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Moorepark Dairy Levy Research Update

Milk Quality Handbook

Series No. 8

Practical Steps to Improve Milk Quality

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Introduction

Why High Quality Milk?

Milk and the range of dairy products derived from it constitute a major component of the western diet, while the supply chain of dairy products is also developing globally. Exacting demands of the consumer for improved food quality and safety are currently, and will in future, place significant responsibility on the producer (farmer) to demonstrate good practice in the sequence of milk production. The milk quality criteria requested by milk processors or by customers of milk processing outlets are becoming more strict and rigorous. With the exception of extremely early and late periods of the lactation cycle, milk from the udder of healthy animals that have been provided with a well-balanced, natural diet and a suitable living environment is essentially a good quality product. However, there are many opportunities along the milk pipeline from producer to consumer where negative impacts on milk quality can occur. While processing technology can address many product manufacturing problems, it cannot yet overcome the effects of poor milk quality, such as high somatic cell count (SCC) or total bacteria count (TBC) in milk; thus, the responsibility reverts to the producer. As a consequence of the tiered milk payment system in Ireland which penalises poor milk quality, high milk SCC and TBC have economic repercussions for dairy farmers. Therefore, the dairy producer must apply 'Good dairy farming practices' in order to positively influence returns on his milk price. It is now becoming increasingly common to introduce penalty and /or bonus payments based on a range of different milk quality parameters. Thus, if milk processors request of their producers a more strict protocol for milk production, then the producer must be supplied with the necessary information required to produce such a milk, and this is particularly important if payment is partially based on this protocol. Milk quality is also important to the processor as it impacts on product yields and consistency, thus affecting profit margins and market access. Milk quality is important to the consumer in terms of taste and flavour attributes and its potential impact on health. Thus, the provision of premium quality milk is in the interest of all sectors. The detail of the milk production process necessary to achieve these standards is particularly important now due to new pressures from the necessary expansion of herds and the reality of reduced labour supply. There is a general consensus that the quality of milk with respect to SCC, TBC and residues, such as antibiotics, iodine and trichloromethane needs to be addressed immediately.

The overall objective of this booklet is to provide guidelines and recommendations for the on-farm milk production process such that the milk produced may achieve increasingly stringent milk hygiene and processing quality standards. It is intended that the genuine problem areas in relation to milk quality will be targeted and an increased awareness and perception of milk quality be provided.

The key to producing quality milk is to have correct information, make the right decisions and carry out the recommended actions correctly

It is critical to perceive milk as a food being consumed by others

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Mastitis and Somatic Cell Count (SCC)

Understanding mastitis and SCC

Mastitis

Mastitis is a disease of the udder. This disease arises when bacteria enter the udder and establish an infection. Mastitis can become a herd problem if a lot of the cows become infected. The best way to avoid a herd problem is to prevent individual cows from getting infected in the first instance.

Mechanism of infection

Bacteria that cause mastitis infection normally enter through the teat canal. There are three circumstances that promote the entry of bacteria into the udder, i.e. (a) the presence of bacteria in other infected quarters or udders within the herd, (b) the presence of large numbers of bacteria in the cows' environment and (c) any condition which would weaken the protective barrier of the teat canal, thus making it easier for bacteria to enter, e.g. malfunctioning milking machine. Normally different types of bacteria are associated with the different infection circumstances or mechanisms.

Cow-associated or contagious bacteria usually originate from infected udders within the herd and are usually spread between cows and quarters via residues of infected milk. The greatest risk of infection by cow-associated or contagious bacteria is during milking. The infected milk can be spread from quarter to quarter or from cow to cow at milking time via milkers' hands or teat cup liners, by splashes of contaminated milk during foremilking or by movement of milk between teatcups as the cups are attached or removed from the cow. For example, after a liner has milked an infected quarter, bacteria may be transferred to the next 5–6 cows milked with that teatcup.

Environmental bacteria are widespread in the cows' environment, e.g. in soil, faeces, skin and hair. Large numbers of these bacteria in the immediate vicinity of the cow mean a greater likelihood of direct transfer through the teat canal and subsequent infection.

Any circumstance that makes the teat canal more vulnerable increases the risk of infection by both cow-associated or contagious bacteria and environmental bacteria.

Common bacterial infections

The most common cow-associated or contagious bacteria found in Irish herds is *Staphylococcus aureus.* In addition to the high risk of infection by this bacteria during milking, it can also readily colonise the skin of chaffed teats, so infection is likely to occur if teat damage is a problem. This bacteria can invade udder tissues, forming pockets of infection that are difficult to reach with antibiotics. **Because infections are difficult to cure, particularly during lactation, prevention is essential.** New infections with cow-associated or contagious bacteria can be controlled by good hygiene at milking, correct use of post-milking teat disinfection, prompt treatment of new mastitis infections, use of dry cow antibiotic treatment and culling of chronic, incurable cases.

The most common environmental bacteria found in Irish herds are *Streptococcus dysgalgactiae* and coliforms. Most mastitis caused by environmental bacteria occur in the period immediately after drying off, before calving and during the initial weeks after calving. Conditions that favour exposure of the udder to bacteria in the environment include over crowding, dirty or wet dry-cow and maternity areas, inadequate ventilation, wet and dirty cubicles, muddy yards and milking of wet udders. *Streptococcus dysgalgactiae* also tends to colonise open wounds at the teat opening so teat damage in the early stage of lactation can also lead to environmental bacteria infection. Generally, control measures rely mostly on the use of antibiotics at drying off, minimising contact with mud, manure, wet and dirty areas together with early detection and treatment of new infections. Coliform mastitis is usually associated with cows confined indoors and out wintering pads may also increase the risk. **Control is very much dependent on minimising the contact of teats with manure, wet and dirt.**

Clinical and subclinical mastitis infections

Mastitis infection is usually described as clinical or subclinical.

Clinical mastitis infection is described as such when changes in the udder and /or the milk are detected easily by the milker, i.e. clotting and discolouration of the milk, reddening, heat, pain, swelling and hardening of the udder.

Subclinical mastitis infection is described as such when the udder and milk appear normal and there are no visible signs of infection but the somatic cell level in the milk is raised. In this case, laboratory tests are required to indicate the changes in milk composition due to the infection. This can be more difficult to deal with than clinical mastitis infection, since the farmer /milking operator may not notice the problem and spread of the infection could be occurring within the herd.

Mastitis infection caused by cow-associated /contagious bacteria is most likely to be subclinical while mastitis infection caused by environmental bacteria is most likely to be clinical. However, clinical mastitis can become subclinical if treatment is ineffective over a period of time and subclinical mastitis can become clinical at any time.

The development of a *Staphylococcus aureus* infection may occur as follows: *Staphylococcus aureus* may become deposited on teat skin (source: hands or cluster from infected cow) of a cow with low SCC (<150,000 cells/ml). If poor hygiene prevails and /or no (or ineffective) post milking teat disinfection is conducted, then *Staphylococcus aureus* may multiply and colonise as "teat orifice infection". Milk may still appear normal and SCC may remain unchanged. The time interval may be variable (weeks or months). Progression may then involve *Staphylococcus aureus* beginning to establish internally in the teat canal. This process may be assisted by faulty milking equipment or technique. The result is "teat canal infection". The milk may still appear normal but there may be a slight increase in SCC. The time interval may again be variable (weeks or months). Over time *Staphylococcus aureus* can progress deep inside the mammary gland and create micro abscesses and tissue damage. At some time point thereafter (weeks or months) the SCC will increase dramatically, yet the milk appearance will remain normal. This state is known as "subclinical infection". Progression from this 'subclinical' status may occur at any time. This will be obvious, as indicated by clotting and discolouration of the milk, reddening, heat, pain, swelling and hardening of the udder. This is now a 'clinical infection'. Again, the time interval is variable (weeks or months). Such an infection is often interpreted as a 'new infection', however, it may have been present as a 'subclinical infection' for some time.

Somatic cell count

In order to minimise subclinical infection in a herd, it is necessary to be able to measure its status within the herd. The best method by which this can be achieved is by the measurement of somatic cells in milk. Somatic cells consist almost totally (98%) of white blood cells. When bacteria exist in the environment close to the teat end, the first line of defence against bacterial infection is the teat canal. If the bacteria succeed in entering the udder, then the second line of defence comes into play and inflammation occurs, i.e. white blood cells or somatic cells. These somatic cells try to destroy the bacteria and prevent it from infecting and damaging the udder tissue. Thus, these somatic cells (SCC) are the first reliable indication of mastitis infection. A certain level of somatic cells are always present in milk, as a protection for the cow against mastitis infection. Most cows that are free of mastitis and have no previous infections would be expected to have an SCC of less than 100,000 cells/ml, with many below 50,000 cells/ml. Variation does occur between herds with different mastitis histories.

Relationship between mastitis and SCC

When the udder becomes infected, the SCC increases significantly. The rise in SCC following an infection can be very rapid – increasing by 100-fold in 6 hours. Some mastitis-causing bacteria stimulate the release of millions of somatic cells within a few hours of infection, while others may stimulate only a few thousand. Large variations in SCC occur between cows and large fluctuations occur within a cow as she deals with the mastitis over a period of time.

Thus, when mastitis infection occurs, if it is a clinical case the milking operator will identify changes in the udder and /or the milk, e.g. swelling and hardness of the udder and clots in the milk. The SCC of the milk will have increased as well. If it is a subclinical case, the milker will not detect any change in udder or milk **BUT** the SCC will have increased. **It is widely accepted that individual cow SCC greater than 150,000 cells/ml or individual heifer SCC greater than 120,000 cells/ml indicates presence of infection.**

How high mastitis incidence and SCC affect the farm operation

The European Union, of which Ireland is a member state, currently impose a regulatory limit of 400,000 somatic cells/ml (Council Directive 92/46/EEC; SI 910, 2005). The monitoring and control of SCC at an individual farm level as well as a national level is vital to identify and monitor trends and is a necessary resource for quality assurance programmes.

The cost of mastitis

The most costly disease of dairy cattle is considered to be mastitis. It is important to realise what costs, both direct and indirect, that producers /farmers incur because of cows infected with subclinical or clinical mastitis.

Subclinical mastitis

The two most easily identifiable costs associated with subclinical mastitis are milk quality price penalties and loss of milk production.

Milk quality price penalties

Recently, dairy product manufacturers have become very concerned about the impact of raw milk quality on finished dairy product quality. Most milk processors wish to purchase milk with low SCC and offer financial incentives (either in the form of penalties or bonuses) to producers for high quality milk. A cow with mastitis not only produces milk with more somatic cells, she also produces milk containing less casein, less fat, more whey proteins, more salt and more damaging enzymes. Such milk is not desirable for processors because it reduces the shelf life of dairy products, diminishes the quality and reduces the yield of the product, particularly cheese. Even modest increases in individual cow SCC (>100,000 cells/ml) have been shown to reduce cheese yield.

Quality premiums (or non-application of penalties) offer an opportunity to the producer to increase the marginal profit of the farm. This should be given due attention since it represents one of the few mechanisms that producers may use to significantly impact on the price of milk that they receive.

Example cost calculation of milk quality penalty /bonus payment
(based on current payment scheme operated by major milk processor):

Maximum milk price (SCC < 200,000 cells/ml) = 30.0 cent/l
Milk price (SCC at 300,000-400,000 cells/ml) = 29.7 cent/l (penalty = 0.3 cent/l)
Milk volume = 4,750 l x 100 cows = 475,000 l
Loss in milk payment associated with SCC 300,000-400,000 cells/ml = €1,425

The cost of the milk quality penalty /bonus payment (lost profit) related to an SCC <200,000 versus 300,000-400,000 cells/ml, for a 100 cow herd, yielding an average of 4,750 l per cow, is an estimated €1,425. The cost of subclinical mastitis on different herd-size farms is shown in Table 1.

Table 1. The cost of the milk quality penalty related to an SCC <200,000 versus 300,000-400,000 cells/ml for different herd-size farms (average milk yield 4,750 l)

Herd size (cow number)	Cost (€) (in milk payment)
50	716
75	1,069
100	1,425
150	2,138
200	2,850

Milk production losses

On many farms subclinical mastitis is the most economically important type of mastitis because of the long-term effect of infections on total milk yields. Persistent long-term infections with contagious pathogens e.g. *Staphylococcus aureus* damage and scar milk secretory tissue in the udder and result in reduced milk production. The loss in milk production does not only occur for the duration of the subclinical case itself, but even after the mastitis incident has cured the milk production level of the cow remains lower. This milk production loss is often not obvious to the producer, because this is milk that is never produced and therefore, never seen. It is a hidden cost or loss in income opportunity.

There is a large amount of published research on such milk production losses. However, one specific study carried out a particularly thorough examination of the association between increased milk SCC and loss in milk production. This study *(Raubertas and Shook [1982]. Relationship between lactation measures of somatic cell concentration and milk yield. Journal of Dairy Science, 65:419)* showed that the Linear Score (LS; another method to measure SCC) is highly related to loss of milk production in infected cows (Table 2).

Table 2. Relationship between SCC, Linear Scores and milk yield loss

SCC mid point (Range)	Linear Score	Milk loss for 1st lactation (kg)	Milk loss for subsequent lactations (kg)
25,000 (18,000-34,000)	1	0	0
50,000 (35,000-68,000)	2	0	0
100,000 (69,000-136,000)	3	88	176
200,000 (137,000-273,000)	4	176	352
400,000 (274,000-546,000)	5	264	529

Example milk production loss for herd of 100 cows (25% 1st lactation) having average bulk milk SCC of 200,000 cells/ml versus 100,000 cells/ml

25 1st lactation x 88 kg (176-88; Table 2) = 2,200 kg
75 older cows x 176 kg (352-176; Table 2) = 13,200 kg
Total loss = 15,400 kg

Other losses associated with subclinical mastitis include occasional lactation therapy with antibiotics and the related costs and culling of cows, which are dealt with in more detail under "clinical mastitis".

Clinical mastitis

The economic damage associated with clinical mastitis can be defined by antibiotic treatments, discarded milk, veterinarian attention, additional labour involved, culling costs and possible mortality incidences.

- **Ultimate target: less than 20 incidences per 100 cow herd per year**
- **Working Target: less than 25 incidences per 100 cow herd per year**
- **Working Guideline: less than 5 clinical cases per 100 cows in the first month of lactation and 2 clinical cases per 100 cows in subsequent months of lactation**

Example cost calculation of clinical mastitis (per mastitis incident):

Antibiotics:	€10
Discarded milk:	€36 (20 litres/day x 6 days =120 litres x 30 cent/l)
Labour:	€10 (42 min) [5 min/milking x 2 milkings/day x 3 days of treatment] + [2 min/milking x 2 milkings/day x 3 days of withholding milk]

Total €56

The cost of one clinical incident is an estimated €56. The cost of various rates of clinical mastitis is shown in Table 3.

Table 3. The cost of different clinical mastitis rates in a 100 cow herd

Number of clinical incidences	Cost (€)
10	560
20	1,120
25	1,400
30	1,680
40	2,240
50	2,800

Antibiotics

Drugs necessary to teat a cow with clinical mastitis obviously have an economic cost.

Discarded milk

The largest proportional cost of clinical mastitis may be the discarded milk associated with lactation antibiotic therapy. Although not advisable from a veterinary point of view, antibiotic contaminated milk is often fed to calves on the farm, when mastitis occurs during the calving period. However, either during or outside of the calving period, farmers /producers must not contaminate the bulk milk supply with antibiotic treated milk.

Labour

Costs for labour associated with clinical mastitis are difficult to calculate. When the time required of hired labour can be reduced by preventing mastitis, then the costs are easy to calculate, e.g. hours x hourly wage. When it is the labour of the farmer himself, costs are more difficult to assess. If the labour comes from the farmers own free time, the cost is the value that the farmer gives to this free time. If the farmer spends less time in management of other tasks because of mastitis, then this may be reflected in the quality of operation of the other tasks. Each episode of clinical mastitis requires significant time for treatment and management. One estimate is the allowance of 5 min per milking during the treatment phase, and 2 min per milking during the milk withholding period.

Veterinary attention

Occasionally veterinary consultation is required to deal with clinical mastitis.

Culling and mortality

The cost of the culled cow is most simply defined as the cost of the replacement cow minus the value of the culled cow. Mortality can also occur as a result of severe mastitis infection.

The remaining area of potential financial loss to the producer (related to mastitis) is the milk quality penalty associated with inhibitory substances (normally antibiotics). The use of antibiotics to treat infected animals (for subclinical or clinical mastitis) is a major risk factor for contamination of the milk in the bulk tank and severe penalties are generally applied. The presence of antibiotics in milk is considered a most serious offence due to the human health risk of developing allergic reactions or immunity to antibiotics and also their adverse effect on starter cultures used in many manufacturing processes such as cheese and yoghurt manufacture.

Calculation of cost of mastitis (subclinical + clinical) in dairy herds of various average bulk milk SCC

Example 1: cost of mastitis in dairy herd of average bulk milk SCC 200,000 cells/ml (137,000-273,000) versus 100,000 cells/ml (69,000-136,000) with 100 cows (25% 1st lactation; assuming potential milk yield of 3,874 kg and 5,165 kg for 1st lactation and older cows, respectively)

Subclinical

Milk price penalty: 0.2 cent/l (milk price = 29.8 cent/l versus 30.0 cent/l)

Milk production loss: The LS goal (3) (Table 2) is subtracted from the actual LS (4) (Table 2) and multiplied by the estimated milk loss to determine the milk lost by the 1st lactation and older cows.

