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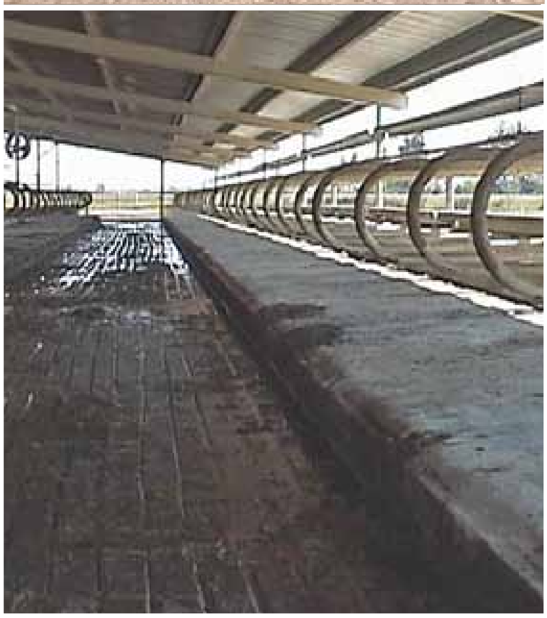
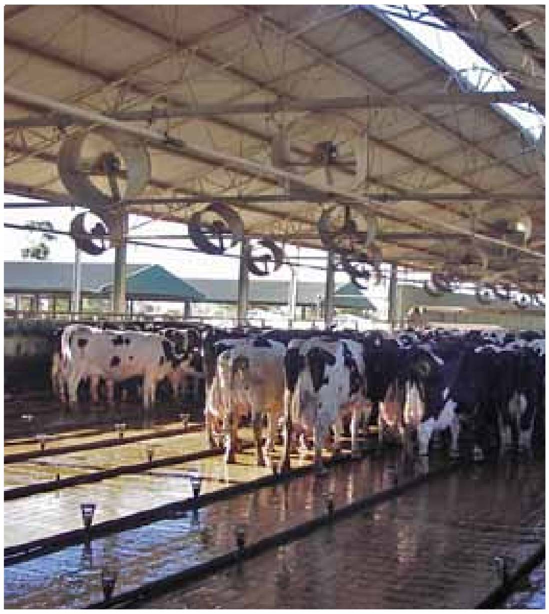


A guide to dairy herd management

RRP AUD$39.00

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Contacts:

Meat & Livestock Australia
Level 1, 165 Walker Street
North Sydney NSW 2060
Australia
Ph: +61 2 9463 9333
www.mla.com.au

LiveCorp
Suite 202, 32 Walker Street,
North Sydney, NSW 2060,
Australia
Ph: + 61 2 9929 6755
www.livecorp.com.au

Author:
John House, The University of Sydney, New South Wales, Australia

Editor:
Ian Partridge

Acknowledgment:
Dr John Moran, Department of Primary Industries, Victoria, Australia

Published by:
Meat & Livestock Australia Limited
ABN: 39 081 678 364
October 2011

ISBN: 978-1-74191-653-9

Introduction

Increasing numbers of Australian dairy animals are being exported to countries seeking to improve their production of milk and dairy products.

Some cattle are going to countries in the tropics and subtropics, other going to countries with more temperate climates.

These Australian dairy cattle are of high genetic potential; they need good management and good feeding to produce high yields of milk in their new homes and environments.

The success of such programs depends largely on the awareness and ability of new owners of these stock to meet these standards of feeding and general herd management, and this book is designed to provide the information needed for good decisions to be made. Key factors in management include nutrition, cow comfort and reproductive management.

In collaboration with the importing countries, the Australian Government has instigated procedures for strict animal selection and quarantine prior to transport, while the exporting agencies are developing post-arrival protocols to reduce stresses on the newly-arrived stock.

A guide to dairy herd management has been developed for distribution to dairy farmers and organisations in the countries that source Australian dairy heifers. It highlights the important dairy herd management practices required to reduce undue stress on unadapted, high genetic merit dairy heifers once they arrive at their new destination.

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1 Principles of dairy farm management

Three fundamental factors that determine the health and productivity of a high-potential dairy cow are nutrition, comfort and reproduction. Cows need to be well fed, maintained in a comfortable environment, and bred in a timely fashion in order to express this potential. Conversely, the health and productivity of cows will be restricted by the factor most limiting.

The limiting factor has a consequence and an interaction. For example, if nutrition is poor, milk production drops quickly and cows in poor condition will not cycle properly for good reproduction. If cows are stressed and uncomfortable, they are more likely to develop lameness and mastitis—which will affect both production and reproduction. Failure to conceive leads to protracted lactations with more cows in the herd in later lactation and less milk. Poor reproductive performance reduces the number of offspring, contributes to forced culling and provides fewer replacement heifers to replace the culled cows.

While the concepts of nutrition, comfort and reproduction are simple, the logistics of catering to the cows' needs for 365 days of the year can be challenging as seasonal conditions and feed availability fluctuate.

This manual outlines the principles and some of the practical challenges that may be encountered in dairy cow management.

Environment and facilities

Cows are resilient creatures but an uncomfortable environment comes at a cost to their health and productivity.

Facilities – Animal housing design can either mitigate or create adverse environmental conditions. Cows need a clean, dry, comfortable place to lie down. Walking surfaces should provide sufficient traction to avoid slipping but should not be too abrasive or rough. Cattle should have constant access to fresh clean water and feed with sufficient trough space for the number of animals in the group to avoid competition between animals. Good feed quality demands feed storage facilities that prevent feed spoilage.

Cow comfort – When cows have to stand for long periods because they cannot lie down in a clean dry area, they may become lame. Cows that are lame or have to stand on slippery surfaces are less likely to show sexual behaviour and hence less likely to become pregnant. If they are forced to lie in wet dirty areas, the risk of mastitis is increased. The results can be more disease, lower production and heavier culling.

Heat stress – The large body mass of cows of temperate breeds and their high metabolism makes them susceptible to heat stress under hot conditions. Hot cows eat less, are more likely to become sick and more difficult to get pregnant. Providing adequate shade and cooling for cows during hot weather promotes milk production, reduces mortality, and improves reproductive performance. Cows should always have access to fresh clean water.

Cold stress – Adult cows are generally more resilient to cold stress than humans because of their larger body mass; however, frost damage to teats can make them more susceptible to mastitis. Young calves need more feed during cold weather.

Hygiene – Good hygiene will prevent transmission of disease, but waste management is a significant logistical problem where cattle are managed intensively. Udder health is largely influenced by the level of hygiene practiced before, during and after milking. Milking wet, dirty udders increases the risk of mastitis, wiping cows' teats with a dirty cloth transmits pathogens between cows, and failing to sanitise teats after milking provides opportunity for disease to spread. Young calves are particularly susceptible to pathogens that cause diarrhoea, but the risk of disease is reduced by feeding adequate colostrum, good milk handling practices, and reducing exposure to manure from other animals.

Biosecurity – It is always preferable to prevent the introduction of disease agents onto the farm. Biosecurity protocols should be developed to identify and manage sources from introduced livestock, people, equipment, feed, wildlife and water.

Human food quality – The dairy produces milk and meat for human consumption, and the consumer expects that the product will be nutritious and safe. A number of pathogens can infect both animals and humans. Properly functioning equipment for milk harvesting, cooling and storage and good milking routines are important for the health of the cows and for milk quality. Some medications to treat sick cattle or to facilitate their reproductive management can have adverse impacts on milk products or people. Individual identification, good record keeping of medication and chemical use, and observance of withholding periods will avoid contamination of human food.

Expertise

Dairy farming is a sophisticated industry that calls for diverse knowledge and expertise relating to animal health, soils, cropping, mechanics, business, and construction. As herd size increases, so does the need for extra staff. The success of the dairy farm is often constrained by the weakest link in the staff team. For example, investing in resources to keep cows comfortable will not achieve high production if the person responsible for feeding the cows does not pay attention to detail and fails to feed cows their appropriate ration.

The complexity and difficulties associated with staff management increase as the number of staff employed increases. Management needs to be proactive in developing staffing structure and protocols. Planning increases the likelihood of good outcomes. Farms that do not have development plans for staff and project plans tend to practice crisis management, moving from one problem to the next.

Proactive strategies include:

- Establishing clear goals for each area of the business
- Developing standard operating procedures for common tasks
- Developing training programs for staff to implement the operating procedures effectively
- Scheduling staff and defining staff roles improves staff productivity
- Identifying individual animals and keeping good records
- Establishing a monitoring system for each aspect of the business to provide rapid feedback regarding program outcomes. It is difficult to manage practices for which there is no measure of success.
- Identifying knowledge gaps and seeking professional input in these areas; examples include nutrition, animal health, milk harvesting and milking machines, milk cooling and storage, agronomy, finance.

Animals

There are numerous approaches to profitability in dairy farming. Some focus on minimising input costs while accepting lower milk production; others use high inputs to maximise production and profitability.

There is no universal ‘best’ system. Which system is ‘best’ will greatly depend on the costs of feed and labour and the price for milk, but will also reflect differences in skills and resources on any given farm.

The genetic capacity of the cow to produce large volumes of milk can be realised only if the amount of nutrients fed meet the nutrient output in the milk. High-potential cows cannot produce large volumes of milk if fed poor-quality or inadequate amounts of feed. They will attempt to produce milk but at the expense of body condition and reproduction.

The five conditions of animal care to promote health, productivity, and longevity are:

- freedom from hunger and thirst
- freedom from discomfort
- freedom from pain, injury or disease
- freedom from fear and distress
- freedom to express normal behaviour.

Dairy herd health and production

The cycle of life

The life cycle of a dairy cow is predictable and therefore can largely be managed with scheduled activities. For dairy farms that maintain a seasonal calving pattern with cows calving every twelve months, the life cycle of the cow can be linked to an annual calendar of management events. However, maintaining a 12-month calving interval poses several reproductive challenges, and farms calving cows all year round often have a calving interval closer to 13 months.

This section focuses on the life cycle of the cow rather than on the calendar year.

Birth – Holstein cows have been selected for milk production and not for ease of calving or mothering ability; thus birth is a high risk event that can lead to the loss of both the cow and calf. Calf mortality is approximately three per cent of those born to cows and some six per cent of those born to heifers. Calf mortality at birth can be much greater when heifers are poorly grown, the nutrition of pregnant stock is poorly managed, the calving area is disruptive to normal cow behaviour, and when sire selection does not take calving ease into consideration.

Strategies to reduce the risk of calving problems include nutritional management of young stock so that heifers are well grown when they have their first calf and use of ‘calving-ease’ sires to breed heifers.

At birth, the calf is immunologically naïve and highly susceptible to pathogens. Good quality colostrum promotes calf immunity and should be fed to calves within six hours of birth. Colostrum quality is influenced by:

- the age and health status of the mother
- the timing of colostrum harvest relative to birth
- the hygiene of the equipment used to harvest and store the colostrum.

As bacteria can multiply in colostrum, it should either be fed directly to the calf after being harvested or cooled rapidly to 4°C for short-term storage.

The risk of calf disease is reduced when calves are fed colostrum at birth, fed milk that has been appropriately handled and stored, born and raised in a clean dry area and kept separate from older calves that could be a source of infection.

Heifer conception – The onset of sexual maturity is related more to body weight than to age. Heifers should weigh 85% of the adult cow weight at the time of calving. Target growth rates and breeding weights for heifers differ slightly for those raised in intensive systems or on pasture. Well-fed Holstein heifers will gain around 800 grams per day to achieve a target breeding weight of 350–375kg by 15 months of age; heifers reared on pasture are more variable, reaching a body weight of 310–350kg at 18 months.

Weight at joining is related to weight at calving and subsequently to milk production. Well-grown heifers are less likely to have calving difficulties, will produce more milk and get back in calf more rapidly than poorly grown heifers.

Calving – Individual animal identification and good reproductive records and management are important for management of calving cows. Reproductive records allow prediction of when cows are due to calve.

Good nutritional management of cows before calving reduces the risk of metabolic diseases that can contribute to weakness and subsequently calving difficulty. For a good ration to be effective, it needs to be fed to the right cow for the appropriate period.

The four weeks prior to calving are recognised as a crucial time for dairy cattle. Cows that are fed and managed well before calving are less likely to have problems with metabolic diseases such as milk fever, ketosis, retained placenta, metritis, abomasal displacement or death.

The health of cows after calving is also influenced by the environmental conditions at calving and by the quality of care provided to calving cows. Cows calving in dirty wet yards are more likely to develop uterine infections, as do unhygienic practices or excessive traction by handlers helping calving cows.

