 doe. It is rare for a doe with gangrene to survive.

Fig. 3 Gangrenous mastitis

1.1.4 SUGGESTED VACCINATION PROGRAM FOR CLOSTRIDIAL DISEASES

Clostridial vaccination programs should be done for all goats in all herds, as these diseases are very common. In Canada, there are no vaccines licensed for use in goats so all recommendations for vaccination require a veterinary prescription. Clostridial vaccines are often "multivalent", i.e. contain 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 enterotoxaemia. When deciding when to vaccinate kids and adults, first read the label and package insert and follow those directions. Below is an example vaccination program (Table VIII.1), but your veterinarian may adjust this depending on the vaccine used and other management factors.

Table VIII.1. Vaccination program to control clostridial diseases in dairy goats

CLASS OF ANIMALS	TIMING OF ADMINISTRATION OF VACCINE
Unweaned kids	No vaccination should be administered to young kids, as the vaccine will not work if antibodies absorbed from colostrum are still present in the kid.
Kids: 12 weeks old	The initial vaccination of the primary series can be administered at this time.
Kids: 16 weeks old	The booster of the primary series should be given 4 weeks after the initial vaccination.
Market kids	Market kids should not be vaccinated within 21 days of slaughter.
Does	The antibodies produced against *Cl. perfringens* D (enterotoxaemia) are protective for less than 4 months in goats – different than in sheep. For this reason, some veterinarians may recommend vaccination three to four times per year depending on the situation in your herd. Regardless of the frequency, does should be vaccinated as a minimum every 12 months – ideally with that vaccination occurring in late pregnancy. This will assure the production of optimal antibodies in the colostrum which will protect kids receiving that colostrum for the first three months of their life.
Bucks	Booster every 12 months as a minimum. Recommendations may differ if the herd has had reported enterotoxaemia in the buck.

1.1.5 REASONS FOR VACCINE FAILURE

- **Vaccine given too young**, i.e. interference from antibodies in 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 animal 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 no less frequently than every 12 months.
- **Dose given is too small**, i.e. not enough antigen to produce an immune response. Don't give less volume than recommended for sheep.
- **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. See Section VI.3.6 for more information.
- **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 properly refrigerated**. Bacteria may grow in the vaccine, making it ineffective.

1.1.6 PRODUCING QUALITY COLOSTRUM THROUGH PROPER VACCINATION

In most instances, the kid must get its initial immunity from the doe's colostrum –whether from its own dam or from "safe" colostrum provided by other does. The kid requires both an adequate volume (calculated as a percentage of body weight – 5% initially, and 20% in the first 24 h of life). If the quantity is sufficient but the quality is poor, the kid may still not be protected. Make sure that the level of antibodies available for the kids is provided through a proper vaccination program (Table VIII.1). The vaccine is best given 4 to 2 weeks prior to the first expected kidding date, or approximately 120 days (4 months) after the buck is introduced to the herd 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 kids.

1.2 CONTROL OF CASEOUS LYMPHADENITIS (CLA)

1.2.1 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, alpacas and farmed deer. The abscesses break and drain and contaminate the environment (e.g. feeders, pen walls), 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. 4 Abscess due to CLA

Abscesses are most often found in the lymph nodes located just under the skin (Fig. 4). Most do not make the animal ill with the exception of a retropharyngeal abscess, which cuts off the animal's ability to breathe (Fig. 5). 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 animal. If you see abscesses in your goats, have your veterinarian culture the abscess to determine if this is CLA.

Fig. 5 Goat with retropharyngeal abscess in severe respiratory distress

1.2.2 VACCINATION

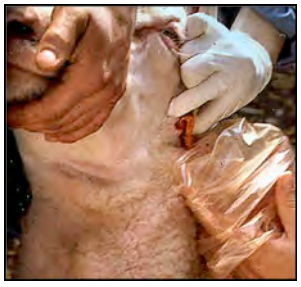
At this time, there is one CLA vaccine licensed in Canada and the USA for use in sheep[1]. It is not recommended for use in goats at this time, as adverse reactions (fever, swelling at the injection site and possible loss of pregnancy) are common. Do not use this vaccine unless by veterinary prescription and never use in pregnant goats. Some veterinarians may recommend the use of an autogenous vaccine (a vaccine made by a licensed company, from bacteria isolated from an abscess cultured from one of your animals). As with commercial vaccines, its use should be closely monitored for adverse reactions.

1.2.3 OTHER CONTROL MEASURES FOR CLA

As part of any control program, it is important to reduce the load of bacteria in the environment. This can be done through the following measures:

- Routinely palpate the external lymph nodes of all, e.g. every 4 to 6 weeks;
- If an abscess is found, isolate the goat in a pen reserved only for goats with CLA abscesses;
- When the abscess is ripe (hair or fibre 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. Gloves are important as the bacteria can infect people causing abscesses;
  - Catch all the pus in a plastic bag for proper disposal (Fig. 6);
  - Scrub the wound and surrounding skin with chlorhexadine or iodine (2 ½% tincture);
  - Keep the goat isolated until the wound in healed;
- Milk all goats with abscesses last and then sanitize the parlour, including head gates and feeders before the next milking;
- Record all treatments so animals which repeatedly get abscesses are culled;
- Spray all wounds or abrasions with iodine or chlorhexadine solution;
- Use feeders designed so that goats do not need to put their heads through slats to reach the feed.

Fig. 6 Lance, clean and disinfect CLA abscesses



[1] Case-Bac (Colorado Serum)

1.3 CONTROL OF ABORTION

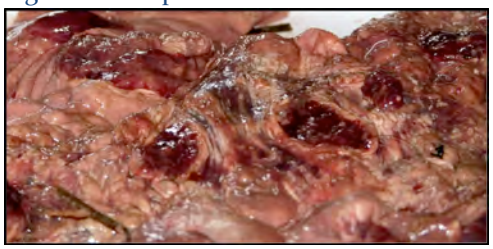
The most common causes are *Chlamydia abortus*; *Toxoplasma gondii* (toxoplasmosis); *Coxiella burnetii* (Q fever); congenital iodine deficiency goiter; and listeriosis. To appropriately control abortion, it is critical to have your veterinarian investigate and institute proper control measures.

1.3.1 FEATURES OF THE COMMON CAUSES OF ABORTION

Healthy goats rarely abort, fewer than 2% per year. But an abortion "storm" of 15 to 30% it is not uncommon in infected herds. When an infectious cause of abortion first enters the herd, initially losses are high. But if the abortion disease is enzootic, most losses are seen in the naive doelings. Abortion rates of 5 to 7 %, although not alarmingly high – indicate there is an abortion problem in the herd.

Fig. 7 Mummified fetus and placenta

Fig. 8 Severe placentitis



Abortions, i.e. premature delivery of kids, usually start about 2 to 3 weeks prior to the first expected date of kidding. Kids born before 142 days of gestation usually can't survive as they are too premature. Aborted foetuses may present in many ways: aborted alive but die soon after; dead – fresh or rotten; macerated; or mummified (Fig. 7). The placenta may appear normal or may be thickened, reddened, or necrotic with purulent discharge (placentitis, Fig. 8). Kids may also reach term – but are either stillborn or weak and alive but die soon after birth. The does may appear healthy or be very sick, depending on the disease agent.

1.3.2 INVESTIGATION OF AN ABORTION PROBLEM

If your herd 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 notice that a doe has aborted, do the following:

1) 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;
2) 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;
    a) 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.
3) Identify and mark the aborted doe;
    a) Move the pregnant healthy does out of that pen – which could be contaminated with the disease agent, and leave the aborted doe there.
    b) She can be culled to slaughter only once the birth fluids have dried up (usually 2 weeks).

c) If the doe 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.

4) 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;
5) Leave your coveralls and boots (and hat and coat) in the barn, wash your hands and arms with disinfectant soap and call your veterinarian;
6) Arrange to take the placentas and foetuses to the veterinary diagnostic lab as soon as you can (the AHL University of Guelph[2] is open in the early evening and weekends);
7) Look up the doe's records with respect to when she was bred and any other history;
8) After kidding is done, that pen will need to be thoroughly cleaned and disinfected and the bedding burned or thoroughly composted for at least 3 months.

Your veterinarian will assess the situation and decide what measures are most appropriate to take, both with that doe and with the herd as a whole. Watch other does 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.

1.3.3 ABORTION DISEASES AND HUMAN HEALTH

Many of the causes of abortion in goats 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 herd:

- Wear protective clothing and disposable shoulder gloves when assisting births;
- Leave all protective clothing in the barn to keep the disease agents out of the house;
- Dedicate a set of protective clothing to kidding so that any disease agents are not spread to healthy animals;
- Frequently wash your hands and arms with disinfectant soap (chlorhexadine; iodine) to prevent accidentally contamination of your mouth, eyes or nose;
- It may be advisable to wear a mask (N95 fitted mask; Fig. 9) when assisting an aborting doe to prevent inhalation of disease agents;
- People who have weak immune systems (e.g. elderly people, or those with chronic illnesses), pregnant women, babies and toddlers should not enter the kidding area;
- The people listed above should also not handle very young or sick kids. 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.

Fig. 9 N95 mask

[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/

1.4 LATE GESTATION AND EARLY LACTATION NUTRITION

Nutrition in the last trimester of pregnancy affects not only the doe's ability to milk well, but also the survivability of her kids and the quality and quantity of the colostrum she makes for those kids. Late gestation requires additional energy and protein. For does carrying singles, this may be provided by good quality forage – but usually some grain and perhaps a protein supplement must be supplied.

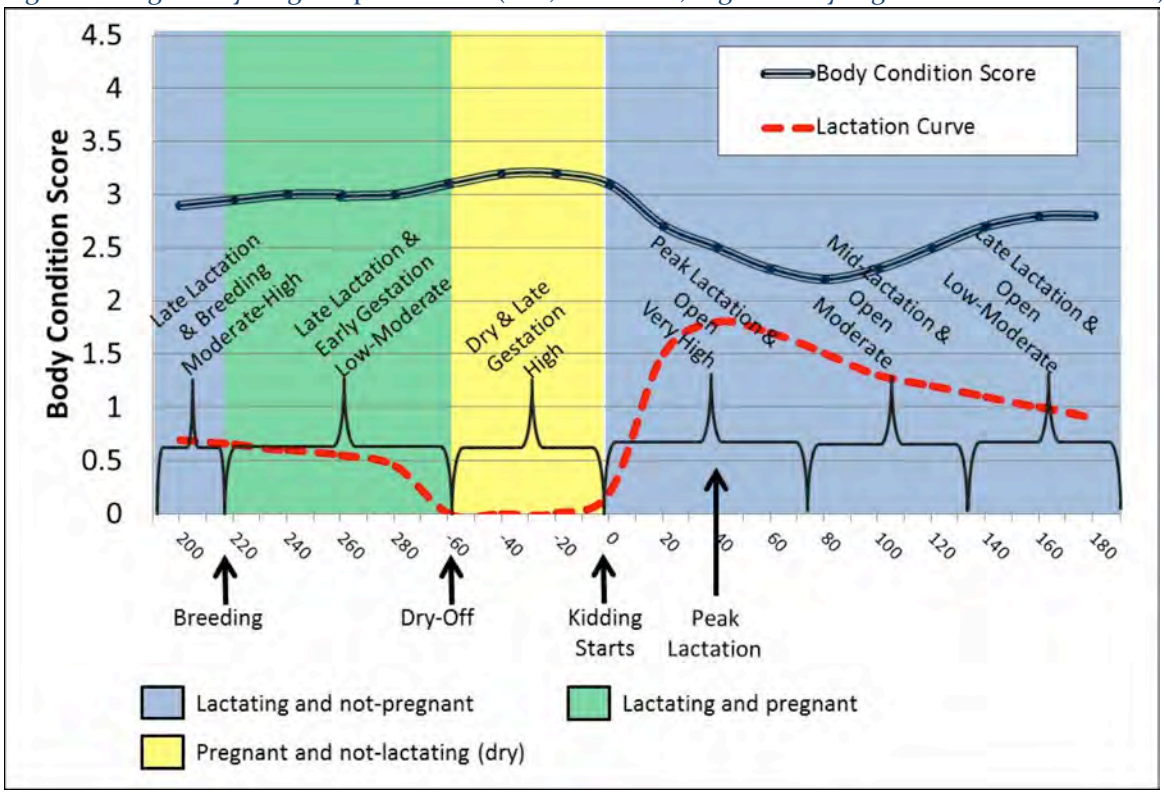
1.4.1 SORTING BY BODY CONDITION SCORE AND NUMBER OF KIDS

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

To properly perform condition scoring, have the doe standing 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 set-up after the doe is dried off (i.e. last third of gestation) to be sorted as follows:

1) Does carrying single kids that are BCS 3.0 to 3.5.
2) Does carrying multiples (twins and triplets) and does carrying singles that are thin (BCS 2.0 to 2.5)
3) If facilities and numbers allow: Does carrying triplets and quads + does carrying twins that are thin.

Fig. 10 BSC goals by stage of production (low, moderate, high or very high nutritional demands)

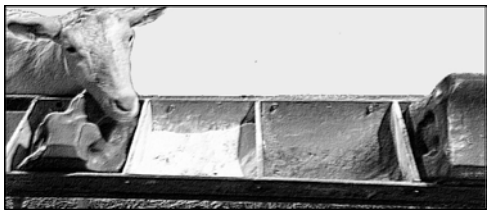


Doelings should be fed differently as they are growing as well as carrying kids. An excellent resource on how to perform body condition scoring in goats is available on-line from Langston University[3]. Body condition scoring goals are described in Fig. 10. There is an expectation that a doe will "milk off her back" in early lactation, but in order to do that without developing nutritional diseases, she must be in good fit prior to kidding and have time to recover an adequate BCS prior to breeding.

1.4.2 MINERAL / VITAMIN SUPPLEMENTATION

Each doe needs to consume an adequate level of the necessary minerals and vitamins on a daily basis. How these are offered and thus consumed is as important as the levels required (Fig. 11). Goats cannot self-select what they need. If you offer a choice of salt and mineral, they will eat what they like and not necessarily what is good for them. Salt is palatable and most minerals are not. For this reason, it is ideal to have a salt-mineral mix available rather than fed separately, as the salt will drive intake of the mineral. Loose is better than a block as it takes less labour for them to get an adequate intake.

Fig. 11 Salt and mineral offered free-choice



Carefully measure what your goats are consuming on a daily basis with the goal of at least ~½ ounce (15 gm) head/day. Keeping the salt / mineral mix fresh and easily available will encourage consumption. Having the salt/mineral "force-fed" by including in a pellet or total mixed ration (TMR) is ideal but not possible in all feeding situations.

Below are some specific and not so specific recommendations. Work with your nutritionist to make sure that your does (and bucks, replacements and kids) are getting the appropriate levels every day of the production cycle.

VITAMIN E AND SELENIUM

Most soils in Canada are deficient in selenium (Se). Vitamin E is plentiful in pasture and newly harvested forages (hay and haylage) as alpha-tocopherol, but declines sharply to zero in stored forages and is always very low in corn silage. Deficiency of selenium and vitamin E not only causes white muscle disease in kids, 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-tasting). These diseases can be prevented by proper supplementation of the doe during pregnancy and lactation, which – if done properly – also removes the need to inject kids at birth.

Work with your nutritionist to make sure the correct amounts are in the doe's ration. Se supplementation to the doe based on 2007 NRC values:

- ~0.2 to 0.5 mg/day to the pregnant doe (higher value for heavier doe);
- ~1.0 to 1.5 mg/day to the early lactating doe (higher value for heavier doe).

[3] http://www2.luresext.edu/goats/research/bcshowto.html

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 doe will generally ingest 0.9 mg of selenium/ day.

Vitamin E requirements also vary with stage of production. For a 60 kg (130 lb) doe the following requirements are suggested by NRC: early gestation - 320 IU/day; late gestation and lactation – 340 IU/day. Heavier animals require higher values. Remember, stored forages have no vitamin E by one month post-harvest and corn silage has none.

CALCIUM AND PHOSPHORUS

Does in late gestation need to be fed adequate calcium for the growing bones of the fetuses. 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 goat. Goats should always have access to a free-choice salt and mineral, 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 does being fed cereal forages (e.g. oat hay) or grazing green cereals (e.g. winter wheat pastures in the fall).

