7

Disease prevention and control

This chapter discusses the most important diseases encountered by SHD farmers in the tropics, their treatment and some of the prevention measures.

The main points in this chapter

- Farmers can develop observation skills to assess the general health status of their herd and individual cows.
- There is a wide diversity of disease agents, ranging from parasites to microbial agents to unbalanced nutrition.
- Every farmer should develop a herd health plan that includes a good recording system and plans for introducing new stock onto the farm.
- Poor animal health can have adverse effects on reproductive performance.
- Cow lameness is a common problem on small holder farms where cows are continually tethered.
- Mastitis has many hidden effects on cow performance and farm profits as sub-clinical infections cannot be readily identified and treated.

It is not easy to say what 'disease' means. In a general sense it means any aspect of a cow's health that is not 'normal'. Disease is then a condition that is detrimental to the health and wellbeing of that animal. It can include injuries, infections by micro-organisms, infestations of parasites, nutritional deficiencies, poisoning and hereditary abnormalities. The presence of disease, whether acute or chronic, reduces cow performance, which invariably reduces farm production and profitability.

7.1 Physical attributes of healthy and sick cows

The physical state of a cow is a good guide to its health status. Healthy animals are alert and active, and have bright eyes, with no discharge, smooth and shiny skin, they breathe and urinate regularly and their tail moves to drive flies away. Signs of stress include loss of appetite, reduced daily milk yield, increased temperature, high respiratory rate,

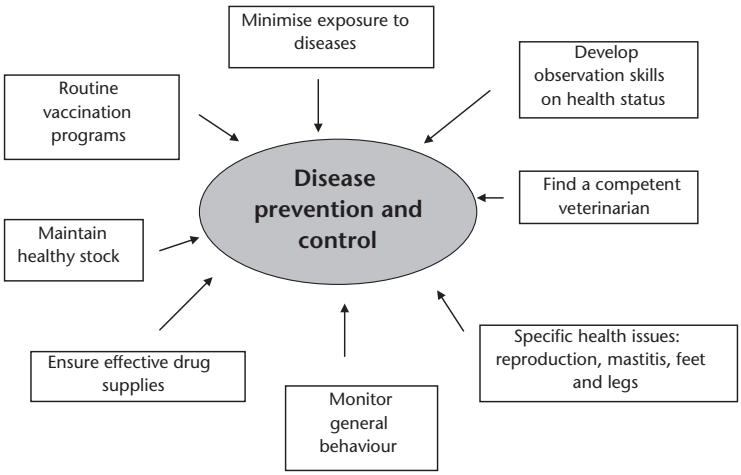


Figure 7.1. The basic elements of the milking herd's disease prevention and control program

protruding tongue, breathing with an open mouth, inability to lie down and a preference for remaining in cool waters, such as swamps.

Symptoms of health problems range from one almost unnoticeable changes in behaviour to sudden death. Some of the signs to look for include:

1. **Nutritional status.** Cows can be fat, normal or thin. Thin cows are not necessarily sick, because they could have recently calved or simply be high-producing animals. However, sick cows tend to lose weight due to depressed appetite, poor feed digestion or loss of body reserves. Cow condition should then be judged in relation to all circumstances.
2. **Walking and standing.** The way an animal moves can indicate pain in the body, the result of a traumatic injury or an infected hoof. A method of scoring the cow's ability to walk (the locomotion score), which provides a good guide to lameness, is described later in this chapter.
3. **Eyes and ears.** Eyes should have a bright and lively expression with no discharge. Sunken eyes indicate dehydration. Ears should be able to freely move around.
4. **Skin, coat or mucous membranes.** The skin of healthy cows is flexible and, when pinched, should quickly return to normal; a lengthy delay indicates dehydration, as does a dry nose. The coat should be smooth and shiny. The mucous membranes around the eye, nose and vagina should be pink to reddish in colour and be moist. In sick cows, these membranes can become either too red or too pale, the later indicating anaemia.
5. **Digestion.** Healthy cows have a good appetite and eat with eagerness. Faeces and urine are discharged regularly, with the faeces having a normal consistency. When digestion is disturbed, the cow's appetite decreases and the faeces is discharged too fast (scours) or too slow (constipation). Cows ruminate frequently when healthy (at least 6–8 hr each day), and if she does not ruminate when resting, her digestion is

disturbed. Troubleshooting problems with feeding management are discussed in Chapter 6 of this manual.

6. **Urine.** It should be thin, yellow and clear; thick, mucous or red urine is an indication of ill health.
7. **Vagina.** It should be closed, with no swelling, no discharge and be slightly whitish-red in colour; a swollen vagina with whitish discharge or decomposing membranes is indicative of reproductive problems.
8. **Respiration.** In healthy cows, respiration is quiet and regular, whereas in cases of unrest, fever, fatigue or heat stress, respiration rates increase. See Chapter 12 for a guide to heat stress based on respiration rates. Coughing, nasal discharge, and rapid or slow breathing can all be symptoms of ill health.
9. **Blood circulation.** Pulse rate is a good guide to cow health, with 60 to 70 beats/min being normal for dairy cows.
10. **Body temperature.** Normal body temperature is 38.5–39.5°C. Higher temperatures are recorded in sick animals (with a fever) or in heat-stressed animals.
11. **Milk production.** When a cow is sick, milk production drops, due primarily to decreased appetite.
12. **Specific signs to look for in calves.** Health problems are likely in calves with droopy ears, head down, not drinking, lying in a corner, dribbling, limping, swollen joints, swollen navel, scour or blood in their faeces. The nose and eyes should be clear and damp with no discharge. Calves should stretch when they stand up following a rest period. An odour of ammonia can indicate poor ventilation and potential pneumonia problems.