Death – Common causes of death include calving difficulty, mastitis and metabolic disease; nearly all occur within 60 days of calving. Strategies to prevent disease and mortality should deal with the period which spans the four weeks before and the four weeks after calving.

Conception – After calving, cows should start into a reproductive management program with targets established for average days-to-first-breeding, efficiency of heat detection and for pregnancy rate. Contingency plans should also be in place for cows that experience calving difficulty, retained placenta, or metritis so as to minimise their impact on reproductive performance. The days between calving and conception dictate the calving interval and have a large impact on future milk production, herd structure, and availability of replacement heifers.

Culling – Cows should be culled from the herd toward the end of their lactation on the basis of a lowered future productive potential. Culling decisions based on voluntary criteria such as low production, age and conformation tend to promote herd productivity whereas those based on involuntary criteria associated with failure of conception, disease or injury have a negative impact on herd structure. Recording the identity of animals culled, stage of lactation at which they were culled and reason for culling helps to identify causes of attrition that need to be investigated.

Dry cows – Cows are dried off 50–60 days before their projected calving date to allow the mammary glands to recover. High-risk periods for new intra-mammary infections include the early and late dry period and early lactation; the non-lactating or 'dry' period provides an opportunity to treat ***existing*** intra-mammary infections and to prevent ***new*** intra-mammary infections.

Strategies to reduce the risk of new intra-mammary infections during the dry period include intra-mammary therapy at the time of drying off and implementing good environmental and nutritional management. Attention to detail is important when working with cows—particularly when administering medications as poor treatment technique can introduce pathogens. When milking is stopped, the mammary gland becomes engorged and some cows may leak milk. This opens the teat end allowing bacteria to enter the gland. Similar engorgement and leakage of milk can be seen before and after calving. During these times, the cows must be kept in a clean environment.

Routines **–** In batch-calving herds where all cows calve over a short period, the cycle of life may be incorporated into an annual calendar. This is not possible with year-round calving herds where efficiencies can be gained by scheduling repetitive routine tasks into daily, weekly or fortnightly activities. A good record-keeping system facilitates scheduling of common tasks with procedures such as vaccination schedules and reproductive synchrony programs linked to the stages of the production cycle. Many dairy software programs can generate lists of cows according to their stage of lactation or pregnancy. Establishing a schedule provides a level of predictability to work routines and assigns responsibility to individuals promoting accountability when multiple people are involved.

2 Nutrition

Key points

- Feed composition – All feedstuffs fed to cows contain some water. To account for the different water contents, the weight of feed is expressed on a dry matter basis. The dry matter of a feed is the weight of the feed after all the water has been extracted.
- The dry matter content of mixed dairy rations is usually formulated to be 50–75% of the ration. Wetter or drier than this limits consumption.
- Feed utilisation – Dairy cows use feed for several different functions. These include 'maintenance' of bodily functions, growth (in young stock), pregnancy and milk production.
- Feed consumption – The daily feed intake for maintenance of a non-pregnant mature cow is about 1.2% of her body weight. Thus a 600kg cow needs to eat about 7.2kg of good-quality dry matter per day just to maintain bodily functions.
- The amount of dry matter fed to heavily pregnant, non-lactating cows should be around 2% of bodyweight. The additional feed is to meet the needs of advancing pregnancy.
- Lactation dramatically increases the feed requirements of high-producing dairy cows. The amount of good-quality dry matter a milking cow should be fed can be estimated by adding 5kg per 10 litres of milk produced to the maintenance requirement of the cow.
- High-producing cows can eat 4% of their body weight in dry matter per day at peak lactation when fed highly-digestible feed.
- When the nutrient output in milk exceeds the amount of nutrients eaten during early lactation, cows lose weight. Excessive loss of weight or 'Body Condition' during early lactation indicates the nutrient requirements of the cow have not been met.
- Milk production is driven by dry matter intake, which is influenced by the **quality or digestibility** of the feed fed.
- Poor-quality feed takes longer to digest and therefore limits the amount of feed a cow can eat each day; this limits the amount of nutrients available for milk production.
- Good-quality forage provides the foundation of dairy rations.
- Key points in growing good-quality forages for dairy cows:
  1. Select the most appropriate species for the region and environment.
  2. Manage the crop to optimise growth and quality.
  3. Harvest the crop at the optimum stage of maturity for nutritive value.
- Excess forage can be conserved as silage or hay.
- Concentrate supplements can be sourced already formulated or as raw ingredients. Their selection should be based on the need for additional energy or protein in the diet.

Feed composition
– nutrients for milk production

When dairy cows eat, they extract from the feed water, energy, protein, fibre, vitamins and minerals. The four requirements that are most commonly limiting are water, energy, protein and fibre.

Water

Water is not a nutrient but is vital for all body functions and in regulating body temperature. The body of a cow is composed of 70–75% water including the rumen contents, and milk is about 87% water. An abundant, continuous supply of clean drinking water is vital for dairy cows.

Energy

Energy is not a nutrient but is derived from most parts of the feed. Cows use energy to function (breathe, walk, graze, gain weight, lactate and maintain a pregnancy). Energy is the key requirement of dairy cows for milk production as it determines milk yield and milk composition. The energy content in feeds is quantified in terms of megajoules of metabolisable energy (MJ of ME) per kg DM. Starch and fats are common sources of energy.

Grain is the main source of starch in the ration of a dairy cow. Cereal grains include maize, wheat, barley and sorghum while dried cassava is a source of highly digestible starch. Fermentation of grain in the rumen favours production of propionic acid (one of the volatile fatty acids) which the cow uses to make glucose and subsequently lactose—the main sugar in milk. Increased lactose increases milk volume and the increased energy availability also promotes synthesis of milk proteins. Conversely, increased lactose reduces milk fat.

The mix of different microorganisms in the cow's rumen depends on the type of feed eaten. Too much grain in a ration produces excess volatile fatty acid and the pH of the rumen fluid may decline below pH 6 (acidosis). This favours the starch-digesting microorganisms and inhibits those that digest fibre. Acidosis from consuming excessive starch contributes to indigestion, laminitis, lameness and possible death.

Fat is a good energy source that is highly palatable and relatively cheap. However, a ration containing more than 6% fat (on a dry matter basis) will decrease the digestion of dietary fibre, and reduce milk protein and milk fat to below 3%. Solid fats are much safer to feed than liquid oils. Examples of feeds containing fat include brewers grain (10%), whole cottonseed (23%), added oils and added rumen-protected or bypass fat.

Protein

Protein is a constituent of all tissues (muscle, skin, organs, foetus), and also builds and repairs the body's enzymes and hormones. Protein is needed for the body's basic metabolic processes, growth, pregnancy and milk production. The protein content in feeds is quantified in terms of per cent of the DM.

The rumen microorganisms can synthesise protein for their own bodies from plant protein (and also from simple, inorganic forms of nitrogen). They cannot breakdown plant fibre or use energy-rich starch if the supply of nitrogen compounds in the ration is low. Slow digestion of fibre prevents the cow from eating more feed, and milk production declines.
Milk production is the major influence on protein needs.

Table 2. 1. Energy requirements for dairy cows

Body function	Energy requirement (MJ)
Maintenance	60 MJ for 500kg bodyweight ± 5 MJ for every 50kg change
Milk production	5 MJ/L for Holstein cows; 6 MJ/L for Jersey cows
Weight change	–28 MJ/kg weight loss; +34 MJ/kg weight gain
Pregnancy	5 months = 5 MJ, 6 months = 8 MJ, 7 mths = 11 MJ, 8 mths = 15 MJ, 9 mths = 20 MJ
Exercise	1, 3 or 5 MJ/km for flat, sloping or hilly land respectively (up to 25% maintenance)

Table 2.2. Crude protein requirement for levels of milk production

Milk yield (litres/day)	Crude Protein %
0	13
10	14
20	15
30	16
40	17
50	18

Fibre

The fibre fraction of the ration is digested slowly in the rumen by rumen microorganisms. For efficient digestion, the rumen must contain fibre from forages. Fibre ensures that the cow chews its cud (ruminates) and therefore produces saliva which buffers the rumen against sudden changes in acidity (see acidosis).

Fibre can be quantified as Neutral Detergent Fibre (NDF) and Acid Detergent fibre (ADF). High levels of NDF reduce the intake of a ration. High-producing dairy cows are limited to a NDF intake that is equal to 1.1% of the cow's bodyweight.

Dry matter intake (DMI) can be estimated for a forage or ration

DMI = (1.1 x Body weight)/ NDF %

For example

If a 500kg cow is fed forage with a NDF of 40%

Estimated DMI = (1.1 x 500)/ 40 = 13.75 kg

Energy and digestibility

In ruminants, energy is released from carbohydrates, lipids (fats and oils), and proteins through digestion by microorganisms in the rumen. Some 75% of the dry matter in plants is composed of carbohydrates, with different forms serving different roles in the plant.

These forms are broken down differentially in the rumen (Figure 2.1). Plant cell walls are made up of cellulose, hemicellulose, lignin, silica (and some protein), and become harder (more lignified) as the plant ages. Lignin is completely indigestible.

Plant fibres require more energy to break down and are generally digested slowly or are indigestible, and so are less efficient sources of energy for the animal.

The plant cells of green leaf contain sugars which are easily digested; starches are generally stored in plant seeds, roots and tubers, while oil is found in the seeds of some plants. Oils have a high energy content, but are generally extracted for commercial vegetable oil with the remaining meal available as animal feed. Too much oil or fat can upset the digestion of ruminants.

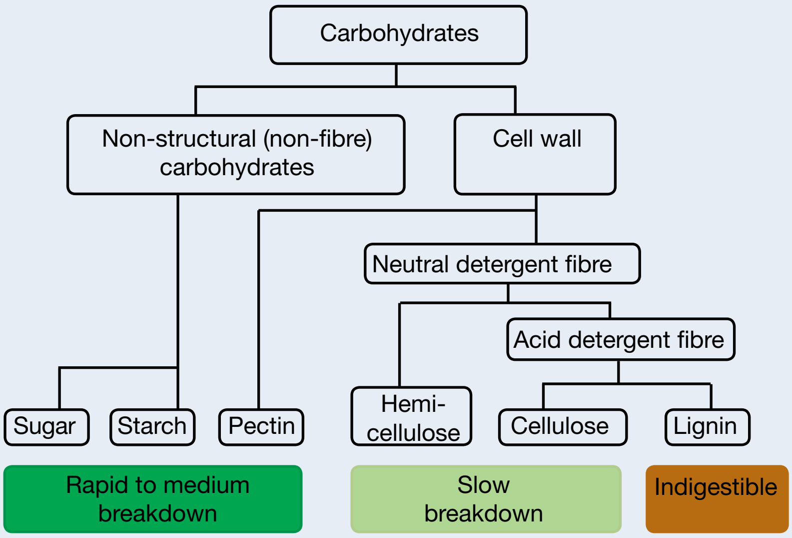


Figure 2.1. Digestibility of carbohydrate components of feedstuffs

Acid Detergent Fibre (ADF) is the more indigestible or more slowly digested component of NDF, and is mostly lignin from plant cell walls. A high ADF content indicates the forage is mature and the amount of available energy will be low. The amount of ADF in the diet is associated with milk fat percentage.

Vitamins

Vitamins are organic compounds that animals require in very small amounts. They are needed for many metabolic processes in the body, eg for production of enzymes, bone formation, milk production, reproduction and disease resistance.

Fresh forages are generally high in vitamins. Vitamins can be water-soluble or fat-soluble. The B group of vitamins are water-soluble and are produced by bacteria in the animal's digestive system. Fat-soluble vitamins (Vitamin A, D, E and K) can be stored in the liver or fatty tissue for 3–6 months. They may need to be supplemented if cattle have been off green feed for a long time as they are lost with prolonged storage of feeds.

Minerals

Minerals are inorganic elements. They are needed for bone and teeth formation, for enzyme, nerve, cartilage and muscle function or formation, milk production, blood coagulation and efficient utilisation of energy and protein.

Table 2.3. The macro-mineral requirements for dairy cows as a percentage of total DM intake.

Mineral	Requirement (% of total DMI)
Calcium (Ca)	0.70%
Phosphorus (P)	0.40%
Magnesium (Mg)	0.30%
Potassium (K)	1.06%
Sodium (Na)	0.25%
Chlorine (Cl)	0.28%
Sulphur (S)	0.20%

Examples of deficiencies of macro-minerals for dairy cows include:

Calcium (Ca) – Deficiency in young animals leads to soft bones and growth deformities. Inappropriate management of cow around calving results in milk fever

Phosphorus (P) – Deficiency results in reduction in intake, lameness, low milk and poor fertility

Magnesium (Mg) – Deficiency results in nervousness, restlessness, twitching of muscle and the cow will collapse.