1st lactation : 1 x 25 x 88 = 2,200 kg

Older cows : 1 x 75 x 176 = 13,200 kg

Combined loss: = {([potential yield 1st lactation x 25] + [potential yield older cows x 75]) x potential price/l} minus {([actual yield 1st lactation x 25] + [actual yield older cows x 75]) x actual price/l}

= {([3,874 x 25] + [5,165 x 75]) x potential price/l} minus {([3,786 x 25] + [4,989 x 75]) x actual price/l}

= {([96,850] + [387,375]) x potential price/l} minus {([94,650] + [374,175]) x actual price/l}

= {(484,225 kg) x potential price/l} minus {(468,825 kg) x actual price/l}

= {(470,258 l) x 30 cent/l} minus {(455,303 l) x 29.8 cent/l}

= {€141,077} minus {€135,680}

= **€ 5,397**

Clinical
Assume 10% rate of clinical infection, i.e. 10 cases in the 100 cow herd during the lactation. Previous example cost calculation of clinical mastitis indicated a cost of € 56 per clinical mastitis incident. Thus, the cost of clinical mastitis in the 100 cow herd = **€ 560.**

Total cost due to subclinical mastitis = € 5,397
Total cost of clinical mastitis = € 560
Total cost of mastitis in the described 100 cow herd per lactation = € 5,957

Example 2: cost of mastitis in dairy herd of average bulk milk SCC 400,000 cells/ml (274,000-546,000) versus 100,000 cells/ml (69,000-136,000) with 100 cows (25% 1st lactation; assuming potential milk yield of 3,874 kg and 5,165 kg for 1st lactation and older cows, respectively)

Subclinical
Milk price penalty: 0.3 cent/l (milk price = 29.7 cent/l versus 30.0 cent/l)

Milk production loss: The LS goal (3) (Table 2) is subtracted from the actual LS (5) (Table 2) and multiplied by the estimated milk loss to determine the milk lost by the 1st lactation and older cows.
1st lactation : 2 x 25 x 176 = 8,800 kg
Older cows : 2 x 75 x 353 = 52,950 kg

Combined loss: = {([potential yield 1st lactation x 25] + [potential yield older cows x 75]) x potential price/l} minus {([actual yield 1st lactation x 25] + [actual yield older cows x 75]) x actual price/l}

= {([3,874 x 25] + [5,165 x 75]) x potential price/l} minus {([3,698 x 25] + [4,812 x 75]) x actual price/l}

= {([96,850] + [387,375]) x potential price/l} minus {([92,450] + [360,900]) x actual price/l}

= {(484,225 kg) x potential price/l} minus {(453,350 kg) x actual price/l}

= {(470,258 l) x 30 cent/l} minus {(440,274 l) x 29.7 cent/l}

= {€141,077} minus {€130,761}

= **€ 10,316**

Clinical
Assume 25% rate of clinical infection, i.e. 25 cases in the 100 cow herd during the lactation. Previous example cost calculation of clinical mastitis indicated a cost of € 56 per clinical mastitis incident. Thus, the cost of clinical mastitis in the 100 cow herd = **€1,400.**

Total cost due to subclinical mastitis = € 10,316
Total cost of clinical mastitis = € 1,400
Total cost of mastitis in the described 100 cow herd per lactation = € 11,716

It is estimated that the cost of mastitis amounts to € 60 per cow for the average milk supplier, € 3,000 for the average herd and € 66 million for the dairy industry.

Additionally
Veterinary consultations at approximately €50/call have not been included above but would likely contribute an additional cost, particularly in the Example 2 scenario, where 25 clinical incidents were experienced during the lactation. Likewise, the cost of culling and mortality was not included, but could again contribute significantly to mastitis costs, and in Example 2, where for example, a culling of 3 cows and a mortality incident of 1 cow would not be unusual.

There are many other costs associated with the presence of mastitis which are particular to individual farms and which have not been included in the above calculation.

Examples include:
- time spent checking the herd for mastitis
- reduced value of the herd as an asset and reduced cow sale value
- potential losses through inability to cull poor producing cows, since mastitis cows must be involuntarily culled
- stress involved in dealing with mastitis problems on farm
- risk that existing mastitis infections pose with regard to spread of the disease within the herd

Detection of mastitis

The detection of mastitis, both clinical and subclinical should be conducted at both herd and individual cow level. The earlier mastitis is detected and treated, the more likely that the quarter will be cured. If the mastitis infection becomes established, the cow is more likely to have permanent damage to the quarter, have reduced milk production and be a major source of infection for other cows.

Clinical mastitis infections

Clinical mastitis infections may be defined as such when: abnormalities are seen in the milk, the udder may be hot, swollen and painful and the animal may have an elevated body temperature. Alternatively, quarters are also considered clinical if the milk is visibly abnormal even though the cow appears normal.

Clinical mastitis incidence in the herd and individual cows may be detected as follows:

- Examination of each quarter for changes in the milk (wateriness or clots) by examining foremilk before the milking cluster is applied
- Examination of the bulk milk SCC to determine the actual SCC level and the 2 to 3 day variation in that SCC
- Examination of the milk filter for clots after each milking
- Examination of each cow udder for heat, swelling or pain at cluster attachment and removal

The most reliable method to detect clinical mastitis infections is by examining foremilk of the cows, i.e. before milking, squirt milk from each quarter onto a dark surface or container. Inspect for abnormal milk that persists for more than three squirts. The milk may be clotted, stringy or contain flakes, or be watery or brownish in colour. It is important to check the filter after each milking and before washing of the milking plant. If there are any clots on the filter, then cow udders and milk should be inspected carefully at the next milking. The bulk milk SCC should also be monitored. If the bulk milk SCC is reasonably consistent as reported in each farm milk collection report, then the effect of a new clinical mastitis case can easily be observed. A new clinical mastitis case (where the cow is not yet identified and milk not withheld from the tank) means that milk with millions of cells will be added to the bulk tank which could significantly increase the bulk milk SCC. A detailed inspection of cows and milk should then be conducted at the subsequent milking in order to identify the affected cow and udder quarter. Milking operators should also be alert for hot, swollen or painful quarters and quarters that have not milked out properly, at cluster attachment and removal, respectively.

In event of high incidence of clinical cases

If it is considered that the incidence of clinical cases in a herd is unusually high or if the type of clinical mastitis occurring is of concern, then it may be worthwhile to check the organism involved before any treatment is administered. Samples for mastitis culture can be frozen and may be stored for up to four weeks.

Udder quarter milk samples should be taken as follows:

- Label a sterile bottle with date and cow identification and cow udder quarter
- Disinfect the teat ends before sampling by vigorously rubbing the teat end for 10 to 15 s with cotton wool soaked in methylated spirits. If sampling more than one teat, then disinfect the teats furthest away first. This prevents accidental contamination of disinfected teats
- Allow the teat to dry
- Discard 3 strips of milk from the quarter in order to flush out any teat canal contaminants
- Strip 1 to 2 good squirts of milk (5-10 ml) into the sterile bottle, holding it in a near horizontal position so that dirt from the udder does not fall into the sample bottle. Also maintain the lid of the

bottle facing downwards for the same reason. Once the sample is taken, put the lid in place immediately
- If collecting samples from more than one quarter, then sample the near teats first in order to lessen the risk of contaminating the other teats
- Wash and dry gloves or hands
- If storage period is short (<24h), place sample in refrigerator (~ 4°C) prior to transport to laboratory. If storage period is longer, then sample should be frozen

Subclinical mastitis infections

The bulk milk SCC is a measure of the somatic cells in milk from all cows contributing to the milk tank. It is an indirect way of estimating the level of subclinical mastitis in the herd.

From previous studies, it is generally accepted that a bulk milk of SCC:

- 100,000 to 200,000 cells/ml indicates that approximately 20% of the herd are infected
- 200,000 to 300,000 cells/ml indicates that approximately 30% of the herd are infected
- 300,000 to 400,000 cells/ml indicates that approximately 40% of the herd are infected

Thus, the bulk milk SCC record for each bulk milk collection should be assessed to establish both the level and trend for subclinical infections. This is most useful when herd bulk milk SCC is consistently low. When the bulk milk SCC is less than 150,000 cells/ml, the onset of new mastitis infections is often indicated by day to day increases in the bulk milk SCC. However, in herds having higher bulk milk SCC levels, the somatic cell contribution varies widely from day to day, making it impossible to differentiate the individual new infections. For example, a herd bulk milk SCC that suddenly increases from a normal 120,000 cells/ml to 150,000-160,000 cells/ml almost certainly means that new infection has developed. However, new infection is difficult to identify in a herd milk SCC that fluctuates between 250,000-300,000 cells/ml.

The best method for obtaining detailed milk SCC information on the herd is by individual cow SCC information. This is a very valuable tool for the management of mastitis on the farm. The individual cow SCC testing can be carried out periodically during the lactation. The same milk samples (one sample per cow) collected from the cows for routine milk recording can be used also to measure SCC levels. Generally, a composite udder sample with a count above 150,000 cells/ml for cows and 120,000 cells/ml for heifers means that the animal is highly likely to be infected in at least one quarter. This is a very reliable indicator of the infection status of the cow and it is recommended that this sampling and testing procedure be carried out at least four times during the lactation.

A cow-side test known as the Californian Mastitis Test (CMT) may also be used to identify subclinically infected quarters. The CMT estimates the SCC of milk by measuring the degree of thickening or viscosity when a reagent is added to the milk sample.

Procedure to carry out a CMT

- Discard the first squirt of foremilk
- Squirt milk from each quarter into a different well on the CMT test tray (approximately 2 ml from each quarter)
- Mix each milk sample with an equal volume of reagent (available commercially)
- Swirl the mixture vigorously for maximum of 20 seconds and examine the degree of thickening /gelling in each sample (gelling may be more visible if the test tray is tilted)

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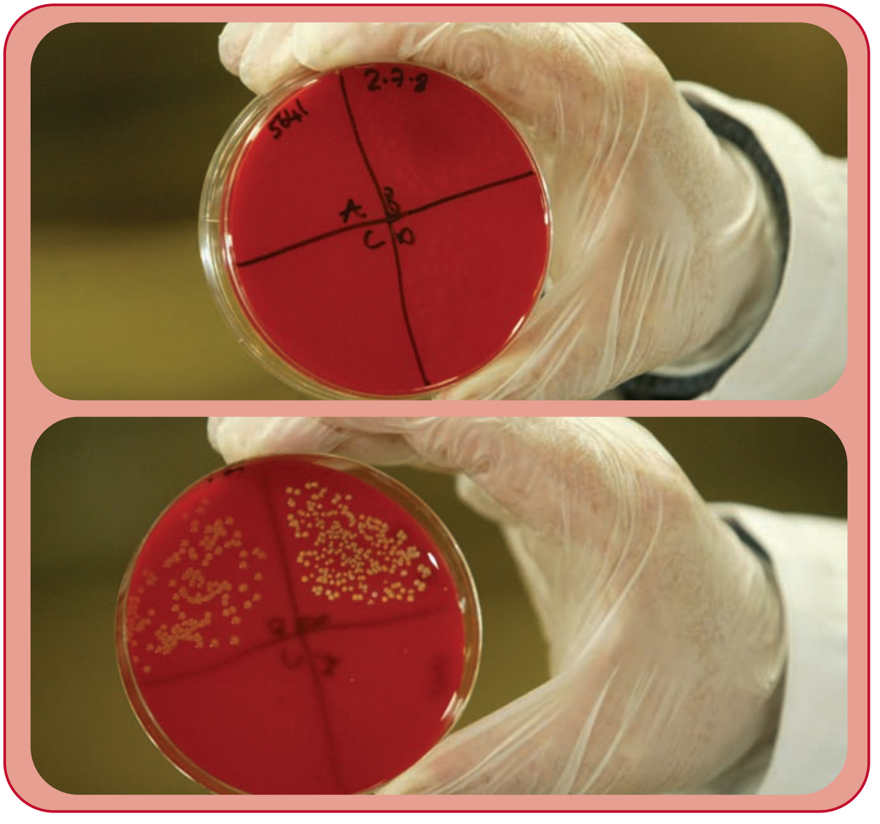
Treatment of mastitis

A new clinical mastitis case developing during the lactation should be treated promptly, when first detected, with a full course of lactating cow antibiotics. Rapid detection and treatment of cases means that fewer further clinical infections develop, and there is less chance of infection being passed to other cows. Also, early detection and treatment increases the chances of a cure because at that point, the bacteria are in a rapidly multiplying state and are most susceptible to antibiotics and there is less swelling and fewer clots to block access of the infused antibiotic.

If information is available about the type of bacteria causing the infection, then this should be discussed with the veterinarian with a view to a recommendation for the appropriate antibiotic to be used.



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When treating cows with intramammary antibiotics the procedure used should be as follows:

- Milk out the quarter fully before infusing the antibiotic
- Disinfect the teat end by vigorously rubbing the teat end for 10 to 15 s with cotton wool soaked in methylated spirits
- Avoid contamination of the nozzle of the antibiotic tube before insertion into the teat canal
- Partially insert (or use short nozzle if supplied) the antibiotic tube nozzle into the teat canal (this is advisable in order to minimize dilation and ensure rapid closure of the teat canal)
- Infuse the contents of the antibiotic tube into the infected quarter – hold teat-end firmly between thumb and forefinger and with other hand, gently massage the antibiotic upwards into the teat
- Teat spray (post milking teat disinfect) treated quarters immediately after infusion
- Clearly mark the treated cow and treated quarter, e.g. ratchet-type plastic tags or velcro bands above the hocks or on the legs of the cow and spray paint on the udder or legs of the cow
- Milk must be withheld from the normal milk supply from the commencement of treatment until the end of the recommended withholding period stated on the label
- The treatment details should be recorded on a chart at the parlour so that other milkers may check treatment details and milk discarding period

Take steps to minimize risk of transfer of infection at milking time

- If milking facility layout allows, it is preferable to draft out high SCC and clinical cows to milk them last in the herd
- If not possible to milk such cows last, then sanitize the cluster by dipping it in a disinfecting solution after milking the infected cow to prevent infection transfer to other cows

Day-to-day management of SCC and mastitis

The management of milk SCC and mastitis within a herd can be quite a complex task. There are two aspects to the problem of high SCC and mastitis, i.e. the cow as a source of infection that is likely to be transferred within the herd over time and incorrect facilities, procedures or practices on the farm that exist as a consistent cause for the development of new infection. Thus, an intent or aim to reduce milk SCC to quite low levels and to minimize clinical infection must apply a dual approach of both removing the existing reservoir of infection and removing the cause for the development of the new infection. For example, the existing clinical cases should be treated and cows with recurring mastitis incidences culled, while simultaneously improving the procedures and practices at milking as well as attention to the milking equipment and the cows' environment. If both aspects of mastitis control are not applied together, then either the existing source of infection will continue to cause new infections by transfer from cow to cow, even though the original reason for the new infection has been removed, or alternatively, if clinical infections are cured and /or offending cows are culled, new infections will continue to develop if the original cause of the new infection is still present, for example, poor hygiene practices or the milking machine malfunctioning.

There are a number of tactics that are vital in the establishment of an effective SCC and mastitis management strategy:

Setting goals for the farm

The goal of the dairy farmer /producer must be to improve and maintain the quality of the milk that is produced. This is a constant challenge. It is primarily a management issue. Management decisions have to be made with regard to making the production of quality milk a priority on the farm. The farm owner /manager and milkers should be involved in decisions affecting milking procedures. Training should be provided for milkers. This is particularly important on farms where a number of different milkers are employed during peak labour periods, at week-ends, etc. All milkers, both full and part-time should take responsibility for activities within the parlour and the quality of product coming out of that parlour. Periodic observations of the milking procedure should be made by milkers and feedback given to the overall milking operator or farm owner /manager. Goals for milk quality must be set and measurements must take place – *"if it is not measured, it will not be improved"*.

Suggested initial goal may be:

<200,000 cells/ml with an ultimate goal of **<150,000 cells/ml**

AND

NOT more than **5 clinical cases per 100 cows** in the first month of lactation and **2 clinical cases per 100 cows** in subsequent months of lactation

Protocols

Written protocols on milking procedures, drying off procedures and mastitis treatment procedures are a very worthwhile strategy. A written milking protocol should be developed (in consultation if more than one milker) and subsequently adhered to. The written protocol has two advantages. Firstly, it forces the farmer or milking manager to consider the detail and importance of correct procedures and secondly, it enforces consistency where multiple people have responsibility for milking tasks.

Example of a written protocol for treatment of a clinical mastitis case

- abnormal milk and swollen quarter detected
- if necessary take milk sample to identify bacteria
- milk out cow
- treat with appropriate antibiotic
- clearly mark cow with leg band and spray paint
- record in dairy: cow number, antibiotic used, date and time of use, frequency and number of applications, milk withholding period, date when milk can re-enter bulk tank
- monitor the milk appearance and udder condition until both return to normal and milk re-enters the bulk tank

Ensure absolutely correct facilities and practices

- Good milking hygiene
- Good milking technique
- Correct post-milking teat disinfection
- Milking machine monitored and maintained
- Cow accommodation and general environment e.g. yards, roadways and paddocks maintained in a clean, dry and comfortable condition
- Early detection of clinical mastitis and immediate treatment and recording
- Milking infected cows last in the herd or sanitizing the cluster by dipping it in a disinfecting solution after milking to prevent infection

transfer to other cows. (Back-flushers have been developed to sanitize the liners and claw-piece between milkings. Back-flushing involves a water rinse, sanitizer rinse and repeat water rinse. Back-flushers do reduce the number of bacteria on the liners between cows and thus, can reduce spread of bacteria.)

Data management (a) monitor bulk milk SCC

The bulk milk SCC is an indirect way of estimating the level of subclinical mastitis in the herd. An approximate guideline states that each 100,000 cells/ml is an indication that 10% of cows in the herd are infected. A series of bulk milk SCC data should be assessed in order to see both the level and the trend for a herd.