7.1.1 Other tools to diagnose diseases

There is much that farmers can do to assist veterinarians or other animal health professionals in diagnosing and treating diseases. These include:

- Examine the history. For how long has the animal been sick, how rapidly did the sickness develop, what are the breeding and calving records of the animal, have new stock recently been introduced to the farm, or have there been any recent environmental changes (such as hot weather)?
- Examine the animal. Use the checklist above.
- Examine the environment. Are other animals sick, could there be poisons or mineral deficiencies involved, what is the water quantity and quality, what are the physical conditions, such as lanes or yards, that cause traumatic problems?
- Prepare for the veterinary visit. Record the important major symptoms using the above checklists, have the sick animal easily accessible with suitable restraining equipment available, listen carefully and take notes for follow up treatment.
- Once the disease has been diagnosed and its cause, symptoms and treatment identified, it is important to develop a control program to reduce its incidence in the future. Veterinarians can assist with such a control program. For the farmer, prevention is just as, and often more important than, cure.

7.2 Disease agents

This section comprises detailed lists of the many agents that cause disease in tropical dairy cattle. They are separated into two main categories: parasites and microbial agents, followed by nutritional (and metabolic) diseases, then miscellaneous agents.

7.2.1 Parasites

Parasites that infect cows include:

- **ectoparasites** (live outside body): ticks, flies, lice, mange, fungus (e.g. ringworm), bacteria (pink eye), viruses (warts)
- **endoparasites** (live inside body): intestinal worms, lung worm, liver fluke
- **tick and insect-borne diseases:** theileriosis (East coast fever), babesiosis, anaplasmosis, bovine ephemeral fever (three day sickness), trypanosomiasis.

7.2.2 Microbial agents

Microbial agents that infect cows include:

- **bacteria:** brucellosis, vibriosis, tuberculosis, paratuberculosis (Johne's disease), pneumonia (also virus agents), trichomoniasis, campylobacteriosis (or vibriosis), leptospirosis, anthrax, and tetanus, black leg and other clostridial diseases, haemorrhagic septicaemia (HS), mastitis, infectious foot rot, joint ill
- **viruses:** rinderpest (cattle plague), foot and mouth disease, enzootic bovine leucosis, bovine viral diarrhoea, bluetongue, infectious bovine rhinotracheitis, pneumonia
- **others:** bovine spongiform encephalopathy (or mad cow disease), facial eczema (fungal), ergot poisoning (fungal), blue green algae poisoning, eye cancer
- *E. coli*, cryptosporidia, rotavirus, coronavirus, *Salmonella*, coccidia (causing **calf scours**).

7.2.3 Nutritional and metabolic diseases

Nutritional and metabolic diseases that affect cows (see also Chapter 6) include: acidosis, milk fever (low blood calcium), grass tetany (low blood magnesium), acetonaemia (or ketosis), bloat, displaced abomasum, photosensitisation, urea toxicity, nitrite toxicity, lead poisoning, foreign bodies (hardware disease) and miscellaneous plant poisonings (e.g. bracken fern, lantana, oleander).

7.3 Managing dairy herd health

The operation of a dairy farm for maximum profit includes good feeding, breeding, care and management, as well as good record keeping and a dairy health program. The objectives of a health program are to prevent the introduction or occurrence of disease and control the spread of infectious diseases and parasites.

The major role of government is to eradicate epidemic diseases and to minimise the transmission of diseases from dairy cattle and dairy products to humans. The role of

dairy cooperatives is to encourage health care and eliminate diseases transmitted from cattle to humans and those that adversely influence milk spoilage.

The roles of veterinarians and dairy extension staff are to emphasise continuing education for farmers in areas of farm management and disease control, as well as providing effective services. In the final analysis, it is the small holder who must understand the reasons for good management practices and the links between nutrition, housing and health.

A written herd health plan should be developed that contains management actions for herd health to prevent and control diseases and disorders that are specific for the region. The plan should contain actions for foot care, mastitis, parasite control, infectious diseases and calf care. As part of this herd health plan, records should be kept of health and other disorders in order to identify changes and assist in management. For example, reproductive failure, udder disorders, low production, calving associated disorders, lameness and mastitis. This plan should also include biosecurity measures for buying new stock and for visitors.

7.3.1 The importance of good record keeping

An important aid for farm management is the keeping of records of all animals and events relating to animals throughout their lives. In some countries, record keeping is provided, supported and designed by government or dairy cooperatives. Records can either be electronic (using computer technology) or be kept as individual cow cards at farms or at the dairy health service or artificial insemination service centre. Records of insemination, birth date, sire, dam, calving date, vaccination date, health problems, treatment, milk yield and feeding can help farmers to predict future or preventative needs for health care.

These records also provide beneficial and relevant information for veterinarians to make correct diagnoses. Therefore, it is best to have well-organised records kept for each animal, with the forms designed to allow for easy interpretation. Most small holders do not seem to pay sufficient attention to keeping good records.

Large-scale dairy herd improvement programs are beneficial tools for farm management but the procedures tend to be costly, and need a lot of technicians to access small holders in the tropics together with considerable education for farmers to use and keep using the data. It is better to start with simple systems in milk collection centres rather than work towards a national database, such as is found in most Western dairy industries.

7.3.2 Nursing and support

Once the veterinarian has provided treatment, it is important to continue to nurse sick stock. Supportive care that can be provided includes:

- providing good nutrition to treated stock, with freely available water and quality palatable forages and concentrates
- ensuring access to water, shade and clean bedding

- maintaining a low-stress environment, with adequate housing, removing competition from other stock, removing parasites, providing pain relief, and cleaning and dressing any wounds
- taking special care of stock unable to stand, providing support such as small hay bales to stop them rolling onto their side, moving them to dry, warm shelter with good footing, in case they try to stand.