Trace or micro-mineral requirements

Table 2.4. Trace mineral requirements for dairy cows in relation to total DM intake

Trace mineral	(mg per kg DM)	Total intake (mg)
Copper (Cu)	12	265
Zinc (Zn)	52	1140
Manganese (Mn)	40	880
Cobalt (Co)	0.11	3
Selenium (Se)	0.25	5.5
Iodine (I)	0.60	13
Iron (Fe)	15	330

Symptoms of deficiency of micro-minerals in dairy cows:

Copper (Cu) – Weak immune system, reduced conception rate, dilution of coat colour, brittle bones and diarrhoea.

Zinc (Zn) – Weak immune system, reduced conception rate, reduced feed intake, increased incidence of lameness.

Manganese (Mn) – Silent heats, reduced conception rates, cystic ovaries.

Selenium (Se) – Increased retained placenta, reduced fertility, weak or silent heats, increased incidence of mastitis, muscle weakness in young stock.

Cobalt (Co) – Rough hair coat, poor intake, anaemia, weakness.

Iodine (I) – Enlarged thyroid gland (goitre).

Sources of feed

Forages

Adequate quantities of high-quality forages are the basis of profitable milk and livestock production. The cheapest source of forage is usually home-grown fodder or grasses.

Where land is available, the cheapest source of forage is usually grazed grass. The aim for dairy production is to manage pastures by fertiliser, grazing management and water (rainfall or irrigation) to keep the pastures in a young vegetative state (see Figure 2.2) and to maximise green leaf intake by the cows.

Because of high or low seasonal temperatures and/or lack of rainfall, there is typically a problem period when the quantity or quality of grazing is inadequate for high milk production. Thus dairy farms may need to integrate a range of feed resources to maintain productivity (milk output/unit input) and profitability.

These forage resources will vary with the region's climate but include temperate, subtropical and tropical pasture species (grasses and legumes) and forage crops. High-quality silages are produced from maize and legume crops, while acceptable quality silage can be produced from the surplus growth from pastures. Feeding silage in combination with concentrates will balance out the seasonality, and maintain production per cow.

Where the land use system is too intense for grazing, cattle are fed harvested forages from pastures or fodder crops. These systems require high inputs of fertiliser and manure to sustain production of high yields of high-quality forage.

Temperate and tropical grasses

Tropical grasses have developed to make efficient use of intense solar radiation and photosynthesise through a C4 pathway. Temperate grasses are adapted to photosynthesis from less intense solar radiation using a C3 pathway.

The C4 pathway is associated with a different leaf structure that is more fibrous than that of the C3 plant, and thus tropical grasses are always of lower digestibility than temperate grasses at similar stages of growth (Figure 2.2). It is thus difficult to get the highest yields of milk from tropical pastures.

Similarly tropical grasses are lower in sugars so that silage fermentation sometimes needs the addition of extra sugar as molasses.

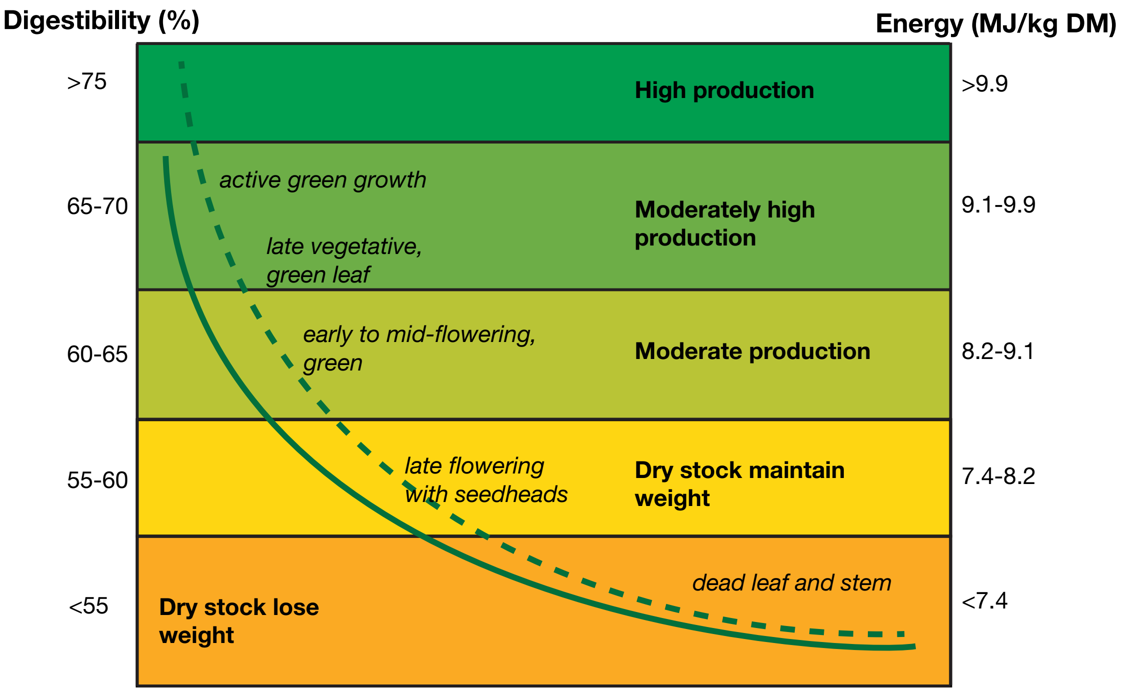


Figure 2.2 Forage quality of temperate (dotted line) and tropical (solid line) grasses at different stages of plant development (modified from NSW Ag Primefact 1070)

The basic principles for producing quality forages are:

1. Select the most appropriate forage species for the region
2. Prepare the forage production area for sowing
3. Manage the crop, particularly with adequate fertiliser, to optimise growth and quality
4. Graze the pasture or harvest the crop at the best stage of maturity for nutritive value.

The saying "Rubbish in, rubbish out" especially applies to dairy cow rations where the quantity and quality of milk produced is a direct result of the ration being fed. The quality of all the components of a ration, with special attention to the forage components, must be monitored when feeding dairy cattle.

Knowing the nutritional value of plants at varying stages of their life cycle will help determine the correct time to harvest forage for maximum quality and quantity (Figure 2.2).

The leaf of a grass plant is at its highest quality (nutritional value) when actively growing, quality declines slightly during the late vegetative stage, and then decline markedly once it flowers and puts up stalks. The quantity moves through the opposite phase. Forages should be grazed during their active growth phase and cut during their late vegetative phase to maximise forage quality.

Forage harvest and preservation

In pasture-based dairy systems, excess forage from the peak production is used to fill feed gaps at the times of year when the growth of forage is inadequate to meet the nutritional needs of the herd. Feed gaps may be caused by low temperatures in temperate and subtropical regions, and by dry seasons in tropical and subtropical regions. Irregular feed gaps may be created by droughts associated with inter-annual climate variability.

Conservation may be as hay or silage but the rule of "Rubbish in, rubbish out" applies; good quality hay or silage cannot be made from poor quality forage.

Choice of method of conservation may be partly driven by rainfall patterns during the growth season but, with dairy cattle, silage increases the yield of nutrients, decreases feed costs, lowers harvest losses, and often increases forage quality.

Silage

Ensilation is an anaerobic fermentation process that converts plant sugars to organic acids. The resulting acidity effectively 'pickles' the forage to maintain its quality for long periods.

Effective fermentation is controlled by:

- moisture content of the forage
- sugar content of forage
- exclusion of air, aided by fineness of chop
- bacterial populations, both naturally occurring and supplemented.

The forage is generally wilted to 30% dry matter before being ensiled, with silage additives added if forage dry matter is below 30%.

Silage must be fine-chopped to allow compaction and exclusion of air.

Poor quality silage - coarse maize stems that do not compact.

Smaller quantities of silage can be preserved in sealed plastic bags.

Wetter forage requires a lower pH to prevent undesirable bacteria growth and this means more sugar must be available for conversion to acid. Legumes have a natural buffering capacity and require more acid to reach a low pH than grasses or corn.

Air is excluded in a silage pit by compaction with heavy tractors; however, suitable anaerobic conditions can be created by compacting and storing the forage in a sealed vessel or plastic bag. For good compaction, the green forage needs to be chopped into lengths of 1–2cm.

Any contact between the silage and air will result in mouldy, decayed, inedible, and sometimes toxic, material that becomes waste. Any small amount of oxygen not removed by compacting is rapidly removed by bacteria.

The quality of fermentation depends on the types of bacteria; effective fermentation requires the presence of lactic acid bacteria and the absence of clostridial bacteria. Lactic acid bacteria convert plant sugars to acids efficiently, and produce the non-odorous fermentation associated with good silage. Clostridial bacteria are inefficient at converting plant sugars to acids, and produce silage of poor nutritional value.

Good silage must be protected against rainfall.

As acidity builds up in the silage, microbial activity diminishes and the plant material is preserved. Corn silage should range from pH 3.5 to 4.5 and haylage from pH 4.0 to 5.5.

Silage storage losses can be high if silos are not sealed properly or become soaked by rainwater or runoff. Silage must be fed soon after removal from storage to avoid spoilage from exposure to air; storage facilities with an exposed silage surface must be sized to match the rate of feeding.

The surface area of the open face should be kept to a minimum to minimise oxidative spoilage. This is achieved by only opening the stack on one side and keeping the face vertical and even.

Poor silage management practices can result in reduced feed quality, low milk production, and increased risk of health problems.

Hay

Hay is made by mowing a forage grass or legume and allowing it to dry in the sun. The dry grass can be baled for ease of handling or stacked. Forage species with heavier stems are cut with a mower and the stems then crushed or crimped with a conditioner to speed drying.

The timing of harvest should be based on the maturity of the crop (for the balance between yield and growth stage) and weather conditions. Grass hay crops should be mowed when or shortly after the plants produce seed heads; lucerne hay should be mowed before the crop is in bloom.

Most hay crops will take two to three days to dry in the spring when the plant is high in moisture and less time during the summer. Feed quality will be lost if the cut forage is rained on. Drying is accelerated by turning the hay with a side-delivery rake or fluffing it with a tedder or inverter. Raking should be done when the hay has dried down to 35 to 45% moisture. It is best done on the day of baling.

Some forage leaf is lost when mowing or by raking during curing. The best practice is to rake the hay once only and that should occur on the day of baling.

Table 2.5. Recommended moisture contents (%) for safe storage of various bale types

Bale type	Moisture content (%)
Small rectangular bales	16–18
Round bales (soft centre)	14–16
Round bales (hard centre)	13–15
Large rectangular bales	12–14

Source: http://new.dpi.vic.gov.au/agriculture/grain-crops/pastures/haystack-fires-spontaneous-combustion

Hay should not be baled until it is under about 20% moisture to prevent spontaneous combustion in the shed or stack.

Hay baled when too moist will heat up and may spontaneously combust when stored.

Concentrate and protein supplements

Milking cows need concentrates to supplement the forage—with the type of concentrate depending on the composition of the forage. Some supplements that are by-products from processing crops include canola meal, soybean meal, cottonseed meal, beet pulp, citrus pulp and rice bran; others are formulated concentrates from feed millers.

By-products can be categorised as energy or protein supplements. Table 2.4 classifies supplements to balance cow diets that may be low in dietary energy or protein.

Products such as citrus pulp may contain a large amount of water. Calculations regarding energy and protein to determine how much should be fed are based on the dry matter content of the ingredients.

Storage

Good conditions for feed storage are important to maintain feed quality, minimise wastage, and reduce the risk of feed spoilage and toxicoses.

Important considerations for storing feed include:

- the characteristics of the feed—particularly moisture content
- accessibility of the location under different weather conditions
- risks associated with poor storage conditions, for example the build-up of mycotoxins in mouldy feed

Table 2.6. Classification of supplements and basal forages according to their energy and protein contents.