- It is important to check bulk milk SCC results when they come from the milk purchaser to see if they have increased
- Herds with a bulk milk SCC < 150,000 cells/ml should be quite stable, however, herds with bulk milk SCC > 150,000-200,000 cells/ml have much more fluctuation of SCC levels on a day-to-day basis because there are so many more infected quarters
- In herds with bulk milk SCC < 150,000 cells/ml, a sudden increase (of 10% or more) may indicate that a clinical case has been missed. Thus, check for clinical cases at the next milking
- If bulk milk SCC results are close to levels at which milk would be downgraded, a price penalty imposed or premiums lost, then management options may include:
  - check all milking procedures
  - check the milking machine
  - exclude milk of high SCC cows from the bulk tank
  - dry off cows or quarters with high cell count
  - treatment of the problem cow(s) and subsequent monitoring
  - notification of milk quality advisor from milk purchasing outlet
  - strategic culling of problem cows
- Plot a graph of the bulk milk SCC values as they are received (from the milk purchaser) and use a graph to follow trend changes. This should then be reviewed by the farm owner /manager and milkers. An example graph is shown below (Figure 1).

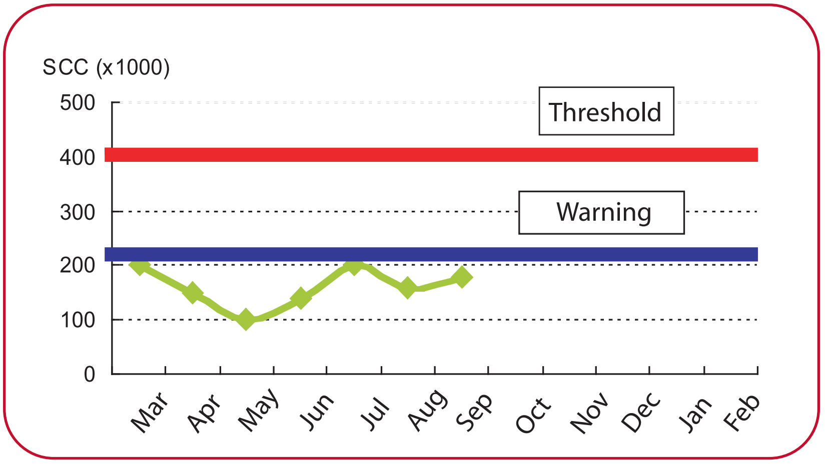

Figure 1. Profile of bulk milk SCC

Data management (b) monitor individual cow milk SCC

Regular individual cow milk SCC allows the farmer /milk producer to monitor the udder health of each cow. It provides knowledge on the contribution of individual cows to the bulk milk SCC, thus enabling the farmer /producer to identify persistently high SCC cows. This information can be used to assist in decision-making on lactation treatment options, selective dry cow therapy and /or culling strategy. Individual cow SCC records should be sought on four occasions during the lactation, as a minimum. This data should include tests carried out at critical points during the lactation, e.g. in early and late lactation.

Continuous and consistent close monitoring of the herd

- Records of all clinical cases and treatments are required in order to monitor herd mastitis properly and to assess individual cows for culling
- If there are more than **five clinical cases per 100 cows in the first month of lactation and two clinical cases per 100 cows in subsequent months of lactation,** then the herd has a significant problem
- Watch for evidence of spread of infection in the herd by checking the percentage of cows and heifers with increased cell counts each month. Heifers are likely to be free from contagious mastitis bacteria at calving, and so can be an 'indicator group' for spread of infection

Suggested mastitis targets

Measure	Target
Average bulk milk (BM) SCC (cells/ml)	150,000-200,000
Maximum BM SCC in early lactation (cells/ml)	<250,000
Maximum BM SCC before drying-off (cells/ml)	<250,000
Proportion of herd above 150,000 cells/ml at herd test	less than 15%
Proportion of heifers above 150,000 cells/ml at herd test	less than 10%
Proportion of clinical cows during 1st month of lactation	less than 5%
Proportion of clinical cows in rest of lactation (per month)	less than 2%

Culling strategy

Consider a workable percentage of the highest SCC cows (based on average SCC) above 400,000 cells/ml, particularly over two consecutive lactations (with dry cow therapy having been used in between). This information should be used in accordance with the clinical mastitis records and particularly, cows with three or more clinical infections during the lactation, together with other production data, when making culling decisions.

Although culling is important in mastitis control, it is an expensive option. **Farm cell count problems are seldom solved by culling alone.** Mastitis control must be a two-pronged approach: cows should be culled based on decision-making strategy outlined above AND management strategies should be developed to prevent new infections.

Set time aside for SCC and mastitis management

Time should be prioritized and set aside for mastitis management on a routine basis during the lactation. For example, one half day per month

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should be planned well in advance and committed to SCC and mastitis issues. It is important that all farm personnel (family and hired) associated with the milking process be present. This is an opportunity to develop and review SCC and mastitis control activities.

The most recent milking machine test report should be available for checking and discussion at this review. The SCC goals and targets set should be assessed and reset if necessary. Facilities or farm infrastructure that would influence SCC and mastitis infection incidence should be discussed and any necessary changes to be detailed. All procedures and practices (e.g. teat preparation, post-milking teat disinfection) should also be reviewed and discussed. The purchase of any cows and heifers and the udder health criteria being set should be discussed. The responsibility for all changes or additional tasks must be assigned to specific individuals. That would help to ensure that the change is made or that the task is carried out before the next review.

Good management requires information. Without records of clinical infections (visually recorded at milking and later as a treatment record) and subclinical infections (revealed by bulk milk and individual cow milk SCC data), mastitis is an invisible disease. Thus, data is critical to the solving of mastitis problems. However, it is **not** sufficient to obtain the data, it has to be interpreted. This means spending time studying the data to identify yearly and monthly trends in bulk milk SCC and to identify high SCC cows and pattern of SCC (consistent or intermittent high SCC) within individual cow SCC data. Data also allows the farmer /milk producer to benchmark his current SCC and mastitis records against previous records and against the records of other producers. It also provides a picture of udder health of the herd which is necessary for the discussion of any problems or new targets with the veterinarian or the milk purchaser.

Prevention of mastitis

Hygiene of the cow

Since mastitis infection is based on bacteria gaining access through the teat canal and becoming established in the interior of the udder, the most successful mastitis control programmes concentrate on creating conditions that minimise teat end exposure to bacteria. Whether cows are grazing in paddocks, standing in yards or in the milking parlour or lying in their winter accommodation, their environment can pose risks of bacterial contamination and mastitis infection. **When dealing with bacterial infection, the most effective means by which presence and transfer of bacteria can be reduced, whether in human or animal health, is by attaining maximum hygiene standards.**

Outdoors

The goal of good pasture management is to balance cow needs with pasture quality and availability while reducing the risk of bacterial contamination of the cows' teats and udder. Grazing intensity should be altered if any build up of manure is observed. Pay particular attention to high traffic areas, such as those adjacent to water troughs and the paddock entrance /exit. An increased number of water troughs and a concrete or solid base rather than a clay area underneath the water troughs would promote the cleanliness of the cow, particularly during wet conditions, and would reduce the likelihood of bacterial infection from this environment. Two entrance /exits from each paddock (rather than one) would also promote cow cleanliness. It is important to have good, well constructed cow roadways of adequate width in order to maintain clean udders. In particular, the approach road to the collection yard (first 100 m of the cow roadway) should be maintained as clean and dry as possible. Cows should not be required to walk through a footbath on their approach /entry to the parlour. Walking cows through a foot bath after milking, when not required, should also be avoided. Yards or cow standing areas should be maintained clean and as free from manure as possible. However, washing of yards should **not** be done while cows are still present.

Hygiene scoring of cows

The relationship between cow udder hygiene and the rate of mastitis infection has been confirmed. An increased risk of mastitis infection was observed for cows with udders characterized as dirty compared to udders characterized as clean. Hygiene scoring systems have been used to quantify this relationship. Thus, hygiene scoring systems have been developed that may be used to assess the cleanliness of cows and the farm environment. Such an udder hygiene score chart may be observed in the 'Checklist' section. The udder hygiene scoring chart may be used to score udder hygiene on a scale of 1 to 4. Score 1 represents a totally clean udder, free of dirt; score 2 represents slightly dirty (2-10% of surface area); score 3 represents moderately covered with dirt (10-30% of surface area); score 4 represents covered with caked-on dirt (> 30% of surface area).

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It is recommended that each farm owner /milking operator would grade their cows for clean udders at regular intervals, e.g. weekly, using the template in the 'Checklist' section. This would firstly, indicate the degree of hygiene of the cows' environment and act as a warning system when action is needed. Secondly, the use of the udder hygiene score chart would highlight the importance of cow hygiene on a continuing basis. If a large portion of cows scored 1 and 2, then the cow udder hygiene could be considered as good on the farm. Alternatively, a large portion of cows scored as 3 and 4 would indicate the need for significant improvement in cow and environment hygiene. This udder hygiene score chart could be used for all milking cows, whether at pasture or indoors.

Indoors

The goal of dairy cow housing is to provide an environment that is clean, dry and comfortable for the cow. While the larger proportion of Irish milk is produced while cows are outdoors, a considerable volume is also produced during the indoor period. The condition of housing for the lactating cow is of critical importance with regard to development of mastitis and subsequent milk quality. The condition of housing for the dry cow is also of critical importance with regard to development of mastitis and subsequent udder health.

The minimum requirement of lying area per cubicle is 2130mm in length by 1160mm in width (measuring from centre to centre of the pipework) with a floor slope of 100mm and kerb height of 225mm for cows of 450 - 570kg. A large cow requires 700 – 1000mm lunging space to rise with reasonable comfort. Cubicle length, width and position of the head rail are a compromise between cow comfort and floor cleanliness. Concrete cubicle beds with mats constitute the most usual cow accommodation at present. Dry bedding material, such as dry sawdust or combination of dry sawdust, limestone or chopped straw may be used. The bedding should be absorbent, comfortable and not encourage bacterial growth. **The important point is that a DRY lie must be maintained at all times.** Cubicle beds should be cleaned twice daily and new bedding applied as necessary to optimize cow cleanliness, comfort and use of the cubicles.

Weanlings should be trained to use cubicles. The approximate measurements for weanlings are 1820mm in length by 910mm in width (centre to centre). The provision of mats in the cubicles has merit for training weanlings to use cubicles.

Yards should be designed for animal safety and cleanliness. Clean water should be diverted before it comes in contact with manure on the yard. Contaminated water should be contained by channelling to a manure store. The concrete yard area should be maintained in a clean condition by removal of manure as frequently as possible e.g. automatic scrapers, slats.

Calving

Cows are very susceptible to infection around calving because their natural defence mechanisms are low. New infections occur and subclinical infections which have persisted through the dry period may develop into clinical cases. As the calving time approaches, the udder is gradually filling with milk and internal udder pressure builds up. This may result in the teat canal being relatively 'open' compared to during the mid dry period. This in turn, may allow easier access of bacteria to the teat, which is not experiencing the flushing effect of milking at this time and therefore the bacteria have a greater chance of multiplying and establishing an infection. **It is absolutely necessary that cows have a clean dry environment for calving.**

Suspected clinical infections should be dealt with promptly in the same manner as during the main lactation. Early detection and treatment of clinical mastitis cases in the calving period reduces the risk of severe cases developing later and the likelihood of infection being passed to other cows. It is particularly important to note the number of cases of mastitis occurring in freshly calved heifers. This is very often an indicator of the state of their accommodation.

Management of the calving/calved cow

- Provide cows with clean dry environment for calving
- Cows should not be left leaking milk post calving. They should be brought to the milking parlour as soon as possible after calving, have their udders checked, milked and have post milking teat disinfection applied
- Colostrum should be collected individually in buckets for the first 2 milkings and fed to the newly born calves; colostrum from milkings 3 – 7 should be diverted for general calf feeding
- Colostrum must be withheld from the normal milk supply for a minimum period of 7 milkings
- Ensure each cow has exceeded her Dry Cow Treatment Dry Period as well as the minimum colostrum period of 7 milkings before putting her milk into the bulk tank
- Look for swollen quarters and check for heat and pain in all freshly calved cows and check milk from all quarters at every milking while cows are in the colostrum phase
- Suspected clinical infections should be dealt with promptly in the same manner as during the main lactation

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Milking equipment

Testing and maintenance

The milking machine is unique in that it is the only machine on the farm that interacts directly with the cow. If basic care and maintenance are neglected it will not perform properly. While most farmers have their milking machines serviced and tested as required and carry out regular checks themselves, there are many who do not. It is not uncommon for many dairy farmers to call the service personnel only when milk SCC or TBC values exceed acceptable limits.

Importance of testing

The most common reason for milking machine problems is inadequate routine maintenance of mechanical components and rubberware. **The milking machine should be serviced and tested by a qualified technician at least once per year,** before the start of the spring season, e.g. first week of February for all herds and again during first week of August for mixed herds. Additionally, daily and weekly checks should be conducted by milking operators as part of their regular list of responsibilities. It is also important that the appropriate person is alerted to any problems that are found or suspected.

The Irish Milk Quality Co-operative Society (IMQCS) undertakes the training and certification of milking machine technicians to ensure that they are up to date with the latest standards for milking machine installation, service and testing. Regular milking machine servicing and testing must be considered as an integral part of modern quality milk production.

Testing procedure

When the milking machine technician is requested to visit the farm, the most usual procedure is that the milking machine technician initially carries out a normal service on the machine and then tests the machine afterwards. However, from a mastitis control point of view, a test on the machine before the normal service is carried out would provide a valuable link to the condition of the machine before corrections and alterations are made. Thus, when a mastitis problem or suspected problem exists, a test should be carried out **before and after** the normal service. A milking machine test gives assurance that machine induced mastitis is minimised when the machine is operating correctly, and it can assist in diagnosing problems if they arise.

The regular servicing and testing of machines is critical, since very often it may not be noticeable that the machine is not operating correctly. If a machine has not been tested and serviced for a period of two years, it will be able to milk cows but there is a high probability that the pulsation system and the vacuum regulator will be showing readings outside of the recommended levels. The vacuum reserve (i.e. the vacuum in reserve over and above what is used by the machine in normal operation) will most likely be lower than recommended, because of air leaks through cracks in rubberware, etc. These are very serious faults that would have been prevented if the machine had been serviced and tested as recommended.

Test reports

A milking machine test report records the state and performance of the machine at a particular moment in time. When the milking machine technician tests the machine, a test report is completed. The report shows the measurements, faults and recommendations. **It is important that the farm owner /manager receive a copy of this test report.** The content of the test report should be discussed with the farm owner /manager. The report should then be filed as a record for future reference.

- This report should include – as a minimum:
  - date of test
  - service check list
  - record of corrections, replacements, adjustments
  - test results of:
    - vacuum level after repair
    - pulsation graphs after repair
    - vacuum reserve after repair

- Service personnel should also carry out a calibration check of all meters and jars, adjust to correct if necessary and provide a result report to the farm manager

Maintenance checks by milking operator /manager

While the milking machine technician will carry out the main service, there are some maintenance checks that the milking operator /manager should carry out daily /weekly.

Vacuum gauge

When the machine is in the 'off' position, the needle of the vacuum gauge should be at the 'zero' position. If not, then the gauge needs to be replaced. It is also important to check the vacuum gauge reading at the start of each milking. The vacuum gauge should be visible from the milker's pit. There should be a pointer on the gauge to indicate the correct vacuum level. If the needle of the gauge is directly in line with the pointer, then the machine is operating at the correct vacuum level.

The vacuum level for typical Irish milking machines should be within the range 47-50kPa. If the operating vacuum of a machine is too low, then it will take longer to milk the cows. Alternatively, if the operating vacuum of a machine is too high, then teat damage, mastitis and raised cell counts may result.

Clusters

The claw air bleeds should be checked and cleared (made free) on a daily basis. Rubber tubes should also be checked daily for cuts, breaks or damage. Leaks in rubber tubes reduce vacuum reserve and allow dirt to be sucked in. Both the short pulse tubes and short milk tubes between the shells and the claw are very prone to damage. Check that the arrows on the liner are lined up, this ensures that the liners are not twisted in their shells. Check the claw bowls for damage. The shut off valve can become worn and may not fully shut off the vacuum when taking off the cluster. This can send air blasts towards the teat ends which could contribute to mastitis.

Pulsation tubes and airlines

Each pair of long pulse tubes (attached to a single relay) should be flushed with warm water at eight-week intervals. The pulsation airline is the pipe that supplies vacuum to work the pulsation system. This airline is not included in the circulation cleaning system. It needs to be washed

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out at least annually and its drain valve needs to be checked regularly and cleaned. The pulsation airline should be flushed with a hot detergent solution and thoroughly rinsed out with hot water. This can be done by connecting a rubber milk tube to the tap or bung at the end of the line.

Pulsation

Modern pulsation systems are very reliable and generally will operate without trouble if serviced annually. When the milking machine technician tests the machine, the ratio and the rate of pulsation is measured. The ratio indicates the proportion of time the liner is in the various stages of its movement (i.e. opening, open, closing and closed), e.g. the percentage time of each pulsation cycle when the liner is open. The rate indicates how often this sequence happens per minute. Some electronic master pulsation control boxes have the ratio and rate displayed on the box. The pulsator ratio should be in the range of 60-68%; this may be checked within some systems (if displayed). The pulsation rate should be between 58-62 cycles per minute and should be checked occasionally. This may be done by insertion of the thumb into a liner and counting the number of pulses per minute.

Vacuum pump and motor

The oil level for the vacuum pump should be checked weekly and topped up as necessary. Check belts for tension. There should be about 12mm play with firm thumb pressure on the belts. A spare set of belts should be carried at all times. If belts have to be replaced or tightened, be sure to maintain pulley alignment. Always isolate the power supply for this type of work and replace safety guards afterwards.

Vacuum regulator

It should be possible to hear air hissing into the vacuum regulator during milking. If there is no sound from the regulator, it indicates that the vacuum reserve is low, the regulator is faulty or there are a lot of unintended air leaks into the machine, probably because basic maintenance has been neglected.