TRACE MINERALS

Does 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 goats:

Fig. 12 Boer kid with goiter

- **Iodine** (I) – to prevent congenital goiter a cause of abortion and stillbirth in kids. Kids are aborted or born very weak and have enlarged thyroid glands (Fig. 12). The Great Lakes region and the Prairie Provinces are deficient in iodine and so this mineral must be supplemented to goats at all ages and times of the year. However, over supplementation can lead to high levels of iodine in the milk which is hazardous to the health of people.
- **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 goats growing poorly - also called ill-thrift.
- **Copper** (Cu) – goats require a similar amount as dairy cattle. Do not feed sheep mineral for this reason as it has inadequate copper levels for goats. However, overfeeding will result in severe disease and death in goats.

OTHER VITAMINS

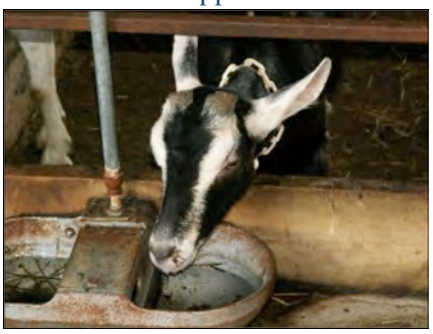
- **Vitamin A** – this is consumed as beta-carotene, which is converted to vitamin A in the intestine. Green forages supply sufficient vitamin A to maintain doe health. Deficiency can result in poor growth and milk production, blindness and sometimes nervous signs. If not present in the green feed, it must be supplemented to the doe 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 D3** –is produced when the skin is exposed to sunlight. Vitamin D3 aids in absorption of calcium from the intestine. If goats 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 kids – as rickets, or in all animals as osteomalacia (soft bones).

1.4.3 WATER

Without water, goats 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 "rule-of-thumb" is that an animal requires 2 to 4 times the amount of water as dry matter intake. This increases in weather > 20°C. For this reason, it is strongly recommended that water be available round the clock free choice (Fig. 13).

It is important to know the weight and level of production, dry matter intake and the environmental temperature when calculating water needs if water supply is limited. For example, a high producing doe in early lactation will consume over 5% of her body weight per day. E.g., an 80 kg doe in early lactation may eat 4.5 kg of feed (DM) and may need 20 to 40 litres of water per day (1 imperial gallon = 4.546 litres; 1 US gallon = 3.785 litres). A less productive and/or smaller animal may require 5 litres/day of water. If the feed is moist (e.g. lush pasture), the goats will drink less than if the feed is dry (e.g. dry hay). If the water is cold, less water (and less feed) will be consumed leading to lower milk production. For this reason, during cold winter months, water should be warmed to encourage consumption.

Fig. 13 Fresh, clean water by tank, water bowl or nipple waterer



Water quality is also critical to assure not only water consumption but safety to the livestock and of the milk produced for humans. Table VIII.2 is a summary of information including the guidelines for Canadian water quality for livestock last updated in 2009. Routine analysis of water quality will help keep your goats healthy and eating.

Table VIII.2. Recommended guidelines for water quality for livestock production[4]

ITEM	MAXIMUM RECOMMENDED LIMIT (MG/L OF WATER)
Total Dissolved Solids (TDS)	Less than 2,500 is recommended for dairy cows and < 5,000 for sheep. Goats are more like sheep although aim for lower levels for dairy animals.
Sodium	1000. < 200 recommended for humans.
Chlorine	1,000 but decreased water consumption at > 250.
Calcium	1,000
Nitrate & nitrite	100 – lower if dietary forages are high in nitrates.
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	0.05
Fluoride	1-2
Magnesium	400
Manganese	5.0 is suggested but little data.
Molybdenum	0.5
Mercury	0.003
Alkalinity (calcium carbonate)	pH between 6.0 and 8.5. 500 or lower if sulphate levels are elevated.
Lipolytic/proteolytic bacteria	≤ 5/100 mL for dairy industry
Coliforms	Recommended: 1 coliform/100 mL water – youngstock < 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 (sheep, no goat values). Usually found in stagnant surface waters.

[4] Olkwoski, A.A. 2009. Livestock Water Quality. A field guide for cattle, horses, poultry and swine. AAFC University of Saskatchewan

1.4.4 FEEDING MANAGEMENT OF THE LATE GESTATION DOE

These does should not be lactating but are dry. Pregnant does require more feeder space than one that has given birth. Because it is critical that all does 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 does are eating. Amounts vary but the ration should be properly balanced for body condition score, number of foetuses and age (doeling versus adult). This is best done by a nutritionist.

1.5 CONTROL OF NUTRITIONAL / METABOLIC DISEASES OF THE TRANSITION DOE

1.5.1 PREGNANCY TOXAEMIA / KETOSIS

These diseases are caused by insufficient energy in the ration causing the doe to be in a negative energy balance. The doe needs to mobilize fat and sometimes muscle to create glucose. The by-product of this are ketone bodies which suppress appetite. Low blood glucose also affects the brain causing irreversible damage – even in moderate cases.

Fig. 14 Early pregnancy toxaemia in a thin doe.

Pregnancy toxaemia occurs in the last 2-4 weeks of pregnancy, and ketosis occurs usually within the first few weeks post-kidding when nutritional demands are highest. For pregnancy toxaemia, does carrying multiple fetuses are more at risk because their nutritional needs are several times higher than a doe carrying a single fetus. Regardless of whether discussing pregnancy toxaemia or post-kidding ketosis, animals with high levels of productivity require higher energy in their diet, usually in the form of grain.

Fig. 15 Doe with severe pregnancy toxaemia.

SIGNS OF PREGNANCY TOXAEMIA / KETOSIS

Affected does stop eating grain or stop fighting for grain but may still eat forage. The rumen is empty and they appear gaunt (Fig. 14). As the sugar levels decline in the blood and brain tissue causing brain damage, the doe shows nervous signs: they press their head into walls (headache from brain swelling); and will hold their head high and appear blind (Fig. 15). Soon they can no longer stand, and are totally off-feed. The low sugar levels cause the kids to die in the uterus – then the doe becomes toxic from the decaying kids, and she dies soon afterwards in 2 to 3 days. Post-kidding ketosis is less severe but does are off-feed and depressed, and may show neurological signs. Even with prompt treatment, production losses are severe.

RISK FACTORS

Risk factors are factors which when combined with **insufficient energy in the diet**, will tip an animal over the edge to develop pregnancy toxaemia / ketosis.

Factors affecting the herd: Bad weather without proper shelter; being held off feed or missing a meal for a procedure (e.g. 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.

Individual animal factors: old age; poor teeth; lameness (e.g. CAE; poorly trimmed feet); thin body condition score (no reserves); over conditioned or fat (pet goat ketosis); any chronic wasting disease such as caseous lymphadenitis or Johne's disease; not able to compete at the feeder for any reason.

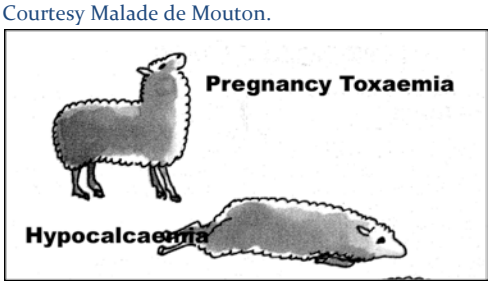
If a late pregnancy doe goes off feed, it is important to call your veterinarian to determine the reason for this. Pregnancy toxaemia can sometimes be successfully treated if caught early but if you wait until the doe shows severe depression and is totally off-feed, death is likely for both her and her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

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 herd for levels of β-hydroxybutyrate (BHB), a ketone body produced when the goat is in a negative energy balance, that is – the doe is not getting enough energy from her feed. Blood BHB levels can detect pregnancy toxaemia in a herd before animals become ill.

1.5.2 HYPOCALCAEMIA (MILK FEVER)

Just like a dairy cow, goats can get "milk fever"– a disease caused by low calcium in the blood (hypocalcaemia). Calcium is necessary for proper muscle contraction. Does with low calcium levels in the blood become excited and stumble and hop around the pen and then become cold, bloated, and down (Fig. 16). 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. 16 Stance of a small ruminant with pregnancy toxaemia or hypocalcaemia. Courtesy Malade de Mouton.



Goats may develop hypocalcaemia prior to kidding – associated with insufficient dietary calcium to meet the demand by the fetuses for mineralization of the bones. Lack of vitamin D3 in the diet (from sunshine) may exacerbate this. Goats may also develop hypocalcaemia after kidding due to the need for calcium in the diet – requirements are about 3 X as high as for late pregnancy.

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 doe's life. Fortunately, unlike pregnancy toxaemia, response to proper treatment (calcium injections given in the vein) is fast and dramatic. However, many other diseases may mimic the signs of hypocalcaemia: ketosis, metritis, toxic mastitis. Giving calcium incorrectly or to animals that don't require calcium can stop the heart and kill the doe – so diagnosis and treatment should be done by a veterinarian.

1.6 MANAGEMENT OF KIDDING TIME

1.6.1 LENGTH OF EXPOSURE TO THE BUCK & LENGTH OF KIDDING PERIOD

Exposure to the buck for breeding must be a planned event. Bucks should be introduced for a specific time period. Does 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 21 days until early winter (e.g. January to early February). At least 75% of does should become pregnant to the first cycle after exposed to the buck and 20% to the second. By having a breeding exposure of 35-40 days, does have at least 2 opportunities to breed and become pregnant. Normally the length of a kidding 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 kidding period is 42 days.

TO KNOW WHEN THE DOES ARE DUE TO GIVE BIRTH:

- Restrict the time the buck is exposed to the does.
- Use a marking harness and recording breedings (marks) (Fig. 17). Change the colour of the crayon every 2 weeks so can visually identify "re-marks".
- Have the does scanned by ultrasound and estimate fetal age if breeding date is unknown (Fig. 18).
- House the late pregnancy does together so appetite and behaviour can be monitored.
- Observe the does at least once / day for udder development starting ~ 1 week before expected kidding date (~ 135 days after the day the buck is first introduced).

Fig. 17 Buck with marking harness

CONSIDERATIONS FOR DOELINGS

It makes sense to breed and manage doelings separately from the adult does as they are still growing as well as being pregnant; and exposure to abortion diseases can be lessened.

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. Doelings 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, e.g. breed at 10 months to kids at 15 months of age.

Fig. 18 Pregnancy diagnosis by ultrasound

1.6.2 ENVIRONMENTAL NEEDS FOR GIVING BIRTH

Close-up does need to be observed frequently so illness can be detected as well as kidding difficulties. Close-up does should be penned or pastured separately from the rest of the herd, and facilities should allow separation of individual does 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 and adverse weather.

Does should be allowed to give birth undisturbed if making good progress. Once kids are born, facilities should allow for easy separation of the doe-kid pairs into claiming pens, unless kids are to be snatched at birth for specific disease control programs.

1.6.3 EQUIPMENT FOR KIDDING

Prior to the start of kidding, make sure you have adequate supplies (Fig. 19). A list of things to have on hand can include:

Fig. 19 Kidding equipment

- Kidding supplies: disinfectant soap; sterile lubricant; disposable shoulder gloves (very important).
- Kidding equipment: lambing snare; soft ropes for legs; clean towels – lots of them.
- Stomach tube for kid; 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 or 0.5% chlorhexidine in alcohol for navels + disposable paper 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).

1.6.4 KIDDING MANAGEMENT

ASSISTING AT KIDDING

It is important to provide proper assistance when needed. Keep 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 bucks were introduced, observe does as frequently as can be managed, i.e. at least every 4 to 6 h.

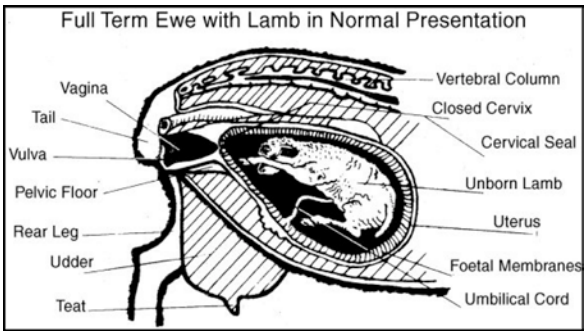
INTERVENING IN A KIDDING

Some guidelines for when to intervene…

- Only part of the kid 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 doe has been straining 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 doe 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. Fig. 20 shows the anatomy of a pregnant ewe – the same as a pregnant doe.

Fig. 20 Courtesy of Ontario Ministry of Agriculture and Food



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 kid 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 kid right side up 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.

KIDDING - TIME EMERGENCIES

A difficult kidding that cannot be easily corrected is a veterinary emergency. If you wait, the placenta will separate from the uterine lining – interrupting the supply of oxygen and the kids will suffocate.

Call your veterinarian immediately if:

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

A caesarean section (C-section) must be done in the following situations: the kid is too large to come through the pelvis of the doe or becomes stuck – this can happen in doelings or when the doe is too fat; a malpresentation cannot be corrected easily (e.g. head back, tangled twins); the cervix doesn't open sufficiently for the kid to be easily delivered (e.g. ringwomb); the uterus is torsed (twisted) inside the doe; the doe has pregnancy toxaemia and is down.

Other obstetrical emergencies include: prolapse of the uterus which most often occurs right after the kids are delivered (the uterine caruncles can be seen; Fig. 21); torn uterus, cervix or uterus; and excessive bleeding.

Fig. 21 Uterine prolapse

RESUSCITATING A NEWBORN KID

Resuscitation of the newly delivered kid 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 kid to draw air into its lungs. Rub it 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 because of the risk to people of abortion diseases. A kid delivered from a prolonged or an assisted birthing is at HIGH RISK of dying from hypothermia / hypoglycaemia (chilling / starvation) and should receive special attention. These kids may also not nurse enough to drink sufficient colostrum and will need to be supplemented by hand, either bottle or tube feeding.

STRAINING AFTER KIDDING

If the doe continues to strain after giving birth, it could be due to a few things. A kid may be trapped in the pelvis – a simple examination will tell. The vagina or cervix may have been damaged and inflamed. Antibiotics and NSAIDS may help but contact your veterinarian.

RETAINED PLACENTA

The placenta is usually passed within a few hours of kidding but is considered to be retained if it has not passed by 24 h. Reasons for this include: a difficult birth; a kid is still inside; abortion. If the doe doesn't "clean" by 24 h, wash her vulva with disinfectant soap, put on a clean glove with lubricant and check for retained kids. If none can be felt, leave the end hanging out and don't trim it although knotting it up or placing it in a plastic bag will keep it from contaminating the udder and making a smelly mess. Monitor the doe for fever and appetite. If the doe 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 MANAGEMENT OF NEWBORN KIDS

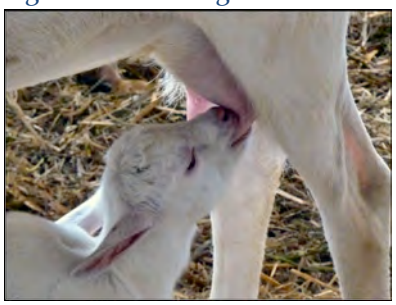
2.1 COLOSTRUM MANAGEMENT

2.1.1 IMPROVING TRANSFER OF ANTIBODIES FROM THE COLOSTRUM TO THE KID

Kids, 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 kid for the first few months of life.

KID NURSING COLOSTRUM FROM DAM

Fig. 22 Kid nursing doe



Normally, the kid will be on its feet in a few minutes, attracted to the curve of the doe's abdomen (Fig. 22). The doe assists this process by licking and nudging the hind end of the kid towards the teat. This stimulates a sucking response. Ideally the kid should be ingesting colostrum within an hour of being born. To assist this behaviour, put the doe and kids in a claiming pen to assist with bonding.

With a weak kid or a nervous doe that won't allow suckling, strip the colostrum and hand-feed the kid. 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 KID NEED?

The kid 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 kid (~ 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 kid is too weak to nurse effectively, it needs to be hand-fed or tube fed.

Make sure that in the first 24 h, the source of colostrum is the *first milking colostrum only*. Colostrum from a doe that gave birth 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 kidded doe, the more dilute and less effective the colostrum will be.

2.1.2 PROBLEMS WITH NURSING THE DAM FOR COLOSTRUM

- If the kid first ingests bacteria from the environment or dirty udder, then the colostrum it ingests won't protect it.
- The ability of a kid to absorb colostrum decreases over time so that waiting even a few hours will impair its ability to absorb antibodies.
- Relying on the kid's ability to nurse adequate amounts may mean that it does not get enough colostrum.
- The dam's colostrum may carry disease agents, e.g. CAE virus, the bacteria which cause Johne's disease (*Mycobacterium paratuberculosis*), or the dam and her environment may carry these infections thus causing infection of the kid at birth (e.g. scrapie).