7.3.3 Scours

The state of manure is a good indicator of cow diet and general health. Scours (or diarrhoea) in adult cows can have many causes, with dietary scours the most common. Other causes of scours are acidosis (or grain poisoning), internal parasites, bacterial infections (such as *Salmonella* and Johne's disease) and viral infections (such as bovine viral diarrhoea and malignant catarrhal fever). The manure may be watery and range from green to light yellow and may or may not contain blood or pieces of bowel, or whole or poorly digested grain. Chapter 4 provides details about scours in milk-fed calves.

For acute scours, antibiotics may be needed in the case of bacterial scours, or rumen buffers (such as sodium bicarbonate) for acidosis. Providing a palatable effective fibre source can also aid in cases of digestive disturbances. For chronic scours, a worm drench may suffice. A scoring system for manure consistency is described in Chapter 6.

7.3.4 Responsible drug handling

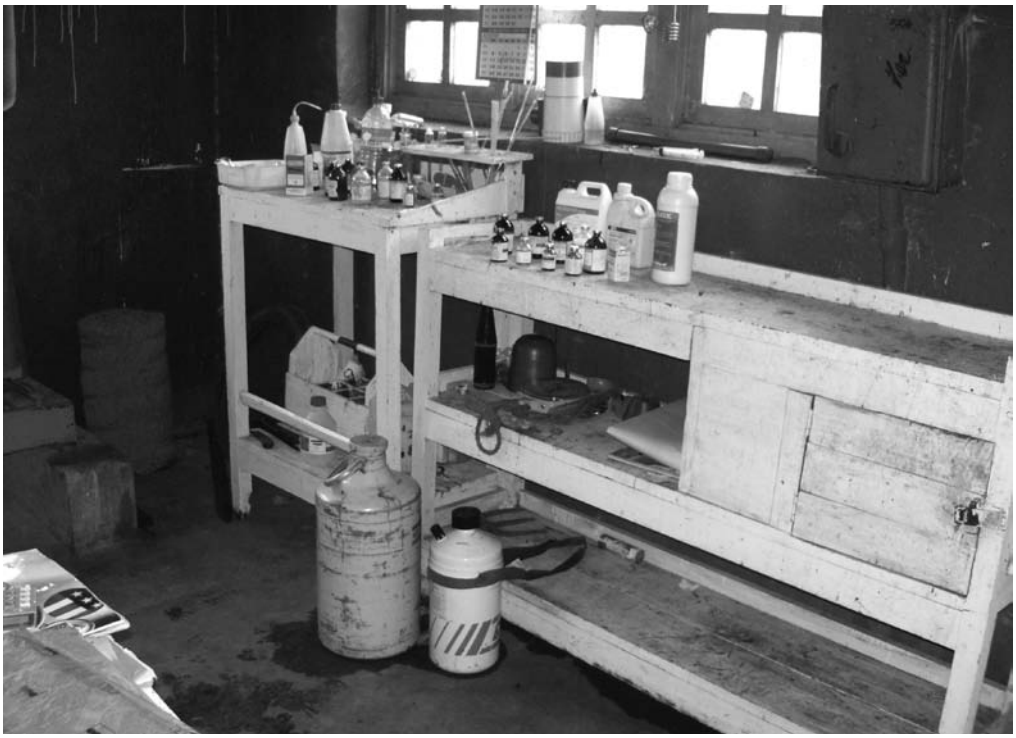
Responsible drug handling and administration are the key to a successful animal health program. Drugs should be sourced from veterinarians or registered agricultural merchants because medicines obtained from other sources may not be safe or effective. They should be stored correctly in accordance with the instructions on the label. Storage temperature is critical for some medicines, especially vaccines. Light can damage others. Drugs should be stored securely and locked where practicable and kept out of reach of children, animals and anybody not supposed to handle them.

Keep records of:

- how much was purchased and when
- the batch number and expiry date
- when it was used and on what type of stock
- the withholding period (start and end dates) for sale of milk or for slaughter.

Use drugs only on animals recommended on the label. Dispose of unused medicines safely when treatment is finished. If using disposable needles and syringes, dispose of them after use in a safe container. For other reusable equipment, clean and sterilise before and after use. If using a syringe that requires filling from a bottle between doses, use one sterile needle left in the bottle during use to fill the syringe and a separate needle to inject the animal. Use a separate needle, or at least sterilise it, between animals. Make sure the injection site is through an area of clean and dry skin.

High standards of sanitation are required at all times to prevent rapid spread of infectious diseases in both young stock and milking cows. The most effective way of



Veterinary drugs should be stored in a cupboard away from the sun (Sri Lanka).

destroying disease-carrying micro-organisms is cleaning and disinfecting (sterilising or sanitising). However, the latter has little effect unless the surface is first cleaned. The best cleaner and disinfectant depends on the type of surface.

7.3.5 Biosecurity when purchasing new stock

Most dairy farmers purchase new stock, so it is important to plan their introduction to minimise the risk that they will introduce infectious diseases. Three factors are important in reducing this risk:

1. protecting the herd with proper vaccination
2. the source of purchased stock, including how they are transported to the farm
3. the method used to introduce the new stock to the rest of the herd.

When purchasing new stock:

- ensure their health status is known
- where possible, ensure details of their vaccination program are known
- avoid purchasing stock from unknown sources or stock that have mixed with other cattle before sale
- purchase heifers because they can be more easily quarantined and are less likely to have mastitis

- calves purchased with no signs of disease should be kept separate for at least a week
- transport purchased cattle preferably in the farmer's vehicle, in a clean truck or trailer.