Clean the vacuum regulator air intake and foam filter(s) with warm water and mild detergent regularly (at eight weekly intervals approximately). Dry the foam filter by squeezing it in a dry cloth. If the regulator body is dusted down and the filters cleaned regularly, then the regulator body may only need to be cleaned by the technician during the service visit.

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Liner change interval

Deterioration of liner condition reduces the speed and completeness of milking, increases teat end damage and increases the spread of bacteria.

The effective life of liners is influenced by the characteristics of the materials they are made from, the working environment, the cleaning routines that are used and the milking use that they are exposed to.

- For spring calving herds, change liners at 2,000 cow milkings or twice per year, whichever is of shorter duration
- For all year round milking, change liners at 2,000 cow milkings or 3 times per year, whichever is of shorter duration

Calculation of due date for liner change (if recommendation of 2,000 milkings occurs more frequently than twice yearly in spring calving herds)

$$\text{Number of days (liner life)} = \frac{\text{2,000 x number of units}}{\text{Herd size x milkings per day}}$$

e.g., A herd of 120 cows milked twice per day in a 16-unit swing-over parlour would allow a liner life of 133 days.

$$\text{Number of days (liner life)} = \frac{2{,}000 \times 16}{120 \times 2} = 133$$

The milking machine technician usually changes the liners at the annual service. The best method of ensuring that liners are changed at the right time is to arrange with the milking machine technician for replacement after 2,000 milkings (based on the above calculation).

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Summary check list

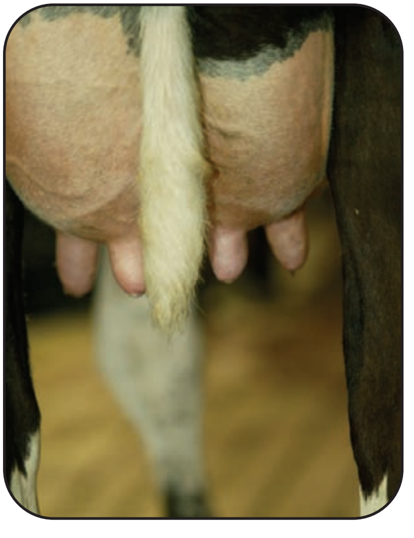
- Daily check of vacuum gauge (47-50 kPa for mid-level plants)
- Daily check to ensure claw air bleeds are free of dirt
- Daily check of rubberware for leaks and replace any worn or broken rubberware
- Weekly checks of oil flow from oil reservoir
- At 8 week intervals, remove filters at vacuum regulator and wash in warm water and dry
- At 8 week intervals, flush each pair of long pulse tubes (attached to a single relay) with warm water
- A quick test for reserve can be carried out at regular intervals, i.e. open one cluster and observe the vacuum drop. The vacuum drop should not be greater than 2 kPa
- For spring calving herds, change liners at 2000 cow milkings or twice per year, whichever is of shorter duration
- For all year round milking, change liners at 2000 cow milkings or three times per year, whichever is of shorter duration
    - Ensure that liners are compatible with shells
    - Change complete set of liners at the same time
    - Record exact dates of liner changing in farm dairy
- If a sudden increase in SCC or TBC is noticed, then service personnel should be called in to carry out basic checks on the milking machine plant

Milking procedure

Good milking management is critical in the production of quality milk. During the milking process, bacteria can be transferred from the environment into the milk. Furthermore, there is a high risk of spread of contagious mastitis from infected to uninfected cows during the milking process unless proper control measures are taken. The milking process may be defined as the overall procedure associated with three distinct activities, i.e. cow preparation for milking, milking technique and post-milking teat disinfection.

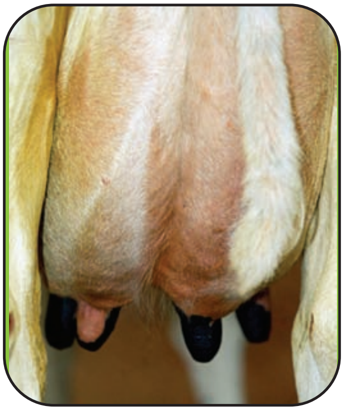
Good milking hygiene

Bacteria that are not removed from the teat surface before cluster attachment will end up in the milk. The ultimate rule is to **PRESENT A CLEAN COW FOR MILKING.** Teatcups should only be attached to **clean and dry teats.** Teats soiled with manure and dirt are laden with bacteria, and water dripping down from the dirty part of the udder onto the teats can also introduce bacteria to milk during milking. A clean cow determines both milking efficiency and rate of udder infection. It is estimated that dirty cows will easily double cow preparation time, and thus unnecessarily slow down parlour throughput. Thus, it is best if cows are as clean as possible when they enter the parlour.



Management practices to improve cow presentation

- Clip tails post-calving, mid-lactation and at drying-off (minimum)
- Clip udders once per year, post-calving or near end of lactation
- Entry and exit to paddocks, areas around troughs and gates, approach roads to the dairy and the collecting yard should all be maintained in a clean condition and without surface water
- Cubicle beds should be maintained clean and dry



Effective cow preparation for milking

- Ensure clean hands and it is recommended to wear gloves during milking
- Inspect foremilk for signs of clinical mastitis
- It is particularly important to inspect foremilk when bulk tank SCC is approaching levels at which milk could be downgraded and foremilking should always be followed by teat washing and drying (to prevent transmission of bacteria from teat to teat and cow to cow), glove/hand washing and washing away of foremilk
- Wash teats of cows with low pressure, warm water if considered necessary
- If teats are washed, it is absolutely necessary to dry teats with paper towel (new individual towel or new section of towel for each cow) - have sufficient paper towel dispensers (e.g. 1 to every 5 cows)
- Highly absorbent paper should be used for drying teats
- It is considered 'best practice' to wash and dry cows before milking, however, it is specifically recommended to wash and dry cows when cows are indoors or on out-wintering pads
- If the udder is exceptionally dirty, then the base of the udder should be washed and dried in addition to the teats
- Teat washing routine should commence only when cows are in place (udders and teats should not be hosed as the cows enter the parlour)

Good milking technique

The main objective when milking should be to remove or harvest the milk as efficiently, gently and safely as possible.

Effective milking technique

- Clusters should be attached to cows in batches as soon as possible after preparation
- The inverted cluster should be held level in the hand such that vacuum is cut off from the cups and air leakage is minimized
- Attach each teat cup in sequence and as quickly as possible
- If right-handed, apply teatcups in a right-direction sequence leaving the nearest teatcup (to operator) to last; if left-handed, apply teatcups in a left-direction sequence leaving the nearest teatcup to last
- Air leaks in the milking system during milking should be corrected immediately
- When animals with three active quarters are being milked, a clean dummy teat should be used for the remaining milking cup and a mechanism to easily identify the cow, such as leg band and udder spray should be in place
- Where manual cluster take-off is practiced, clusters should be removed when milk flow ceases in the claw-piece by shutting off vacuum at the claw-piece before removing the cluster and the four teatcups should be removed together. (Automatic cluster removers are an effective method by which to avoid over or under milking, particularly if there are different operators in the parlour)
- **It is most important that a set of procedures is chosen that requires each milker to be absolutely consistent at every milking**

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Hygiene during milking

- Avoid splashes or sprays of milk on hands or on clusters
- Use running water and disinfectant solution to remove infected milk from gloves, clusters or other surfaces
- Dirty clusters should be washed externally between milkings
- Dirty clusters should not be washed /cleaned while still attached to the cow
- Standing areas should be washed only when cows have exited
- All used gloves and towels, disinfectant wipes and used antibiotic tubes should be assembled as waste
- Washing of yards should **not** be done while cows are still present
- Avoid walking cows through a foot bath after milking when not required

Filter sock

A new or freshly cleaned filter sock should be put in place <u>before</u> each milking and removed <u>after</u> each milking, before washing of the machine takes place. The sock should be fitted correctly. The sock should be examined for indications of clinical mastitis (clots) after milking.

Correct post milking teat disinfection

The correct application of a good post-milking teat disinfection product to cow teats after milking is a most significant and important task. After milking, bacteria multiply on the teat skin and may extend into the teat canal. If the whole surface of each teat is disinfected immediately after milking, this establishment of bacteria can be minimized. Teat disinfection is one of the most effective cell count and mastitis control measures available, but it only works if it is done thoroughly. Failure to cover the whole teat of every cow at every milking is the most common error in teat disinfection. Specifically, teat disinfection after milking (when applied correctly) reduces new *Staphylococcus aureus* infections by 50%.

Effective teat disinfection

- **Spray all teats of all cows** (in batches) as soon as possible **after every milking** throughout the lactation (the recommended use level is 20 ml per cow per application – BUT note that adequate volume alone does not ensure that teats are covered)
- Ensure that **the entire circumference of the teat is covered.** All of the teat surface touched by the teatcup liner should be covered with the disinfectant. A drop of disinfectant should be observed at the end of the teat – BUT note that the drop alone does not ensure that teats are covered sufficiently
- Teat spray should be applied **from directly underneath the tips of the teats,** not sprayed from the side. Teat spray should never be applied as cows are walking out of the parlour

- Check the 'far sides' of teats of at least some cows after spraying to ensure that correct coverage is being achieved
- Have sufficient teat disinfection sprayers (e.g. 1 per 4 units)
- Ensure that teat disinfection sprayers are operating correctly and specifically, ensure that all spray head nozzles are fully functional - all farms should have spray nozzles in reserve
- If using a teat disinfectant that is not 'ready to use', then dilute daily as directed for that product
- If using a dip cup, wash daily or more frequently if contaminated
- If teat condition deteriorates (e.g. chaffing) during adverse weather conditions, change to a teat disinfectant with a higher emollient content for a period of time. BUT the emollient content and duration of usage are important. For example, do not exceed 10% glycerine for regular use - higher levels may interfere with the killing power of the disinfectant. Also, if teat condition is particularly bad, glycerine concentration may be increased to 20% but not for longer than two weeks.
- Any changes in teat disinfectants used and the date of change should be logged by farm manager

Only licensed teat disinfectants from reputable sources should be used (do not buy /use unidentified products). The use of an Iodine type disinfectant ensures that the coverage of the teats is visible and the inclusion of an approved emollient(s) is also important.

Drying-off management

At the end of each lactation, the udder tissue needs to repair itself. Dairy cows require a dry period which is sufficiently long to allow repair of udder tissue. Also, the processing quality of milk starts to deteriorate as the cow approaches natural drying off (involution). Milk from low producing cows may cause processing problems for some dairy products. The processing problem may be exacerbated by elevated SCC of low yielding cows at this time. Those cows may contribute significantly to the bulk tank milk SCC, even though their milk volume is low. For all of these reasons, milk removal must cease. A dry period of approximately eight weeks is recommended. The aim is to shut down milk secretion and allow the teat canal to seal as rapidly as possible. The teat canal is sealed by the development of a keratin plug which is complete at between 10 and 20 days after drying-off (approximately). The dry period is a critical time for the development of mastitis (Figure 2). Dry cows are at risk of mastitis for a number of reasons. During the dry period important preventative practices, such as foremilking and post-milking teat disinfection are discontinued. Also, as calving approaches, the cow's immune system becomes depressed, thus reducing the ability of the gland to fight off new infections.

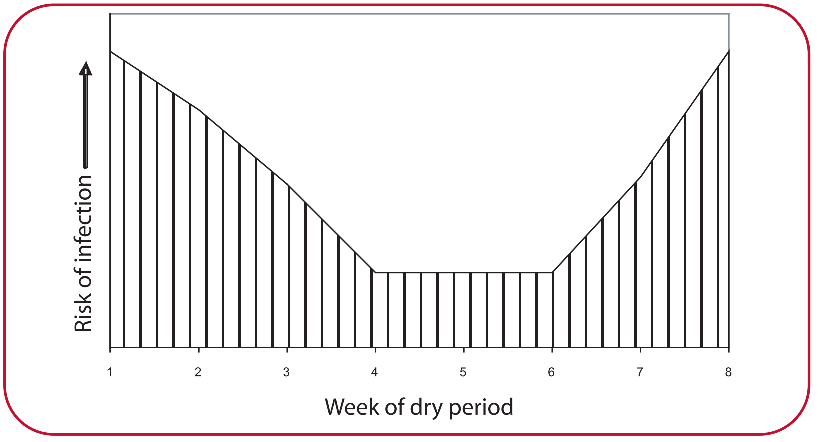

Figure 2. Risk of mastitis during dry period

The two important aspects of managing the drying-off of cows are (i) correct decision-making and (ii) correct application of procedures.

Decision-making on drying-off date

The best means by which decisions on drying-off date can be made is by having clear, correct and up-to-date information on expected calving date, daily milk yield and SCC for each individual cow. If milk yield and SCC recording of individual cows is not conducted frequently, it is important that the last recording of the lactation is conducted quite close to the end of lactation so that results may be used to identify low yielding cows and high SCC cows that need to be dried off.

The decision to dry-off should be based on the following criteria:

i. **Expected calving date:** cows at 56 days or less to expected calving date should be dried off

ii. **Daily milk yield:** cows at greater than 56 days to expected calving date BUT with milk yield at 8-9 kg or less /cow/day

iii. **SCC:** cows at greater than 56 days to expected calving date and milk yield greater than 8-9 kg/cow/day BUT milk SCC greater than 300,000 cells/ml

In the event of individual cow milk yields not being available, once the average cow (in the herd) milk yield decreases to less than 10-11 kg/cow/day, then close examination of all cows must be carried out with a view to drying-off individual cows or alternatively, the complete herd should be dried off.

Decision-making on dry cow therapy

The application of dry cow therapy is normally recommended for all cows. Dry cow therapy may take the form of (a) dry cow antibiotic treatment, (b) non-antibiotic teat sealant or (c) both dry cow antibiotic treatment and teat sealant used together. The dry cow antibiotic treatment is a formulation of antibiotic prepared for installation into the udder immediately after the last milking of lactation. The objective of using dry cow antibiotic treatment is to (i) treat existing infections which have not been cured during lactation and (ii) reduce the number of new infections which may occur during the dry period. The teat sealant is an inert substance that is infused into the teat after drying off. The material fills the teat canal and lower part of the quarter and acts as a physical barrier to any invading bacteria. Thus, the teat sealant helps to prevent new infections from developing during the dry period and around calving.

Dry cow antibiotic treatment is recommended for all cows that (a) encounter a peak individual cow SCC of greater than 150,000 cells/ml during the lactation (and heifers that encounter a peak individual SCC of greater than 120,000 cells/ml during the lactation), (b) had a clinical mastitis case during the lactation or (c) that has a 'suspect' mastitis history (or incomplete or unknown mastitis records). In all other cases, non-antibiotic teat sealant may be used on its own. Dry cow antibiotic treatment is most common as the majority of cows may be defined under the categories (a), (b) or (c) above. The use of both dry cow antibiotic treatment and teat sealant together is not common. It is recommended that whichever form of dry cow therapy is selected for an individual cow, then all teats of that cow should receive the same therapy.

Decision-making on dry cow antibiotic treatment

The type of dry cow antibiotic treatment to be used on an individual cow should be based on lactation milk SCC and infection type (mastitis culture results) and incidence. This decision must also be taken in association with the expected length of the dry period and particular attention must be given to the recommended milk withholding period after calving. Additionally, it is recommended that an individual cow selected for treatment would receive the same treatment in all four quarters.

Preparation for drying-off

- When deciding on the antibiotic product type to be used, the dry period duration of individual cows needs to be considered. This is necessary in order to avoid a risk of antibiotic residue in milk in the early stage of the subsequent lactation. Additionally, the product most suitable for the specific farm should be identified in terms of infection type prevalent in the herd (mastitis culture results), previous antibiotic responses in the herd, mastitis infection cure rates and the minimum protection periods of the different products. This information should be discussed and subsequent decisions made in consultation with the veterinarian
- Drying-off should occur by abrupt ceasing of milking. It is not advisable to commence milking at different intervals, e.g. once a day or 3 times in every two days at this stage of the lactation
- If cows are producing more than 12 kg/day, then reduce food intake in order to reduce production to 12kg or less by drying-off date
- Consider culling any cow that had three or more clinical cases during the current lactation and /or cows with high milk SCC in two consecutive lactations, despite treatment with dry cow antibiotic therapy in the dry period in between
- Do not use dry cow treatment on cows to be culled

Dry cow antibiotic /teat sealant administration

Administration of dry cow therapy is a critical and difficult task. It is vitally important that the dry cow therapy be administered carefully, as bacteria can be easily introduced into the teat and can result in severe clinical mastitis if the teat end is not disinfected properly. Cows should be dried off in batches if possible. It is necessary to plan in advance for the time and knowledge that is required to carry out this task properly. Allow plenty of time to treat the cows. More than one person is often needed to do the job well. Ensure that the person carrying out the task is well trained in the procedure, and if a number of operators are involved, that they are well trained also, and adequately supervised.