2.1.3 SAVING GOAT COLOSTRUM

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

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

2.1.4 CAN COW COLOSTRUM BE USED INSTEAD OF GOAT COLOSTRUM?

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

- It must be first milking colostrum only – ideally from a lower producing cow to avoid dilution.
- Use only colostrum from a healthy, older cow without mastitis.
- Diseases that can infect cows can also infect goats and can be transferred in the colostrum, e.g. Johne's disease.
- Donor cows should be properly vaccinated against clostridial diseases.
- Occasionally, but rarely cow colostrum contains antibodies that attack the kids' bone marrow causing them 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 kids, or pool colostrum from several healthy cows to dilute any potential issue.

2.1.5 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 up **to 56 °C to 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 accurate enough. Stove top can work but requires constant attention. Never use a microwave, as heating is too uneven.

2.1.6 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 kids – follow the directions! Any substitute without antibodies may keep the kid alive temporarily, but they generally die of disease within a week or two.

2.1.7 REFRIGERATING COLOSTRUM

No matter how clean you are when milking the doe, 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 >48 h, the colostrum should be heat treated first as described above. You will have healthier kids as a result.

Fig. 23 Heat treated, labelled and frozen goat colostrum

2.1.8 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 other clean container (Fig. 23). 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.

2.2 PROCESSING NEWBORN KIDS

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

1. Dip the navel (umbilical cord) in a 2.5% tincture of iodine or 0.5% chlorhexidine 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 the belly is included. A non-return teat dipper can be used (label for navels only) or a disposable paper cup (Dixie cup). Use fresh dip on each kid. This will help to prevent navel ill and joint ill.
2. Identify the kid by ear tag or paint branding and record.
3. Weigh the kid and record. Record any particulars with regards to difficulty of birth, health of doe, status of litter-mates.
4. If the doe has not been properly supplemented with selenium and vitamin E in the feed during pregnancy, or if using colostrum from a source where you don't know the feeding management, the kid 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 (sciatic 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 selenium / mL product)! There have been several cases of over-dosing newborn kids at birth with selenium and vitamin E causing death.
5. After 24 h when the kid has consumed adequate colostrum and only if it is strong and healthy: disbud; 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 OMAFRA Factsheet Nutrition of the Young Goat - Birth to Breeding at http://www.omafra.gov.on.ca/english/livestock/goat/facts/goatnutrition.htm and Care of the Newborn Lamb available at: http://www.omafra.gov.on.ca/english/livestock/sheep/facts/98-087.htm

2.3 PREVENTION AND TREATMENT OF HYPOTHERMIA/HYPOGLYCAEMIA

If kids fail to get enough nutrition in the first few weeks of life – particularly in a cold environment -, they are at high risk of dying of hypothermia (chilling) and hypoglycaemia (starvation). This information is available from the OMAFRA factsheet Hypothermia in Newborn Lambs available at http://www.omafra.gov.on.ca/english/livestock/sheep/facts/98-089.htm . The techniques used for lambs will work very well for goat kids. Talk to your veterinarian before kidding season begins. Discuss and review any techniques used to revive chilled kids.

2.4 KID REARING

The practice of allowing kids to nurse does while on the milking line has many disadvantages:

For the kid:

- Exposure to the bacteria shed in manure and milk which causes Johne's disease in goats. This infection is common in dairy goats and robs profits as well as being suspected as a possible cause of Crohne's disease in people.
- Exposure to CAE virus from the milk and respiratory secretions of the infected does.
- Increased difficulty of controlling environmental cleanliness including diseases such as coccidiosis.

For the doe:

- Lost milk sales. This is potentially very expensive.
- Transmission of mastitis causing bacteria through nursing kids.
- Risk from contagious ecthyma lesions on the teats (orf, soremouth).
- Risk of biting wounds on the teats.

2.4.1 REMOVE THE KID AT BIRTH

For dairy systems, it is strongly recommended to remove the kid immediately at birth and do not allow the doe even to clean the kid off. This is called "**snatch and rear**" method. Colostrum is hand-fed as previous described to assure adequate intakes of "safe" colostrum.

Fig. 24 Disposable kid box for newborn kids

Hand-feed a milk replacer product formulated for goat kids (not lambs as it is too rich), 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 kids after birth, do not use later as this will encourage piling and may lead to pneumonia.

Cardboard boxes that can be burned when dirty (Fig. 24) or rubber tubs that are washed and sanitized between uses (Fig. 25), work well for the newborn kids until they are strong enough to compete for milk. It is critical that these containers be kept very clean to prevent transmission of diarrhea causing agents.

Fig. 25 Washable tub for newborn kids

2.4.2 ARTIFICIAL REARING

If strong at 3 days, move to a kid bar but continue to pay close attention to the kids' feeding behaviour. The care you take now to make sure the kid gets up and suckles will pay back in improved survival and growth.

The method of delivering milk replacer is varied, from individual bottles, to kid bars, to use of automated milk dispensing systems. The important aspects of any delivery system to avoid digestive upsets are: 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 a sanitizing 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^{o}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.

Kid illness and mortality due to a variety of diseases is a major problem in the first 4 to 8 weeks of age. Diarrheal diseases are usually due to poor colostrum management, poor nutrition, hygiene of the feeding system and allowing build-up of pathogenic viruses and bacteria in the environment. Pneumonia is usually due to over-crowding, poor colostrum management, inadequate ventilation (drafts, temperature fluctuations, too high humidity, ammonia build-up from urine and manure). Coccidiosis is usually due to a build-up in the environment and feeders which allow fecal contamination either directly (defecation in the feeder) or indirectly (dirty feet in the feeder). Have your veterinarian visit to help problem solve rather than "living" with the problem. Kid mortality rates should be less that 5% pre-weaning.

2.5 MOVING THE DOE TO MILKING STRING – CONSIDERATIONS

When first introduced to the milking parlour, the newly kidded doeling may be nervous and not let milk down properly. Make sure that it is allowed to enter by following an experienced animal, and that noises are kept to a minimum. For does that may have been dry-treated for mastitis, assure that the milk is free of residues of veterinary drugs including antibiotics. Goats may require longer milk-withdrawal periods than cattle. Consult the herd veterinarian if any questions. See Section VI for more information.

3 ENVIRONMENTAL MANAGEMENT OF THE DOE

Below is a summary of recommendations for environmental management of the dairy doe (Table VIII.3) and are adapted for those developed for dairy sheep.

Table VIII.3. Environmental factors affecting udder health and recommendations for dairy does

ENVIRONMENTAL FACTOR	RECOMMENDATION FOR DAIRY DOES
Stocking Density	2 m^2 per doe 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 doe as a minimum. (1 m^3 = ~ 1.3 cubic yards)
Ventilation – Summer	70 m^3/ h / doe is moderate.
Ventilation – Winter	47 m^3/ h / doe.
Flooring	Slatted flooring requires stocking densities of < 1 m^2 / doe 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.
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.

3.1 HOUSING VERSUS PASTURE FOR LACTATING DOES

Grazing does on pasture has many benefits with respect to controlling the environmental risks for mastitis – as long as the does have shelter from inclement weather, extreme heat and sunshine. However, the nutritional needs of the heavily lactating doe must be considered. Additionally, gastrointestinal nematode parasites (GIN) such as *Haemonchus contortus* (barberpole worm) are common on goat farms in Canada and can kill adult goats as well as kids. There are no dewormers approved for use in lactating dairy goats. Extra-label drug use may require a milk withdrawal of greater than one week even for those products approved for dairy cattle. More information on control of GIN in sheep and goats is available on-line[5].

3.2 BEDDING AND FLOORING

Different types of bedding have not been well evaluated in dairy goats 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 doe can rest comfortably and warm. Slatted flooring systems allow for many advantages for labour savings, but are cold and does should be provided with a platform – bedded and dry – to rest on, if that system is used.

4 FEEDING MANAGEMENT OF THE DAIRY DOE

The nutritional needs of the dairy goat cannot be extrapolated from those published for dairy cattle. Proper formulation of rations is beyond the scope of this course. An excellent 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.

4.1 FEEDING THE LACTATING DOE

4.1.1 FIRST 2 MONTHS OF LACTATION

This encompasses the period just after kidding when the doe's digestive system is adjusting to feed changes and she has been under tremendous stress from kidding 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 5% in early lactation. The doe must mobilize body fat to meet her lactation output and so must kid 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 doe requires highly digestible feedstuffs balanced for energy, protein and fibre to maintain rumen health. Does on pasture must be supplemented if high milk production is expected.

4.1.2 SUB-ACUTE RUMINAL ACIDOSIS (SARA)

Also called "simple indigestion", this is a term for when the pH of the rumen temporarily drops into the acid range because of too much grain or other soluble carbohydrate is eaten. The types of bacteria in the rumen change and start to produce acid. The doe will go off feed, often only for a few hours until things balance again. But the result is lower milk production and sometimes off-tasting milk. This is not as severe as grain overload when the goat won't recover without treatment – but is probably

[5] http://www.uoguelph.ca/~pmenzies/Handbook_Home.html

more of a risk in most dairies where the feeding program allows for development of SARA. Types of feeding programs that cause SARA are: eating grain in the parlour where intakes are short and uncontrolled; feeding grain or pellet only twice daily; fibre particles are too short in the diet; sorting in a total mixed ration (TMR); too finely ground carbohydrate so highly soluble in the rumen. Many producers offer free-choice sodium bicarbonate to their does although it is probably better to include in the total diet at < 1% of dry matter content. Although when no roughage is fed to does, this may prove useful in preventing suppression of milk fat production. Chewing forages such as alfalfa is as effective or more effective as it stimulates normal buffering of the rumen through the action of saliva.

4.1.3 LATER LACTATION

From mid to late lactation, the doe's dry matter intake is high 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-kidding) and should enter dry-off having recovered to BCS of 3.0 or 3.5. A condition thinner (e.g. 2.5) or fatter (e.g. 4) than this predisposes to pregnancy toxaemia. Again, high quality forage must be offered and usually some concentrate in order to allow does to have a persistent lactation. However concentrate will not substitute for poor quality pasture or hay.

4.1.4 TOTAL MIXED RATION

Total mixed rations (TMR) can be an excellent way to deliver nutrients to dairy goats 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 goats are excellent at sorting feed. Particle size should be smaller than that chopped for a cow TMR so that they 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 or SARA and cause off-flavours in milk.

Pelleted feeds are a way to incorporate most of the nutrients needed. However, effective fibre consumption is critical to prevent SARA. Most pellets offer little fibre so the goat must also consume hay or straw to encourage rumen health, cud chewing and saliva production which helps to buffer the rumen.

4.1.5 PARLOUR FEEDING GRAIN

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

- Total amounts eaten cannot be controlled as does with big appetites may eat leftovers from does that are less aggressive eaters;
- A sudden "dump" of carbohydrates in the rumen can cause SARA and the doe may go off-feed for half a day or more;
- The amount of grain that needs to be consumed by the high producing doe 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 for optimal rumen health;
- Grains should be fed after the does 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 doe.

4.1.5 MINERAL AND VITAMIN FEEDING

Mineral and vitamin deficiencies and toxicities have been covered previously in Section VIII.1.4.2. 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 doe 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.

4.2 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 (see Table VIII.3 for recommendations).

4.3 FEEDING, HOUSING AND BACTERIA IN THE MILK

4.3.1 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 greater than 5. But it also can cause subclinical mastitis in goats or be shed without any signs 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.

4.3.2 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 doe. If the udder and teats are not properly prepped and sanitized, these spores contaminate the milk. The spores are not destroyed by pasteurization and 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.

4.4 FEEDING THE DRY DOE

Although extended lactations are common in dairy goats, regardless of the length of lactation – the doe needs a period when she is not lactating to allow the udder to rest prior to kidding again. Research shows that without a dry period, the amount of milk produced is less. Additionally there is

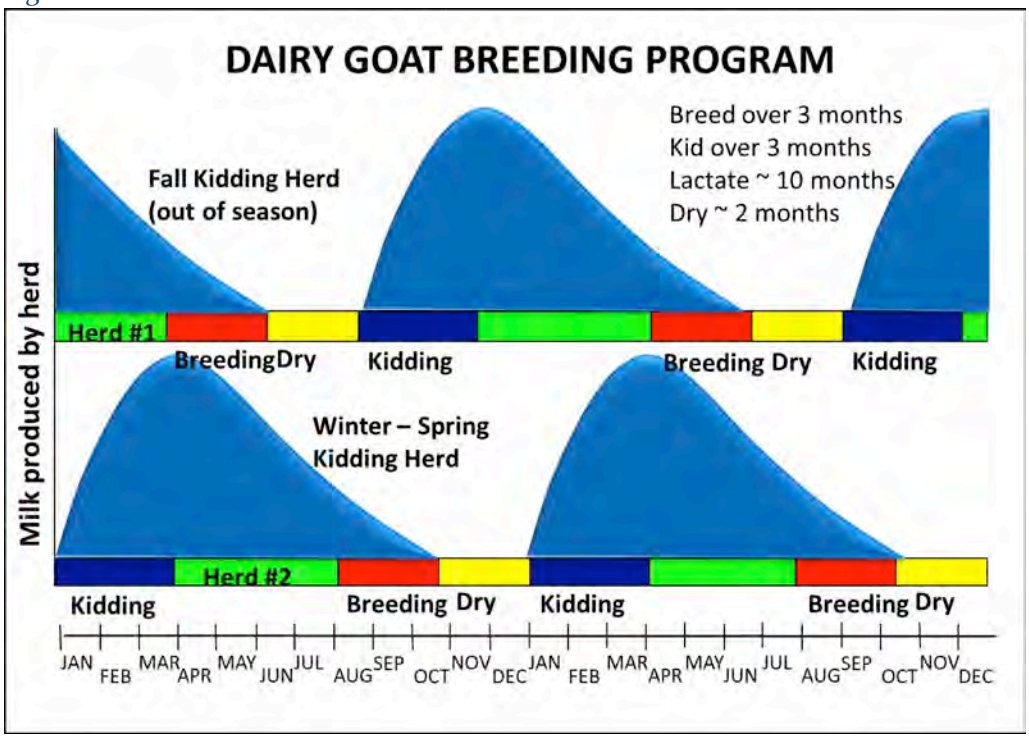
no opportunity to get condition back on thin does or to treat intramammary infections during the dry period. The dry doe still in the first two trimesters of pregnancy (120 d) requires good quality forage + salt and mineral but does not require grain. Exercise is important as well. In the last trimester, she may require additional energy to prevent pregnancy toxaemia and ketosis (see Section VIII.1.5.1).

5 REPRODUCTIVE MANAGEMENT OF THE DAIRY DOE

5.1 KIDDING FREQUENCY, LACTATION LENGTH AND KIDDING SEASON

Generally, because lactation lengths average 305 days (10 months) and the length of the dry period is not less than 2 months – dairy does do not kid more than once/year. However, processing plants often demand milk for cheese making year round so there is a need to have does kidding at different times of the year. Proper management of the reproductive cycle is very important. An example of how to combine out-of-season breeding and kidding with in-season breeding and kidding – to assure year-round milk supply is given in Fig. 26. It requires managing the dairy herd as two separate herds with respect to breeding, kidding and dry does.

Fig. 26



5.2 BUCK MANAGEMENT

Here are some points to implement to improve buck performance.

- Approximately 6 weeks prior to breeding, have the bucks 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 bucks to does is low – and one infertile buck can lower pregnancy rates precipitously.

- If you breed year round, then have the bucks checked annually – ideally in the early autumn when they should be at their most fertile.
- Prior to breeding, bucks should be in a body condition score of 4 out of 5. Bucks will lose weight during breeding and if not in top fit, may not perform well.
- When not being used for breeding, bucks should be kept well away from the breeding herd, 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 so does can be fed properly to accommodate proper fetal development and avoid pregnancy toxaemia.
- Plan purchases of bucks well ahead of when they are needed. Make sure they come from herds with good health status. Many important diseases can be carried by an apparently healthy buck. Avoiding sharing or purchasing a "used" buck. Not only can it introduce some abortion diseases (e.g. chlamydia) but also foot rot, Johne's disease, CAE – the list is long!

5.2.1 GROUP-MATING

Many times it is sufficient to have the buck join a group of does for breeding. This can be done when the health status of the buck is the same as the doe group (e.g. CAE). If the sire of the kids is to be known, then only one buck should be used in one group of does. Otherwise, groups can be larger.