Energy/protein classification	Poor energy (<8 MJ/kg DM of ME)	Moderate energy (8–10 MJ/kg DM of ME)	Good energy (>10 MJ/kg DM of ME)
Poor protein (<10% CP)	Corn stover	Rice bran (poor) Most native grasses Sweet corn cobs	Molasses Maize silage Citrus pulp
Moderate protein (10–16% CP)	-	Well managed grasses Soybean Immature grasses	Maize grain Sorghum grain Rice bran (good) Wheat pollard
Good protein (>16% CP)	Urea	Legume hays	Whole cottonseed Brewers grain Soybean curd Soybean meal Cottonseed meal

- wastage
- turnover

Dry commodities need to be kept dry. Wet commodities should be held in a concrete silo, and the volume of feed ordered must be matched to the amount required so that the feed remains fresh. Wastage is generally highest when the feed is stored on soil, which may also contaminate the feed with stones and dirt. Flies can be a problem with wet protein sources and wind loss with dry dusty ingredients.

Feed wastage

Feed may be wasted through physical loss of dry matter or by spoilage of feed quality. Physical loss occurs if the feed is trampled by cows; spoilage with reduced energy and protein value occurs with contamination by moulds or fungal toxins, moisture damage or leaching. The most common example is mould on spoiled silage.

Feed losses occur during delivery and storage, when diets are mixed, and especially when the diet is fed out to cows.

Wastage can be less than 5% with good feeding systems but as high as 30% when fed on bare ground.

These cows will waste less than 5% of their feed.

Feed digestion and utilisation

Feed eaten by cows is initially digested in the rumen by the mix of microbes present, and these rumen microbial flora must be kept healthy for the health and productivity of the cow. Good-quality forage provides the foundation of the ration; concentrates and by-products are added to provide additional energy and protein.

Cows may trample and waste about 30% percent of hay fed in the field.

Digestion is facilitated by continuous regurgitation (rumination) of plant fibre (cud) and chewing to reduce particle size. Chewing promotes the production of saliva, which contains high levels of buffering salts and so helps to maintain a stable pH of the rumen fluid. The rumen microbes break down plant cell contents and cell walls, including fibres, for their own multiplication. They use the plant protein and derive energy from sugars and starchs; in the process, they generate volatile fatty acids (VFAs) that are absorbed through the rumen wall to provide the major source of energy for the cow. The main VFAs are acetic acid (acetate), propionic acid (propionate) and butyric acid (butyrate).

The microbes are continually washed out of the rumen and are in turn digested further down the digestive system. This microbial protein is an important source of energy and protein for the cow.

The type and number of microbes present in the rumen depends on the type and quality of feed in the ration. The microbes that breakdown fibre prefer a pH range of 6.2–6.8 whereas the microbes that breakdown starch prefer a pH range of 5.2–6.0. Under normal conditions, the pH is maintained at 5.5–6.5 by the buffering action of the saliva.

Achieving optimal rumen function involves promoting maximum microbial growth, survival and activity with a rumen pH of 5.8–6.4.

Factors that affect rumination are:

- order in which the ration is fed
- particle size of the ration
- number of times the ration is fed per day
- type of ration fed.

The stability of rumen pH is normally maintained by the inflow of saliva, the rapid absorption of VFAs from the rumen and the predominance of acetic acid within the rumen.

Order in which the ration is fed

There are numerous approaches to feeding cows. In 'component feeding', ingredients are fed separately; this gives variable intakes of different components and results in an unbalanced diet. The greatest risk associated with component feeding occurs when concentrates are fed before the forages as this leads to rapid fermentation in the rumen and disruption of the normal rumen flora.

Forages should always be fed before concentrates, or the ingredients mixed together as a 'Total Mixed Ration' (TMR), to promote consumption of a balanced ration.

Particle size of ration

All forage pieces must be longer than 11mm but with only 10% of the ration being longer than 40mm. This will stimulate bolus formulation, increase chewing and saliva production and hence increased buffering. The overall affect is to improve the rumination process.

If the forage is cut too short, rumination and saliva production will be reduced, with the increased risk of the cow developing ruminal acidosis. If the particle size is too long, digestion will slowed, reducing feed intake and limiting the availability of nutrients for milk production.

Number of times the ration is fed per day

Feeding a cow more than once per day stimulates continuous saliva production and buffering, which helps maintain a stable rumen pH. Cows are also stimulated to eat by the presentation of fresh feed.

Type of ration fed

A ration high in roughage is associated with a rumen pH of 6.5 whereas a ration high in concentrate is associated with a rumen pH of 5.5. Prolonged acidic conditions within the rumen increase the risk of damage to the rumen papillae and their capability to absorb nutrients.

Nutritional requirements

The nutritional requirements of the cow change with growth, pregnancy and lactation. Most health-related problems and deaths in mature dairy cows occur within 60 days of calving. Correct management of the 'transition period', which covers the month before and the month after calving, is particularly important. Good reproductive management with accurate pregnancy determination establishes when the cow is due to calve and that the correct rations are fed to the right cow at the right time.

The daily maintenance feed intake of a non-pregnant mature cow is about 1.2% of her body weight per day—a 600kg cow needs to eat about 7.2kg of good-quality dry matter per day. The amount of dry matter fed to heavily pregnant non-lactating cows should be around 2% of bodyweight or 12kg DM to meet the needs of the developing foetus. The cow's appetite will decline during the last 3–4 weeks of pregnancy, particularly during the last week of gestation when dry matter intake may be reduced by 50%.

Thus appetite is decreasing while the nutrient requirements of the developing calf and the cow are increasing.

Three common nutritional problems that occur around the time of calving are:

- negative energy balance (ketosis and fatty liver)
- hypocalcaemia
- ruminal acidosis

Negative Energy Balance – The first aim of the transition ration is to minimise the energy deficit experienced by the cow in the face of a declining appetite by adding concentrates to her ration during the last 3–4 weeks of pregnancy.

Cows that experience excessive negative energy balance are more likely to retain their placenta, develop metritis, and displace their stomach. These cows also take longer to get pregnant increasing the risk of culling due to conception failure.

Hypocalcaemia – High-producing older cows are prone to experiencing a rapid decline in blood calcium around the time of calving. This reflects the large amount of calcium that is incorporated into the milk produced by the cow. The second objective of the transition ration is to minimise the decline in blood calcium around the time of calving to prevent cows from going down with milk fever (weakness caused by low blood calcium).

Cows with milk fever need immediate injection with calcium boro-gluconate.

Older cows are more likely to have problems with milk fever than heifers. Cows that succumb to milk fever are more likely to have calving difficulty, retain their placenta, and have problems with mastitis than cows that do not. Less than 2% of cows should experience problems with milk fever.

A high incidence of milk fever indicates a nutritional management problem.

Strategies to prevent milk fever include:

- ensuring that there is adequate magnesium in the ration by including 50 grams of magnesium oxide per head per day in the feed during the last 3–4 weeks of gestation.
- keeping the fat content of the diet below 4% during the last 3–4 weeks as excess fat binds to magnesium preventing its absorption in the rumen.
- feeding a diet low in calcium, typically by feeding higher levels of cereal hays such as oaten or wheaten hay that are low in calcium. However, it is often difficult to find feedstuffs that are low in calcium but provide enough energy and protein to overcome the negative energy balance.
- feeding a diet that contains low levels of potassium and higher concentrations of chloride and sulphur by feeding forages that are low in potassium and adding salts such as calcium chloride or ammonium sulphate to the feed. As the salts are not very palatable, it is important to monitor how much the cows are eating to avoid inducing negative energy balance. Commercial salt preparations such as Biochlor (Arm and Hammer Animal Nutrition) are reported to be more palatable.

Ruminal acidosis – Lactation dramatically increases the feed requirements of high-producing dairy cows. An extra 5kg of high-quality dry matter should be added to the maintenance ration per 10 litres of milk produced; high-producing cows can consume 4% of their body weight in dry matter per day at peak lactation when fed highly digestible feed. Abrupt increases in the energy content of the ration causes excessive fermentation (ruminal acidosis) and disruption of the microbes in the rumen. Gradual increases in the energy content of the ration before calving promote gradual adjustments in the microbes in the rumen allowing the cow to safely eat the higher energy lactating-cow ration.

Feeding the milking cow

Milk production is driven by dry matter intake, which is influenced by the **quality or digestibility** of the feed fed. Poor-quality feed takes longer to digest and therefore limits the amount of feed a cow can eat each day and the amount of nutrients available to produce milk. When the nutrient output in milk exceeds the amount of nutrients ingested during early lactation, cows lose weight. Excessive loss of weight or 'Body Condition' during early lactation is associated with reduced milk production and an increased risk of disease.

Milk fat and milk protein

Rations high in starch or non-fibre carbohydrate are fermented to propionic acid and have the greatest influence on milk protein.

Rations high in fibre are fermented to acetic acid and have the greatest influence on milk fat.

At least 60% of the ration should be forage as lower levels will reduce milk fat and increase the risk of ruminal acidosis. The quality of the forage determines the intake and digestibility of a ration.

Milk protein is dependent on the total intake of digestible energy. A cow eating large amounts of high-quality feed will produce milk with a high milk protein (>3.3), whereas a cow consuming small amounts of low-quality feed will produce milk with a very low milk protein (<2.9).

The ratio of milk protein to milk fat indicates the energy and fibre balance in the ration. A milk protein to fat ratio of 0.81–0.85 indicates that the cow is well fed and the ration is balanced. A ratio of less than 0.75 indicates insufficient energy; a ration above 1.00 suggests insufficient fibre in the ration.

Manipulating nutrition to improve milk production

The major influences on milk production from the herd are nutrition, cow comfort and the demographics of the milking herd, which is determined by the reproductive management of the cows. Dairy herds respond to nutrition when the cows are not stressed by poor comfort and the herd is not 'stale' with a high proportion of cows in late lactation.

Cow soon to calve. Note constant access to fresh water and feed and quiet low-traffic area to avoid disturbing the herd when she goes into labour.

Feeding the non-lactating or 'dry' cow

Milk production over the cow's lifetime is increased when she is not milked for 50–60 days between lactations. Stopping milking is referred to as 'drying off' and the non-lactating period as the 'dry' period. Ideally, cows should be dried off in the body condition in which they should calve; this is a body condition score of 3.25 on a scale of 1 to 5 (where 1 is very skinny and 5 very fat). Dry cows should be heavily pregnant and should not lose weight during the dry period.

The amount of dry matter fed to heavily pregnant non-lactating cows should be around 2% of bodyweight, or 12kg of good-quality dry matter for a 600kg cow.

The loss of appetite around calving has to be minimised. As after she has calved, the cow will be fed a high-energy ration, she should be fed increasing amounts of energy from 4 weeks before calving to allow the rumen to adjust to the new diet.

Useful resources

- Nutrition resources on the Dairy Australia website. http://www.dairyaustralia.com.au/ Specific resources include Grains2milk, Feeding systems, Home grown feeds, bought in feeds and nutrition management.
- Dairy Co's Farm Info Center contains information on a diversity of topics including nutrition. http://www.dairyco.org.uk/about-us/what-is-dairyco.aspx
- The University of Pennsylvania Cooperative Extension site describes the equipment required for and the process of making hay. http://bedford.extension.psu.edu/agriculture/BeginFarmer/HayMakingEquipment.htm
- The infovets website on how to condition score dairy cattle. http://www.infovets.com/healthycowinfo/A084.htm
- The Nutrient Requirements of Dairy Cattle (Seventh Edition 2001) outlines the nutritional requirements of all classes of dairy stock and the nutrient values of common feedstuffs. It can be previewed at the National Academies of Press website. http://www.nap.edu/openbook.php?isbn=030906997.

3 Feeding management

Key points

- Good-quality feed and water should always be available.
- Sufficient feed bunk and water trough space will minimise competition at the feed bunk.
- Milking cows need a lot of drinking water— as much as 150–200 litres per day for high-producing cows during the hot season.
- Most forages will support only 6–8kg of milk/cow/day, and must be supplemented with high-energy concentrates.
- As a general guideline, feed 1kg concentrate for every 2kg of milk produced above that supplied from forages.
- Better decisions can be made if the feeding value of the forages and concentrates, and their costs are known.
- Diets should be balanced for energy, protein, fibre and certain minerals for optimum cow performance and to prevent any metabolic problems.
- A well-balanced ration will give production only if enough is fed.
- Simple observations of the cattle can identify problems with feeding management.
- Maximise feed intakes around calving and in early lactation by providing enough high-quality feed.
- Avoid sudden changes in diet when cows calve and join the milking herd.
- Do not overcrowd cows before and after calving.
- Manage first-lactation cows as a separate group to reduce bullying by older cows.
- Cows are social animals, and frequent changes in cow grouping can be disruptive; for example, introduce cattle onto the pre-calving ration once a week rather than daily.