Other steps that can be taken with newly purchased stock include quarantining them in an area separate from other cattle on the farm, using a medicated foot bath before allowing them to enter the herd, and vaccinating them during the quarantine period to make sure they are integrated into the farm vaccination program.

Other biosecurity measures that should be considered include controlling the movement of people, animals and equipment onto the farm. Some diseases are spread on clothing and boots. If equipment is borrowed from other farms, it should be cleaned prior to use. Keeping transport or service personnel away from the main herd area, especially the calf shed, or at least providing them with footwear, will also reduce the likelihood of introduced diseases.

7.3.6 Animal and human health

Government veterinary services must maintain surveillance of infectious or notifiable diseases, such as rinderpest, foot and mouth disease and contagious pneumonia, through vaccination and quarantine measures. However, as farms become more intensively managed, non-infectious diseases play a more important role in limiting cow performance. These could be called disease-causing risk factors such as undernutrition, poor hygiene and other management factors affecting herd productivity.

Farmers are only interested in herd health programs when the link with production is clear, such as declining milk yields, increasing mortality and poor reproduction. Mastitis, for example, is hard to manage because the sub-clinical form is very prevalent, difficult to detect and causes higher milk losses per affected cow. It is often difficult to incorporate economic parameters in such programs because of the small number of stock, and hence the influential impact of the performance of each animal.

There are many diseases that can be transferred from intensively managed livestock to humans. These include *Salmonella* (and other calf scour-causing micro-organisms), ringworm, mange (and other skin diseases) and *Leptospirosis*. Children are particularly susceptible because of their affinity to young calves, and their poor understanding of human hygiene. Other potential hazard for young children are veterinary drugs and chemicals used for cleaning or sanitation. These should be stored in a secure place.

7.4 Health and reproductive performance

There are many health management problems that can adversely affect fertility, such as:

- management of twin calves
- assisted calving
- retained foetal membranes (RFMs)
- uterine infections and vaginal discharges
- lameness
- ketosis
- displaced abomasum

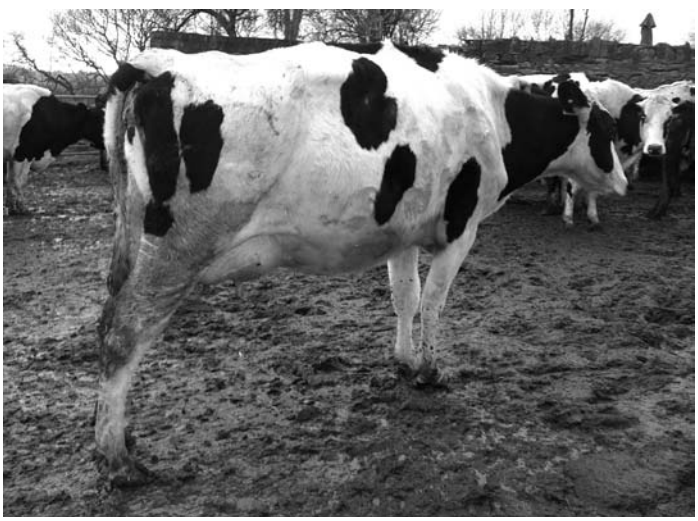
- cystic ovaries
- abortions.

Some health problems affect the reproductive tract directly (such as RFMs and vaginal discharges) while others reduce feed intake leading to rapid body condition loss and anoestrus (such as lameness and ketosis). It is important to keep good records and have a planned approach for treatment and prevention.

Cows with problems at calving have an increased risk of infection of the reproductive tract. Such infections can last for weeks (even months) after calving and cows can even show normal heats with no abnormal discharge, yet still have reduced fertility. They may cure themselves over time but are more likely to show repeat heat cycles. As well as immediate treatment, follow up treatments are available such as prostaglandins or antibiotics.

To improve cow health, it is important to keep accurate records and seek veterinary advice if the percentage of naturally calving cows (excluding cows induced to calve early) with this problem exceed the number shown in brackets below:

- any cow having twins (no practical strategies prevent twin calves)
- any assistance required to deliver a calf (seek advice if >6%)
- any calf born dead or died within 24 hr of birth (seek advice if >1%)
- RFMs, that is membranes visible externally on the day of calving (seek advice if >4%)
- vaginal discharge or pus discharging from the vulva more than 14 days after calving (seek advice if >6%)
- lameness, or cows not bearing full weight on at least one leg which affects walking (seek advice if >3% of first calvers or >2% of older cows)
- abortions (seek advice if >5%)
- other health problems, including ketosis, displaced abomasum or cystic ovaries (seek advice if >5%).



Cow lameness can reduce intakes, milk yield and hence profits.

Some infections that cause abortions in cattle can also infect humans, so only handle aborted foetuses and membranes with disposable gloves and avoid contact with vaginal discharges from aborted cows. Bury the foetus and membranes ensuring that dogs are not allowed access to them.

7.5 Lameness

Foot problems can be caused by the environment (continuously wet floors, uneven or broken cement), poor sanitation, infectious organisms or nutritional imbalances. With tethered cows, annual trimming can extend herd life by at least a year.

Overgrowing will cause the toe angle to decline and foot length to increase, placing more weight on the heels, thus creating discomfort and walking difficulty. The rear feet appear to be more subject to disorders. High levels of concentrate feeding can lead to a condition called laminitis, which causes softening of the tissue between the claws of the feet. Trauma injuries can occur on uneven concrete floors, leading to swollen hocks, knees or even hips.