Avoid mixing pregnant and open does as this may make it more difficult for the buck to find the open does to breed. Use marker harness as previously described. Each buck should have a different colour to determine activity of the individual bucks and whether the does are cycling.

5.2.2 BUCK TO DOE RATIO

Making sure that there is sufficient buck power when implementing any breeding program, is critical for optimizing fertility and prolificacy. Below (Table VIII.4) are suggested ratios to use under different circumstances. All numbers assume that all bucks are fertile.

Table VIII.4. Suggested buck to doe ratios for various breeding situations

BREEDING SITUATION	BUCK:DOE 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 male 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

5.2.3 SINGLE-MATING

It is possible to heat detect a doe and then single mate her with a buck either in a small pen or hand-mating. Heat detection can be done by using a teaser buck or doe, or buck rag or bring the buck alongside the pen to see who is attracted. Does in heat will flag their tails, be restless and vocalize and – of course – be attracted to the smell of a buck. The advantage of single mating is that the sire and date of breeding are known with certainty. The disadvantage is that it is labour intensive.

5.2.4 ARTIFICIAL INSEMINATION

This method of breeding has many advantages. It is easier to access superior genetic bucks and achieve faster genetic improvement in the dairy herd and it is easier to keep the herd biosecure and not introduce production-limiting diseases such as CAE, Johne's disease and abortion diseases. Goats are relatively easy to inseminate but proper training and experience will improve pregnancy rates.

Fig. 27 Artificial insemination

5.3 DOE MANAGEMENT

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

5.3.1 CULLING DOES NOT SUITABLE FOR BREEDING

It is expected that approximately 20 to 25% of does will be culled annually. Research suggests that for economic purposes, the optimal age for a doe to voluntarily leave the herd is 4.8 years. Does are culled either because they are unable to produce milk for another lactation (involuntary culling – e.g. due to mastitis or reproductive failure) or because they are the lowest producers and better animals can replace them (voluntary culling). Culling decisions should be made before rebreeding a doe. Through good health management practices, most culls should be voluntary rather than involuntary. Reasons to select does 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;
    - Chronic mastitis despite treatment.
- Test positive for CAE infection or Johne's disease;
- 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; low total solids.

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

5.3.2 PREPARING THE DOE FOR BREEDING

The doe will still be lactating when asked to breed again. It is important that she be in a body condition score of 3.0 to 3.5 (Fig. 10) but not overly conditioned. 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 buck exposure and continued through the breeding to 3 weeks after the buck is removed.

5.3.3 PREPARING THE DOELING FOR BREEDING

Doelings 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 doe in your herd is 75 kg (165 lbs.), then the doeling can be bred when it reaches ~ 50 kg (110 lbs.). Usually this is at 7 months of age, with the expectation that they will kid at 12 months of age.

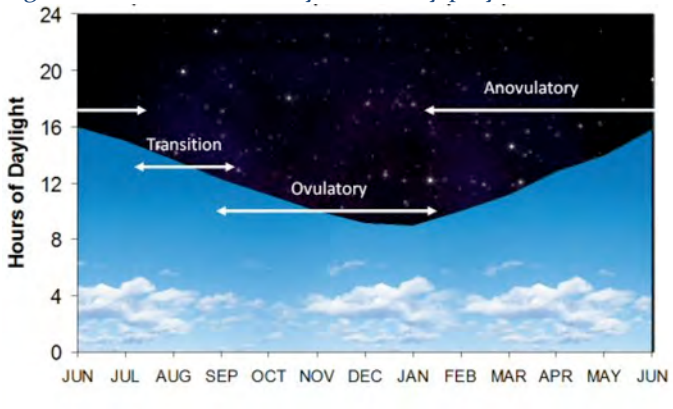
Doelings that are fed to reach this weight too quickly, i.e. fed as if a market animal, will put on fat. This is very detrimental for two reasons:

- Fat doelings will produce less milk as adults as the fat will replace udder tissue.
- Fat doelings are less fertile.

5.4 NORMAL REPRODUCTIVE CHARACTERISTICS OF THE DOE

5.4.1 SEASONALITY OF BREEDING

Fig. 28 Goats are short-day seasonally polyestrous

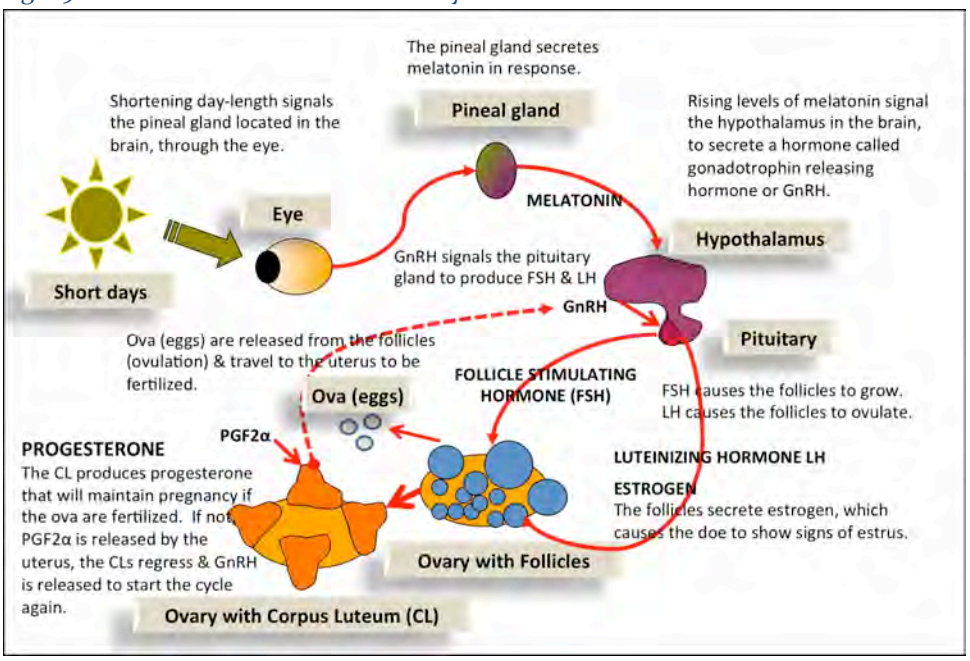


Does cycle in response to shortening daylight that starts after June 21st (summer solstice) and usually start fertile heats in September or October depending on breed and age. They will come into estrus (heat) every 21 days until early winter. This period is called the ovulatory season (Fig. 28). Does are less likely to 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 called the transition season. The does are not yet cycling but their hormone levels are starting to rise. Doelings tend to have shorter ovulatory seasons.

The first cycle of the ovulatory season is silent. Does will cycle but are not receptive to the buck. The next cycle is fertile and of normal length and fertility. Does are in heat for about 30 h and are most fertile about 24-48 h after estrus starts. During a normal breeding exposure, all does should be bred at the first heat and about 75% or more should conceive to that breeding. Over three cycles, over 95% should conceive.

As illustrated in Fig. 29, the trigger for does 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

Fig. 29 Hormonal events in the estrus cycle of the doe



starts the brain into producing hormones. During the ovulatory season, this hormone cascade will continue every 21 days until the doe 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.

5.4.2 SYNCHRONIZATION / INDUCTION OF ESTRUS

Synchronization of estrus in the ovulatory season when does are normally cycling can optimize your planning for milk production. It may be that you wish to have groups give birth over the normal kidding season in order to spread out milk production, or to have your entire herd give birth within a very short time, to optimize labour and limit the number of months you need to milk the does. Induction of estrus out of season will allow milk production year round. Work with your veterinarian to develop these programs when using hormones, particularly to preserve the safety of milk (see Section VI).

5.5 METHODS OF SYNCHRONIZATION / INDUCING ESTRUS

5.5.1 PROSTAGLANDIN (PGF2α)

This drug is only effective during the normal autumn breeding season. It will induce estrus by causing the corpus luteum (CL) to regress, dropping the level of progesterone – which then brings the doe into estrus about 48-72 h later. Normally the CL will last about 17 days before it starts to regress.

Approximately 60 to 70% of does are responsive at any time (i.e. have a CL on the ovary) to an injection of PgF2α. If one injection is given, those does 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 were too early in the cycle and will be in heat in about 12 to 14 days. If two injections of PgF2α are given 10-14 days apart, all does will be synchronized after the second injection.

No prostaglandin products are approved for use in goats 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 Canada; 5 mg/mL); dose for goats - 10 mg i.m.

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

5.5.2 CIDR®

Fig. 30 Sheep 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 doe (Fig. 30). It is not it licensed in this country for use in goats nor 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. The silicone device is inserted into the vagina of an open doe and left there for several days.

USE OF A CIDR® DURING THE OVULATORY SEASON

A recommended program for use of CIDR®'s during the ovulatory season would be to insert them for 11 to 14 days, withdraw the CIDR® and join with the buck no later than 24 h after pulling the CIDR®. If left in for a shorter time, e.g. 5-7 days – an injection of PgF2α on the day of withdrawal will be required to induce estrus. If the does are being milked at this time, seek advice from your veterinarian on a proper milk withholding period.

It is important to not have the buck in the pen with the does while the CIDR® is inserted, as this will lower fertility. Put the buck to the does 18 to 24 h after pulling the CIDR®. Make sure there is an adequate number of bucks per doe in the group (Table VIII.4) and that breeding is occurring. A marker harness can be used to detect mounting behaviour.

USE OF A CIDR® DURING THE ANOVULATORY OR TRANSITION SEASON

The following recommendation must be approved by your herd 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 injection. Neither product is licensed for use in goats. 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® (Merck Animal Health; 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 out of season. See Table VIII.4 for buck – doe ratios.

If there is concern that some of the does 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.

5.5.3 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 goats. MGA, which is biologically active synthetic progesterone, should never be used in lactating dairy does as it is passed in the milk. When consumed by a woman, it can affect her reproductive cycle. However, it is effective in synchronizing / inducing estrus in non-lactating doelings. **It must be used ONLY under the guidance of a licensed veterinarian with whom you have a valid veterinary-client-patient relationship**.

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 11 to 14 days in season and not less than 7 days out of season. The buck is introduced 24 h after the MGA is withdrawn. 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. Buck 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 doelings don't have equal opportunity to consume it.

5.5.4 PHOTOPERIOD (LIGHTS)

Because cycling is normally stimulated by the shortening day-length, it makes sense to attempt to convince does 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 does 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 (Fig. 31). This stimulates production of melatonin by the pineal gland. The melatonin acts on the hypothalamus as is depicted in Fig. 29.

The program usually starts in late December or early January to get does to cycle in April to May so it is ideal for dairy does 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 Canada. 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. Does 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.

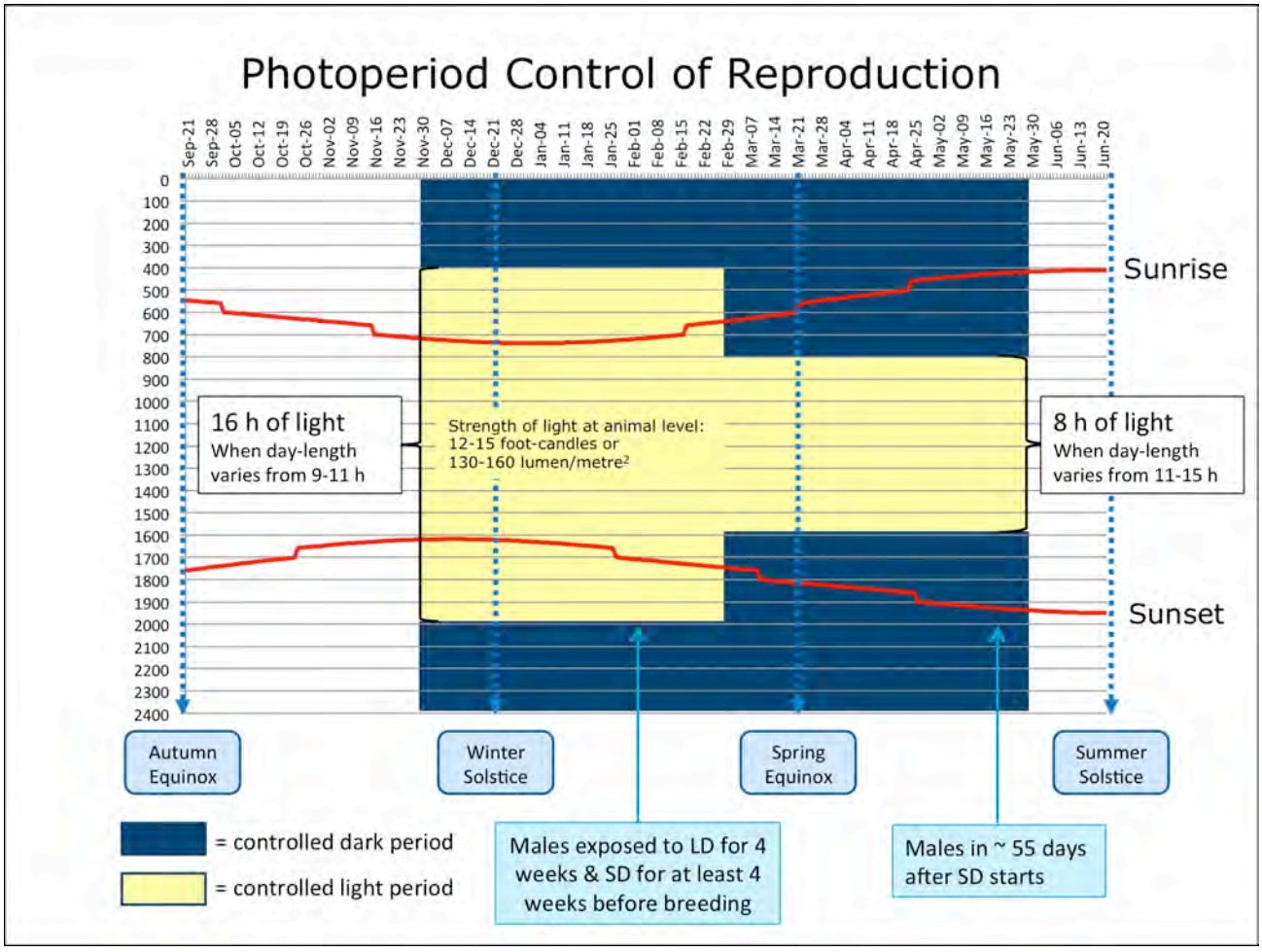
Bucks also need light treatment to improve their fertility. Two months prior to when they are needed, the bucks need to be exposed to the Long-Day regime for one month, followed by the *Short-Day* regime for one month. This increases semen quantity.

5.5.5 MALE EFFECT

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

The bucks used to stimulate the does, must be new to the does, i.e. the does cannot have seen, smelt or heard the bucks for 30 days prior to being used. The bucks only need to be exposed to the does for 24 h to work.

Fig. 31



TEASERS

Teaser bucks, usually vasectomised and so infertile while still keeping their libido, or androgenized does – will induce the does to come into heat. If using teaser bucks, select mature, experienced, healthy males. They will know how to "work" the does. Don't use bucklings or animals with temperament or health problems. Ask your veterinarian about performing a teaser surgery – it should

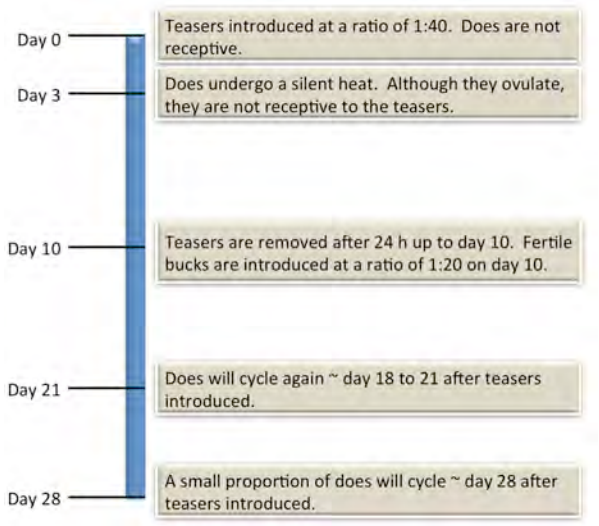
be done at least 60 days prior to needing the teaser. If you wish to androgenize a doe, this requires the use of a testosterone injection and can only be done by a licensed veterinarian as it is a controlled substance. Select a doe that is healthy and not too big.

BUCK MANAGEMENT

If teasers are not used, you will need good gates and fences. Fertile bucks novel to the does should be placed in an adjacent pen or pasture.