- Treat all quarters of each individual cow with the same treatment
- Dry cow antibiotic tubes and /or teat sealant should be administered after the final milking (decision based on lactation milk SCC, infection type and incidence for individual cows)
- Milk out the quarter fully before infusing the dry cow antibiotic /sealant
- Disinfect the teat end - vigorously rub the teat end for 10 to 15 s with cotton wool soaked in methylated spirits
- Avoid contamination of the nozzle of the antibiotic tube before insertion into the teat canal
- Partially insert (or use short nozzle if supplied) the antibiotic tube nozzle into the teat canal (this is advisable in order to minimize dilation and ensure rapid closure of the teat canal)
- Infuse the contents of the antibiotic tube into the quarter – hold teat-end firmly between thumb and forefinger and with other hand, gently massage the antibiotic upwards into the teat (this is not done with teat seal)
- Teat spray (post milking teat disinfect) treated quarters immediately after infusion
- Record cow number, date and product details of all dry cow treatments
- Mark the cow (leg band and spray paint on udder) so that cows that have received dry cow therapy can be readily recognized
- Do not leave cows in yards or soiled areas in the period immediately after dry cow therapy application
- Maintain dry cows separate from the milking herd if possible and put dry cows in clean, dry paddocks (particularly for the first two weeks after drying-off) to reduce teat exposure to environmental mastitis bacteria

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Following dry cow treatment

Cows are particularly susceptible to new infections during the first week of the dry period, before the teat canal has sealed. During this time, the cows should be checked on a daily basis for swollen udders or signs of illness. All quarters of all cows should be observed weekly for at least three weeks. The quarters should be inspected for signs of clinical mastitis, such as heat and swelling. Milk or secretion should only be removed if the quarter is suspected of having clinical mastitis.

In the event of a case of clinical mastitis, the cow should be separated from the main herd. All milk or secretion should be removed or stripped from the quarter. A full course of lactating cow antibiotic treatment should then be administered to the quarter. The teats should be sprayed with disinfectant after each administration. Treatment details should be recorded. When the clinical case has cleared, application of the dry cow antibiotic treatment should be repeated.

Troubleshooting

If the herd has a high milk SCC then the milk production system must be examined. Many farmers delay carrying out an examination /investigation because of the cost and scepticism that it will not deliver a result. However, the economic cost can be recouped from the increased milk production and payments for improved quality milk. The other most substantial resources that the farmer may need to allocate are TIME and ATTENTION. It is beneficial if there is a group approach to the problem, i.e. the farmer, milk quality advisor, veterinarian and milking technician, so that all influencing parties have an input.

The following factors should be considered

- **Malfunction of Milking Equipment** – Many farmers do have a regular preventive maintenance service of the milking machine performed by their technician. But equipment failure can happen and can certainly contribute to an SCC problem. For the average size dairy, if the milking equipment has not been evaluated and serviced in the past 9-12 months, this would be a good place to begin troubleshooting.
- **Dirty Cows -** If over 5% of the cows are heavily contaminated with manure on the rear legs and udder (especially on the teats), there is a problem with the hygiene management. This is usually a more significant problem during the housing period. It is very common for *Staphylococcus* and environmental *Streptococcus* organisms to be present on the udders of many of these cows. These organisms cause chronic, subclinical mastitis and a significant rise in the milk SCC. The cause of the dirty cow problem should be determined and corrected as quickly as possible so that most of the cows will be clean as they come to the parlour.
- **Contagious Mastitis and Milking Procedures -** The most common form of contagious mastitis is caused by *Staphylococcus aureus.* Almost all herds have some infected cows. The milking preparation procedures should be reviewed and compared to the ideal and improvements and changes made where needed.
- **Post Milking Teat Disinfection and Dry Cow Therapy -** Both of these are valuable tools that should be incorporated into the management plan for all herds. If these tools are not being used, they should be considered.
- **Dry Period and Calving Management -** This is a critical time in the lactation cycle. These cows should be kept very clean, dry and comfortable, especially at calving.

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Short Check List

- Correctly teat disinfect all teats of all cows after each milking
- Treat all quarters of all cows with dry cow therapy at end of lactation
- Have milking equipment checked and serviced at least once per year
- Review milking practices and hygiene
- Keep cow udders clean between milkings and maintain good teat condition
- Remove clusters carefully
- Cull chronic problem cows
- Culture and identify the bacteria if there is a recurring herd problem

The 10 SMART guidelines to achieve milking excellence

1. SET PERFORMANCE GOALS

Achievable goals for bulk milk SCC should be set initially based on current farm status, e.g. set a goal of less than 200,000 cells/ml if current bulk milk SCC is 350,000 cells/ml. Once the initial target is met, a further target may be set. The ultimate target should be to produce milk of approximately <150,000 cells/ml.

2. RAPIDLY IDENTIFY MASTITIS PROBLEMS

Farms that consistently produce high quality milk have methods to monitor herd performance. The rate of both clinical and subclinical mastitis infections are very often unknown to the milking manager. A clearly defined monitoring system should be in place e.g. checking data of bulk milk SCC report and individual cow milk SCC, inspecting the filter sock, cow udders and foremilk at milking time.

3. MILK CLEAN COWS

Many studies have demonstrated that cleanliness is a good predictor of herd milk SCC. On many dairy farms, cows are exposed to contagious mastitis bacteria during the milking process. Alternatively, milking cows may be exposed to environmental bacteria between milkings in their accommodation area.

4. STANDARDISE THE MILKING ROUTINE

Achieving a consistent, good routine is a key to quality milk. Different milkers on the same farm often follow different routines. To avoid this, milking routines should be written down and posted in the milking area. The writing of the routine emphasises the importance of the concept of milking routine and milk quality to both manager /writer and staff /milker.

5. TRAIN STAFF

It is important to ALWAYS train other milking operators, whether family or hired members of staff. Investing in and improving employees is a smart management strategy that will reward in better job performance.

6. HAVE TREATMENT PROTOCOLS

It is advisable to have treatment protocols which define standard treatments for mastitis. Such a treatment protocol should include as a minimum, the type, number and frequency of antibiotic treatment (tubes) during a mastitis incident, the administration procedure and milk withholding times.

7. MAINTAIN AND UPDATE THE MILKING SYSTEM

A properly functioning milking system is essential for the production of high quality milk. Thus, the plant must be updated in accordance with herd expansion, must be checked and maintained regularly by the owner and expertly checked by a milking machine technician at least once per year.

8. SET TIME ASIDE TO MANAGE MILK SCC AND MASTITIS INCIDENCE

This means creating time to manage milk SCC and mastitis within the herd, both on an ongoing brief daily basis and on a planned half day per month. Management should refer firstly, to the management of data, i.e. the collection, recording, checking and interpretation of herd and individual cow SCC levels as well as clinical mastitis incidences, and secondly, to the management of the cow in her environment, i.e. milking technique and cow accommodation.

9. BUY ONLY HEALTHY COWS

Practising mastitis bio-security means keeping cows safe from contagious mastitis bacteria, such as *Staphylococcus aureus.* Buy only healthy cattle. Young, non-lactating heifers are a minimum risk. Also, buy cows of known SCC from a healthy herd, e.g. a milk recording herd with a normal SCC of less than 150,000 cells/ml.

10. USE DRY COW THERAPY

The dry period is a critical time for the development of mastitis. All cows should receive dry cow therapy and subsequently, be checked regularly and cow accommodation must be maintained well.

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Bacterial Growth in Milk

Achieving low bulk milk total bacterial counts (TBC) on dairy farms

Microbial quality of milk is an important measure and is associated with a number of farm management practices. Total bacterial count (TBC) is an indicator of on-farm general hygiene conditions, milking equipment cleanliness and milk storage (temperature and time).

Hygiene

Due to its very specific composition, milk is susceptible to contamination by a wide variety of bacteria. Farm milk may contain anything from a few thousand bacteria per ml, from a farm with good hygiene practices, to several million if the standard of cleaning, disinfection and cooling is poor. Daily cleaning and disinfection of all milking equipment is therefore the most decisive factor for the bacteriological quality of milk. For milk to be classed as top quality, the bacterial count should normally be less than 100,000/ml. In some countries, 10,000 cells/ml can be reached easily.
It pays to produce milk of high hygienic quality. Systems must be developed and implemented that are capable of delivering consistently high levels of hygiene management and bacterial control. Many factors influencing milk SCC also affect milk TBC. An effective dairy hygiene programme should incorporate four individual stages:

- Pre-milking hygiene
- Udder hygiene
- Milking plant hygiene
- Bulk tank hygiene

Pre-milking hygiene

A good level of general farm hygiene should be achieved and maintained. This may be defined as management that provides an environment in which cows are maintained in a clean condition and one in which bacterial challenge to the udder is minimized. Elements of this management system include:

- Clip tails post-calving, mid-lactation and at drying-off (minimum)
- Clip udders once per year, post calving or near end of lactation
- Entry and exit to paddocks, areas around troughs and gates,

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approach roads to the dairy and the collecting yard should all be maintained in a clean condition and without surface water
- The milking parlour and dairy areas should be maintained in a tidy, clean and hygienic manner
- Cubicle beds should be maintained clean and dry (as recommended to minimize milk SCC)

Udder hygiene

A regular routine before milking that ensures minimal bacteria on the udder and teat skin is required. This may be achieved by:

- Ensure clean hands and it is recommended to wear gloves during milking
- Inspect foremilk for signs of clinical mastitis
- It is particularly important to inspect foremilk when bulk tank SCC is approaching levels at which milk could be downgraded and foremilking should always be followed by teat washing and drying (to prevent transmission of bacteria from teat to teat and cow to cow), glove/hand washing and washing away of foremilk
- Wash teats of cows with low pressure, warm water if considered necessary
- If teats are washed, it is absolutely necessary to dry teats with paper towel (new individual towel or new section of towel for each cow) - have sufficient paper towel dispensers (e.g. 1 to every 5 cows)
- Highly absorbent paper should be used for drying teats
- It is considered 'best practice' to wash and dry cows before milking, however, it is specifically recommended to wash and dry cows when cows are indoors or on out-wintering pads
- If the udder is exceptionally dirty, then the base of the udder should be washed and dried in addition to the teats
- Teat washing routine should commence only when cows are in place (udders and teats should not be hosed as the cows enter the parlour)

Milking plant hygiene

An effective cleaning routine should be put in place to clean the milking plant after each milking. **The most relevant and important points are to operate whatever cleaning system is in place according to the manufacturer's instructions and use cleaning products from reputable suppliers. A build up of milk deposits provides perfect conditions for bacteria to grow.** A thermometer should be used to check water temperatures regularly (75-80°C initially, before circulation and 43-49°C subsequently, after circulation, is recommended).

Typical residues that occur in milking machines

- Organic residues from milk – removed by detergent wash
- Mineral deposits from water – removed by descale hot wash /acid wash
- Biofilm due to extensive thermoduric bacterial growth – removed by proper washing
- Chemical residues, e.g. teat dips, cleaning agents – use correct amounts

Further typical machine hygiene problems

Deposit	Diagnosis	Cause
Fat	soft and greasy	- low temperature washing - poor initial rinse after milking - ineffective detergent
Protein	hard brown film	- poor washing circulation - ineffective detergent (chlorine)
Iron	hard orange film	- inadequate frequency of descale - low concentration of acid detergent

Three different cleaning routines for milking plants are outlined below. Cold circulation cleaning with one hot circulation cleaning carried out per week may be sufficient in many instances. However, in milking machines with additional fittings such as milk meters or large milklines, it is necessary to carry out at least one hot circulation cleaning per day. Additionally, there may be other systems, using recently developed products that offer the option of use with cold water and **may** be equally effective.

Automatic machine washing

Operate the system as recommended by the manufacturer and installation guidelines.

Note:

- Some products can crystallize or become more viscous over time. This may result in a lower level of the product being drawn through the milk lines for washing. A warning system generally does not exist within the system to alert the operator, therefore the rate of usage of the product needs to be monitored
- Check that an adequate quantity of detergent sterilizer (as recommended by the manufacturer) is used weekly, e.g. for PRODUCT X to wash a 20-unit machine: Use 9 litres hot water per unit at 75-85°C

x number of units [20]) = (9 x 20) = 180 litres. 312 ml of PRODUCT X should be used per 45 litres of water, therefore: 1248 ml of PRODUCT X should be used per day and 1248x7 = 8.736 litres of PRODUCT X should be used per week. Therefore: 25 litre container should last for not longer than 20 days with a 20-unit machine

- Use a descaler once weekly. A warning system generally does not exist within the system to remind the operator (e.g. light), therefore, weekly washes with descaler should be recorded on a wall chart in the dairy to ensure regularity
- Always use the detergent sterilizer product that is recommended by the manufacturer /installer of the automatic washing system
- Automatic washers should be serviced annually
- Check temperature of hot washes periodically to ensure that water heaters are functioning properly

Manual machine washing

Hot circulation cleaning – Option 1

1. Wash jetters and outside of clusters and attach clusters to jetters (remove milk filter)
2. Rinse plant with 14 litres cold water per cluster
3. Mix an approved **alkaline chlorine detergent-steriliser** at the recommended use rate in hot water at 75-80°C allowing about 9 litres of solution per cluster
4. Circulate the solution for 10 minutes having allowed the first 5 litres to run to waste. If the detergent is recommended for re-use, return the remainder of the solution to the wash trough and retain for the second daily wash
5. After the circulation wash, rinse the plant with 14 litres of rinse water per cluster to remove the detergent residue
6. Ensure that milklines are drained completely before milking

Regular descale acid wash routine for hot circulation cleaning
(weekly intervals recommended)

a) Once weekly, use a solution of approved **milkstone remover (acid detergent)** as recommended, (preferably hot water) for 5 to 10 minutes and flush to waste with cold water
b) Follow with usual **alkaline chlorine detergent-steriliser** wash, preferably in hot water at about 60°C
c) Follow by flushing plant with 14 litres cold water per cluster

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Important notes for hot circulation cleaning

- Inadequate initial rinsing will result in milk residues remaining in pipelines. This will neutralise the chlorine in the washing solution, thus making the detergent ineffective
- It is recommended that the water temperature at the start of the cycle should be 75–80°C and at the end should be 43–49°C
- The alkaline chlorine detergent-steriliser should be circulated for 10 minutes
- A circulation rate of 3.5 – 4.5 litres/min/unit is required for effective cleaning
- A sufficient level of water should be maintained in the wash trough to prevent air being drawn into the system
- The alkaline chlorine detergent-steriliser solution should be rinsed from the plant directly after circulation (**NOT** left in plant until next milking)
- Detergent products should be stored as directed on the label, otherwise, chlorine can evaporate from the detergent, thus making the detergent ineffective

Cold circulation cleaning – Option 2

1. Wash jetters and outside of cluster and attach clusters to jetters (remove milk filter)
2. Rinse plant with 14 litres cold water per cluster
3. Dissolve an approved **caustic detergent** in cold water as recommended, allowing about 9 litres of solution per cluster
4. Circulate the solution for 10 minutes having allowed the first 5 litres to run to waste. Return the remainder of the solution to the wash

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trough and retain for the second daily wash. Leave the solution stain in the plant until the next milking

5. Before the next milking, add hypochlorite at 14 ml per 45 litres of rinse water, allowing 14 litres of rinse water per cluster. Rinse the plant with this solution
6. Ensure that milklines are drained completely before milking

Regular descale hot wash /acid wash routine for cold circulation cleaning
(weekly intervals recommended)

a) Once weekly, use a solution of approved **milkstone remover (acid detergent)** 560ml as recommended for 5 to 10 minutes, preferably in hot water at about 60°C and flush to waste with cold water
b) Follow by circulating **caustic detergent** in hot water (75-80°C) to which 168ml hypochlorite has been added. Allow 9 litres per cluster
c) Follow by flushing plant with 14 litres cold water per cluster

Important notes for cold circulation cleaning

- The caustic detergent should be circulated for 10 minutes
- A circulation rate of 3.5 – 4.5 litres/min/unit is required for effective cleaning
- A sufficient level of water should be maintained in the wash trough to prevent air being drawn into the system
- The stain of the caustic detergent should be left in the plant after each milking and until the next milking, except on the one morning weekly when the hot wash /acid wash has been completed (the hot wash /acid wash involves hypochlorite which would damage rubberware if exposed to it over long period of time)
- Caustic detergents are primarily intened for cold circulation cleaning, but can also be used in warm or hot water

General notes on milking machine hygiene

- It is important to start with a clean plant. If the plant is not clean use the routine as outlined for the weekly hot wash
- Two wash troughs of adequate volume are necessary; one for rinse water and the other for retaining the detergent solution
- Remember to renew the cleaning solution after two milkings - do not reuse the cleaning detergent for further washings

- If milk meters are used for recording milk yield, use the hot wash routine
- During frosty weather the machine should be rinsed and allowed to drain after milking
- Always check specific product recommendations – use products from a reputable supplier and do not buy /use unidentified products

Bulk tank hygiene

Automatic bulk tank washing

- Ensure that the washer is connected to the tank and that the refrigeration is turned off
- Put the correct amount of detergent in the detergent bowl and replace it on holder
- Start the wash programme according to the manufacturer's instructions

Choice of detergent

Hot washing may be used for every wash with water fed at 70°C or maintained at 50°C in an inline heater in the wash circuit. The following types of detergent are suitable: a liquid alkaline chlorine detergent-steriliser at 28ml/5 litres of wash water (essential for automatic intake) or a powder caustic detergent containing chlorine at 227g (added to a caustic resistant detergent bowl) per 45 litres wash water. A low foam iodophor may be used as an alternative detergent. Suitable products will not leave any undissolved residue in the detergent bowl. In the case of hard water, use a milkstone remover at 28ml/5 litres of wash water once or twice per month.

Routine inspection

- Ensure that tanks are serviced regularly and include checking of the thermostat
- Before milking, disconnect the washer from tank outlet
- Check that spray heads are giving good spray coverage in all parts of the tank (can be safely checked during pre-rinse cycle). Partially blocked spray heads should be removed and cleaned
- Check filters on water intake valves regularly and clean if necessary
- When inspecting totally enclosed tanks for cleanliness, pay particular attention to the lid and vent pipes, which, if unclean can readily contaminate the milk
- It should not be necessary to brush wash the tank internally. Entering tanks for cleaning can be hazardous and could result in damage to the tank floor

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Milk cooling and storage

Milk leaves the udder at approximately 35°C, but only rapid cooling to a storage temperature of around 4°C prevents or minimizes micro-organism growth. It is not only the storage temperature that is important; the cooling time to reach storage temperature is also critical. Bulk milk coolers, generally, are designed to cool the milk to 4°C within a specified time period. The use of plate coolers do reduce the milk temperature before entering the bulk tank and therefore, assist in more rapid cooling and in reducing electrical running costs.