Inside the hard, outer layer of the hoof wall and sole, there is a sensitive layer rich in blood vessels and nerves. If a cow stands on a stone, or some other small hard object, its sole bends upwards over the stone, severely squeezing the sensitive layer. This can cause bleeding within the claw, and subsequently pressure, pain and lameness. Bruising is identified in a well-cleaned sole as pink or dark red flecks. Very soft feet, due to moist or wet conditions, are more prone to bruising. If the sole is thin due to excessive wear, it offers less protection to such damage. Such wear can result from standing on very rough concrete floors or animals being bullied by dominant animals or even excessive turning on floors when on heat.

Bruising will repair with time, but rest is important. Particularly severe bruising may need some form of relief from the pressure of body weight and walking. If bruising is largely confined to one claw, glue-on plastic or leather lace-up shoes can be fitted. Preventative measures include ensuring floors are not too abrasive, with all stones and broken pieces of concrete removed. Hoof trimming will also assist. Foot baths containing formalin (for hardening hooves) or sprays of zinc sulphate solution (for treating sore feet) are also useful.

Providing cows with soft bedding, such as a dirt lounging area or rubber mats improves cows' comfort and reduces feet and leg problems. Other factors influencing sore feet resulting from acidosis are discussed in Chapter 6.

7.5.1 Assessing cow lameness

Lameness is an increasing problem in both grazing and housed cows, which has economic implications. Locomotion scoring from 1 to 5 (for increasing lameness) is a new tool (Sprecher *et al.* 1997), which provides a quick measure of the cow's ability to walk normally. These scores are presented in Table 7.1. Observations should be made of cows' standing and walking (gait), with emphasis on their back posture, and should be made on a flat surface that provides good footing for cows.

Locomotion scores of individual cows can be used to select cows for hoof examination before they become clinically lame. Those with scores of 2 and 3 are

Table 7.1. Locomotion score guide based on observations of back posture and behaviour when walking

Score	Clinical description	Back posture	Assessment
1	Normal	Flat	Cow stands and walks with a level back. Gait is normal.
2	Mildly lame	Flat or arch	Cow stands with level back, but arches when walks. Gait is slightly abnormal.
3	Moderately lame	Arch	Stands and walks with arched back. Short strides with one or more legs.
4	Lame	Arch	Arched back is always evident and gait is one deliberate step at a time. Cow favours one or more legs/feet but can still bear some weight on them.
5	Severely lame	Three–legged	Cow demonstrates an inability or extreme reluctance to bear weight on one or more legs/feet.

(Source: Sprecher *et al.* 1997)

considered sub-clinically lame and their hoofs should be examined and trimmed to prevent more serious problems. Scores of 4 and 5 represent those cows that are clinically lame. The higher the lameness score, the greater the reduction in feed intake and milk yield and the poorer the body condition. For example, a score of 4 can reduce DM intakes by 7% and milk yields by 17%, while a score of 5 can reduce DM intakes by 16% and milk yields by 36%. Advice should be sought if more than 3% of first calving cows, or more than 2% of older cows, show signs of lameness.

7.6 Mastitis

7.6.1 Causes of mastitis

Mastitis is an inflammation of the udder caused by a variety of microbes, mostly bacteria, that gain access to the interior of the mammary gland through the teat canal. These microbes live on the cow, its udder and in its environment, including the floor, faeces, soil, feedstuffs, water, plants, and milking equipment and utensils. In response to these bacterial invasions, cells move from the blood stream into milk in order to fight the infection. Fortunately, these organisms are normally killed by pasteurisation and thus seldom cause disease in humans, unless the equipment is faulty or if raw milk becomes contaminated with these organisms.

There are over 100 types of microbes that can cause mastitis and, for convenience, they are grouped into two main types:

1. **Contagious bacteria.** These spread from infected quarters to other quarters, such as *Streptococcus agalactiae* and *Staphylococcus aureus.*
2. **Environmental bacteria.** These are commonly present in the cow's environment, such as environmental *Streptococcus uberis, Streptococcus galactidae* and the coliforms *Escherichia coli* and *Klebsiella.*

At low levels of infection, the disease may go unnoticed in the form of sub-clinical mastitis. However, it eventually becomes sufficiently severe to be classed as clinical

mastitis, leading to pathological changes in the mammary tissue and physical, chemical and bacteriological changes in the milk. If the infection is not cleared up, chronic mastitis may result. As long as it persists, infected quarters can lose up to 25% of their potential milk production and produce only poor-quality milk.

The economic importance of mastitis is very high, through reduced milk production and treatment costs. Losses caused by clinical mastitis include discarded milk with antibiotic residues, drug and veterinary costs, the sale or possible death of infected animals, udder damage and the interruption to breeding improvement programs.

Clinical mastitis is easily recognised through visible abnormalities in the milk and udder. The sub-clinical form cannot be detected visually and requires tests to identify the microbes or their products of udder inflammation, such as somatic cells in the milk.

For each case of clinical mastitis in the herd, there will be 15–40 sub-clinical cases, while most clinical cases are preceded by infection at the sub-clinical level. Sub-clinical mastitis tends to cause a herd problem, is of long duration, reduces milk production and adversely affects milk quality. More importantly, it constitutes a reservoir of mastitis organisms that may spread to other cows in the herd.

Mastitis may be attributed to poor management, improper milking procedures, faulty milking equipment, inadequate housing and breeding for ever-increasing milk yield. Climate, season, herd size, type of housing, nutrition and stress all influence the incidence of mastitis. These all interact with genetic and physiological factors such as the stage of lactation, milk yield, milk flow rate and pregnancy.

7.6.2 The importance of the teat

The teat canal is the natural barrier to infection, but it is not always able to resist invasion by bacteria. The condition of the milking machine and how it is used, and damage to the teat canal orifice all influence the rate of mastitis infection.