Regardless of how the does are teased, make sure that the bucks you wish to use for breeding are put with the does no later than 10 days after the start of teasing. Does will synchronize into two groups with most in the early breeding group, and a smaller group in the later breeding group (Fig. 32).

Fig. 32 Use of buck effect



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

6 CONTROL OF PARASITES

6.1 GASTROINTESTINAL PARASITES

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 goats and to prevent the formation of parasite resistance to anthelmintics (dewormers) (Fig. 34). Adult goats don't develop immunity to parasites well and often have problems with GIN including *Haemonchus contortus*, a blood-sucking parasite that resides in the abomasum of the sheep and goats. 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 goats in Canada and so nothing for lactating dairy goats 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. Some anthelmintics can be detected in the milk for weeks or months after treatment, including those licensed for lactating dairy cows.

Fig. 34

6.2 COCCIDIOSIS

Coccidiosis is a disease of kids and not adult goats. 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 goats. Any coccidiostat that is used in goats MUST be accompanied by a veterinary script written and signed by the herd veterinarian.

6.3 EXTERNAL PARASITES

There are many external parasites which affect goats. Below are the most common and damaging. To control, it is important that you get the correct diagnosis.

6.3.1 CHEWING / BITING LICE

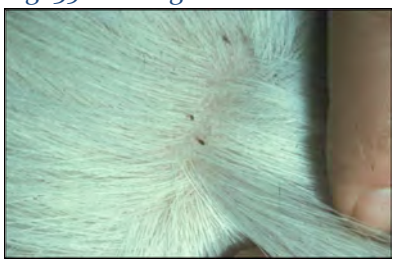
There are three types of biting lice that are mostly found in the head and neck region but can crawl quickly over the animals (Fig. 33). They chew on the hair but the excrement of the lice causes itchiness. The goats rub and break off the hair. They may be seen biting at themselves as well. Treatment 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

Fig. 33 Biting lice – Angora goat
Dr. Whalen, U of Guelph

dairy goats. Consult your veterinarian for advice on their control.

6.3.2 SUCKING LICE

Fig. 35 Sucking lice



Sucking lice are common in dairy goats and in severe infestations, can cause anaemia and weakness (Fig. 35). They are found mainly on the face but can be anywhere. The louse is very small with a narrow head 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.

6.3.3 CHORIOPTIC MANGE

Fig. 36 Chorioptic mange
Dr. Peregrine, U of Guelph

Chorioptic mange caused by *Chorioptes bovis* – goat 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 does, and the scrotum of the buck. The lesions are red, scabby, irritating and itchy. Lesions on the buck's scrotum can cause low fertility because the inflammation heats up the testicles. Often, even after successful treatment, the doe will be itchy for weeks because of the allergens contained in the dead mites and their excrement. The eggs of the mite can contaminate the bedding so proper control involves bedding removal. Again, consult your veterinarian on how best to treat them in lactating dairy does.

7 DISEASES WHICH CAUSE CHRONIC WASTING OF DAIRY GOATS

Chronic wasting syndrome is also known as "thin goat syndrome". There are many infectious and non-infectious diseases that can cause weight loss, other clinical signs, early culling and death in adult dairy goats. Some of these infections are quite common in Canada, and their control is important to the overall health of the herd. The diseases, signs and control are listed in Table VIII.5. Complete discussion of these diseases is beyond the scope of this guide. To know the status of your dairy goat herd, consult your herd veterinarian for appropriate testing programs.

Table VIII.5. Important conditions which cause chronic weight loss in dairy goats in North America

DISEASE	SIGNS	CONTROL
Dental disease Common	Slow eating, not chewing cud, swellings on jaw or face.	There is no treatment. Forages and pastures should be free of weeds, stones and gravel.
Caprine Arthritis Encephalitis Very Common	Decreased milk production, hard udder, lameness (Fig. 37).	It is caused by a slow virus. Once infected, goats will shed the virus for life, infecting their kids and herd-mates. Control is discussed in Section VI.6.
Johne's disease Very Common	Weight loss, sometimes diarrhea. Always fatal (Fig. 37).	Control is difficult but relies on prevention of transmission of the bacteria Myco*bacterium paratuberculosis* to kids. More information is available at http://www.johnes.org/ and http://www.johnesdisease.org/index.html

DISEASE	SIGNS	CONTROL
Scrapie Reportable	Weight loss, nervous signs, over-react to stimuli (Fig. 37). Always fatal.	Has recently been diagnosed in several dairy goat farms in Canada. 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 Very Common	External and internal abscesses, weight loss, sudden death.	Vaccination, isolation of animals with abscesses, culling, shearing biosecurity. Control is discussed in Section VIII.1.2
Foot Disease Very Common	Goat is reluctant to stand. Slow moving. Lame	Routine foot trimming to keep the foot sound (every 8 weeks as needed). Clean and dry environment, no sharp stones or unsound footing.
Competition Common	Weight loss, fighting	When animals of different sizes, classes are housed together and there is insufficient feeder space.

Fig. 37 Does with CAE arthritis (left); advanced Johne's disease (middle); and terminal scrapie (right)

Fig. 40. Foot diseases. Interdigital fibroma (left); under running of the sole - footrot (middle); chorioptic mange of the pastern (right)

8 BIOSECURITY OF THE GOAT HERD

Biosecurity means those measures to prevent disease from entering a herd, spreading within the herd and being released from the herd. Risk to the flock comes from animals – goats, sheep, other livestock, vermin and wildlife; equipment; and people. Recently the Canadian Food Inspection Agency, goat producer groups and veterinarians composed a Biosecurity Standard as well as a guide for goat 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/goat-industry/eng/1367131154680/1367131213133

Fig. 41 Is your herd biosecure?

9 FINDING A VETERINARIAN

Graduate veterinarians have received education on management of mastitis in dairy animals – including cattle, sheep and goats. Within local practices, there is often a veterinarian with a special interest in working with dairy goats. It is recommended to set-up an appointment with your local practice – somebody who can provide you with a valid veterinary-client-patient relationship (Section VI.1.2), and discuss your herd's veterinary needs. There are veterinary organizations which provide continuing education to veterinarians (Small Ruminant Veterinarians of Ontario[6]; American Association of Small Ruminant Practitioners[7]). If not a member, recommend to your veterinarian to join as there is an amazing wealth of information amongst members. If you are still struggling with finding a veterinarian with expertise in dairy goats, contact your province's / state's veterinary licensing body. For example, in Ontario – this is the College of Veterinarians of Ontario. They often have lists available for the public to help them find a veterinarian able to provide service to their area.

[6] Small Ruminant Veterinarians of Ontario http://srvo.ca/. Map of SRVO veterinarians available at http://srvo.ca/members/

[7] American Association of Small Ruminant Practitioners http://aasrp.org/

APPENDIX I
WORD OR PHRASE DEFINITIONS

Some words or phrases used in this course may be unfamiliar to you. The words or phrases are a different colour in the text of the section listed below. We hope these definitions are helpful. The section refers to where the word or phrase is first used.

SECTION I	WORD OR PHRASE	DEFINITION
1.1	**Glandular tissue**	Tissue that contains glands. Glands have specialized cells, which secrete a specific substance, e.g. sweat, saliva. The glandular tissue of the udder secretes milk.
1.1	**Secreted**	This is an active process by a cell, which produces a special liquid containing specific compounds, which are then actively expelled from the cell – usually into a duct or lumen. There are many types of secretory cells in the body – in this case, we are concerned about those cells that secrete milk.
1.2	**Alveoli**	A structure containing cells lining a lumen or space that is connected to a duct is usually termed an alveolus (alveoli is plural). An example is the alveoli in the lungs. We are concerned about the ones in the udder.
1.2	**Casein**	The most common type of protein found in the milk and important in cheese production.
1.2	**Lactose**	The most common type of sugar found in milk.
1.2	**Lipids**	This is another word for fat. There are many types of lipids found in milk.
1.2	**Minerals**	This includes calcium and phosphorus – common in milk, and also trace minerals such as zinc, magnesium, copper, selenium etc.
1.2	**Vitamins**	Includes vitamin A, D, E and some B vitamins.
1.2	**Antibodies**	These are proteins produced by lymphocytes, a type of white blood cell. These proteins, also called immunoglobulins, are important in fighting infection.
1.2	**Lymphatics**	These are a network of tubes, similar to blood vessels that bring white blood cells and lymph (a clear liquid that contains protein) to all areas of the body. Wherever there are blood vessels, there are also lymphatics.
1.2	**Interstitium**	The tissue which carries blood vessels, lymphatics and nerves. In this case the interstitium is between the alveoli.
1.2	**Nerves**	Nerves allow for impulses to go to the brain and back again. Not only does this function allow the animal to feel pain, but also the nerves are critical in allowing for milk letdown.
1.2	**Suspensory ligaments**	Ligaments are structures that hold the body together and do not contain muscles (unlike tendons which hold muscles to the bones). The suspensory ligaments hold the udder suspended from the body wall.
1.2.1	**Apocrine secretion**	Cells which are classified as apocrine bud their secretions off through the plasma membrane producing membrane-bound vesicles in the lumen. The end portion of the secretory cell of the gland pinches off and enters the lumen. It loses part of its cytoplasm in their secretions.
1.2.1	**Lumen**	This is another word for hole. In this case, the hole holds milk.
1.2.1	**Cytoplasmic**	Cytoplasm is the contents of the cell excluding the nucleus, which contains the DNA. There are many components of the cytoplasm.
1.2.1	**Merocrine**	A type of secretion from the cell where the cell membrane opens up temporarily to release the secreted product. The type of secretion found with cow's milk.

SECTION I	WORD OR PHRASE	DEFINITION
1.2.1	Cytokines	These are compounds released by the cell and help it to communicate to other cells. They may be released in response to damage or attack by microorganisms and help to attract white blood cells.
1.3	Mucous membrane	This membrane lines the insides of all tissues that communicate with the outside of the animal, e.g. the inside of your nose and mouth, the inside of your intestines and windpipe (trachea). In this case, also the lining of the teat and gland cistern.
1.3	Sphincter	A muscular, circular structure that can open and close an opening.
1.3	Lymphoid follicle	An area where lymphocytes, a type of white blood cell, are formed. The structure cannot usually be seen with the naked eye, unlike a lymph node, which is a larger structure where lymphocytes are produced.
1.3	Keratin	A fibrous protein material produced by specialized epithelial cells. It contains no live cells. Fingernails, hair, wool and hooves are composed of keratin.
1.4	Ectopic	Means in a location which is not normal.
2.1	Lobules	A group of alveoli connected by ducts with a single duct exiting the lobule.
2.1	Progesterone	A hormone produced either by the corpus luteum on the ovary or by the placenta. This hormone is present in high levels during pregnancy or between heat cycles.
2.1	Estrogen	Also spelled estrogen. A hormone produced by a follicle that forms on the ovary when the ovum (egg) is about to be produced. Animals under the influence of oestrogen often exhibit signs of estrus or heat.
2.1	Corpus luteum	Also called “yellow body”, this is a structure left on the ovary once the ovum (egg) is released from the ovary. The cells in the corpus luteum produce progesterone, the hormone of pregnancy.
2.1	Ovum	Also called an egg, this is the female cell that will merge with a sperm to produce the embryo.
2.1	Ovulation	When the ovum (egg) is released from the follicle on the ovary. The ovum then travels down a duct (oviduct or fallopian tube) to the uterus where it is fertilized.
2.1	Trimester	Pregnancy is most often divided into 3 periods: early, mid and late pregnancy. With pregnancy in goat being approximately 150 days, the first trimester is up to 50 days gestation, the second trimester is 51-100 days of gestation and the third trimester is 101 to 150 days gestation.
2.1	Foetus	Also spelled fetus. When the ovum is first fertilized, it is called an embryo. After the embryo begins to resemble a kid, it is called a foetus until it reaches 142 days of gestation – the time when it is generally accepted that the kid can survive outside the doe.
2.2	Colostrum	The first milk of the doe. It contains high levels of immunoglobulins (antibodies) and extra protein. It is produced by the doe during the last few weeks of pregnancy.
2.2.1	Galactopoietic	Means to stimulate production of milk.
2.2.1	Growth hormone	A hormone produced by the pituitary gland in the brain that is responsible for signalling many different tissues to grow.
2.2.1	Prolactin	A hormone secreted by the pituitary gland, which causes the tissues in the udder to proliferate and grow.
2.2.1	Oxytocin	A hormone secreted from the pituitary gland that causes the myoepithelial cells in the alveoli of the udder to contract, therefore forcing the milk down into the cistern. Oxytocin release is controlled by the brain.
2.2.2	Pituitary gland	A small gland located just below the brain behind the eyes. This gland produces many different hormones in response to signals from the brain.

SECTION I	WORD OR PHRASE	DEFINITION
2.2.2	**Conditioned response**	This refers to when the brain is subconsciously trained to expect something to happen, e.g. when you hear the table being set for dinner – you start to experience hunger in anticipation of eating.
2.2.2	**Epinephrine**	A hormone produced by the adrenal gland in response to an animal feeling pain or stress. It causes an increase in heart rate and blood sugar levels.
2.2.2	**Adrenal gland**	This gland is located near the kidney (one on each side) and produces epinephrine and cortisol.
2.2.2	**Cortisol**	Produced by the adrenal gland, it is released in response to stress and will reduce inflammation and weakens the response of the immune system.
2.3	**Machine stripping**	This is the action of using the milking machine to obtain the last of the milk (residual milk) after normal milking is complete. The teat cups are attached and the action of the hands forces more milk out of the alveoli and into the teat.
3	**Involute**	To return to a former condition, in this case to reduce the number of alveoli and secretory cells producing milk.
3	**Apoptosis**	The process of intentional death of cells necessary for involution.
4.1	**Parity**	This refers to the number of times an animal has given birth, i.e. nulliparous = never given birth; primiparous = has given birth once; multiparous = has given birth more than once.
4.3.1	**Photoperiod**	This term refers to the length of daylight in one day.
4.3.4	**Multiparous**	Has kidded twice or more. For example, a second lactation doe has kidded twice. Parity = number of times having given birth

SECTION II	WORD OR PHRASE	DEFINITION
1.1	**Anatomy**	The structure of a tissue or organ.
1.1	**Physiology**	How an organ or tissue functions.
1.1	**Systemic**	A disease that affects the whole body. The illness may cause symptoms in one or two areas, such as the lungs or digestive system, but the whole body is affected.
1.1	**White blood cell**	A cell that helps to fight infection or cleans up the damage from injury. There are many types of white blood cells: neutrophils, lymphocytes, macrophages etc. Each has a special function but they work together.
1.1	**Somatic cells**	Includes white blood cells and epithelial cells (a type of cell that lines the skin or, in this case the lining of the alveoli of the udder).
1.2.1	**Benefit – cost**	This is usually expressed as a ratio between the money and labour spent controlling a disease and the financial return from the increased production seen from those expenditures.
1.2.1	**Cull**	This is the action whereby a goat is removed from the herd because it can no longer produce well. The reasons for culling may be voluntary (e.g. the doe doesn't milk well enough) or involuntary (e.g. the doe didn't kid or had mastitis severe enough that her milk wasn't saleable). It does not include losses from death.
1.2.1	**Turnover rate**	This is rate by which adult animals leave the herd for any reason, including death and opportunity sales – as well as culling. In a perfect world, deaths and involuntary culling would be minimal and goats would leave only for sales and culling due to low productivity.
1.2.1	**"Dry-cow" intramammary antibiotics**	This term is often used in reference to antibiotic products infused into the udder of cows when they are dried off at the end of lactation. These products will kill existing infections and help to prevent new ones.