Feeding high-production cows

Water

Lactating dairy cows need 60–70 litres (L) of water each day for maintenance, plus an extra 4–5L for each litre of milk produced. Water intake is influenced by the size of the cow, dry matter intake, ambient temperature and humidity, and milk production. During hot weather, high-producing cows may drink up to 200 litres of water per day.

As cows drink 50–60% of their daily water intake immediately after milking, the water trough must provide 75cm of linear trough space per cow for at least half of the cows in the milking parlour when exiting the parlour.

When cows are housed, there should be a minimum of two water sources per group in the areas where the cows are housed and they should never have to walk more than 20 metres to get a drink of water. Water sources should be close to feed bunks.

Clean water is especially important.

> *'If you would not be prepared to drink water like that in the trough, it is not clean enough for the cows'.*

Filling capacity of water troughs

Cows should never have to wait for a slow-filling trough. Water pipes should be 75mm in diameter with sufficient pressure to provide 20L per cow per hour to cope with peak demand. Shallow troughs (15–30cm depth) are better than deep troughs as the more rapid turnover of water avoids stagnation; they are also easier to clean.

Feed intake and milk production are depressed when access to water is restricted.

Forages and supplements

Milking cows should be fed at least 30–40kg of fresh good-quality forage daily (equivalent to 6–8kg of dry matter) to provide enough fibre for optimal rumen function. For optimum rumen function and hence milk production, the non-fibre carbohydrate (NFC) proportion of the diet should be 35–40% of dry matter. Milk fat will be reduced if NFC is above 40%, and NFC must be balanced with degradable protein so that degradable protein is 35% of NFC.

Effective fibre in a diet will be helped if all forage is more than 11mm long but with only 10% greater than 40mm long. The ratio of forage NDF to rumen-degradable starch should be higher than 1.1:1 to support the provision of effective fibre.

As a general guide, 1kg of concentrate should be fed above that supplied from forages for every 2kg of milk produced. This is a safety measure when the nutritive value of the feeds, particularly the forages, is not known.

In any dairy system, the principles for feeding milking cows should be:

- Feed sufficient quality forages first
- then supplement with concentrates
- concentrates should be formulated to overcoming specific nutrient deficiencies to achieve target milk yields.

Cows in a free-stall barn that includes lockups to facilitate reproductive management. Note the area where shy cows can access feed without putting their head in the lockups. Performance is ultimately dictated by the ration consumed, which is influenced by the way the feed is delivered.

Milk production is highly responsive to nutrient intake with the cow's milk yield today being directly affected by their feeding management yesterday. No other type of livestock provides such a rapid feedback to herd management.

Once farmers set their target milk yields, they can monitor their success or failure in achieving these by gradually changing one of the feeds in the cows' ration.

Intake

Cows require enough feed to satisfy their nutritional requirements, and a well-balanced ration will provide beneficial results only when intake is not limiting. High-producing cows are normally fed 5% more than they are expected to eat each day to avoid them running out of feed and limiting production. Feed that has not been eaten at the end of the day is collected and fed to young stock.

Feed intake is influenced by the composition of the ration, the amount of feed offered, the number of times the cows are fed per day, water availability, and accessibility of the feed. Feed bunk access is important for cows to maximise their dry matter intake. Milking cows should have at least 65cm of feed bunk space per cow.

Cows respond strongly to the delivery of fresh feed; delivering fresh feed after milking keeps the cows standing and allows the teat sphincter to close before the cow lies down. The teat sphincter should close within 30 minutes. Pushing up feed keeps it in front of cows, but has little effect on stimulating feeding activity.

Mature forages such as rice straw are digested slowly, reduce total intake and provide insufficient nutrients for good milk production.

A milking cows needs to eat this amount of forage each day.

More frequent feed delivery results in greater access to the feed bunk and less feed sorting by the cows.

Dairy cows maintain a social structure that may impact on the amount of feed consumed by each cow. If feed bunk space is limited, the more dominant cows will prevent those less dominant from eating as much as they should.

Indicators of nutritional problems

Diets should be properly balanced for energy, protein, fibre and certain minerals for optimum cow performance.

Important simple indicators of unbalanced diets include:

- *Lack of rumination.* If fewer than 50% of the milking herd are ruminating—chewing their cud—while relaxing, there may not be enough fibre in the diet. This may be confirmed by examining the cows' manure and looking for changes in milk composition.
- *Loose manure.* Very loose and watery dung may indicate a lack of fibre in the diet. Bubbles in the manure indicates acidosis from a relative excess of starch to fibre.
- *Many lame cows.* Ruminal acidosis is a common cause of lameness in housed dairy cattle, but there could be other causes.
- *Milk components.* Milk analysis provides useful information about the diet.
  - Milk fat. Milk fat test tends to drop when the herd is placed on a low fibre diet (such as a diet high in cereal grain).
  - Milk protein**.** Low milk protein or solids-not-fat (SNF) content is common in early lactation because the cow's energy needs are greater than their intakes causing them to lose body condition. Shortages of energy reduce protein use by the rumen microbes. Generally providing extra energy in the diet will lift protein or SNF test.
- *High incidence of disease* in the herd. This is most commonly observed around the time of calving and during the first 60 days of lactation.
  - Down cows at calving (>2%).
  - Retained foetal membranes following calving (>8%).
  - Displaced stomachs (>3%)
  - Uterine infections

A high incidence of health problems during early lactation leads to poor milk production and poor reproductive efficiency.

The risk of a cow developing a uterine infection following calving is increased by depressed feed intake before calving. For every

Cows that develop milk fever at calving are three times more likely to retain their placenta and so more likely to develop a uterine infection.

10 minutes less feeding time each day before calving, the risk of cows developing a uterine infection almost doubles; for every kilogram dry matter less feed a cow eats each day, the risk of uterine infection increases threefold.

Conception rates are compromised in cows that develop a uterine infection.

Trouble-shooting feeding problems

Many simple observations can identify problems with feeding management. These include:

- Manure consistency, colour and content. The manure should have moist but thick consistency. Dry manure suggests insufficient water and/or carbohydrate in the diet. Loose manure that contains bubbles indicates ruminal acidosis, and reflects incomplete digestion of feed in the rumen with further fermentation of nutrients in the lower bowel.
- Comparing the composition of the feed fed with the feed remaining at the end of the day. If forage fibre length is long, cows may sort through the feed and consume the concentrates but not the fibre. This 'sorting' can lead to subclinical acidosis despite an apparently balanced ration. The ration that dictates performance is that which is actually eaten by the cows. Chop the hay to shorter lengths.
- Individual cows may 'sort' feed differently. Dominant cows that eat more concentrate may develop acidosis; timid cows that are left with the less digestible portion of the ration eat more fibre and produce less milk. Variable manure consistency is often observed in group housing facilities.
- Rumination; ideally half the herd should be ruminating when resting. If the percentage is low and there are other indicators of ruminal acidosis (loose manure, lameness, low milk fat percentage) there is probably not enough effective fibre in the ration. This could result from inadequate fibre, chopping the forage too finely or excessive fat in the diet, or from cows 'sorting' and failing to eat the fibre.
- Physical appearance and smell of forages. Moist feedstuffs are prone to spoilage by the growth of moulds. Some moulds produce toxins.
- Physical appearance and smell of concentrates. Mould can also be a problem in moist concentrate feeds such as corn gluten.
- Sudden changes in milk yield. Rapid changes in milk yield most likely reflect adverse environmental conditions such

Manure consistency reflects feeding management. Normal consistency (left) indicates good feeding, whereas loose manure (right) is associated with excess starch or insufficient fibre.

as heat stress or changes in nutrition. Attention to detail and consistency in ration preparation and delivery are important. Cows are creatures of habit and do best when a consistent routine is maintained.

- Sudden changes in milk composition, namely fat and protein (or SNF) contents
- Disease incidence, as discussed above
- Body condition at different stages of lactation. Cows should calve in a body condition score of around 3.25 on a scale of 1–5 (BCS1 is very skinny and BCS5 is fat). Cows should not lose more than 0.5 of condition score during the first month of lactation.

Cows calving in poor body condition or fed insufficient nutrients in early lactation lose body condition, reduce milk production and often fail to cycle.

A sudden change in one of these quick checks may be due just to a temporary change in environmental conditions. If the check quickly returns to normal, cow performance may not be adversely affected. But it is important to take action when a quick check remains abnormal for several consecutive days and/or several quick checks become abnormal at the same time.

Good nutritional management during the dry period and early lactation is the key to preventing or minimising metabolic disorders.

The aim is to:

- maximise feed intakes around calving and in early lactation by providing enough high-quality feed
- avoid decreases in intake and disruption of rumen function caused by sudden changes in diet when cows calve and join the milking herd
- avoid overcrowding cows prior to and following calving
- always provide good-quality feed and water
- provide sufficient feed bunk space to minimise competition at the feed bunk
- manage first-lactation cows as a separate group to reduce bullying by older cows
- minimise changes in cow grouping as cows are social animals; for example, introduce cattle onto the pre-calving ration once a week rather than daily.

Useful resources

- The nutrition management section of the Grains 2 Milk Dairy Australia program contains a number of resources regarding the formulation of diets for dairy cattle, transition cow nutrition, monitoring and preventing acidosis and numerous other tools. These can be found at http://www.dairyaustralia.com.au/Farm/Feeding-cows/Nutrition-management.aspx.
- A good review of transition cow monitoring is published in the Ireland Veterinary Journal and can be viewed online. Note that the body condition score at calving recommended in this article is 3.0 rather than 3.25. The North American literature tends to recommend cows calve in slightly higher body condition than the Irish. http://www.veterinaryirelandjournal.com/Links/PDFs/CE-Large/CELA_September_06.pdf

4 Managing young stock

Key points

- Good management starts at birth when calves are born in a clean area.
- About 5% of calves die at, or shortly after, birth. Mortality is higher for calves born to heifers than for those born to cows.
- Calves should be removed from the cow at birth and placed in a clean dry area.
- Calves should be given at least four litres of good-quality colostrum during their first twelve hours of life. This can be given through a bottle or through a stomach tube if the calf will not suckle.
- Calves should be fed 15% of their body weight in milk each day, with the volume adjusted as the calf grows.
- Feed calves milk twice a day for the first four weeks of life, then once a day.
- Bacteria numbers in warm colostrum and milk double every 30 minutes—poor storage will lead to more sick and dying calves.
- Rumen development in calves is promoted by feeding some high-quality forage with high-quality concentrates.
- Calves can be weaned once they are eating 900 grams of concentrates per day.
- Scours is the most common disease problem in calves under five weeks old. Calves can become infected when fed contaminated milk or colostrum or when placed in a dirty environment.
- Scouring calves should be immediately rehydrated with oral electrolyte solutions to keep them on their feet, and may be given antibiotics depending on veterinary advice.
- Aim for less than 3% pre-weaning calf mortality. A high proportion of sick calves indicates high pathogen exposure; high mortality in affected calves indicates inappropriate therapy.
- Heifers must be grown well for future fertility and milk production and to minimise calving difficulties.
- Calves should gain 600 grams per day before weaning and 800 grams per day after weaning.

Maternity management

The risk of difficult calving and calves dying at or shortly after birth may be influenced by environmental conditions, nutrition, technical expertise, age of the cow and sire selection.

Calving environment

Scours is a common disease problem, and the young calf may be infected by the cow and the environment into which it is born. As the cow's immunity is depressed around the time of calving, they are more likely to shed pathogens in their manure. Some of the pathogens may also proliferate in a moist environment.

Cows should calve in a clean environment with calves removed at birth and placed in a clean dry pen.

This calf will be exposed at birth to salmonella in the bedding of packed manure. This dairy experienced a calf mortality of 60% over a six-week period due to salmonellosis.

Nutrition

Cows that are too fat or too thin at calving are more likely to experience calving difficulty than appropriately conditioned cows. Fat cows experience difficulty because fat deposited in the pelvis reduces the diameter of the birth canal; thin cows may simply be too weak to deliver the calf normally.

Age

Heifers often have difficulty delivering their first calf. This is largely influenced by their growth, nutrition during the last trimester, and by the sire they conceived to. The most common cause is a failure of the calf to fit through the birth canal especially in poorly-grown heifers. Calving difficulty in older cows is more often associated with metabolic disease such as milk fever or negative energy balance.

Technical expertise. Some heifers and cows will experience calving difficulty associated with their prior nutrition and management. The outcome for the calf and the dam is influenced by the technical skill of the staff that assists with the delivery.