The physical condition of the cows' teats is an excellent indicator of the state of the environment, the milking management and the milking system used on a dairy herd, and can also be used as an indicator for the risk of intramammary infections. The risk of mastitis is a 'numbers game' – greater numbers of bacteria near the teat end increase the risk of infections occurring. Teat sores and cracks provide sites where bacteria can multiply. They can be painful to the cow, causing her to kick and mess more frequently during milking, and to have poor milk let-down.

7.6.3 Environmental mastitis

Most cases of environmental mastitis occur within a few weeks of calving, when the cows' natural defence mechanisms are low and their udders have been in contact with mud and manure during calving. However, exposure of teat ends to environmental bacteria can occur at any time: before heifers have even calved, during calving, at milking time or in paddocks or yards during the lactation or dry periods. During lactation, factors that predispose cows to infection with environmental bacteria include milking udders that are wet or dirty, or administering intramammary infusions if the teat orifice is not sterile. During the early and late dry periods, the absence of the keratin plug in the teat canal may make cows highly susceptible to infection.

Control is best achieved by deceasing exposure of the teats to these organisms, through keeping cows in a clean environment. With *Streptococcus uberis*, which commonly occurs during the dry period, antibiotic treatment is not always efficient and chronic cases must be culled.

Good udder hygiene, correct use of good milking machines, dipping teats after milking and dry cow therapy are the keys to controlling environmental mastitis. In addition, heifers should be milked first, followed by uninfected cows with infected cows milked last. The steps outlined in Table 7.3 provide a comprehensive plan for mastitis control.

7.6.4 Contagious mastitis

The main mechanism of transmission of contagious mastitis is spread of pathogens from cow to cow at milking. These bacteria live on the teat skin or in the udder. Spread occurs when infected milk contaminates the teat skin of clean quarters or other cows. This can be by milk on milkers' hands or teat cup liners, through splashes or aerosols of milk during stripping, and by cross flow of milk between teat cups.

The spread of mastitis infections can be minimised by good hygiene, keeping teat ends healthy, using milking equipment that is operating well, and disinfecting teat skin after milking.

7.6.5 The dry period

The method used to dry off cows can influence how many udder infections establish during the dry period. The aim is to shut down milk secretion and seal the teat canal as rapidly as possible – this usually takes about 2 weeks. Most new infections occur in quarters where the teat canal has not sealed.

Drying off should be done abruptly. Cows should be milked as usual up till drying off. Once-a-day milking or milking every second day will greatly increase the risk of mastitis infection. The risk is higher because the stimulation provided by milking the cow impedes the ability of the teat to seal the canal.

Cows should also be removed from the sights and sounds associated with milking. These all stimulate the cow to let milk down, which leads to the breaking of the teat seal, which is vitally important in preventing infections during the dry period.

Special care needs to be exercised when using treatments at drying off. Dry cow therapy (DCT) when incorrectly administered can introduce bacteria into the teat.

After drying off the udders, the cows need to be checked each day for a week. Swollen quarters could indicate infections, which need to be treated so that they do not persist and create additional problems in the future.

7.6.6 California mastitis test (CMT)

This is a test performed on milk samples to indicate the level of somatic cells in the milk. It is sometimes referred to as the rapid mastitis test. It involves milking each suspect cow into a plastic container with four wells each containing a reagent: a detergent that bursts the somatic cells (from mastitis) in the milk. Equal quantities of a reagent and the milk sample to be tested are mixed and stirred for approximately 10–15 seconds. Any thickening or development of floccules in the solution indicates excessive somatic cells

The rapid mastitis test is the basis of good mastitis management programs (Malaysia).

present in the sample. The greater the reaction the greater the somatic cell count (SCC), which increases three times for each unit increase in score (Table 7.2). The test is subjective, but is an excellent indicator of SCC, particularly when used as a cow-side test to detect problems in individual quarters.

7.6.7 The role of mastitis therapy

Despite good preventative procedures, new infections will occur while spontaneous recovery may also occur in some cases. However, drug therapy is the main treatment, with culling of chronic cases that resist antibiotics. Successful drug therapy requires the drugs to reach all sites of infection in the affected quarters, to remain at adequate therapeutic levels for sufficient time and to kill all the infecting microbes.

Table 7.2. Reaction scores, average somatic cell counts (SCC) and their description when read at 10 seconds in a California mastitis test

Score	Meaning	SCC (000 cells/mL)	Description of visible reaction
0	Negative	100	Mixture remains liquid and homogenous, with no evidence of thickening
T	Trace	300	Slight thickening when paddles tipped backwards and forwards. Disappears over time.
1	Weak positive	900	Distinct thickening, but no gel formation. May disappear after 20 seconds.
2	Distinct positive	2700	Mixture thickens immediately with gel moving towards centre when paddles shaken. Mixture settles on bottom of well when rotation stopped.
3	Strong positive	8100	Gel is formed with centre of surface elevated above main mass, even after rotation is stopped

7.6.8 Lactation therapy

The most effective treatment protocol will depend on previous experiences of the veterinarian, clinical signs and environmental management. Drugs should be chosen according to diagnoses of infective organisms, while the CMT allows monitoring of sub-clinical cases. For acutely ill cows, treatment with oxytocin and frequent milking out will aid recovery. Combination therapy, with both intramammary and systemic drugs, can improve cure rates of chronic cases.

7.6.9 Dry cow therapy

This involves long-acting drugs given to all cows, whether infected or not. There is no evidence of increased resistance to drug treatment through the use of dry cow therapy. Every udder of all cows must be treated, while reducing energy intake to ensure cows cease lactation. Prior to treatment, the teat must be disinfected with 70% alcohol to reduce the likelihood of introducing microbes with the dry cow therapy. The administration and drug withdrawal instructions should be followed carefully.