SECTION II	WORD OR PHRASE	DEFINITION
1.2.3	**Pasteurization**	Heat-treating a liquid (in this case milk) to the point where most microorganisms are killed. For milk, there are regulatory levels so that temperature and duration are long enough to make sure most microorganisms are killed.
1.2.3	**Antimicrobial drugs**	This is a group of chemicals that are known to kill microbes and includes antibiotics. Antibiotics are derived from living organisms (e.g. penicillin mold) whereas antimicrobial drugs includes that may be chemicals (e.g. sulfas)
1.2.3	**Antimicrobial Resistance (AMR)**	When microorganisms – often bacteria – are not affected by the antimicrobial. Although AMR has many causes, one of the causes is through over-use of antimicrobials through either long-term or frequent use or use at levels too low to kill all the bacteria.
1.2.3	**Dewormers**	Also called anthelmintics or parasiticides. These products kill "worms", such as gastrointestinal nematode parasites, which commonly infect goats.
2.1.1	**Dehydration**	Means the animal has lost too much fluid from the body, either because of losses (e.g. diarrhoea or scours) or because of not drinking enough.
2.1.1	**Spores**	Some types of bacteria produce spores that can stay in the soil for years and can infect an animal when conditions are right.
2.1.1	**Clostridial organisms**	These bacteria are a large group that cause different diseases in livestock and humans (e.g. tetanus, pulpy kidney, gas gangrene). They can live in the soil for years as spores and once they infect an animal, produce toxins, which cause disease.
2.1.1	**Purulent**	This means the presence of pus. Pus is composed mostly of dead inflammatory cells but also bacteria.
2.1.1	**Fly struck**	Certain types of flies are attracted to decomposing material. They lay their eggs in this material and the maggots hatch and eat the pus and dead tissue. Unfortunately the maggots secrete enzymes, which further cause tissue damage. The animal absorbs the toxins from the decaying flesh and become very ill or "toxic". Fly strike can kill a goat within a few days.
2.1.2	**Palpation**	Means to firmly touch in order to determine how an object feels.
2.1.2	**Fibrotic**	Fibrosis means to scar in. When healing, scar tissue replaces healthy tissue that was damaged by disease. The scar tissue is harder and may feel lumpy.
2.3	**Congenital**	The animal was born with the condition. It may be genetic, i.e. it inherited the condition but often it is a mistake that occurs when the embryo or foetus was developing in the womb.
3	**Pathogen**	A pathogen is a microorganism (or "germ"), such as a bacteria, virus, fungus or prion.
3.1.3	**Arthritis**	Inflammation of the lining of the lining of the joints (synovium and cartilage lining the bone within the joint). Inflammation can be acute with painful swelling or chronic where the cartilage is eroded and scar tissue interferes with movement. This damage cannot be reversed with treatment.
3.1.4	**Zoonotic disease**	When an infectious organism can be transferred from infected animals to people, making them ill.
3.2.1	**Nervous system**	Includes the brain, spinal cord and nerves.
4.5.2	**Coronary band**	This is the sensitive top of the hoof of goats. It is a thin band of tissue from which the hoof wall grows.
4.5.2	**Poll region**	This is the top of the head of the goat. Because bucks fight with each other, this region is often bruised – making it susceptible to other infections.
4.7.1	**Callus**	This is the term applied to a build-up of dead skin and keratin usually on part of the skin subjected to repeated use or damage (in this case, the teat end).
4.7.1	**Proliferation**	Build-up or growth.

SECTION II	WORD OR PHRASE	DEFINITION
4.7.1	**Hyperkeratosis**	Another term for callus. A build-up of keratin on the surface of the skin.
4.7.2	**Papilloma**	Another term for wart, which is a proliferation of epithelial cells in response to a viral infection (papilloma virus). The virus is contagious to other goats. The wart will usually disappear when the animal mounts an immune response to the virus – but this may take weeks or months.
4.10.1	**Heritable**	The trait is carried on the genes of the animal and can be passed on to the offspring. Lowly heritable traits are not well passed on and highly heritable traits are very likely to show up in the offspring.
4.11.1	**Negative energy balance**	During early lactation it is very difficult to meet the energy needs of a heavily producing doe. This means that she is milking "off her back" i.e. using fat reserves and so is losing body condition.
4.11.1	**Body Condition Score (BCS)**	Fat and muscles are palpated along the backbone and the goat is scored from 1 to 5 based on the level of fat and muscle present. A score of 1 being very thin (no fat reserves) and 5 being severely over-conditioned (fat).
5.3.7	**Nucleic acid**	This is the DNA and RNA within the cell.

SECTION III	WORD OR PHRASE	DEFINITION
1.2.1	**Disinfectants**	A chemical that kills or inhibits the growth of bacteria. It is usually designed to be used on non-living objects (e.g. floors). Antiseptics are designed to be used on skin. Often the terms are used interchangeably but products designed to be used on skin should be labelled as safe for such use.
1.2.2	**Sanitizing**	When a surface is cleaned and disinfected at the same time. If the udder and teats are washed with a soap and an antiseptic agent, this will sanitize the udder
6.1	**Drug Identification Number (DIN)**	A specific number that is allocated to each drug that is approved for use in both human and veterinary medicine through Health Canada
6.1	**Extra Label Drug Use**	(ELDU) The use of drugs not in accordance of its intended use.

SECTION V	WORD OR PHRASE	DEFINITION
1.1.1	**Inhibitor**	In the context of quality milk, this refers to the presence of drugs or other chemicals (e.g. disinfectants) that inhibit the growth of bacteria in the presence of the milk sample.
3.1.1	**Aerobic**	Needs presence of air to grow. Anaerobic bacteria require the absence of air to grow, i.e. exposure the air will inhibit their growth.
3.1.1	**Aseptically**	Without the presence of bacteria.
3.1.3	**Prototheca**	A type of colourless algae (single-celled plant) present in dirty water that is a cause of mastitis in dairy cattle. It may also be a problem in goats.
3.4	**Pasteurized**	A specific process where milk is heated rapidly to kill harmful organisms without harming the quality of milk. Named after Louis Pasteur, a 19 century physician in France.
3.7.4	**Grains of hardness**	A measure of the amount of calcium in the water. 1 grain of hardness = 17 ppm of calcium.

SECTION V	WORD OR PHRASE	DEFINITION
5	**Withdrawal period**	Also called withholding period. The time (hours or days) from the last treatment of a veterinary drug until the milk or meat from the treated animal can enter the food-chain. This time period is determined through scientific testing of the target animals and may change with the species of animal, route of administration, dose and duration of treatment.
5	**Veterinary Client Patient Relationship (VCPR)**	This is legally defined within each province. When a particular medication is prescribed by a veterinarian licensed in that province, the veterinarian must have knowledge of the animal being treated – usually be clinical examination or from knowledge from a recent visit; the treatment is therapeutically indicated for that animal or herd; the owner of that animal is willing to accept the treatment; the veterinarian is readily available in case of treatment failure or adverse reaction; and the veterinarian is responsible for assuring residues do not enter the food chain (meat or milk).
5	**Topical**	A topical treatment is applied to the skin. In this case, it may be on the skin of the teat or udder but may also be a foot bath or an antibiotic applied elsewhere on the body that may have been absorbed or contaminated the udder or teats.

SECTION VI	WORD OR PHRASE	DEFINITION
1.	**Residue**	Traces of a chemical (e.g. a veterinary drug) remain in the food product (e.g. meat or milk) or in the tissues of the animal – usually days but sometimes even weeks or months after the chemical was administered to the animal. These residues may be harmful to people consuming these products. All members of the value chain have a responsibility to make sure that all actions are taken to avoid them.
1.1.1	**Active Pharmaceutical Ingredients**	(API) A substance or mixture of substances used as an active ingredient in the development of a drug product.
1.1.1	**Compounded drugs**	The combination of more than one ingredient to make a final drug product, in its dosage form.
1.1.3	**Metabolize**	When the body's organs – usually the liver – change a drug or chemical into another chemical, or break it down into harmless substances. These changed or broken down chemicals are called metabolites.
1.1.4	**Intramammary**	To administer into the mammary gland through the teat opening. Usually to administer an antibiotic to treat or prevent mastitis.
1.1.4	**Adulterants**	Chemicals or organisms (e.g. bacteria) that are in a product (e.g. drug or vaccine), which may be harmful and should not be present.

SECTION VIII	WORD OR PHRASE	DEFINITION
1.2.7	**Multiparous**	Meaning the doe has kidded more than once. Primiparous means kidded for the first time. Nulliparous means has never kidded.
1.1.1	**Bacterial toxin**	A bacterial toxin is usually a protein that causes damage to the normal function or structure of tissues of the body. It may be excreted when the bacteria is alive (clostridial bacteria do this) or released when bacteria die.
1.1.2	**Digestive tract**	This includes the esophagus, the 4 stomach compartments (rumen, reticulum, omasum, and abomasum), the small intestine (duodenum, jejunum, ileum) and the large intestine.
1.1.2	**Abomasum**	This is the glandular compartment of the stomach and is most like our stomach. Digestive juices and acids are secreted so normally the environment is very acidic

SECTION VIII	WORD OR PHRASE	DEFINITION
		(pH of 2)
1.1.3	**Gangrene**	Gangrene occurs when the blood supply is cut-off to living tissue and so the tissue dies. This can be from injury, or from some bacterial infections.
1.1.4	**Vaccination**	A non-harmful source of a disease-causing microorganism (virus or bacteria) is administered to an animal – usually in the muscle or under the skin, but could also be by another route – with the purpose of stimulating an immune response. This response will protect the animal in the future from infection from the real disease-causing microorganism.
1.1.4	**Antigens**	Microorganisms are complex but parts of them (antigens) are recognized better than others by the animal's immune system. The best vaccines contain antigens that stimulate a very strong and protective immune response.
1.1.4	**Primary series**	The initial vaccination and the booster vaccination given a few weeks or months later. With many vaccines given for the first time to an animal, it is necessary to give two injections to properly "prime" the immune system so that it can provide protection against the microorganism that causes disease.
1.1.4	**Booster**	This refers to any subsequent vaccination given after the initial vaccine. It could be part of the primary series, or the annual vaccine given to keep the immune response active.
1.1.4	**Inactivated**	This means that the disease-causing microorganism has been killed – usually through heat or addition of a preservative (e.g. formalin), which will preserve the antigens but make it so the microorganism cannot cause disease.
1.1.4	**Toxoid**	This is an inactivated form of the toxin that the microorganism produces. It stimulates an immune response but cannot cause disease.
1.1.4	**Expiration date**	Every batch of vaccine or drug has a limited shelf-life. On the bottle or box, an expiration date is provided. The vaccine used after the expiration date may not be effective as the contents may have degraded. The vaccine should not be used and should be properly discarded.
1.2.1	**Abscess**	This is a structure formed when the body is fighting some types of infections. It contains purulent material surrounded by a wall of smooth tissue.
1.2.1	**Lymph nodes**	This is part of the lymphatic system, which carries white blood cells around the body. They store as well as manufacture white blood cells.
1.2.1	**Chronic wasting**	This term refers to loss of condition (fat and muscle) over weeks to months; to the point the animal is very thin and weak.
1.2.3	**Isolate**	The goat is isolated from healthy goat – with no contact. The length and degree of isolation depends on which disease the goat may have. Some diseases require no shared feeders and waters and no opportunity for direct contact, some also require housing in a separate airspace.
1.3.1	**Abort**	This is the premature loss of a fetus from a pregnancy.
1.3.1	**Enzootic**	When disease is present in a population at a constant but low level. Epizootic (epidemic when referring to people) means a sudden and rapid rise in level of disease.
1.3.1	**Macerated**	The fetus is dead and decayed – usually to the point that it is falling apart.
1.3.1	**Mummified**	The fetus is dead, in one piece but is dried up and leathery. The death likely occurred several weeks prior to the abortion and is "sterile", i.e. in the absence of a bacterial infection – but may be due to parasites or a virus.
1.3.1	**Placentitis**	Inflammation of the placenta. It may be mild or very severe, involve just the cotyledons (the buttons) or also the placenta between the cotyledons.
1.3.1	**Term**	For goats, gestation is between 143 and 155 days – term refers to the kids being born at the full gestational age.

SECTION VIII	WORD OR PHRASE	DEFINITION
1.3.1	**Stillborn**	The kid is born at term but dead and never takes a breath. It may have died before the birth process started, died during the birth process or died within minutes of being born.
1.3.2	**Placenta**	There are two layers to the placenta. The inner layer is the amnion, which is clear and surrounds the kid. The outer layer is the chorion. It contains numerous cotyledons, which are large button-like structures. The chorion is the part that must be submitted.
1.3.2	**Cotyledons**	The cotyledon is the part of the placenta through which nutrients and oxygen are passed from the dam to the fetus. The cotyledons attach to the maternal caruncles inside the uterus.
1.3.3	**N95 fitted mask**	This mask is used by hospital personnel. It is a special mask that will filter out 95% of infectious microorganisms. It must be specially fitted so that all air inhaled by the wearer, first passes through the mask's filter. Masks cannot be reused and are disposable.
1.4.1	**Pregnancy scanning**	An ultrasound machine that projects an actual picture (real-time) of the scan, can be used to visualize the contents of the uterus and can see foetuses and the placenta.
1.4.2	**Selenium (Se)**	This is a trace mineral that if present in the soil, is taken up by plants. It is important in enzyme systems that protect against damage caused by free radicals. Soils in much of Canada are low to deficient in Se and so the ration must be supplemented.
1.4.2	**Vitamin E**	This is a vitamin, also called α-tocopherol, found in abundance in fresh forages but degrades quickly once those forages are stored. Along with selenium, it provides protection against free radicals that damage the body. It cannot be produced by the goat but must be fed.
1.4.2	**ppm**	Parts per million. This is a measure of concentration of a substance. PPM can also be defined as milligrams per kilogram (mg/kg) or grams per tonne (gm/tonne). Both of these are often used when balancing rations. ppb is parts per billion or micrograms per kilogram (µgm/kg).
1.4.2	**IU**	International units is a measure of activity of some compounds. It is often used for measuring vitamin activity.
1.4.2	**Congenital goiter**	Goiter is an enlargement of the thyroid gland, located in the neck. Growth hormones require iodine. If iodine is either deficient or fed in excess, the thyroid gland become enlarged. Congenital goiter refers to kids either aborted or born with enlarged thyroid glands due to lack of iodine in the doe's diet during pregnancy. They are either born dead or born weak and soon die.
1.4.2	**Vitamin B12**	Vitamin B12 is necessary to keep goats healthy. It is produced in the rumen but requires cobalt (Co) to be made. For this reason cobalt must also be supplemented in the feed if soils are deficient.
1.4.2	**Rumen microflora**	The rumen of the goat contains special bacteria that digest the feed the goat consumes. These bacteria are called "microflora" and do not harm the goat. Without these bacteria, the goat could not digest most forages and so their health if very important.
1.4.3	**mg/L**	Milligrams of a substance per litre of water
1.6.1	**Polyestrous**	This means that during the ovulatory season, the doe may cycle many times rather than just once.
1.6.1	**Cycle**	The estrous cycle is what this refers to, i.e. the 21 day period in which a doe comes into heat, ovulates, forms a corpus luteum and if she does not become pregnant, will come into heat or estrus again.
1.6.1	**Breeding**	When a buck is joined with a group of does, the does are considered to be

SECTION VIII	WORD OR PHRASE	DEFINITION
	exposure	"exposed" to the buck for purposes of breeding. At some point in that time period it is expected that they will be bred by the buck when they come into estrus or heat.
1.6.1	**Marking harness**	This is a nylon or leather harness with a crayon that fits on the brisket (sternum) of the buck. When he mounts the doe to breed, the crayon leaves a mark on the doe's rump indicating that she has been mounted and possibly bred.
1.6.1	**Puberty**	This refers to the age when a doeling starts to cycle for the first time in their lives.
1.6.3	**Oxytocin**	This is the hormone that causes milk let-down and is available as a veterinary drug.
1.6.3	**Non-steroidal anti-inflammatory drug (NSAID)**	These are a group of drugs that reduce the level of inflammation and pain without harming the immune system, which may be fighting disease. There are a group of these drugs available by veterinary prescription only and must be used with a valid veterinary-client-patient relationship.
1.6.4	**Malpresentation**	When the kid is not presented normally and its position must be corrected for the kid to be delivered.
1.6.4	**Caesarian section**	This is the name for the surgery when an incision is made in the abdomen of the doe and the kids are delivered surgically through an incision in the uterus.
1.6.4	**Ringwomb**	A condition where the cervix does not dilate when it is time for the kids to be delivered. The cause is unknown.
1.6.4	**Torsed**	Uncommonly the uterus may twist inside the doe so that the cervix will not open properly to deliver the kids.
1.6.4	**Diaphragm**	The muscle separating the lungs and heart from the abdominal muscles. Its movement is responsible for breathing.
1.6.4	**Hypothermia**	Chilling, low body temperature. Normal for a kid is 39^{o}C. If less than 37^{o}C, the kid's life is at risk from chilling.
1.6.4	**Hypoglycaemia**	Starvation, low blood glucose. If the kid depletes its fat reserves and does not get colostrum or milk, it will quickly starve to death – particularly if the environment is cold.
2.1.4	**Johne's disease**	A common infection in cattle, sheep and goats caused by the bacterium *Mycobacterium paratuberculosis*. It causes chronic wasting and death of adult goats and is common in Ontario. There is not treatment or cure.
2.1.4	**Anaemic**	This is a condition when there are too few red blood cells in the body or the red blood cells have too little haemoglobin – the protein that helps oxygen move from the blood to the tissues.
4.1.4	**Ad libitum**	Ad lib. Means without restriction. In this case, the does eat as much as they want. Use of TMR's is healthier for the rumen microflora and the doe.