Temperature and bacterial count in milk

Rapid cooling to below 4°C greatly contributes to the quality of the milk on the farm. This treatment slows down the growth of the bacteria in the milk, thereby greatly improving its keeping qualities. Efficient cooling of milk directly after production to 4°C, or even 2°C (cooling to 2°C is technically difficult), in conjunction with good milking hygiene makes it possible to deliver good quality milk at two or three-day intervals, provided that the milk container /tank is well insulated. However, in situations of non-hygienic milk production, the initial bacterial count may be high and bacterial reproduction starts at an already high level. Combined with an optimum temperature, subsequent bacterial growth may be enormous.

Time, temperature and bacterial count in milk

It is important to set TBC goals in herd bulk milk. Targets representing good hygienic quality milk may be as follows: milk TBC <1,000/ml as it leaves the udder, <3,000/ml as it leaves the milking machine and <5,000/ml in the bulk tank.

The data in Table 4 indicate that both storage temperature and time are important. Milk with an initial TBC of 5,000 cells/ml and stored at 4°C would be expected to have a TBC of 10,000 cells/ml or 30,000 cells/ml after 2 or 3 days storage, respectively. This incorporates the effect of the periodically increased blend temperature of the milk, which occurs as additional milkings are added to the bulk tank at morning and evening.

Table 4. Milk TBC as affected by duration of storage at various storage temperatures

Starting TBC of 5,000/ml	Expected TBC after storage		
Milk storage temperature °C	**2 days**	**3 days**	**4 days**
2	5,000	15,000	50,000
4	10,000	30,000	100,000
6	30,000	100,000	1,000,000

Typical growth (doublings) of bacteria and how this is influenced by duration of storage and temperature of storage is shown in Table 5. When milk is stored at 4°C, the number of bacteria would be expected to double after 2 days, i.e. **one doubling of bacterial growth is observed after 2 days when milk is stored at 4°C.** This is increased to 3 and 6 doublings with storage for 3 and 4 days, respectively, at 4°C. Alternatively, when milk is stored at 2°C, two doublings are observed after 3 days storage. **However, the final TBC is dependent on the initial TBC.** For example, milk can be stored at 3°C for 3 days without appreciable multiplication taking place, provided that the initial milk TBC (the TBC as the milk enters the bulk tank) is low, preferably less than 5,000 cells/ml.

Table 5. Typical growth (doublings) of bacteria in farm refrigerated milk

Milk storage temp. °C	No. of doublings after			
	1 day	2 days	3 days	4 days
2	-	0.7	2.0	4.0
4	-	1.0	3.0	6.0
6	1.0	3.0	6.0	10.0

The initial milk TBC necessary to achieve TBCs of 50,000 cells/ml and 30,000 cells/ml after different storage temperatures and at different storage times are shown in Table 6. If the target is to achieve a grade of < 50,000 cells/ml in milk stored at 4°C for 2 or 3 days, then an initial milk TBC of 25,000 cells/ml or of 6,250 cells/ml would be required, respectively. Alternatively, if the target is to achieve a grade of < 30,000 cells/ml in milk stored at 4°C for 2 or 3 days, then an initial milk TBC of 15,000 cells/ml or of 3,750 cells/ml would be required, respectively. **Attention to detail is required in order to achieve initial TBCs of this magnitude.**

Table 6. Starting TBC necessary to meet 50,000/ml and 30,000/ml premium grades

Grade	Milk storage temp. °C				
50,000		1 day	2 days	3 days	4 days
	2	50,000	35,000	12,500	3,125
	4	50,000	25,000	6,250	781
	6	25,000	6,250	781	49
30,000					
	2	30,000	21,000	7,500	1,825
	4	30,000	15,000	3,750	467
	6	15,000	3,750	467	29

It is important that **all producers** take a responsible attitude towards the production of good quality milk. One supplier with a milk TBC of 2,000,000 cells/ml can have a detrimental effect on a tanker of milk containing milk from 10 other herds having average TBCs of 20,000 cells/ml (Table 7).

Table 7. Effect of mixing "BAD" and "GOOD" milk supplies

	Volume (litres)	TBC (cells/ml)
10 suppliers	14,061	20,000
1 supplier	1,406	2,000,000
1 tanker	15,467	200,000

Summary guidelines for extended storage of milk

- If tank is operating correctly, most milk will be cooled in appropriate time
- Slow initial cooling is not advised, tank specification must be correct
- Fast cooling rate is necessary, avoid high blend temperatures
- Milk temperature should reach ~ 4.5°C within 30 min of milking
- Plate cooling helps (35°C reduced to 18°C approximately)
- Accurate temperature control during storage (3-4°C)
- Excellent hygiene from teat to tank and low SCC

It is vital to recognize that cooling is a compliment to, not a substitute for hygienic milking conditions

Reducing thermoduric bacteria in milk

Although most bacteria found in raw milk are non-pathogenic and are mostly destroyed by pasteurisation, a specific group of bacteria, known as thermoduric bacteria have the capability of surviving pasteurisation. Thus, close monitoring of these thermoduric bacteria is crucial to maintain consumer confidence in the quality of milk produced and is of increasing interest to milk purchasers and processors. Thermoduric bacteria are organisms capable of surviving pasteurisation and carry over into product causing quality defects (e.g., reduction in shelf life of pasteurized milk). These product quality defects cause significant problems for food manufacturers and much time and effort has been expended on studying methods for controlling numbers of these bacteria in milk and milk products. Milk processing control methods are costly, and indeed in many cases result in quality defects in the product due to the severity of the treatment required for removal of these thermoduric bacteria. Invariably, attention is drawn back to the stages of primary milk production, where the problem first arises and where control steps can be more effectively applied.

Sources of thermoduric bacteria

Silage, faeces, animal bedding and soil contain large numbers of thermoduric bacteria and are the most important sources of these bacteria in raw milk. It is impossible to exclude them completely from milk, but the challenge however, is to contain numbers entering raw milk to a minimum. *Bacillus* and *Clostridium* are the most common thermoduric species and exist in the very heat resistant form of spores, and in this state are not killed on pasteurisation. This emphasises the importance of limiting their numbers in raw milk.

Transfer of thermoduric bacteria into milk

Contamination via teat surface

It is inevitable that cows feeding on silage (particularly poor-quality silage) will produce faeces which will contain thermoduric bacteria. Cows subsequently walking or sitting on the bedding material or lying at pasture will become contaminated with thermoduric bacteria. Thus, the teat surfaces of cows are contaminated and these microorganisms are readily transferred to the milk during milking. A particular problem can occur in summer milk supplies, which can become contaminated with a specific thermoduric organism identified as *Bacillus cereus,* giving a quality defect called 'bitty cream'. Cows resting on bare pastures can become contaminated with this soil micro-organism during summer drought periods.

Contamination via milking machine

Milk contamination with thermoduric bacteria from teat surfaces will, in turn, contaminate milking machine clusters, milk receivers, milk pipelines and bulk tank. **With inadequate cleaning, contamination will build-up,** particularly in hard to clean areas, such as pipeline joints and dead ends. Biofilm formation on pipelines arises from extensive thermoduric growth and this residual contamination can contribute to high bacterial counts in subsequent milkings, if it is not removed by proper washing of the equipment.

Controlling numbers of thermoduric bacteria in milk

Hygienic milking practices

The problems of thermodurics in milk arise initially due to either bedding contamination of teats during winter or soil contamination of teats during pasture, both of which can be reduced by milking clean cows. High numbers of thermoduric bacteria exist in the farming environment, and furthermore, these will readily transfer to milk unless procedures are put in place to prevent contamination. The first and most important step is to ensure cow teats are clean, though how to achieve this requires considerable care. The procedure requires time and effort and the temptation is to avoid it entirely or take short-cuts which in either event will lead to unacceptably high levels of thermodurics in milk. Washing teats alone without further treatment is not effective in controlling contamination of milk with thermodurics, and in fact may lead to increased contamination due to mobilisation of deposits from the teat surface into the milking cluster. Similarly wiping alone is not effective. Washing teats with water and drying with paper towel has been shown to be the minimum treatment required in order to prevent significant contamination of milk with thermodurics. Using an approved disinfectant in the wash water would be a further help. A study at Moorepark has demonstrated the benefits of teat washing and drying on reducing faecal residues in milk with a concomitant increase in microbial quality. It must be stressed that water itself can be a source of contaminating bacteria, and water used in any part of the milking process must be of bacteriologically potable quality. Clearly, in-house cows will require more attention in terms of these hygienic practices than cows at pasture. Lack of good practice at this stage is a major factor in contaminating milk with heat resistant thermoduric bacteria.

Hygienic milking equipment

The other major source of the thermoduric problem in milk is the build up of thermoduric contaminated deposits within the milking machine. This risk can only be corrected by an appropriate machine washing routine. The milking machine must be cleaned between milkings to prevent build-up of bacterial deposits on the equipment, and it should be remembered that dried-on residues will be more difficult to remove. Recommended cleaning procedures must be put in place and strictly adhered to.

These procedures may include a hot detergent-steriliser or a cold caustic based detergent with an acid wash recommended weekly. Dried on residues, couplings, dead ends, etc. will harbour thermoduric bacteria and in poorly cleaned equipment can contribute substantially to the thermoduric count in the milk. Thermoduric bacteria may endure in low numbers on equipment surfaces that may be considered to be efficiently cleaned with hot water. If milk residue is left behind, growth of these organisms, though slow, may persist. Old cracked rubber parts are also associated with higher levels of thermoduric bacteria. Thus, thorough cleaning of all surfaces in contact with milk, including the bulk tank is essential if milk is to meet processor specifications with regard to thermoduric bacteria.

Hygienic milking parlour

The environs of any work area can contribute to the quality of product produced there, and this includes the milking parlour which is very prone to bacterial contamination from animals present. In particular, it is essential to avoid contamination of milk with faecal material, it being potentially a source of thermoduric bacteria. Maintaining clean surroundings and walkways is very important. Additionally, yard washing procedures should be such as to minimise splashing and aerosol formation, so as to avoid further contamination of animal and equipment milking surfaces.

Recommendations

Thermoduric bacteria are widespread in the farm environment and major routes of entry into milk are dirty cow teat surfaces, poor parlour hygiene and residues on milking machine equipment. These sources are critical in determining levels of thermodurics in milk, and lack of attention in this regard can result in milk in the bulk tank containing substantially more than 1,000 thermoduric bacteria/ml, rendering it unsuitable for processing. In-house animals are more likely to be a source of thermoduric bacteria than animals at pasture. Clean cubicles and passageways and feeding good quality silage are absolute requirements. Greater care is required to ensure hygienic milking conditions in the late autumn and winter-spring period, so as to obtain thermoduric numbers of less than 500/ml milk which should reduce to less than 100/ml in the summer period.

The thorough cleaning of all surfaces in contact with milk is an absolute requirement. Not even the best cleaning method removes all bacteria and spores. Consequently, it is of great importance to take steps to maintain good hygiene at all stages of the dairy production process.

Steps to maintain low thermoduric bacteria levels in milk

- Present clean cows for milking
- Change rubberware at least yearly
- Use cleaning products as recommended for machine and bulk tank
- Use correct water quantity for wash and rinse
- Use hot water (75-80°C), check temperature regularly
- Descale plant weekly if hard water (water softener) or at least, at two week intervals
- Avoid storage of warm water (plate cooler) for machine cleaning

Residues in Milk

It is important that the person responsible for milk production on the farm be aware of all chemicals that may leave residues in milk. This may include antibiotics, detergents, disinfectants, herbicides, pesticides and fungicides.

Responsible action includes:

- Using chemicals only for the purpose for which they are approved – lactating cows should never be treated with veterinary products that are not recommended for treatment of cows producing milk for human consumption i.e. food products or liquid milk consumption
- Reading the label – it should contain all of the information on legal and safe use of the chemical
- Following the advice given on the label and any data sheets accompanying the chemical
- Observing withholding periods (the minimum time when milk should not be sold for human consumption after application of chemicals)

Antibiotics

Milk is screened for antibiotic residues on a routine basis. Dairy products must be totally free of antibiotic residues in order to meet milk quality standards at home and abroad. It has been estimated that over 70% of such residues result from the use of lactating and dry cow intra-mammary antibiotic formulations.

Failure to discard the milk from treated cows for the recommended period is the principle cause of antibiotic residues in milk

In many cases the failure to discard the milk from treated cows for the recommended period arises due to the failure of the milking operator to identify the treated cows in the herd and thus, not withhold the milk.

Contamination of milking equipment after milking a treated cow will also cause antibiotic residues in milk

A further cause of antibiotic residues in milk is insufficient cleaning of the milking equipment after milking a treated cow. The milking equipment as a source of residues has received little attention. When a treated cow is milked, and her milk discarded, some residual milk containing antibiotic will remain on the equipment. This will be washed into the bulk tank when the next cow is milked and could result in contamination of the bulk supply.

Antibiotic residues on the milking equipment can be avoided by milking the treated cows last or by flushing contaminated parts of the equipment before it is used on subsequent cows. This flushing may be done manually by draining affected parts such as the long milk tube, claw and liners, then dipping the cluster in a container of water and then draining again. Alternatively, this procedure may be done automatically if a back-flushing system is incorporated into the milking system. This should remove any antibiotic remaining on the equipment. If a large number of cows are being treated with antibiotics, some increase in milking time is unavoidable.

Management methods to avoid antibiotic residues in milk

- Discard milk for the recommended period
- Record antibiotic treatments on parlour notice board - this record should include cow number, date of first antibiotic treatment application (tube), number of treatments and the interval at which they are to be to be administered together with the expected date of milk entry to the bulk tank
- Clearly identify treated cows, using a double marking system if possible, e.g. leg band and udder spray paint
- Use antibiotics from reputable manufacturers
- Where possible, draft out antibiotic treated cows and milk them last in the herd
- If it is not possible to milk antibiotic treated cows last, then flush the milking cluster with water after milking a treated cow to prevent transfer of antibiotic residues in milk. Alternatively, back-flushers may be used to sanitize and remove residue from the liners and claw before attachment to the next cow.
- When the veterinarian injects a cow, advice should be given on the milk withholding time – this information must be made available on the parlour notice board
- Dry cow product should be appropriate to the length of the dry period

Iodine

Milk consumers and regulatory agencies demand that milk be free of harmful adulterants. While background levels of some minerals do not create a problem, excessive levels of others, such as iodine may be a cause for concern. The source of concern may be human health, export regulations for dairy products or interference with the manufacturing process where yoghurt and cheese starter cultures are inhibited.

Iodine is an important trace element and is essential for human health. Approximately 95% of iodine is accumulated in the thyroid gland. Iodine is important for its role in growth, the nervous system and brain development. The iodine requirements of humans depend on age and physiological state. Various scientific committees (German and US) together with WHO (World Health Organisation) have indicated human requirements to vary from 40-80 μg/day (birth – 1 year) to 180-200 μg/day (adults). But some populations worldwide still experience iodine deficiency. Globally, about 800 million people currently suffer from iodine deficiency. Therefore improvement in iodine supply is still a great challenge for nutritionists and other clinicians. However, the tolerable upper levels of iodine intake of healthy humans must also be considered. In the case of iodine, there is just a relatively small range between human requirements and tolerable upper levels. Iodine belongs to the group of trace elements that have a high risk of deficiency and also have a high risk of excess. It is for this reason that milk iodine levels need to be monitored and procedures advised on, in order to maintain acceptable milk iodine levels.

High iodine levels in milk are currently having a negative impact on exports of dairy products from Ireland due to increasingly competitive standards. Currently the most stringent standard in Ireland requires that iodine levels do not exceed 250μg/l milk. The highest levels of milk iodine are observed during winter months. This trend is also observed in Norwegian milk where average summer and winter season iodine levels are 88 μg/l and 232 μg/l, respectively. This seasonal variation is usually attributed to the proportion of pasture feeding versus the use of indoor feeding. The two main sources of iodine in milk are animal feed and iodophor products used for cleaning and disinfection. Veterinary products may also contribute to iodine levels in milk.

Animal feed

The use of iodine in animal nutrition and its subsequent transfer during animal metabolism is certainly a significant contributor to milk iodine levels. The direct relationship between iodine in animal feed and iodine in milk has been shown in several studies. They have demonstrated that 30-40% of iodine in animal feed is transferred to milk, within dairy cows. Dietary iodine is reflected quickly in milk. A recent study has indicated that after 10 days on specific dietary treatments containing different iodine levels, a steady-state of iodine concentration in milk in relation to the dietary supply of iodine was observed. High levels of iodine in feedstuffs can result in dramatic increases in iodine concentration in milk (Figure 3). In consequence of the high iodine transfer from feed into milk, the EU-Commission have decreased the maximum iodine level in feedingstuffs for dairy cows from 10 mg/kg to 5 mg/kg.