It is false economy not to treat infected lactating cows, and all cows at drying off. The extra milk produced is worth considerably more than the reduced milk yields of infected cows.

7.6.10 Preventing mastitis

As already stressed, the cost of doing nothing is very high, so prevention is better than cure. There are many procedures that should be routinely followed to reduce the high economic impact of mastitis.

Suggested trigger points for seeking professional assistance are:

- six clinical cases of mastitis for every 100 cows during calving
- five clinical cases of mastitis for every 100 cows in the first month after calving
- two clinical cases of mastitis for every 100 cows per month for the remainder of the lactation.

7.6.11 Recommended milking procedures

The 15 min each day when cows are milked is a prime time for increased susceptibility to new mastitis infections. Correct milking procedures are important, regardless of whether cows are milked by hand or machines. Preparation of teats and udders for milking reduces the number of contaminating microbes on teat skin, and stimulates milk let-down. As well as reducing this contamination, it decreases residual milk left in the udder at the end of milking, increases milk yield, decreases milking time and reduces the spread of contagious and environmental organisms that cause mastitis and reduce milk quality. Key milking procedures include the following:

- Provide cows with a clean, stress-free environment. The cows should not be frightened or excited before milking because this stress will release hormones that interfere with normal milk let-down and reduce the cow's resistance to mastitis.

- When washing the cow or cooling it down, ensure that at least 30 min elapses before milk harvesting, to minimise the likelihood of dirty water dripping off the teats during milking
- Check the udder and foremilk for mastitis. Clinical mastitis can be visually detected from clotty, stringy or watery milk or hot, hard and enlarged quarters.
- Wash the teats and lower surfaces of the udder. Correct washing and massaging releases hormones for milk let-down. A sanitising solution should be used in the bucket with an individual cloth or paper towel to wash the udder. Do **not** use a common cloth because it allows for cross contamination between cows.
- Use a pre-milking teat dip (optional). Disinfecting teats before milking reduces the rate of infection of environmental mastitis by 50%, as well as reducing contagious mastitis. The recommended procedure is to wait 20–30 seconds after pre-dipping teats, then thoroughly dry the teats prior to applying teat cups.
- Dry the teat thoroughly. Using excess water to wash teats and udders and not drying them properly results in water laden with microbes draining down into the milk bucket (with hand milking) or being drawn into the teat cups of milking machines.
- Hands should never come into direct contact with milk.
- Attach teat cups within 1 min. Attachment must be done carefully to prevent entrance of excessive air into the milking system. Maximum internal udder pressure is reached within 1 min after udder preparation and lasts for about 5 min. Because the majority of cows will milk out in 3–5 min, the 1 min delay in attaching the milk cups maximises the effectiveness of the milk let-down hormone oxytocin.
- Observe milking units closely while attached to ensure that they are adjusted correctly and to aid in preventing cup slip. Slipping or squawking cups slow down the milking operation and may cause machine-induced infections. Liner slip can allow tiny droplets of milk to be quickly propelled against the end of the teat, which may penetrate the teat canal. Because most liner slip occurs towards the end of the milking, the chance of these organisms being flushed out is reduced, leading to an infected quarter.
- Avoid irregular vacuum drops due to sudden air intakes when connecting or removing the milk clusters.
- Shut off the vacuum before removing the teat cups at the end of milking. Never pull the milking unit off the udder while still under vacuum because this causes the same problem as squawking cups, leading to infections (referred to above). A minute or two of over milking with a properly functioning milking unit does not pose a major risk in term of mastitis. If one quarter milks out ahead of the others and if the teat cup remains attached to the teat without slipping, it should be left on because careless removal may permit air to enter, possibly leading to liner slip-induced infection. If there is a probability of cup slip on a particular teat, then the cluster should be lifted gently to seal the short milk tube of the liner over the ferrule of the claw to shut off the vacuum before detaching it from the teat. Never remove a teat cup while under vacuum.
- Don't over milk any cow; 8 min is maximum milking time, even for a slow milker.
- Dip teats with an effective teat dip. This is the most important way to reduce new infections of environmental mastitis. The goal should be to dip the entire surface of the teat that comes into contact with the teat cup liner. Teat spraying never covers the entire teat surface. Teat cups should be kept clean and sanitary, but teat dip should

never be poured back into the original container because the strength of the used teat dip may be reduced and allow organisms to survive.
- Disinfect teat cups between cows (optional). Teat cups can spread organisms from one cow to another. If they are to be disinfected between cows, two teat cups should be dipped at a time in a disinfectant solution. The solution should be changed when it becomes cloudy to ensure mastitis organisms are killed rather than spread.
- When the milking session is complete, clean and disinfect the teat cup liners properly, using hot water plus detergent followed by hot water plus sterilising agents.
- Allow each cluster to drain between milking sessions.
- If using a bucket milking machine, ensure the bucket is hung upside down so it can drain properly before reuse.
- Feed the cows immediately after milking to ensure they do not lie down for at least 30 min.
- Ensure the cows lie down on clean bedding or a clean floor.

When milking mastitis-infected cows:

- Draft out clinically affected cows and milk them last.
- Use gloves when milking mastitis-infected cows.
- Rinse and sanitise the milk cluster after milking each mastitis-infected cow and don't touch any other cluster or cow for at least 20 seconds.

To reduce exposure to environmental mastitis:

- Calve cows down in a clean and dry area.
- Be alert to the number of cases of mastitis occurring in freshly calved heifers; this is an indicator of the state of the calving area.
- Bring cows into the dairy for milking out and checking, certainly within 24 hr post-calving.
- Look for swollen quarters and check them for heat and pain.
- Check milk from all quarters of freshly calved cows.
- Take special care of induced cows; that is, cows that have been treated to calve down early.
- Take special care with pre-milking preparation; that is, teat cleanliness and ensuring all milking equipment has been sterilised and allowed to drain.