APPENDIX II
SELF-ASSESSMENT QUIZ

These questions are designed to prompt readers to self-assess their understanding of the contents of this guide. All information needed to answer the questions is found in the section indicated. The correct answers are located at the end of this section. An answer form is provided to allow other people to use this quiz or to test yourself before reading the guide and then repeat to see how much you have learned.

SECTION I: NORMAL LACTATION

1) What characteristics are used to assess milk quality?

   a) somatic cells
   b) drug residues
   c) flavour, colour, smell
   d) level of bacteria
   e) freezing point
   f) all of the above

2) What is the most important reason for poor udder health?

   a) weather
   b) mastitis
   c) udder conformation
   d) producer knowledge
   e) doe genetics

3) Define what udder health means:

4) Milk is produced in what part of the udder?

   a) gland cistern
   b) lobar ducts
   c) secretory cells in alveoli
   d) teat cistern

5) *True or False:* Mastitis rarely causes permanent damage to the secretory cells in the udder.

6) What hormone produced by the doe, is required for milk let-down?

   a) progesterone
   b) estrogen
   c) epinephrine
   d) oxytocin

7) What happens when does are not prepped properly prior to attaching the milking machine?

   a) milk-out time is increased
   b) peak milk flow is delayed
   c) the teat sphincter may become damaged from over-milking
   d) mastitis- causing bacteria may enter the damaged teat end
   e) all of the above

8) *True or False:* A dairy goat does not require a dry period (a period in which it doesn't lactate) between lactations.

9) *True or False:* A doe's total milk production during lactation depends on the timing of maximum peak milk and the persistency of the lactation.

10) *True or False:* First lactation does have similar peak milk levels and persistency as does with multiple lactations.

SECTION II: MASTITIS – WHAT CAUSES IT AND HOW IT IS DETECTED

11) Inflammation of the udder (mastitis) can be caused by:

   a) bacteria
   b) viruses
   c) systemic illness in the doe
   d) injury to the udder
   e) all of the above

12) Costs associated with mastitis include:

   a) the value of discarded milk
   b) lost milk production
   c) losses associated with poor cheese production
   d) premature culling
   e) all of the above

13) Signs of acute severe clinical mastitis include:

   a) fever (≥ 40.5°C)
   b) dehydration (sunken eyes)
   c) off feed
   d) udder is hot or cold to the touch
   e) abnormal appearing milk
   f) all of the above

14) *True or False:* Does with gangrenous mastitis often survive with the udder returning to normal milk production.

15) Signs of moderate clinical mastitis include:

   a) changes to the appearance of the milk and udder, doe is healthy
   b) changes to the appearance of the milk and udder, doe is sick
   c) changes to the appearance of the milk only
   d) udder and milk appear normal, doe is sick

16) Subclinical mastitis means

a) The doe is ill with mastitis, but we need to take its temperature to detect infection
b) The udder is infected, but milk production is not harmed
c) The udder is infected, and milk production is harmed but can't be detected without using tests
d) The udder is infected, milk production is harmed and the tests cannot detect the infection.

17) The most common form of mastitis is:

a) clinical mastitis
b) gangrenous mastitis
c) subclinical mastitis
d) agalactia

18) *True or False:* Subclinical mastitis is diagnosed using tests that either culture the milk or detect somatic cells.

19) Contagious mastitis bacteria are usually transferred at milking from:

a) milker's hands
b) towels that are used on multiple does
c) milk remaining in teat cup liners of milking machines
d) all of the above

20) *True or False: Staphylococcus aureus* mastitis is very treatable during lactation.

21) *True of False: Staphylococcus aureus* mastitis is commonly a subclinical, chronic infection resulting in high somatic cell counts.

22) Which of the following is **NOT** true about nursing kids and mastitis?

a) Bites from kids may cause scarring of the teat cistern and blockage of milk
b) Soremouth (orf, contagious ecthyma) infections of kids may also result in teat infections in does
c) A single nursing kid will keep both glands evacuated milk and so lowers the risk of mastitis
d) Staphylococci infections can be transmitted from doe to doe by nursing kids
e) None of the above, all are true.

23) *True or False:* Coagulase negative staphylococci are the most common cause of subclinical mastitis in goats.

24) *True or False:* Caprine arthritis encephalitis virus targets the udder and causes damage and scarring of the udder and decreased milk production

25) Environmental mastitis bacteria are usually found where the animal is housed and can be transmitted through:

a) bedding
b) manure
c) water sources
d) flies
e) udders and teats not properly prepped for milking
f) all of the above

26) Risk factors for mastitis in does include:

a) poor udder preparation
b) lactation number

c) days in milk
d) poor ventilation
e) dirty bedding
f) all of the above

27) *True or False:* Udder shape and size are not risk factors for a doe developing mastitis.

28) Which of the following is NOT a risk factor for mastitis

a) Not using disposable gloves when hand-milking
b) Using pulsation rates of 85 cycles/minute
c) High vacuum levels
d) Low vacuum reserve
e) Machine stripping

29) *True or False:* Somatic cells are mainly white blood cells that are excreted into milk and defend the udder from bacterial infection.

30) *True or False:* A somatic cell count measures the risk of infection in the udder.

31) *True or False:* As somatic cell counts increase, so does the amount of milk lost.

32) Which somatic cell count values of a doe in early lactation are likely associated with mastitis? Anything over

a) > 150,000 cells/mL
b) > 500,000 cells/mL
c) > 1,000,000 cells/mL
d) > 1,500,000 cells/mL

33) *True or False:* The California Mastitis Test is a practical tool that can be used on-farm to detect does that have increased somatic cell counts.

34) *True or False:* The higher the somatic cell count, the less gelling of the CMT/milk solution that occurs.

35) When collecting a milk sample for culture, the following should be performed to decrease the chance of a contaminated sample:

a) wear gloves
b) remove excess dirt or manure from the udder
c) clean and dry the teats using a single service towel or wipe
d) remove the first 4-5 strips of milk from the teat to be sampled
e) clean teat end with alcohol swabs until clean
f) all of the above

36) *True or False:* Milk samples can be sent fresh to a lab on ice or frozen for one month before culturing.

37) Milk culture results that return as having "No Growth" may be due to:

a) the infection having been cleared by the doe's immune system at the time of sampling
b) non-bacterial infections (e.g. viruses)
c) the doe recently being treated with antibiotics and it is preventing bacterial growth in the milk
d) the volume of milk sent for culturing was too small
e) all of the above

38) *True or False:* Culturing bulk tank milk samples can tell you about milking equipment hygiene but also mastitis infections occurring in does.

SECTION III: MILKING MANAGEMENT

39) *True or False:* Pre-dipping is done to decrease the level of environmental bacteria on the teats.

40) *True or False:* Using the same cloth towels, paper towels or udder wipes prior to milking on more than one doe is an acceptable practice.

41) *True or False:* Udder preparation prior to milking is important because it stimulates milk let-down and removes dirt and bacteria from the teats.

42) *True or False:* Attaching milking units to wet teats will lower bacterial levels in the milk.

43) *True or False:* Mastitis in does can be detected by stripping fore-milk into a strip cup.

44) *True or False:* Human hands are a risk factor for spreading contagious mastitis pathogens.

45) Milking units should be attached within this time after udder preparation:

a) immediately
b) < 30 seconds
c) <60 seconds
d) <90 seconds

46) *True or False:* Over-milking a doe causes teat end damage and increases the risk of mastitis.

47) *True or False:* Maintenance of milking equipment on a regular basis does not need to be performed since it has little impact on udder health.

48) *True or False:* Teat cup liner slips may cause milk flow to reverse, resulting in milk droplets being forced at high speed towards the teat end.

49) *True or False:* Machine-stripped does take longer to milk out in general than does that are not machine-stripped.

50) *True or False:* Removing milking units while the vacuum is still on will not damage teat ends.

51) Which of the following post-dip practices is NOT recommended for dairy does:

a) Disinfectants suitable for post-dipping must be labeled as such
b) When applying a post-dip, only the teat end needs to be covered.
c) Post-dip cups contaminated with bedding is not suitable for use and should be discarded
d) Post-dips should never be diluted with water
e) Spray dipping is a suitable method but requires care to assure that the entire teat is sufficiently covered.

52) After milking, the teat sphincter is open and relaxed and does not close for approximately?

a) 5 minutes
b) 20 minutes
c) 30 minutes
d) 45 minutes

53) *True or False:* To lower the risk of environmental bacteria entering the teat sphincter following milking, offer fresh water or feed to encourage does to stand.

54) Iodine residues in the milk can be minimized by:

a) properly applying teat dips
b) using only Health Canada approved teat dips
c) properly drying teats after dips have been applied
d) all of the above

55) It is a good idea to milk doelings first:

a) to save time in the parlour as milk-out times will be more consistent among these animals
b) to ensure they are comfortable in the parlour and not bullied by older does
c) to prevent exposure to contagious mastitis bacteria carried by older does
d) all of the above

56) *True or False:* A good way to manage does known to be infected with a contagious mastitis pathogen is to milk these animals last to prevent spread to uninfected does.

SECTION IV: PROPER MAINTENANCE AND USE OF MILKING EQUIPMENT

57) In Ontario, dairy goats are milked:

a) in parlours
b) into buckets
c) by hand
d) all of the above

58) *True or False:* Parallel milking parlours are the most common type seen on dairy goat operations in Ontario.

59) *True or False:* When trying to bring nervous or stubborn does into the parlour, shouting and physical force work best.

60) Disadvantages of feeding concentrate in the parlour include:

a) poor rumen health due to slug feeding
b) does may develop laminitis
c) lower milk production in does that can not eat enough concentrate
d) all of the above

61) *True or False:* Low-line pipeline systems provide a constant downwards flow of milk to the line, which allows for stable vacuum.

62) What is/are the basics of cleaning a milking system?

a) time
b) temperature
c) chemical concentration
d) physical action
e) all of the above

63) In the correct order, the key steps involved in the milking equipment cleaning process are:

a) pre-rinse, acid-rinse, hot wash, sanitize
b) pre-rinse, hot wash, acid-rinse, sanitize
c) hot wash, pre-rinse, acid-rinse, sanitize
d) pre-rinse, hot wash, sanitize, acid-rinse

64) *True or False:* Rinsing milking equipment surfaces removes 90-95% of milk solids.

65) In the pre-rinse cycle, the water temperature should start at:

a) 39°C to 48°C
b) 47°C to 62°C
c) 43°C to 49°C
d) 30°C to 37°C

66) *True or False:* The purpose of the hot (chlorinated alkaline detergent) wash cycle is to remove fat, protein and bacteria from the milking system.

67) Which of the following statements is true regarding water temperature

a) The start temperature of the hot wash cycle should be 71°C to 76°C and not less than 49°C at the end
b) The start temperature of the hot wash cycle should be 71°C to 76°C and end temperature is not a concern
c) The start and end temperature of the hot wash cycle should not be less than 49°C.

68) *True or False:* Hard water does not decrease the effectiveness of dairy cleaning products.

69) *True or False:* The purpose of the acid-rinse cycle is to remove detergent residues, neutralize alkali residues, prevent mineral deposits and suppress bacterial growth.

70) *True or False:* The acid-rinse cycle shortens the life of inflations and gaskets.

71) *True or False:* The purpose of the sanitizing cycle prior to the next milking is to disinfect the system by eliminating bacteria that may grow on surfaces between milkings.

72) *True or False:* The sanitizing cycle should be run no more than 30 minutes prior to milking.

73) *True or False:* Bulk tanks are often more difficult to clean than pipelines and may require some manually cleaning.

74) *True or False:* Milk containers used for freezing milk must be clean and completely dry before stacking to prevent molds and bacteria from growing and contaminating milk later on.

75) *True or False:* The chemicals used for cleaning and sanitizing the milking system are corrosive, can damage skin and are very dangerous if ingested.

76) Cleaning failures of the milking system may result in:

a) biofilms
b) protein films
c) mineral films
d) fat films
e) all of the above

77) If a cleaning problem is suspected, the following equipment can be used to start the investigation:

a) a thermometer to check water temperatures
b) a strong flashlight for examining milk contact surfaces
c) pH paper to check acidity and alkalinity
d) all of the above

78) *True or False:* The recommended claw vacuum at peak flow is 10 to 12 inches of mercury.

79) The recommended pulsation rate for dairy goats is:

a) 60 to 120 cycles/minute (85 cycles/minute commonly recommended)
b) 50 to 120 cycles/minute (95 cycles/minute commonly recommended)
c) 140 to 200 cycles/minute (170 cycles/minute commonly recommended)
d) 80 to 220 cycles/minute (150 cycles/minute commonly recommended)

80) *True or False:* Milklines should have a continuous and even fall towards the receiver jar, with a minimum of 10 mm of drop for every metre of pipe.

81) *True or False:* The flow of milk inside the milkline should be at a level of greater than 50% to prevent slugging of milk and liner slips.

82) *True or False:* The cleanliness of the milk filter reflects udder preparation and health.

83) *True or False:* Inflations may harbour bacteria if they become worn and cracked

84) Rubber used in milk inflations breaks down with:

a) time
b) exposure to heat and cold
c) chemicals
d) all of the above

85) A blue rainbow haze on the inside surfaces of the bulk tank may indicate which of the following:

a) a protein film
b) a biofilm
c) milkstone
d) a fat film

SECTION V: MILK QUALITY

86) The quality of milk will influence its:

a) taste
b) shelf-life
c) the quality and quantity of cheese produced
d) its safety for human consumption
e) all of the above

87) *True or False:* Milk processors have the right to reject milk if it doesn't meet their "in-house" standards.

88) *True or False:* The acceptable upper limit for bulk tank somatic cell count level for dairy goat milk in the United States is 1,500,000 cells/mL.

89) *True or False:* Standard plate count (SPC) is a measure of the total number of bacteria in a raw milk sample.

90) *True or False:* In Ontario, the standard plate count allowable level in goat milk is <50,000 CFU/mL.

91) High bacterial counts in milk:

a) cause the milk to spoil faster
b) can be a public health risk
c) can interfere with cheese-making
d) all of the above

92) *True or False:* Elevated standard plate count (SPC) is associated with poor milking and equipment hygiene.

93) *True or False:* Standard plate count and somatic cell count both occasionally increase at the same time when the herd has a high prevalence of subclinical mastitis caused by environmental pathogens.

94) *True or False:* Pasteurization will fix poor milk quality.

95) High bacterial counts in milk may be due to:

a) milk stone in milk line or bulk tank
b) bulk tank milk temperature >4°C
c) improperly prepped teats and udders
d) all of the above + many more reasons!

96) *True or False:* Coliform counts are a measure of the number of coliform bacteria (e.g. *E. coli*) in raw milk.

97) *True or False:* Elevated coliform counts are usually due to udders or milking units contaminated with manure.

98) *True or False:* Excess water in the milk is monitored by measuring the freezing point.

99) Bulk tank milk samples are tested for which of the following chemicals:

a) antibiotics
b) dewormers
c) anti-inflammatory drugs
d) treatments for external parasites
e) all of the above

100) *True or False:* When an intramammary antibiotic product is used to treat one half of the udder, milk from the other half can still be milked into the bulk tank.

101) *True or False:* When an intramammary antibiotic product labelled for cattle is used in dairy goats, the cattle milk withdrawal time can be followed.

SECTION VI: TREATMENT AND CONTROL OF MASTITIS

102) *True or False:* In Canada, there are no approved veterinary medicines for use in lactating dairy goats, where the milk is for human consumption.

103) Which of the following constitutes extra-label drug use in goats when the drug is labelled for use in goats?

a) different dose than on the label

b) different duration than on the label
c) different frequency than on the label
d) different route of administration than on the label
e) different class of animal than on the label
f) different indication than on the label
g) all of the above

104) *True or False:* Unapproved bulk active pharmaceutical ingredients and compounded drugs are considered extra-label drug use by Health Canada.

105) *True or False:* It is okay for your herd veterinarian to give you verbal directions/instructions on using a drug in an extra-label manner.

106) The milk withdrawal time following use of an intramammary product approved for dairy goats from another country will be:

a) longer than on the label
b) the same as on the label
c) unknown, have your veterinarian contact CgFARAD prior to using
d) shorter than on the label

107) *True or False:* Giving too large a volume of a drug in one spot may increase a milk withdrawal time.