Key points regarding calving assistance include:

1. *Timing of intervention.* The cervix must be dilated before attempts are made to deliver the calf. Most mature cows will either have delivered the calf or be making good progress in delivering it within 30 minutes of starting vigorous pushing. If after 30 minutes of pushing the cow shows no signs of progress, she should be checked for complications. As heifers tend to take longer, wait for 60 minutes.
2. *Sanitation.* Washing and cleanliness are important when calving is assisted to prevent dirt and manure being introduced into the uterus. The handler should be as clean as possible and wash hands and arms using a couple of buckets of warm soapy water. They should clean the vulva before introducing their hand to check the position of the calf.
3. *Lubrication and patience.* The skill of a calving assistant is not measured by the speed of the delivery but rather by the health status of the cow and calf following the delivery. Lubrication and dilation help to avoid tearing of the cow's reproductive tract. A cycle of lubrication, traction and relaxation is recommended.

When a cow is standing, the calf should be pulled in a downward direction

4. *Positioning and angles.* When a cow is standing, the calf should be pulled in a downward direction. If a cow lies down on her side during the delivery, the sides of the crush or race should be able to be opened so that the calf can be pulled in the same direction.

Sire selection

In many countries, semen can be ordered from bulls that are known to produce smaller calves at birth. This can help reduce the risk of calving difficulty in heifers delivering their first calf.

Calf management

Calf environment

After birth, calves should be removed from the cow and placed in a clean dry environment. Newborn calves should not be mixed with older calves as this could expose them to pathogens that cause diarrhoea.

There are many systems of calf rearing ranging from individual calf hutches through to group rearing systems. Where calves are raised in groups, it is best to keep them in batches of similar age and size, and to clean the facility thoroughly between batches.

Place calves in a clean dry environment after birth. Feed 4 litres of colostrum during the first 12 hours of life to boost their immunity.

Calf-raising facility using individual calf hutches.

There are numerous different systems for raising calves. In year-round calving herds, it is best to raise milk-fed calves in individual pens as pathogen loads build up over time in group housing systems. If individual housing is not possible, calves can be raised in batches with facilities cleaned between batches.

Calves raised in elevated pens. Ideally calves should not be able to touch each other or contact manure from other calves.

Keep calves reared in batches grouped by age and size.

Colostrum quality

The quality of colostrum may be measured by the amount of immunoglobulin antibody it contains and by the amount of bacterial contamination. Immunoglobulins enhance the calf's immune function. The immunoglobulin content of colostrum is influenced by the timing of harvest relative to when the cow calves with the best quality colostrum harvested directly after calving. The immunoglobulin content of colostrum declines after calving whether the cow is milked or not. Colostrum from cows tends to have higher levels of immunoglobulins than colostrum from heifers, but all colostrum is valuable. If there is excess colostrum it may be used to supplement the milk fed to young calves.

The capacity of calves to absorb the protective antibodies in colostrum diminishes rapidly after birth and is lost by 24 hours of age.

Colostrum is often contaminated by bacteria in containers that have not been properly cleaned. Storage at room temperature is associated with bacterial proliferation as the number of bacteria may double every 30 minutes. The risk associated with bacterial contamination can be minimised by feeding colostrum immediately after harvest from the cow. A high bacteria count in colostrum interferes with absorption of immunoglobulin by the calf.

Colostrum feeding

Calves should consume four litres of colostrum within the first 12 hours of life given as two feeds. Calves that will not suckle colostrum from a bottle can be tube-fed. Holstein cows have been selected for their capacity to produce milk and not for their capacity to raise calves. As over 60% of calves left with their mothers for the first 24 hours of life fail to consume enough colostrum, the manager has to ensure that they do consume enough.

When colostrum is given through a stomach tube, it must not be allowed to flow when the tube is inserted or removed. It is generally easier to pass the tube with the calf standing with its tail in a corner and using minimal restraint. Rough handling tends to cause calves to fight and makes the procedure traumatic.

Calf nutrition

Calf nutrition and calf health are closely linked, with well-fed calves generally more robust and less likely to succumb to disease. Calf nutrition includes colostrum, milk, water, concentrates, and high-quality forage. Calves grow well when fed plenty of milk but are often weaned early because the milk is so valuable for sale. Early weaning requires good nutritional management to encourage early rumen development.

Milk feeding

Newborn calves have a small non-functional rumen. Milk flows from the oesophagus through an oesophageal groove directly to the true stomach for efficient digestion. This groove is formed when the calf suckles but is less efficient if it drinks from a bucket. Milk that stays in the rumen may cause scours. The calf cannot digest sufficient solid feed to survive and grow until the rumen develops. Calves should be fed milk at about 15% of their body weight per day, with milk fed twice a day until four weeks of age and then only once a day. The volume of milk fed is increased as the calf gains weight.

Bacterial contamination of milk, and subsequent disease in the calf, is reduced by harvesting into clean containers and feeding to the calf soon after milking.

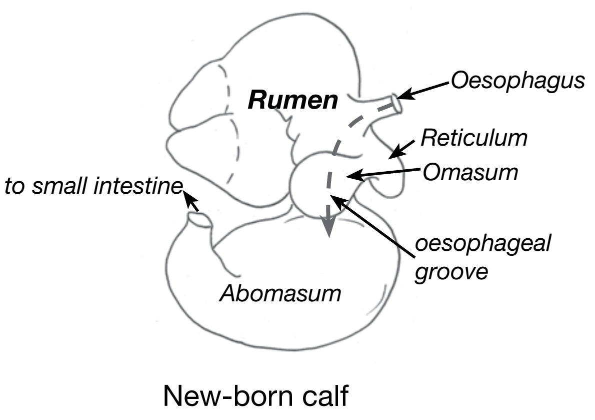
Hygiene

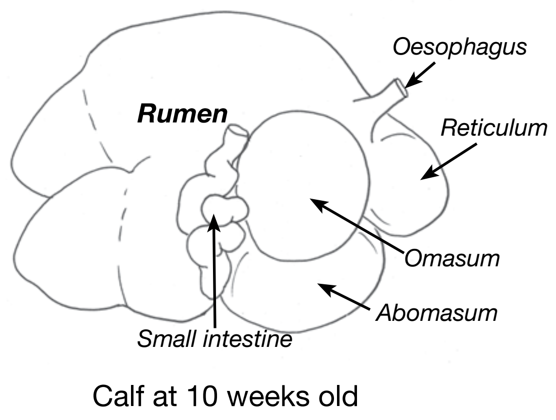
Calves may become infected with diarrhoea pathogens by contact with other infected animals, through contaminated milk or colostrum, from a contaminated environment or by contaminated equipment or people.

Important principles with calf rearing include:

- Always work from youngest to oldest

Figure 4.1. The rumen of the young calf develops as it begins to eat fibrous feed





- Never work with sick calves and then give colostrum to newborn calves. Handler's hands and clothes become contaminated and can transmit infections between calves.
- Pathogens that cause disease in calves can survive and multiply in milk and dirty equipment. After every feeding, clean the equipment with warm soapy water to remove any fat residue.
- Equipment used to give colostrum to newborn calves should not be used to feed or treat sick calves. It is best to have equipment dedicated to handling colostrum to avoid the risk of contamination and infection of newborn calves.
- Ninety nine percent of cleaning is achieved by the physical removal of organic debris. Disinfectants do not work properly in the presence of dirt, milk residue, and manure.

The cleanliness of equipment for calf milk and colostrum handling is important for reducing the risk of disease. Check its design and wear as worn rubber and old galvanised buckets contain cracks and crevices that make effective cleaning impossible.

Calf-feeding equipment must be kept immaculately clean.

Concentrate feeding

Rumen development is stimulated by the physical scratching of roughage and the products of rumen fermentation. Calves should be encouraged to eat solid feed at an early age by offering high-quality concentrates (grain and or calf pellets) and good-quality hay during the first week of life.

The calf ration should be specially formulated with protein levels of 20–22%; milking cow concentrate formulations contain only 16%. Initially calves should be fed only a couple of handfuls a day to keep it fresh, encourage consumption and avoid wastage; dusty feed is less palatable. Calves prefer to eat out of shallow bowls. The amount of concentrate fed is increased as they eat more; feeding milk once a day when the calf is over four weeks of age helps them to develop an appetite for the concentrates.

It is easy to monitor consumption when calves are raised in individual pens, but more difficult in group facilities. Calves should be grouped on size and age to avoid bullying and uneven consumption.

Forage feeding

The rumen must be functioning to efficiently digest forages. Young calves cannot extract sufficient nutrients from hay and straw alone to grow well. Calves fed very poor quality forages and insufficient concentrate are thin yet have large abdomens reflecting accumulation of poorly digestible feed. It is not essential to feed forages before weaning; when good-quality forage is fed it should be limited to 100–200g/calf/day.

Calf eating poor-quality hay—notice the rough coat and thin condition despite a full rumen. Calves fed poor quality forages become weak and more susceptible to infectious diseases and parasites.

Water

Calves should have access to fresh water at all times. Limiting access to water will reduce consumption of dry feed and so will delay weaning.

Calf diseases

Scours

Scours (diarrhoea) is the most common health disorder and cause of mortality during the first four weeks of life. Pathogens commonly implicated in calf scours include rotavirus, coronavirus, *Cryptosporidia*, *Salmonella* and enterotoxigenic *E. coli*. Sources of infection have been discussed under the headings of calving management, colostrum, milk and feeding management.

Calves often become infected shortly after birth, with the disease manifesting at four to seven days of age. During outbreaks of disease, nearly all calves may develop diarrhoea, and up to 80% may die. A high proportion of calves with scours indicates a breakdown in biosecurity procedures and the need to review management procedures for the calving area, calf housing, colostrum and milk management. High mortality indicates treatment failure.

Calves with scours experience a number of medical problems that may contribute to death; these include dehydration, acidosis, bacterial infection, low blood glucose and hypothermia. Fluid therapy is the cornerstone of treating calf scours. Calves infected with bacterial pathogens and calves that are severely debilitated also benefit from antimicrobial therapy. Affected calves need a clean, dry, warm environment and nutritional support.

Fluid therapy – Young calves with diarrhoea rapidly become dehydrated and collapse. As it is difficult to manage collapsed calves on the farm, sick calves should be identified and treated early while they still have a suck reflex. Oral electrolyte solutions are effective at rehydrating calves. Oral electrolyte solutions should contain: sodium; agents to facilitate absorption of water and sodium from the intestine (glucose, citrate, acetate, proprionate, or glycerine); an alkalinising agent (acetate, proprionate, or bicarbonate to correct acidosis; and a source of energy such as glucose.

During a disease outbreak, it is usually possible to identify the age of onset of diarrhoea. Oral electrolytes should be offered to calves slightly younger than the observed age of onset as an additional feed spaced evenly between their normal feedings. It is generally easier to keep calves hydrated and standing than it is to resuscitate recumbent calves that do not want to suckle. The interval between milk and electrolyte feedings is important. When calves are sick, appetite is depressed; they will consume more fluid when the feedings are spaced as widely as possible. Sick calves may refuse to drink milk yet consume electrolyte solutions. Electrolytes can be administered with an oesophageal feeder or stomach tube if calves refuse to suckle. Calves with severe diarrhoea may need to be treated with oral electrolytes several times a day to remain hydrated. Electrolyte feedings are usually limited to two litres at each feeding with the number of feedings tailored to the needs of the calf. Most calves will get by with two to three feedings per day but those severely affected may require more.

Antibiotic therapy – Pathogens such as rotavirus, coronavirus, and cryptosporidia are not susceptible to antimicrobial therapy. However, antibiotics are useful for the treatment of scours caused by enterotoxigenic *E. coli* and *Salmonella* spp. and for treating secondary bacterial infections in severely debilitated calves. As different antibiotics target different bacteria it is best to seek veterinary assistance.

Dehydrated calves must be given electrolytes immediately.

Nutritional support – Calves with diarrhoea have depressed appetites, compromised intestinal function, and often lose nutrients from the damaged gastro-intestinal tract. Young calves also have limited fat reserves to maintain bodily functions when they are sick. The inclusion of glucose in calf oral electrolytes facilitates sodium absorption and provides calves with a source of energy. The amount of energy that can be provided to calves in the form of glucose each day is limited so it is desirable to get calves back onto milk as soon as possible. As the damaged intestine may not be able to digest and absorb the volume of nutrients fed, diarrhoea may be exacerbated when calves are re-introduced onto milk unless smaller volumes of milk are fed more frequently.

Environmental support – Sick calves lose body condition and are vulnerable to cold and heat stress. In cold climates, calves need to be provided with a warm dry environment; in hot climates, they need shade and ventilation.