7.6.12 Recommendations for milking machines

Mastitis can result from improper design, malfunctioning, misuse or improper cleaning of milking machines. If they are properly designed, maintained and used, milking machines will account for only 6% of all udder infections.

Although they differ in design and size, all milking systems have the same basic components. These include systems to produce a vacuum, pulsation, milk removal and milk handling, which are all run by an electrical system. With respect to mastitis control, it is the milk removal system – in particular the teat cup liner slips – that are associated with milking machine-induced infections. A problem with liner slip exists if there are more than 5–10 liner slips per 100 cows milked. Some of the causes of this include poor

cluster alignment, poor liner design, uneven weight distribution clusters, blocked air vents at the claw and flooded milk lines. In addition, cup slip results from inappropriate liner design, cluster weight, vacuum levels, vacuum fluctuations, milking wet teats, absence of hose support arms, over milking and teat size.

The steps in milking machine maintenance include the following:

- Ensure the milking machine technician closely follows the maintenance schedule for testing and servicing the machine.
- Regularly check the pulsation rate of the machine: 60 pulsations/min is the recommendation.
- Regularly check the vacuum pressure and ensure it is not too variable during milking.
- Ensure the diameter of the vacuum line corresponds with the capacity of the vacuum pump.
- Ensure the vacuum line is not too long; that is, the distance between the vacuum pump and the teat cups.
- Routinely replace any cracked milk tubes.
- Replace the milk cluster rubber liners after 2500 milkings, using the following simple formula:

$$\text{Replacement age (days)} = \frac{2500 \times \text{number of claws}}{\text{herd size} \times \text{milkings/day}}$$

Therefore, for a 40 cow farm milking twice daily, with one mobile milking machine with two claws, the rubberware should be replaced every $(2500 \times 2)/(40 \times 2)$ or every 62 days.

The following treatment protocol for mastitis should be followed by the veterinarian or dairy cooperative animal health staff:

- Regularly monitor each cow for sub-clinical mastitis, preferably using the CMT.
- Apply antibiotics under veterinary supervision, ensuring it is the most appropriate for the mastitis infection.
- Use the full course of antibiotics, as specified on the label.
- Clearly mark treated cows.
- Keep records of treatment to clinically affected quarters.
- Ensure the withholding periods (for drug use) are followed before mixing the milk with that of the rest of the milking herd.
- Discard milk from all quarters of cows that receive treatment.
- If a cow fails to respond to full treatment, consider a repeat course of the same or another antibiotic, drying off the infected quarter, drying off the cow or even culling the cow.

7.6.13 Controlling mastitis

Mastitis is best viewed as a herd problem rather than an individual cow problem. Unlike other cattle diseases, such as brucellosis or tuberculosis, mastitis cannot possibly be eradicated on a large scale. Each individual herd is the unit of control by itself. The level of mastitis in a herd has nothing to do with the level in a neighbouring herd.

Table 7.3. Comprehensive mastitis control

Management task	Specific actions
Milking hygiene	Milk teats that are both clean and dry
Milking machines	Stable milking vacuum No slipping or squawking of liners Shutting off vacuum before removing
Post-milking teat dipping	Immediately after removing teat cups Full teat immersion, not spraying
Drying off	All quarters of all cows after last milking
Treatment of clinical cases	Early detection and treatment Maintain records
Culling	Cull chronic cases
Environment	Clean and dry Uncrowded and well ventilated
Herd replacement	Test new animals before adding to herd Check new animals regularly

(Source: Thirapatskun 1999)

A control program for each herd must be practical, easy to understand, highly effective, increase economic returns, reduce new infections, shorten the duration of pre-existing infections, provide tangible evidence that clinical mastitis is reduced and be subjected to easy modifications as improved methods are developed.

The level of infection in a herd must be known to be able to assess its seriousness, and the source and risk of spread of infections. Prevalence of mastitis indicates a level of infection or the proportion of cows or quarters infected with the disease at a given time. Regular monitoring of each farm is necessary. If the rate of infection is reduced, the level of infection will fall, though very slowly. If the duration of infection is effectively shortened, the level of infection will soon be reduced, provided that no new infections occur. To keep mastitis at a low level, it is necessary to prevent as many new infections as possible and then shorten the duration of those that do occur and finally eliminate the existing infection. Table 7.3 summarises an effective approach to controlling mastitis.

7.6.14 Heifers

Udder infections among heifers are quite common, even in very young animals and can cause inflammation and tissue damage prior to calving. Sources of infection can be insects, sucking among calves (particularly those fed mastitic milk), and microbes in the mouth and on the skin and coat. Strategically treating pregnant heifers using drug therapy is effective. Extreme caution must be exercised to make sure the teat ends are sanitised before injecting antibiotics.

7.6.15 Establishing goals

As with any control program, it is important to establish realistic and achievable goals. These can be based on milk somatic cell counts, herd milk bacteria counts, proportion of cows with sub-clinical or clinical infections and the volume of discarded milk.

A high incidence of clinical mastitis usually indicates a major deficiency in management, such as an unsanitary milking area, inadequate milking hygiene, faulty milking machines or purchases of infected cows. It is important to determine whether the mastitis is environmental or contagious, so that the most appropriate measures can be taken.

Evidence of progress will often require several months, so regular monitoring is necessary to maintain motivation and identify areas where the program may have to be re-evaluated. As with any successful control program, follow up visits are necessary. Bulk milk somatic cell counts and inflammation and infection percentages on a cow and quarter basis are useful tools.