108) *True or False:* Milking once/day versus twice/day will not affect a milk withdrawal time.

109) *True or False* The Canadian National Goat Federation Goat On-Farm Food Safety Program has guidelines specifically written for dairy goat operations

110) *True or False:* A drug that has expired 8 months ago will still work as well as one that hasn't expired

111) *True or False:* Veterinarians can dispense drugs without having seen the animal to be treated, nor having visited the farm

112) *True or False:* Testing milk on-farm for antibiotic residues can be a good screening tool to avoid shipping potentially contaminated milk.

113) On-farm antibiotic test kits can be used on:

a) milk from buckets
b) individual animal milk samples
c) bulk tank milk samples
d) all of the above

114) Testing an individual doe for antibiotic residues in milk may be recommended if:

a) the doe was treated with more than one drug at once
b) a doe kidded earlier than expected and was given a dry period mastitis treatment
c) does are added to the herd with an unknown treatment history
d) an extra-label drug was given to the doe
e) all of the above

115) *True or False:* On-farm test kits are as accurate as those used in laboratories.

116) Which of the following methods is not recommended for keeping track of treatments on animals?

a) recording on treatment charts in a binder
b) recording treatments on a piece of paper towel
c) recording treatments on a whiteboard or chalkboard in the parlour
d) recording treatments in a computer program

117) *True or False:* Milking treated animals last or into a separate bucket is a good way to ensure treated milk does not enter the bulk tank.

118) *True or False:* Drugs that need to be refrigerated can stay at room temperature for several hours without harming the effectiveness of the drug.

119) *True or False:* Intramammary products for lactating dairy does and dry treatment should be stored separately to avoid accidently using a dry treatment product in a lactating animal.

120) Which of the following is true with regards to storage of livestock medicines?

a) direct light or sunlight can damage certain drugs
b) do not keep drugs in the door of the refrigerator as it can be much warmer than the rest of the fridge
c) never keep drugs on a window shelf as excessive heat can damage the drug
d) all of the above

121) *True or False:* Inserting a used needle into a bottle of antibiotics can contaminate the drug with bacteria making it ineffective.

122) *True or False:* If a drug is labelled for use in the muscle (intramuscular injection), you can still give the drug via a teat cannula into the udder (intramammary).

123) *True or False:* If an on-farm test kit shows positive for drug residues in the bulk tank, drain the milk and completely sanitize the milking system (milkers, pipes, tank) before milking again.

124) *True or False:* A teat end does not need to be disinfected prior to giving an intramammary treatment.

125) *True or False:* Do not fully insert the tip of the mastitis tube into the teat opening.

126) *True or False:* When treating a doe for mastitis, using half of an intramammary tube is just as effective as using the whole tube.

127) When treating a doe with mastitis, treating the uninfected gland is not recommended because:

a) overuse of antibiotics can cause yeast infections
b) it is an additional cost to use a second tube
c) overuse of antibiotics can lead to antimicrobial resistance
d) all of the above

128) The chance of curing a doe with *Staphylococcus aureus* mastitis through the use of intramammary antibiotics is improved if:

a) the doe is in early lactation
b) the doe is younger
c) the doe has recently become infected with the bacteria
d) the doe is treated while dry rather than lactating
e) all of the above

129) Using a dry treatment product in dairy goats has been shown to:

a) cure existing mastitis infections
b) decrease somatic cell counts
c) prevent new infections in the dry period
d) increase milk production in the next lactation
e) all of the above

130) *True or False:* Does are at an increased risk of acquiring new infections in the first few days of the dry period when the keratin plug is still forming.

131) *True or False:* Mastitis seen in early lactation may be due to infections acquired during the dry period.

132) *True or False:* Selective treatment of does at dry-off is best done in herds with a low prevalence of mastitis, consistently low somatic cell count and good environmental management.

133) *True or False:* Blanket treatment of does means that only does with udder problems are treated with antibiotics at dry-off.

134) *True or False:* Dirty, wet environments increase the risk of mastitis in summer and winter.

135) *True or False:* Identifying 2 cases of *Staphylococcus aureus* clinical mastitis in the herd likely means that there are more does subclinically infected.

136) *True or False:* Does with a chronic history of mastitis or those that do not respond to treatment are good candidates for culling.

SECTION VII: MONITORING AND GOAL SETTING

The recommendation is to fill out Table VII.2, including goal setting and current status by reviewing your records.

SECTION VIII: DAIRY GOAT HEALTH MANAGEMENT

137) The best time to vaccinate does for clostridial diseases and caseous lymphadenitis to ensure that kids receive antibodies via colostrum is

a) At kidding
b) 4 weeks prior to kidding
c) Annually at any point in their production cycle
d) At dry-off
e) When foot-trimming

138) *True or False:* If a vaccine label states that the primary series requires two doses 4 weeks apart, the second dose is not necessary for the vaccine to work.

139) When investigating an abortion, diagnosis of the cause is best achieved by:

a) submitting both the placenta and fetus
b) submitting two fetuses
c) submitting a frozen placenta
d) submitting blood from the does which aborted

140) *True or False:* Many of the causes of abortion in goats can be transmitted to humans and cause them to become ill.

141) Poor doe nutrition in the last trimester of pregnancy will harm:

a) the likelihood of its kids to survive
b) the amount of colostrum produced
c) the quality of colostrum produced
d) the doe's ability to milk well during lactation
e) all of the above

142) *True or False:* Goats are very prone to copper toxicity and should never be fed cattle mineral.

143) Pregnancy toxaemia is caused by:

a) insufficient protein in the late gestation diet
b) insufficient energy in the early lactation diet
c) insufficient energy in the late gestation diet
d) insufficient energy and protein in the diet

144) Hypocalcaemia (milk fever) in goats rarely occurs:

a) at kidding
b) 2 weeks before kidding
c) 1 to 2 weeks after kidding
d) at peak lactation

145) The optimal colostrum requirement for a kid is:

a) 100 mL/kg body weight in the first 24 hours of life
b) 50 mL/kg body weight within 6 hours of birth and another 50 mL/kg 6 hours later
c) 400 mL within 12 hours of birth
d) 50 mL/kg body weight within an hour of birth and 200 mL/kg body weight in the first 24 hours of life

146) If a doe does not have enough colostrum to feed kids, the following may be used as a replacement:

a) thawed frozen goat colostrum
b) a commercial colostrum replacement product for kids
c) cow colostrum
d) any of the above

147) *True or False:* Off-flavours in milk may be associated with high levels of vitamin E in the feed.

148) *True or False:* Over-conditioned doelings will produce less milk as adults and are less fertile.

149) *True or False:* Melengestrol acetate (MGA) should never be used in lactating dairy goats because it is passed in the milk and when consumed by women, can affect their reproductive cycles.

150) *True or False:* Milk and meat withdrawal times for dewormers used in dairy goats are the same as for cattle.

ANSWER GUIDE

SECTION I

1. f
2. b
3. See Introduction
4. c
5. False
6. d
7. e
8. False
9. True
10. False

SECTION II

11. e
12. e
13. f
14. False
15. a
16. c
17. c
18. True
19. d
20. False
21. True
22. c
23. True
24. True
25. f
26. f
27. False
28. b
29. True
30. True
31. True
32. b
33. True
34. False
35. f
36. True
37. e
38. True

SECTION III

39. True
40. False
41. True
42. False
43. True
44. True
45. c
46. True
47. False
48. True
49. True
50. False
51. b
52. c
53. True
54. d
55. d
56. True

SECTION IV

57. d
58. True
59. False
60. d
61. True
62. e
63. b
64. True
65. c
66. True
67. a
68. False
69. True
70. False
71. True
72. True
73. True
74. True
75. True
76. e
77. d
78. True
79. a
80. True
81. False
82. True
83. True
84. d
85. a

SECTION V

86. e
87. True
88. True
89. True
90. True
91. d
92. True
93. True
94. False
95. d
96. True
97. True
98. True
99. e
100. False
101. False

SECTION VI

102. True
103. g
104. True
105. False
106. c
107. True
108. False
109. True
110. False
111. False
112. True
113. d
114. e
115. False
116. b
117. True
118. False
119. True
120. d
121. True
122. False
123. True
124. False
125. True
126. False
127. d
128. e
129. e
130. True
131. True
132. True
133. False
134. True
135. True
136. True

SECTION VII

Fill out goals form (Table VII.2)

SECTION VIII

137. b
138. False
139. a
140. True
141. e
142. False
143. c
144. d
145. d
146. d
147. False
148. True
149. True
150. False

APPENDIX III
REFERENCES AND ADDITIONAL READING MATERIALS

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Keeping Milk Bacteria Counts Low
Milking Procedure Tips
Improving Milk Quality with Udder Preparation for Goats (Order No. 03-061)
The Importance of Water Quality to Your Bottom Line
Storage and Handling of Livestock Medicines on the Dairy Farm (Order No. 92-055)
Troubleshooting Antibiotic Residues in Goat Milk
The Science Behind the Smell
Troubleshooting High Bacteria Counts

Milking Equipment Maintenance

Attention Bucket Milkers
Goat Milk Cooling
Heat Recovery from Milk Cooling Systems (Order No. 88-032)
Maintain Milk Quality By Decreasing Biofilm In The Pipeline (Order No. 06-089)
Maintenance of Milking and Milk Handling Equipment (Order No. 85-001)
Pipeline Cleaning System Guidelines
Replacing Rubberware
Troubleshooting tips for bulk tank washers
Checking temperatures to stay out of hot water
Troubleshooting Films and Deposits on Dairy Goat Milking Equipment

Biofilms in Milking Systems
Milking Equipment Maintenance

Milk Sampling and Testing

Regulating Sampling and Testing under the Raw Goat Milk Quality Program
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Culture Results And Treatments Of Individual Does

DATE	DOE I.D.	GLAND (L / R)	SIGNS OF MASTITIS?[1]	TREATMENT HISTORY			SCC / CMT RESULTS	CULTURE RESULT[2]			TREATMENT PLAN	
				DATE	PRODUCT USED	# OF TIMES		BACTERIAL TYPE	GROWTH	ANTIBIOTIC SENSITIVITY	DATE	PRODUCT USED

[1] Record if doe was ill (e.g. fever), the gland was abnormal (e.g. swollen, hot), the milk was abnormal (colour, consistency), or if mastitis was sub-clinical.

[2] Results as provided from the diagnostic laboratory. Usually bacteria isolated are identified, the amount of growth (e.g. # colonies or 1+, 2+, etc.) and if requested, which antibiotics appear to kill the bacteria.

Assessment Of Udder Health In Dairy Goats

DATE OF ASSESSMENT	MILKING SYSTEM	FARM NAME	HERD VETERINARIAN

Average # does milked in previous 12 months	Avg. # days post-kidding does put into milk-line	Avg. length of lactation (milked)

MEASUREMENT OF PERFORMANCE	PREVIOUS LEVEL	GOAL FOR HERD	CURRENT LEVEL	ACTION NEEDED?	ADDITIONAL ASSESSMENT
ASSESSMENT OF CLINICAL MASTITIS					
Annual incidence of clinical mastitis[i] (%) *Calculate: (# does with 1 or more cases of clinical mastitis[ii] in last 12 months / average # does milked in last 12 months) X 100*		**< 5%**		☐YES ☐NO	• Investigate stage of lactation, season, parity of animals with clinical mastitis • Culture cases before treating to determine if contagious or environmental organisms • Review milking management, milking equipment
Annual incidence of repeat cases of clinical mastitis (%) *Calculate: (Total # cases of clinical mastitis in last 12 months / average # does milked in last 12 months) X 100*		**<1.5 X above**		☐YES ☐NO	• Culture cases to determine organism. • Investigate reasons for failure to manage clinical cases (e.g. treatment protocols)
Prevalence of does with a blind gland (%) *Calculate: (Total # of glands that did not produce milk in the last 12 months/total # of does milked in last 12 months) X 100*		**< 5%**		☐YES ☐NO	• Examine history of does with blind glands to determine reason. E.g. mastitis, teat damage. • Review culling policy.
ASSESSMENT OF SUB-CLINICAL MASTITIS					
Proportion of does with SCC level > 800,000[iii] (linear score 6) each test (%) *Calculate: (# does with SCC > 800,000 at last milk test/# does tested) X 100*		**< 20%**		☐YES ☐NO	• Investigate stage of lactation, season, parity etc. of animals with subclinical mastitis • Review milking hygiene and maintenance of milking equipment • Review management of does with contagious mastitis • Review hygiene of environment • Determine prevalence of teat end lesions and their cause (e.g. over-milking, high vacuum) • Review biosecurity protocol when purchasing animals • Investigate risk from nursing kids of teat damage
Incidence of new infections during lactation (%) *Calculate: (# does with SCC > 800,000 at last milk test and ≤ 800,000 at previous milk test/# does ≤ 800,000 at previous milk test) X 100*		**< 5%**		☐YES ☐NO	

MEASUREMENT OF PERFORMANCE	PREVIOUS LEVEL	GOAL FOR HERD	CURRENT LEVEL	ACTION NEEDED?	ADDITIONAL ASSESSMENT
Prevalence of chronic infections (%) *Calculate: (# does with SCC > 800,000 at 3 or more tests this lactation / total # lactations assessed) X 100*		**< 5%**		☐YES ☐NO	• Determine period of onset of chronic mastitis cases with respect to stage of lactation, parity, season • Culture to determine pathogen type • Investigate status of CAE infection in the herd
Prevalence of infections at first test post-kidding (%) *Calculate: (# does with SCC > 400,000 at first test post-kidding/total # first tests) X 100*		**< 10 %**		☐YES ☐NO	• Determine parity of affected animals • Investigate whether due to damage from nursing kids prior to placing in milk line • Review dry-period mastitis treatment protocols and hygiene at treatment • Investigate dry-off management • Review environment of dry does
ANIMAL LOSS DUE TO MASTITIS					
Turnover rate due to mastitis (%) *Calculate: (# does culled and died due to mastitis/average # milked in last 12 months) X 100*		**< 5%**		☐YES ☐NO	• Review treatment protocols, including methods of detection of does with clinical mastitis • Investigate causative agents causing death (e.g. *Staphylococcus aureus*) • Investigate and review as outlined above under clinical and subclinical mastitis • Review culling policies as well as areas above
Incidence of does dying of mastitis annually (%) *Calculate: (# does dying of mastitis / avg. # milked in last 12 months) x 100*		**< 0.5%**		☐YES ☐NO	
Proportion of does culled due to mastitis (%) *Calculate: (# does culled due to mastitis / avg. # milked in last 12 months) X 100*		**< 5%**		☐YES ☐NO	
Proportion of does culled that were culled due to mastitis (%) *Calculate: (# does culled due to mastitis / total # does culled[iv] in last 12 months)*		**< 20%**		☐YES ☐NO	

[i] A case of clinical mastitis is one in which there is a change to the udder and / or milk of one or more glands as detected by visual inspection.
[ii] Count does with multiple cases of clinical mastitis only once.
[iii] You may wish to lower this cut-point as udder health improves and average herd SCC drops. A goal would be to use SCC > 600,000 (linear score 5.5).
[iv] Do not include does that were sold for dairy, i.e. into another herd to be milked, but only those does sent to slaughter.

Name: **Answer Form for Quiz** **Date:**

Section I		Section II		Section III		Section IV		Section V		Section VI		Section VIII	
1		11		39		57		86		102		137	
2		12		40		58		87		103		138	
3		13		41		59		88		104		139	
4		14		42		60		89		105		140	
5		15		43		61		90		106		141	
6		16		44		62		91		107		142	
7		17		45		63		92		108		143	
8		18		46		64		93		109		144	
9		19		47		65		94		110		145	
10		20		48		66		95		111		146	
		21		49		67		96		112		147	
		22		50		68		97		113		148	
		23		51		69		98		114		149	
		24		52		70		99		115		150	
		25		53		71		100		116			
		26		54		72		101		117			
		27		55		73				118			
		28		56		74				119			
		29				75				120			
		30				76				121			
		31				77				122			
		32				78				123			
		33				79				124			
		34				80				125			
		35				81				126			
		36				82				127			
		37				83				128			
		38				84				129			
						85				130			
										131			
										132			
										133			
										134			
										135			
										136			

TOTAL CORRECT ANSWERS

I	II	III	IV	V	VI	VIII	TOTAL
10	28	18	29	16	35	14	150

A Guide to Udder Health for Dairy Goats

Version 1.0 ~ 2016