Umbilical infections and swollen joints

Good colostrum management helps to protect calves from bacterial pathogens, but poor colostrum management can be manifested by an increased incidence of umbilical or joint infections.

Cows should calve in a clean environment and the calves should be fed four litres of high-quality (clean) colostrum during the first 12 hours of life. Dipping the umbilicus with 2% chlorhexidine at birth may also reduce the risk of infection, while dipping in an iodine solution will reduce the risk of screw worm infection in many tropical regions.

Damage from an umbilical infection when calf.

Umbilical infections can be treated with anti-microbial therapy and may require surgery to drain and resect the infected umbilical structures.

Pneumonia

Pneumonia refers to disease of the lungs and is most common in calves around the time of weaning. Poor colostrum management, overcrowding, poor ventilation (especially in indoor housing), nutritional stress, concurrent disease, mixing of different age groups and environmental stress can predispose calves to pneumonia.

Several viral pathogens can be transmitted between calves when calves are weaned and placed into groups, and these may compromise respiratory defence mechanisms. Coccidiosis around the time of weaning can make calves more susceptible to respiratory disease. Coccidiostats such as monensin, lasalocid or decoquinate should be included in calf rations to prevent coccidiosis.

Pneumonia is unusual in calves less than four weeks of age unless they are housed in poorly ventilated barns. If calves develop pneumonia during the first two weeks of life, it may be associated with feeding through stomach tubes as poor technique or damaged equipment can lead to calves breathing liquid into their lungs.

Young calves may also develop pneumonia, joint infections, and ear infections if they become infected with mycoplasma—an organism that causes contagious mastitis in cows. Calves become infected when they are fed milk from mastitis-infected cows. Other diseases that may be transmitted through mastitis milk include salmonella, mycobacterium paratuberculosis (Johnes Disease), bovine leukosis and pestivirus.

If a farm experiences problems with pneumonia in calves, it is best to seek veterinary assistance to diagnose the cause of the problem and establish an appropriate treatment and management plan.

Common management procedures

Identification

Calves born alive should be ear-tagged at birth so that their parentage can be traced and to account for any subsequent losses. Ear tagging equipment should be kept clean to avoid infections.

Animal identification and good record keeping will allow tracing of animals and monitoring of disease.

Vaccination

Vaccination is another strategy to promote the immunity of calves. The pregnant cow can be vaccinated during late pregnancy to boost her immunity, which is passed onto the calf through feeding colostrum, or the calf can be vaccinated.

There is a diversity of diseases and vaccines available in different countries. An appropriate vaccination program requires local knowledge of endemic disease and available vaccines. In Australia, cattle are commonly administered vaccines to prevent clostridial diseases and leptospirosis, while other vaccines are available against diseases caused by *Moraxella bovis* (pinkeye), *Salmonella*, enterotoxigenic *E. coli*, pestivirus, *Mannhymia hemolytica*, vibriosis, *Babesia bovis* and bovine ephemeral fever.

Dehorning

The best time to dehorn Holstein calves is between two and three weeks of age as soon as the horn buds can be clearly identified. This early dehorning is less traumatic for the calves and poses less risk of complications. The calf should be well restrained for the safety of the operator and calf.

Cautery with a hot iron is the preferred method. The dehorning iron should be red hot and applied to the horn bud to produce a copper ring around the horn bud.

Cows should be vaccinated for tetanus and calves fed colostrum from vaccinated cows to reduce the risk of tetanus. Equipment used for dehorning needs to be well-maintained, clean and sharp.

Caustic dehorning chemicals should be avoided as they can spread if wet and cause blindness.

Extra teats

Extra teats should be removed at the same time as calves are dehorned. This is best done with the calf lying down so that all of the teats can be seen and the normal teats identified. Extra teats are removed with a pair of scissors with the cut lengthwise with the body. The cut surface should be painted with a topical antiseptic.

Weaning

Solid concentrate feed, rather than milk, should provide the bulk of nutrients for calf growth, and calves can be weaned off milk when they are eating 900 grams of concentrate per day for three consecutive days. This usually occurs by about six to eight weeks of age. Feeding poor quality concentrate or too much milk will reduce concentrate intake and delay weaning.

> Wean on concentrate consumption,
> —not on the age of the calf.

When milk is stopped, the calf should remain in the same location for another week to check concentrate consumption. If the calf is not eating well after weaning it may need to be fed milk again and weaned later.

Weaning to breeding

After weaning, calves are placed in group pens where they interact socially. They tend to do better when they are initially placed in small groups of eight or less of uniform size. With mixed sizes, the larger calves bully small ones and take more than their share of feed. After four weeks in small groups, the groups can be amalgamated to 16 calves and further expanded after another four weeks. Calves that are not doing well can be more easily detected in a small group.

This post-weaning calf facility includes lockups for calves to get the calves familiar with lock-up stations.

Gates can be opened or closed to adjust group size.

A *dry-lot pen for older calves. The size of the lockups is proportional to the size of the calves in the pen.*

Growth

Heifers should enter the milking herd at 85% or greater of the mature cow weight; this requires an average daily gain of approximately 800 grams per day. Dairy heifers need to be well fed between weaning and first calving. If growth rates are not maintained, heifers will not reach their target live weights for mating and first calving. Even if well fed after mating, their ultimate mature size is restricted and any extra weight tends to be fat.

Most growth in skeletal size occurs before, not after, puberty.

> Calves that are poorly managed after weaning are disadvantaged for life.

Under-sized heifers have more calving difficulties, produce less milk and have greater difficulty getting back into calf during their first lactation. When lactating, they compete poorly with older, bigger cows for feed. Because they are still growing, they use feed for growth rather than for producing milk.

Poorly grown heifers do not last long in the milking herd. They are more likely to be culled for poor milk yield or poor fertility during their first lactation.

Targets for replacement heifers

Well-grown Holstein heifers should reach a breeding weight of 350–375kg at 15 months (455 days) of age. Withers height (or height at the shoulder) is a good measure of bone growth and frame size in heifers. Holstein heifers should be 128–130cm at 15 months of age.

Measuring heifer growth (both height and weight) provides an assessment of heifer nutritional management. Heifers should not be allowed to lose weight or to grow slowly for long periods of time. Adequate levels of protein in the heifer diet will achieve appropriate skeletal growth, whereas feeding excess starch results in target daily weight gain but inadequate stature. This results in shorter, heavier heifers that are more prone to calving difficulty.

Getting good quality heifers into the herd in a timely fashion reduces the total number of young stock on feed.

If cattle weighing scales are not available, body weight can be estimated using an inexpensive weight tape to measure girth circumference.

Changing environmental conditions can also result in significant changes in heifer requirements and growth. During cold wet weather, the amount of energy fed may need to be increased; when weather turns milder, the extra energy fed may need to be lowered to avoid over-conditioned heifers.

Breeding to calving

The emphasis of heifer management from breeding to calving is to maintain appropriate growth, determine the time of conception, acclimatise heifers to the milking facility, and manage the last four weeks of gestation to minimise the risk of metabolic disease.

Heifers should enter the milking herd with a weight equal to or greater than 85% of mature body weight. Growth should be relatively consistent. It is risky to under-feed heifers during early gestation and then strive for compensatory growth later as this predisposes to heavy calves and calving difficulties.

Establishing the time of conception is important for determining when to move heifers onto the transition ration four weeks before calving. Reproductive examinations of heifers also identifies freemartins so that they may be culled to avoid the expense of feeding non-productive stock.

The importance of acclimatising heifers to milking facilities is influenced by the temperament of the heifers and their prior human exposure. Intensively-reared heifers tend to be used to people and settle into the milking parlour routine. Heifers that have not been handled much tend to be more nervous and benefit from walking through the milking parlour with the milking cows before calving. Although they are not milked at this time, they get to experience the milking parlour routine. A high incidence of leg injuries in recently calved heifers indicates a need to pay more attention to acclimatising heifers before calving. A high incidence of leg injuries across age groups suggests a general problem with cow handling.

Useful resources

- In Calf - The In Calf web site has been developed by the Australian Dairy Industry to provide information for dairy producers regarding reproductive management of dairy cattle. The site provides useful information about raising replacement heifers ready to enter the milking herd. http://www.incalf.com.au/
- Management of Dairy Heifers
  Produced by the University of Pennsylvania available at: http://www.das.psu.edu/research-extension/dairy/nutrition/pdf/management-of-dairy-heifers.pdf
  Additional information is available from the host site: http://www.das.psu.edu/research-extension/dairy
- The University of Wisconsin presents useful information about calf health and tools for investigating calf health problems http://www.vetmed.wisc.edu/dms/fapm/forms_info.htm
- Meat and Livestock Australia produce a number of useful documents relating to animal husbandry. Written for beef cattle but applicable also to dairy operations. http://www.mla.com.au/Livestock-production/Animal-health-welfare-and-biosecurity/Husbandry

5 Reproduction management

Key points

Key factors that influence reproductive performance include:

- heat detection
- artificial insemination technique or bull management
- nutrition
- environmental conditions
- growth of replacement heifers.

All dairy farms should:

- have a reproduction plan
- a plan for cows that experience problems during the transition period
- have regular routine reproduction examinations to establish which cows:
  - are pregnant
  - can be bred
  - have uterine or ovarian disease.
- keep full and up-to-date records
- reduce the risk of introducing reproductive diseases through strict biosecurity.

Heat detection

A common cause of poor reproductive performance in artificially inseminated herds is poor detection of heat. This can often be addressed by personnel training, scheduling, and record keeping.

The average duration of heat or oestrous activity is about 14 hours in normal weather conditions. As it may be as long as 28 hours or as short as 2 hours, twice daily observations are essential to catch any short heats. Observations in the cool of early morning and evening are more likely to detect heat than those in the middle of the day—particularly during hot weather.

Signs of oestrous that may be observed include:

- cows standing to be mounted
- cows mounting other cows
- increased activity (restlessness)
- reduced feed intake
- clear stringy mucus hanging from the vulva
- swelling and redness of the vulva.

Heat detection must be optimised to limit missed heats. If the cow is not pregnant, oestrous will re-occur 18 to 24 days after the last heat, and this can be predicted with good farm records.

At the same time, feeding management must ensure:

- body condition scores are adequate at calving
- losses in body condition are minimised during early lactation
- target live weights are achieved for growing heifers.

The first step to investigating heat detection efficiency is to determine which cows are eligible to be bred. After calving, cows are not normally bred for 40–60 days—referred to as the voluntary waiting period. Breedings conducted less than 40 days after calving have a lower conception rate.

Routine pregnancy diagnosis is an integral part of good reproductive management.

Cows eligible for heat detection include non-pregnant milking cows that are past the voluntary waiting period and that are not to be culled.

Even if all these eligible cows are watched closely for 21 days, only 50–75% will be observed to have a heat. This suggests that between 25 and 50% of heats are missed or cows are not cycling.

The proportion of eligible cows observed to have a heat over a 21-day period is referred to as heat detection efficiency. For example, if 60 of 100 eligible cows are observed to have a heat, the heat detection efficiency would be 60%.

Note the blue tail paint on the tailheads of these cows. Paint rubbing off suggests that they may have been ridden by other cows.

Poor heat detection efficiency (<60%) reflects either failure of detection or failure of the cows to cycle. Rectal palpation to check the presence of ovarian structures (follicles and corpus lutea) can distinguish heat detection failure from failure to cycle while observation of the cows may reveal rub marks on the pin bones where the cows have been ridden.

Heat detection can be improved by:

- increasing the number of observation periods
- clarifying signs of heat with the people responsible for detecting cows in oestrous
- checking records for days since previous heat (for closer observation).
- using heat detection aids such as tail paint, kamars, or estrous alerts.
- running vasectomised bulls or hormone-treated steers with the mating herd
- using oestrus synchronisation as a management aid.

Heat synchronisation can offer more efficient use of labour as the work of heat detection and AI is shortened into planned, intensive periods. Synchronising cows to come into oestrous at the same time increases the number of sexually-active cows making it more obvious which cows are in heat.

Cessation of ovarian activity (anoestrous).

Anoestrous or cessation of ovarian activity may be associated with poor body condition, small inactive ovaries or cystic ovaries. The combination of poor body condition and small inactive ovaries suggests cows are failing to cycle due to inadequate nutrition.

Inadequate nutrition is often reflected most by cows in their first lactation as they have the additional nutritional demand associated with growth. Holstein cows have been selected for their capacity to produce milk; when nutrition is limiting, they will direct available nutrients to milk production before reproduction.

Anoestrous resulting from poor nutrition is best prevented through nutritional management of the cows before and after calving.