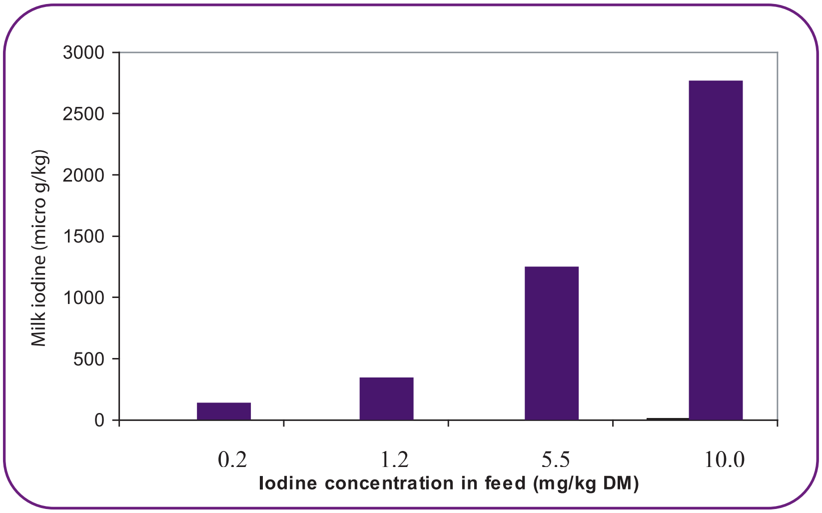

Figure 3. Iodine concentration in milk as influenced by iodine concentration in feed (13 kg DM fed per day)

Iodophors

Pre and post-milking teat disinfection

Teat dipping /spraying with iodine containing substances (iodophors) can substantially increase iodine content of milk. The effect of different pre and post-milking procedures involving iodophors on iodine residues in milk have been investigated in a number of studies. The iodine concentration of disinfectant can vary. It is estimated that up to 70% of cows are dipped /sprayed with such disinfectants either post-milking alone or pre- and post-milking.

The practise of pre-milking dipping /spraying cows with iodophors can have a significant impact on milk iodine levels. It has been reported that pre-dipping with an iodine solution reduces udder infections caused by environmental pathogens (coliforms and nonagalactiae *Streptococci*) by 51.5% compared to good udder preparation (washing and drying) alone. However, pre-milking spraying or dipping of teats with iodophors carries with it a substantial risk of direct transfer of iodine to milk unless all of the iodine is carefully removed from the teats before cluster attachment.

It is considered that the practise of post-milking dipping /spraying cows with iodophors can also result in increased milk iodine levels, but the risk is not as great as with pre-milking dipping /spraying. A recent study conducted in Germany has indicated that post-milking disinfection with a 0.3% iodophor solution (and not conducting any pre-milking udder preparation before the next milking) increased milk iodine concentration significantly from 100 µg/l to 154 µg/l. It has been previously observed that milk iodine levels (resulting from post-milking teat disinfection) may be dependent on the intensity of the pre-milking udder washing. It is suggested in the literature that the bulk of iodine residue resulting from post-milking teat disinfection is due to direct skin contamination, i.e. direct transfer of iodine from the teat skin into the milk. However, it has also been shown that a portion of the iodine (approximately 36%) is also absorbed through the teat skin into the blood and milk system of the cow.

Equipment disinfection

Excessive use of iodophors in cleaning of milking equipment surfaces can also result in iodine transfer to milk. Even with good careful cleaning procedures, bulk tank sanitation can be expected to cause a rise of ~ 98 µg/l.

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Achieving acceptable milk iodine levels

Previous limits on iodine levels in milk were at 500μg/l in Australia. In New Zealand, the authority has set a limit of 300 μg/l for bulk milk. **The limit in Ireland at present in one milk processing area is 250 μg/l.** Increases in milk iodine levels have been measured following pre-milking and post-milking teat disinfection and following bulk tank sanitation. Therefore, the use of such teat and equipment disinfectants could exceed the maximum acceptable levels in milk if extreme care is not exercised. The use of iodophor solution does undoubtedly benefit milk quality in that it controls /reduces bacterial transfer and growth, but its use should be controlled and cleaning /removal precautions carried out in association with its use. It has been shown that using a 1% post-milking disinfectant as a pre-milking disinfectant and drying for 10sec did reduce TBC. A similar trend was observed with the coliform count and the *Staphylococcus* count and further, that the drying with paper towels for 10sec prevented iodine residues in the milk. If a post-milking teat disinfection routine only is used, then a 5% solution should be used due to its effectiveness against new infection, but a thorough pre-milking wash and dry procedure should be included in order to minimize the likelihood of exceeding the regulations regarding milk iodine levels.

Caution

The now reduced iodine level in feed should assist in minimising the problem of high milk iodine levels. However, sufficient removal of iodine from teat surfaces before milking is critically important. Additionally, caution needs to be exercised with regard to the solution strengths of teat dips/sprays that are used together with solution strengths of those used in milking equipment cleaning. The use of veterinary products containing iodine should also be monitored.

Trichloromethane (TCM)

Currently, there are a number of quite strict export regulations in place for specific dairy products. One such regulation is the content of trichloromethane (TCM), otherwise known as chloroform. Presently, Irish dairy processors are experiencing difficulty in producing products that meet the TCM regulation of the country importing the products. The legal limit is set at 0.1 mg of TCM/kg of product. While much of the product exported from Ireland has TCM levels just within this limit, this is not sufficient, since the level of TCM in products has now progressed to being a marketing tool. Thus, there is competition between the different exporting countries and in order for Ireland's product to be at the forefront, it is now necessary to have a TCM level of 0.03 mg/kg or less.

There are four basic principles that need to be adhered to in order to minimise TCM levels in high fat dairy products

1. Sufficient pre-rinsing (rinsing of the machine after milking and before circulation of the cleaning and disinfection solvent) is necessary to remove all traces of milk, such that milk will not interact with the active chlorine in the cleaning and disinfection solvent, thus minimising TCM formation
2. Only the recommended and accurate volume of cleaning and disinfection solvent containing the correct level of active chlorine should be used. All cleaning and disinfection solvents should be purchased from reputable suppliers
3. Storage and re-use of cleaning and disinfection solvents should be minimised, e.g. storage between and re-use over a number of milkings
4. Sufficient post-rinsing (rinsing of the machine after circulation of the cleaning and disinfection solvent) is necessary to remove all traces of the cleaning and disinfection solvent, such that any TCM residue within the milklines will not contaminate the milk going through at the next milking

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Thus, the development of TCM in product is reduced by milkers being alert to manufacturers' instructions when using chemicals or cleaning agents in the dairy and milking parlour, using correct procedures for general cleaning and rinsing and ensuring good water quality. The following checklist should assist in maintaining undetectable levels of chloroform in milk produced on-farm and therefore also afford protection to the butter product.

Cleaning and disinfection of the milking system while ensuring the absence of TCM residue in milk

- In preparation for cleaning the milking system after milking, the remaining milk left in plant should be drained such that there is no remaining milk in tubes /pipelines.
- The plant must then be rinsed with fresh water – flush with water until remaining traces of milk have disappeared and drain the plant. At end of this first rinsing, no milk should remain in the plant and the rinse water should run clear.
- The main wash of the plant with cleaning and disinfection solvent (detergent solution) is then undertaken. The main wash must be conducted with a reputable detergent, at the correct concentration, at the recommended temperature and for the recommended period of time.
- The second rinsing with fresh water then takes place - flush with water until remaining traces of detergent have disappeared and drain the plant. At the end of the second rinsing, no detergent should remain in the plant and the rinse water should run clear (use ~14 litres water/ milking unit). Drain until there is no remaining water in plant.

Cleaning and disinfection of bulk tank while ensuring the absence of TCM residue in milk

- In preparation for cleaning the bulk tank system after milk removal, the remaining milk left in the tank should be drained such that no milk remains in the tank.
- The tank must then be rinsed with fresh water – flush with water until remaining traces of milk have disappeared and drain the tank. At end of this first rinsing, no milk should remain in the tank and the rinse water should run clear.
- The main wash of the tank with cleaning and disinfection solvent (detergent solution) is then undertaken. The main wash must be conducted with a reputable detergent, at the correct concentration, at the recommended temperature and for the recommended period of time.
- The second rinsing with fresh water then takes place - flush with

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water until remaining traces of detergent have disappeared and drain the tank. At the end of the second rinsing, no detergent should remain in the tank and the rinse water should run clear. Drain until there is no remaining water in the tank.

TCM development at the different stages of the milking process

It has been established and is widely accepted that the development of TCM arises from the cleaning and disinfecting procedures that use solvents containing active chlorine. Cleaning and disinfecting of equipment is an important part of milk production. But premium milk quality means (a) perfect hygiene status and (b) absence of residues. Chlorine containing compounds are normally used for cleaning and disinfection (at least 80% of all German certified cleaning and disinfection products for application in milking machines are chlorine based). This is because active chlorine is still one of the most effective and the most economical antimicrobial compounds. Compared to surface active and phenolic disinfection compounds (which are also employed in cleaning and disinfection solutions), active chlorine remains most efficient in killing /removing bacteria over a broader temperature and concentration range.

However, the use of cleaning and disinfection solvents containing active chlorine can lead to a further reaction taking place, resulting in an unintentional side effect, i.e. the development of TCM. If active chlorine comes in contact with an organic material, such as milk, cream or butter, chlorine binds to the organic compound and forms total organic chlorine. This substance incorporates volatile organic chlorine and the most common volatile organic chlorine is TCM. Thus, TCM develops within the cleaning and disinfection solvent. This solvent is used and often re-used to clean and disinfect milking and milk storage equipment. If this cleaning and disinfection solvent is not removed completely from the equipment by rinsing, then TCM will be transferred to the milk that subsequently comes in contact with those surfaces.

A number of facts have been determined regarding TCM development. **Firstly,** the cleaning and disinfection solvent has to come in contact with milk before the active chlorine can react with the milk and form TCM in the cleaning and disinfection solvent. **Secondly,** there is a direct relationship between the formation of TCM and (i) the amount of milk coming in contact with the active chlorine, and (ii) the concentration of active chlorine in the cleaning and disinfection solvent. **Thirdly,** the storage of the cleaning and disinfection solvent over time allows further development of TCM and the re-use of the cleaning and disinfection solvent poses a significant risk of milk contamination with TCM at the next milking, when milk is transferred through the same pipelines. **Fourthly,** the transfer of TCM from the cleaning and disinfection solvent to milk is directly proportional to the TCM concentration in the cleaning and disinfection solvent. **Finally,** when TCM contaminates raw milk, it tends to be associated with the fat phase and therefore accumulates in high fat products subsequently manufactured, e.g. cream and butter.

Thus, it is critical that the four basic principles, e.g. (i) sufficient pre-rinsing of milking plant, (ii) correct volume of cleaning and disinfection solvents, (iii) minimal re-use of cleaning and disinfection solvents and (iv) sufficient post-rinsing of milking plant are adhered to in order to minimise TCM development in milk.

Added water

It is important to measure added water in milk since consumers who buy milk are entitled to receive milk and not milk diluted with water. It is illegal to sell milk containing added water. Thus regular monitoring of milk for added water has been put in place by all milk purchasing outlets. Added water reduces the value of the milk by diluting the protein and other milk components that will influence product yields. Added water in fluid milk can also dilute the sweetness, potentially resulting in a "flat" taste.

The cleaning of milking equipment on the farm generally involves water in the process, and thus leaves ample possibility for the accidental addition of water to milk. Common causes of water addition to milk include:

- Transfer of the milk pipeline inlet to the bulk tank before rinse water has been fully drained
- Careless drainage of water from the milking plant after washing
- Leaking of equipment such as plate cooler
- Sweeping through milk with water to clear pipelines
- Switching on automatic cleaning too early

The freezing point test is the recognized international reference test for added water to milk. The freezing point of milk, particularly pooled milk is taken as constant so the freezing point test is used to assess whether or not water has been added to milk. The freezing point of water is 0°C. If salts are added to water, the freezing point is lowered below 0°C. The greater the amount of salt added, the lower the freezing point of the mixture. This is why seawater freezes at -1°C to -2°C and why salt is added to roads in the winter time to reduce icing. Solutes exist in milk such as lactose and dissolved salts, which depress its freezing point to below that of water. The current normal freezing point for whole-herd, bulk-tank samples or processed milk samples is taken as -0.525°C (°H scale is often used for milk freezing point; it is a derivative of °C). Thus, taking a freezing point for milk of -0.525°C and a freezing point for water of 0°C, then addition of water will increase the freezing point of the mix to a level between -0.525°C and 0°C, depending on the volume of water added. For example, the addition of 1 % water to milk would increase the freezing point of the mixture from -0.525°C to -0.512°C.

Sediment

Physical cleaning of teats before milking is essential for lowering sediment in milk. Sediment in milk is generally due to poor pre-milking hygiene procedures that allow soil and other materials to enter the milking system. Proper environmental conditions are important in order to maintain cow cleanliness and to reduce soil on animals so that pre-milking hygiene procedures can be effective. Sediment in milk is measured by filtering the milk through a fine filter and visually examining it. High sediment levels in milk are associated with dirt and increased potential for bacterial contamination, thus adversely influencing milk quality. **A clean or new filter sock fitted correctly before each milking will assist in reducing sediment levels.**

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Milk Lactose Concentration

Lactose is a natural sugar found in milk which gives milk its sweet taste. Lactose is a composite of two simple sugars, glucose and galactose. It is synthesized in the cow's udder and its average content in milk varies between 4.6 % and 4.9 %. In nature, lactose is found only in milk and a small number of plants.

Some milk processors are now incorporating milk lactose content into milk payments. In this scenario, lactose percentage is used as a measure of milk processability and must be above a certain threshold (normally 4.3%) to achieve a bonus and above e.g. 4.2% to avoid rejection.

There is currently an increased focus on lactose content in milk. Lactose is being used as an indicator of late lactation milk which is generally of poorer quality than early or mid lactation milk. Other tests could also be used to indicate poor quality late lactation milk, e.g. milk coagulation tests, however such tests are not suitable to conduct in a routine or automated manner. Lactose content is already being measured as part of the gross composition measurement conducted by all milk purchasing outlets. Milk lactose content is largely an indicator of cow milk yield; as milk lactose decreases (as it does towards the end of lactation) then milk volume also decreases.

Importance of milk lactose measurement

Product problems in latter part of calendar year
(seasonal spring-calving system)

↓

Due to altered milk composition

↓

Due to (a) migration of different constituents into milk (from blood)
and
(b) enzymatic breakdown of some other constituents

↓

Due to altered physiology and metabolism of mammary gland in late lactation

↓

Lactose is associated with all of the above changes, thus
lactose may be used as indicator of the above changes

↓

Recommendations for milk lactose level > 4.3%

These changes in late lactation milk (above) resulting in poor product quality are promoted and exacerbated by a low nutritional level and high SCC.

Product quality issues observed in cheese manufactured in Autumn/ Winter

Yield and composition of cheese is negatively affected by late lactation milk. An Australian study showed that advanced stage of lactation adversely affected cheese yield and quality, as evidenced by lower recovery of fat and poorer flavour score for the cheese. A Moorepark study also showed that late lactation milk (273-286 DIM [days in milk]) resulted in lower cheese yield, higher cheese moisture of approximately 2%, softer cheese and lower chewiness in the melted cheese together with poorer flavour score for the cheese.

Why is product changed in late lactation?

Product is changed in late lactation due to altered composition of late lactation milk. Both the protein and casein content of milk are a major determinant of cheese yield. Both protein and casein contents increase in milk as lactation progresses (241-265 DIM) but subsequently, decrease in very late lactation milk (273-286 DIM). A contributing factor in the deterioration of late lactation milk for cheesemaking is the enzymatic breakdown of casein by plasmin. The mineral balance is also changed in late lactation milk, with increased sodium and reduced potassium which can also influence cheesemaking.

Summary of changes in composition of late lactation milk

Reduced lactose; Reduced protein; Reduced casein; Reduced casein number; Increased enzymes (e.g. plasmin); Breakdown of casein components; Change in casein composition; Increased sodium; Reduced potassium; Altered mineral composition; Increased SCC

Milk lactose as an indicator of late lactation milk

Changes in milk lactose levels are initiated by changes in the physiology and metabolism of the mammary gland. Changes in the physiology of the mammary gland refer to changes in the permeability of the mammary epithelium or epithelial membrane. Under normal circumstances in early or mid lactation, the epithelial membrane in the mammary gland is quite impermeable and little transfer of constituents would occur. The change in permeability of the mammary epithelium in late lactation allows direct transfer of some components from blood to milk systems more easily e.g. sodium. Increased permeability of the mammary epithelium at this time also influences a reduction in lactose synthesis, which in turn reduces lactose secretion. The volume of milk secretion follows the changes in the secretion of lactose very closely, thus when lactose secretion decreases, an associated drop in milk yield is observed. Therefore, lactose may be used as an overall indicator of changes in milk yield and composition in late lactation.

Guidelines to maintain milk lactose >4.3 %

It is recommended that milk lactose level be maintained at > 4.3%. Cow diet and cow drying-off strategy are the two main factors.

Diet:

A good quality diet should be maintained in late lactation in order to maintain milk yields. Cows with access to high quality autumn grass produce milk of higher lactose concentration than cows indoors fed average quality grass silage. Generally, supplementation with 2 kg concentrate per day maintains milk lactose concentration and is recommended from late September onwards, depending on grass growth conditions.

Drying-off strategy:

Individual cows should not be milked at yields of < 8-9 kg/day. In the event of individual cow milk records not being available, once the average cow (in the herd) milk yield decreases to 10-11 kg/cow/day, then close examination of all cows must be carried out with a view to drying off individual cows or alternatively, the complete herd should be dried off. Length of lactation should not exceed 310 days for low yielding cows.

SCC:

Low milk SCC in late lactation is also important as a high SCC is generally associated with all of the above changes irrespective of stage of lactation.

Milk lactose data

The importance of cow nutrition and drying-off strategy in maintaining good milk lactose content is shown in Figure 4. This graph shows milk lactose content of two spring-calved herds within Moorepark Research Centre in autumn /winter of 2004. The diet of the high nutritional level group was supplemented with 2 kg concentrate /cow /day from early October onwards. The low nutritional level group did not receive concentrate supplementation. A similar drying-off strategy was applied to both herds. Milk lactose content of the high nutritional group remained above 4.3 % until early /mid December. Milk lactose content of the low nutritional group decreased below 4.3 % from mid November.

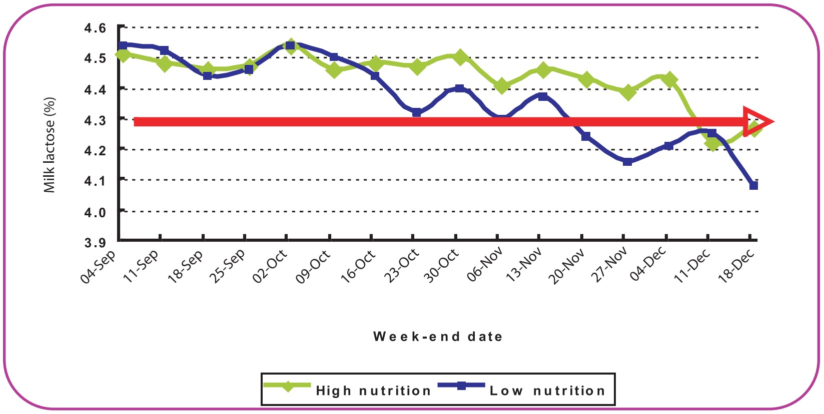

Figure 4. Milk lactose in late lactation (Moorepark study 2004)

Figure 5 shows a profile of the average milk lactose content for all spring-calved cows for the years 2001 to 2005 at the Moorepark Research Centre. Again, with the assistance of good nutrition and drying-off strategy, milk lactose levels were maintained above 4.3 % over the complete lactation.

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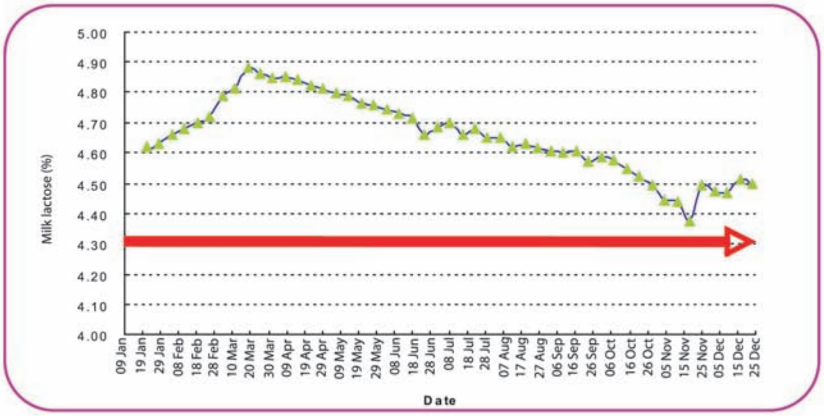

Figure 5. Profile of the average milk lactose content for all spring-calved cows for the years 2001 to 2005 (inclusive) at Moorepark Research Centre

Summary recommendations to maintain milk lactose content > 4.30 %

- Dry off cows producing less than 8-9 kg/day
- Dry off the herd when producing less than 10-11 kg /cow /day, on average
- Extend the grazing season in autumn/early winter, if possible
- Feed 2kg meal to spring calvers in late lactation
- Dry off high cell count cows
- Ensure the milking machine is working properly

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Checklists

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1. Record of cow udder hygiene score

UDDER HYGIENE SCORING CHART

SCORE 1:	SCORE 2:	SCORE 3:	SCORE 4:
Free of dirt	Slightly dirty	Moderately covered with dirt	Covered with caked on dirt
	2-10% OF SURFACE AREA	10-30% OF SURFACE AREA	>30% OF SURFACE AREA

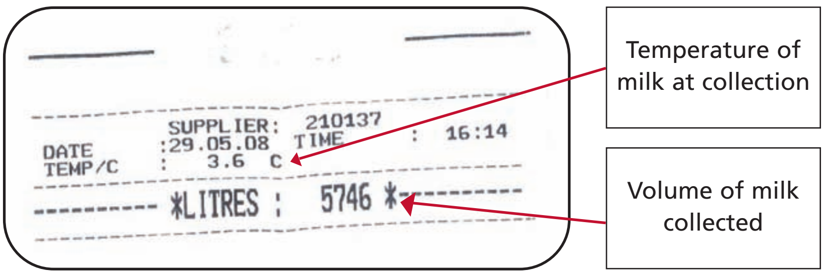
Source: Milk Money Programme, UW-Madison

Ideally all cows in the herd should be scored at 1 or 2. It is definitely NOT good management practice to have greater than 20% of the herd score 3 or 4.

2. Record of clinical mastitis incidence

Cow	Date	Quarter	Antibiotic	No. of tubes	Date for milk entering bulk tank

3. Example of bulk milk tank docket information



4. Example of monthly milk purchasers statement (milk quality section)

Milk Quality Statement					Deductions		
	TBC Result	GR	SCC Result	GR	Type	Cent per Litre	Euro €
Test 1	12,000	1	267,000	1	TBC penalty		
Test 2	12,000	1	256,000	1	SCC penalty		
Test 3	0		257,000	1	Added Water		
Test 4	0		235,000	1	Inhibitors		
Overall		1	249,000	1	Dairy Hygiene		
Geometric	11,000		238,000		**Total Deductions**		

5. Yearly profile of SCC, TBC and Thermoduric bacteria counts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Av. Bulk tank SCC reading												
Av. Bulk tank TBC reading												
Av. Bulk tank Thermoduric reading												

6. Record of milk quality issues as identified by milk purchaser

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Elevated water												
Elevated sediment												
Antibiotic residues												
Elevated thermodurics												

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7. Example of ICBF Milk Quality Report – Page 1

Milk Quality Report

ICBF SOCIETY LIMITED
SHINAGH HOUSE,

BANDON, CO. CORK
Tel: (023) 20222

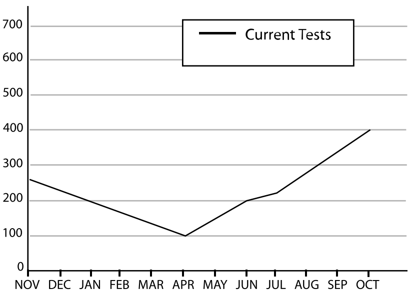
Herd owner: TEAGASC
Herd No: IE1515492
Print date: 22/01/08
Test date: 14/09/07

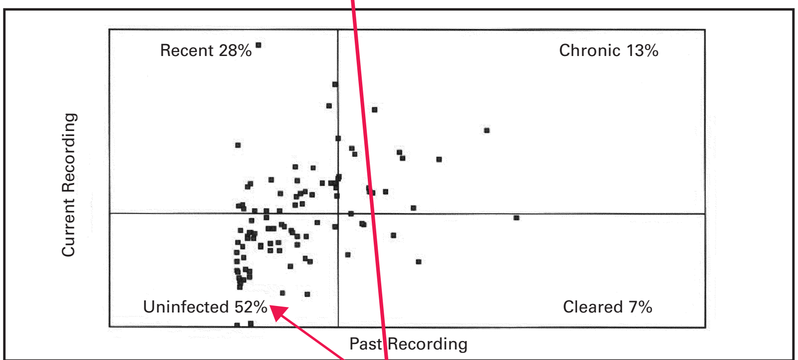
Scheme A4

Page 1(6)

1. Summary
This report is a summary of the SCC data from your most recent milk recording *(from ICAR-approved milk recording organisations).* The summary relates to the current lactation.

Current Test	
Test Details	
Date of milk recording	17-OCT-2007
Total cows recorded in milk	109
Average days in milk	217
Herd Performance	
Average daily milk yield (kg)	12
Average SCC ('000 cells/ml)	346
Median SCC ('000 cells/ml)	186
Since previous test	
No. of clinical cases	0
No. of affected cows	30
During current lactation	
Cumulative no. of clinical cases	10
Cumulative no. of affected cows	53





Overview of mastitis status in herd

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Example of ICBF Milk Quality Report – Page 2

Milk Quality Report

ICBF SOCIETY LIMITED
SHINAGH HOUSE,

BANDON, CO. CORK
Tel: (023) 20222

Herd owner: TEAGASC
Herd No: IE1515492
Print date: 22/01/08
Test date: 14/09/07

Scheme A4 Page 2(6)

2. Herd Performance

The performance of your herd has been expressed relative to other herds with recorded SCC data *(from ICAR-approved milk recording organisations)*. For example, the average SCC in your herd is currently 346,000 cells/ml, in comparison with a national herd average of 215,000 cell/ml. Further, 15% of recorded herds achieved an average SCC of 175,000 cells/ml or less at the last recording.

a. All cows

I. Average SCC

Average SCC ('000 cells/ml) at last milk recording test

Your Herd	**346**
National Average	**215**
Discussion Group Average	

II. Median SCC

Median SCC ('000 cells/ml) at last milk recording test
(50% of animals had a cell count below this, and 50% above)

Your Herd	**186**
National Average	**210**
Discussion Group Average	

b. Cows with a low SCC (no greater than 250,000 cells/ml)

i. Not infected

% of recorded herd with a SCC no greater than 250,000 cells/ml at the current and previous tests

Your Herd	**52%**
National Average	**45%**
Discussion Group Average	

i Not Infected, recently cleared

% of recorded herd with a SCC no greater than 250,000 cells/ml at the current test, but exceeding 250,000 cells/ml at the previous test

Your Herd	**7%**
National Average	**7%**
Discussion Group Average	

c. Cows with a high SCC (greater than 250,000 cells/ml)

i Recently Infected

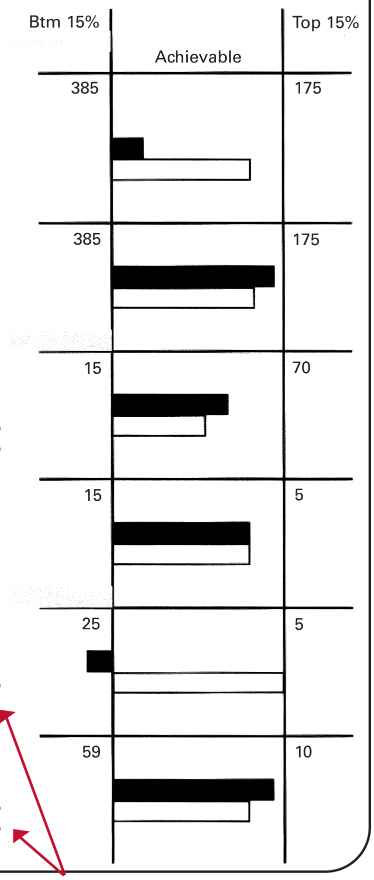
% of recorded herd with a SCC exceeding 250,000 cells/ml at the current test but no greater than 250,000 cells/ml at the previous test

Your Herd	**28%**
National Average	**5%**
Discussion Group Average	

ii. Chronically infected

% of recorded herd with a SCC exceeding 250,000 cells/ml at the current and previous tests

Your Herd	**13%**
National Average	**20%**
Discussion Group Average	



Important benchmarks for comparison

8. On-farm antibiotic residue check

Problem period	Early lactation	Mid lactation	Late lactation
Antibiotic used Dry cow Lactating cow			
Number of days milk is discarded after calving			
Number of days milk is discarded after lactation therapy			
Is milk discarded from all quarters of treated cows			
Is milk only discarded from treated quarters			
Is milking equipment washed after milking a treated cow			

9. Milking machine service dates

Date of service

Milking machine
(including automatic washing system
and teat spray system) ....
Liner change ....
Bulk tank ....
Stray voltage ....

10. Checks of milking equipment by milking operator

- Daily check of vacuum gauge (47-50 kPa for mid-level plants)
- Daily check to ensure claw air bleeds are free of dirt
- Daily check of rubberware for leaks and replace any worn or broken rubberware
- Weekly checks of oil flow from oil reservoir
- At 8 week intervals, remove filters at vacuum regulator and wash in warm water and dry
- At 8 week intervals, flush each pair of long pulse tubes (attached to a single relay) with warm water
- A quick test for reserve can be carried out at regular intervals, i.e. open one cluster and observe the vacuum drop. The vacuum drop should not be greater than 2 kPa
- For spring calving herds, change liners at 2000 cow milkings or twice per year, whichever is of shorter duration
- For all year round milking, change liners at 2000 cow milkings or three times per year, whichever is of shorter duration

- Ensure that liners are compatible with shells
- Change complete set of liners at the same time
- Record exact dates of liner changing in farm dairy
- If a sudden increase in SCC or TBC is noticed, then service personnel should be called in to carry out basic checks on the milking machine plant

11. Sample of test report information available from milking machine technician after completion of test

Maintenance

Vpump oil ____ Vpump belt ____ Mpump belts ____ Milk pump diaphragms ____ Liners ____
Milk tubes ____ Pulse tubes ____ Relay diaphragms ____ Pulsators/relays clean ____

Air Flow and Vacuum Regulator Tests

1. Operating vacuum - AFM at test point near regulator	____	(kPa)	Recommended vacuum	____	(kPa)
2. Pump capacity - AFM direct to pump, speed ____ rpm	____	(l/min)	Required pump capacity	____	(l/min)
3. AFM at test point near regulator - teat plugs inserted					
Air pipeline added only, regulator plugged	____	(l/min)	Air pipeline leakage (2-3)	____	(l/min)
4. Add milking system, close claw air admission	____	(l/min)	Milking system leakage (3-4)	____	(l/min)
5. Open air admission claws			Claw admission/unit (4-5)	____	(l/min)
6. Add pulsators - all units milking	____	(l/min)	Pulsation use (5-6)	____	(l/min)
7. Add ancillary equipment (specify ____)	____	(l/min)	Ancillary equip use (6-7)	____	(l/min)
8. Drop vacum2kPa - all units milking, regulator plugged	____	(l/min)	Regulator leakage (8-9)	____	(l/min)
9. Add regulator, drop vacum 2kPa - all units milking	____	(l/min)	Required reserve	____	(l/min)

Pulsation **Pulsation Tests**

	No.	Make	Model	Sim/Alt 4x0/2x2		Max	Min
Individual				rate c/min			
Master				Ratio 'a+b'			
Relays				'a' value			
Pulsation graphs attached ____				'd' value			

12. Weekly check of machine washing system

Date (Week-ending)									
Temperature of water (°C) before circulation									
Temperature of water (°C) after circulation									
Acid wash Completed (√)									

13. Bulk tank wash completed

	Mon	Tue	Wed	Thur	Fri	Sat	Sun
Bulk tank washed (√)							

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14. Check of water quality

Water quality should be checked at intervals. The frequency should be dependent on source and type of water supply.

15. Milking machine washing systems

Hot circulation cleaning – Option 1

1. Wash jetters and outside of clusters and attach clusters to jetters (remove milk filter)
2. Rinse plant with 14 litres cold water per cluster
3. Mix an approved **alkaline chlorine detergent-steriliser** at the recommended use rate in hot water at 75-80°C allowing about 9 litres of solution per cluster
4. Circulate the solution for 10 minutes having allowed the first 5 litres to run to waste. If the detergent is recommended for re-use, return the remainder of the solution to the wash trough and retain for the second daily wash
5. After the circulation wash, rinse the plant with 14 litres of rinse water per cluster to remove the detergent residue
6. Ensure that milklines are drained completely before milking

Regular descale acid wash routine for hot circulation cleaning
(weekly intervals recommended)

a) Once weekly, use a solution of approved **milkstone remover (acid detergent)** as recommended (preferably hot water) for 5 to 10 minutes and flush to waste with cold water
b) Follow with usual **alkaline chlorine detergent-steriliser** wash, preferably in hot water at about 60°C
c) Follow by flushing plant with 14 litres cold water per cluster

Important notes for hot circulation cleaning

- Inadequate initial rinsing will result in milk residues remaining in pipelines. This will neutralise the chlorine in the washing solution, thus making the detergent ineffective
- It is recommended that the water temperature at the start of the cycle should be 75–80°C and at the end should be 43–49°C
- The alkaline chlorine detergent-steriliser should be circulated for 10 minutes

- A circulation rate of 3.5 – 4.5 litres/min/unit is required for effective cleaning
- A sufficient level of water should be maintained in the wash trough to prevent air being drawn into the system
- The alkaline chlorine detergent-steriliser solution should be rinsed from the plant directly after circulation (**NOT** left in plant until next milking)
- Detergent products should be stored as directed on label, otherwise, chlorine can evaporate from the detergent, thus making the detergent ineffective

Cold circulation cleaning – Option 2

1. Wash jetters and outside of cluster and attach clusters to jetters (remove milk filter)
2. Rinse plant with 14 litres cold water per cluster
3. Dissolve an approved **caustic detergent** in cold water as recommended, allowing about 9 litres of solution per cluster
4. Circulate the solution for 10 minutes having allowed the first 5 litres to run to waste. Return the remainder of the solution to the wash trough and retain for the second daily wash. Leave the solution stain in the plant until the next milking
5. Before the next milking, add hypochlorite at 14 ml per 45 litres of rinse water, allowing 14 litres of rinse water per cluster. Rinse the plant with this solution
6. Ensure that milklines are drained completely before milking

Regular descale hot wash /acid wash routine for cold circulation cleaning

(weekly intervals recommended)

a) Once weekly, use a solution of approved **milkstone remover (acid detergent)** as recommended for 5 to 10 minutes, preferably in hot water at about 60°C and flush to waste with cold water

b) Follow by circulating **caustic detergent** in hot water (75-80°C) to which 168ml hypochlorite has been added. Allow 9 litres per cluster

c) Follow by flushing plant with 14 litres cold water per cluster

Important notes for cold circulation cleaning

- The caustic detergent should be circulated for 10 minutes
- A circulation rate of 3.5 – 4.5 litres/min/unit is required for effective cleaning
- A sufficient level of water should be maintained in the wash trough to prevent air being drawn into the system
- The stain of the caustic detergent should be left in the plant after each milking and until the next milking, except on the one morning weekly when the descale hot wash /acid wash has been completed (the hot /acid wash involves hypochlorite which would damage rubberware if exposed to it over long period of time)
- Caustic detergents are primarily intended for cold circulation cleaning, but can also be used in warm or hot water