Attempting to promote ovarian activity in anoestrous cows using hormonal therapies is not generally effective, and is expensive.

Good nutrition of the herd and good breeding records are more effective.

Artificial insemination and conception

For artificial insemination to be effective, viable sperm needs to be delivered to the bifurcation of a healthy uterus shortly before ovulation.

Key factors are:

- timing of insemination
- viability of sperm
- insemination technique
- uterine health.

Timing of insemination

Cows usually ovulate about 12 hours after the onset of oestrous. Best conception rates occur following insemination 4 to 12 hours after the first signs of heat are observed, but it is not always known at what stage of oestrus the heat was detected.

Cows should be inseminated at the next opportunity after detection of standing heat. The cow does not need to be re-inseminated if she is still on heat at the next milking, but should be if still on heat two milkings (24 hours) later.

Sperm viability

The viability of frozen semen is influenced by tank handling, semen thawing and insemination technique.

Handling of semen tanks

- Check the liquid nitrogen level twice a week using a dipstick.
- Lift the canister only to the frost line—NOT to the top of the tank
- Always use tweezers to remove straws from the tank.
- Keep good records of straw locations to find straws faster.

Thawing straws

- Do not lift straws out of the tank for more than two seconds.
- Only thaw as many straws as you can use in 10 minutes
- Thaw straws in water at 32–38°C
- Ensure the water level covers all but the top one centimetre of the straw.
- Thaw straws for at least 30 seconds.
- On cold days, rub the gun briskly with a dry paper towel to avoid cold shock and keep the loaded gun warm before use.
- Only touch the ends of the straw, and do not allow it to flick.
- Dry each straw thoroughly with a paper towel before loading into the gun.
- Load the straw into the gun, then cut it at right angles with clean scissors before covering with a sheath.
- Keep the loaded gun free of contamination and out of direct sunlight.

Insemination technique

Patience, practice and proper hygiene are the keys to good insemination technique.

- Wipe the lips of the cow's vulva clean of mucus, dirt and faeces using a clean paper towel.
- Provide a clean entry for the gun through the vulva – open the lips by pressing your arm down in the rectum or with the aid of paper towel.
- Direct the gun upwards at 45° to avoid the opening to the bladder.
- Follow the progress of the gun with your hand in the rectum.
- Do not push your hand towards the cervix ahead of the gun.
- Work the gun through the cervix. Place the index finger at the front of the cervix to feel the gun passing through, preventing the gun progressing too deep into the uterus.
- Position the gun so it is only just protruding from the front of the cervix.
- Deposit all the semen slowly into the body of the uterus just through the cervix.
- Wait a moment before withdrawing the gun.
- Remove the gun with a smooth action while the arm is still inserted in the rectum.

Good insemination technique is critical for high conception rates.

Uterine health

The health of the uterine environment is influenced by the prior nutritional management of the herd, maternity pen management, and insemination technique.

Cows that have difficulty calving or that get sick following calving are more likely to develop uterine infections. Good records regarding health events helps the identification, evaluation, and treatment of these cows prior to mating.

Treatment options include short-cycling the cows with prostaglandin and/or intra-uterine infusion with antibiotics, and are best administered 3–4 weeks after calving.

Conception rates and pregnancy rates

The proportion of cows that conceive following insemination is referred to as the conception rate. In the previous example with 100 eligible cows and a heat detection efficiency of 60%, if 20 of the bred cows conceive, the *conception rate* would be 20/60 or 33%. The proportion of eligible cows that get pregnant during the 21 day period is the *pregnancy rate* which, in this example, would be 20/100 or 20%.

Note that heat detection efficiency and pregnancy rate relate specifically to the proportion of cows that cycle and conceive during one heat cycle respectively. Calculations of conception rate are not necessarily limited to one heat cycle.

When investigating reproductive performance, it is normal to evaluate conception rates achieved by different inseminators, different sires, and different classes of stock.

Comparisons of conception rates should be based on a minimum of 50 breeders in each group. Inseminator-related problems should be suspected when there is greater than a 15% difference in conception rate between inseminators. A low first-service conception rate may indicate transition-related problems leading to poor uterine involution. Differences in conception rates are common between different AI sires. When poor conception rates are observed across sires and inseminators, the problem may be with semen storage.

Bull breeding

Some herds may choose to use bulls to breed cows that have failed to conceive to artificial insemination or to breed all cows. There must be enough functional bulls for the number of cows to be bred. In a year-round calving herd, this means one bull for every fifty cows if these are not synchronised to come into heat at the same time; with synchronisation, one bull for every twenty five cows.

The keyword with bulls is ‘functional’; poor reproductive performance should be expected if the bull is lame or sick. Problems with bulls include fighting between bulls and the potential for bulls to injure people. Fighting can be minimised by rotating bulls weekly and grouping bulls of similar size, age, and temperament. With small herds, it is best to avoid using a single bull in case it is infertile. Younger bulls are less likely to charge people than older bulls, and are less likely to be infected with sexually transmitted diseases. It is recommended to use bulls between 15 months and four years of age, and all bulls should be regularly vaccinated against vibriosis.

Herd grouping

Cows in early lactation have high nutrient demands but may not reach full intake capacity until two to three months post-calving; thus many lose weight and body condition, delaying their first heat. When all of the milking cows are managed together as a single herd, early-lactation cows have a relatively higher nutritional deficit relative to their milk production. Feeding cows according to their production helps to minimise this disparity with cow grouping facilitating good nutritional and reproductive management.

If the reproductive program goes according to plan, the lower-producing cows should include the pregnant cows in later lactation while the higher-producing cows will include non-pregnant cows in early lactation. Grouping non-pregnant cows together enables heat detection to be focused on the cows that need to be bred.

In larger herds where it may be feasible to have multiple groups, it is beneficial to group first-lactation cows together so they do not have to compete with the heavier, more dominant older cows.

Regular reproductive examinations

Early pregnancy diagnosis is important not only to identify cows that have conceived but also cows that have not conceived and need to be re-bred. Skilled operators can identify cows that are 6 weeks pregnant. Testing for pregnancy between 6 and 10 weeks of gestation provides accurate conception dates; these can be used to determine the appropriate time for cows to be dried off and moved onto the transition ration.

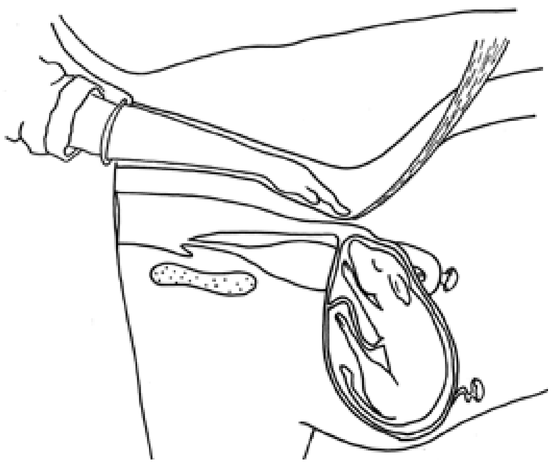
Cows to be examined each month include:

- Cows mated more than six weeks previously or those running with a bull for more than 80 days and not confirmed pregnant.
- Cows that are eligible to be bred that have not been observed to cycle during the previous four weeks. Examination can determine if the heat was missed or the cow has failed to cycle due to cystic ovarian disease, an infected uterus, or inadequate nutrition.
- Irregular heats. Cows normally have a heat every 18–24 days but those with ovarian dysfunction or low-grade uterine infections sometimes have short irregular cycles. Examination is focused at detecting ovarian cysts and potential uterine infections.
- Failure-to-conceive cows. Cows that have had more than 5 breedings but have failed to conceive may be normal on rectal examination. Occasionally examination identifies the presence of ovarian (cysts) or uterine disease (adhesions). The decision is whether to continue breeding the cow with artificial insemination, put her with a bull, or cull her.
- Reconfirmation of pregnancy at 120–150 days of gestation. Pregnancy loss is a fact of life with 5–9% of pregnancies lost prior to term. Many of these losses occur during early gestation when the expulsion of a foetus may not be noticed.

Reproductive goals

Numerous parameters can be used to assess reproductive performance. In year-round breeding herds, the following parameters are particularly useful.

- Average days to first breeding. This is the average interval from calving to first breeding for milking cows that have been bred (target 65 days) This helps determine if cows are cycling after calving, and provides an indication of heat detection.
- 80-day submission rate. This is the proportion of cows bred by 80 days after calving (target greater than 73%). This parameter is also useful for determining if cows are cycling following calving and provides an indication of heat detection. Average days to first breeding only considers cows that have been bred. 80-day submission rate provides an early indication as to the proportion of cows that have not been bred in early lactation. A low 80-day submission rate may be seen when cows have inadequate nutrition or when heat detection is poor.
- Heat detection efficiency. The proportion of eligible cows bred every 21 days (target 70%). Heat detection efficiency is largely influenced by management's ability to identify cows in heat. It provides immediate feedback as to what has been done during the preceding three week period.
- Conception rate. The proportion of breedings that resulted in a pregnancy. During



Reproductive examinations can be performed manually or with ultrasound. The expertise of the person performing the procedure is more important than the method adopted.

monthly visits, the conception rate is normally calculated for the cows that were bred 6–10 weeks before the day of examination.

- Pregnancy rate. Pregnancy rate is the proportion of cows that conceive during each 21-day period (target 20%). Pregnancy rate provides the most up-to-date feedback about reproductive performance. The pregnancy rate for the period 6–10 weeks before the reproductive examination provides feedback about reproductive performance to those involved in detecting heats and inseminating cows.
- Proportion of cows pregnant by 100 days in milk (target 40%). This shows the distribution of pregnancies in the herd. A low proportion of cows pregnant by 100 days in milk indicates that the cows are unlikely to get pregnant by the target of 120 days.
- Average days to conception (target 120 days). For cows to maintain a 13-month calving interval, they need to get pregnant by 120 days after calving. A long average-days-to-conception indicates that the calving interval will be prolonged which will reduce herd productivity.
- Proportion of cows not pregnant by 150 days in milk (target <18%). Failure to conceive by 150 days after calving is a measure of reproductive failure. These cows may be culled from the herd if they do not conceive soon.
- Percentage of pregnancies lost (target <9%). This figure is affected by when pregnancies are diagnosed. If pregnancies are diagnosed after 150 days of pregnancy, the percentage tends to be quite low (<2%) as most pregnancies are lost during early pregnancy and are often not noticed. When reproductive examinations are conducted around 42 days of pregnancy, the presence of the pregnancy is documented and the loss will be accounted for. Some infections that cause abortions in cattle can also infect humans, so handle aborted foetuses and membranes only with disposable gloves, and avoid contact with vaginal discharges from aborted cows. Bury the foetus and membranes so that dogs cannot get at them.

A breeding wheel may be used to track the reproductive status of cows in the herd.

Nutrition, cow health and reproductive performance

Nutrition has an important impact on the reproductive performance of dairy cattle. Inadequate energy intake reduces reproductive activity, and cows under negative energy balance often fail to cycle for extended periods. Poor fertility is often associated with rapid losses in body condition during early lactation.

Health management problems that can adversely affect fertility include:

- assisted calving
- retained foetal membranes (RFMs)
- uterine infections and vaginal discharges
- lameness
- ketosis
- displaced abomasum
- cystic ovaries
- abortions.

Some health problems, such as RFMs and vaginal discharges, affect the reproductive tract directly while others (such as lameness and ketosis) reduce feed intake leading to rapid body condition loss and interruption of normal ovarian cycles.

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 causing reduced fertility. These infections can last for weeks (even months) after calving even if the cow shows normal heats and no abnormal discharge. She may cure herself with time but is more likely to show repeat heat cycles. Any immediate treatment can be followed up with treatments such as prostaglandin or antibiotics.

Keep accurate records and seek veterinary advice if the per cent of naturally calving cows with this problem exceed the number shown in brackets below:

- Any assistance required to deliver a calf (seek advice if >5%).
- Any calf born dead or that died within 24 hours of birth (seek advice if >5%).
- RFMs—membranes visible externally more than 12 hours after 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).
- Other health problems including ketosis, displaced abomasum or cystic ovaries (seek advice if >5%).

Biosecurity

Several pathogens can cause reproductive losses. One of the risks associated with bringing cattle onto a farm is the introduction of an infected animal. Biosecurity protocols will reduce this risk.

Risk management options include maintaining a closed herd, purchasing stock from farms or sources known to carry a low risk of disease, and testing stock for some pathogens before purchase.

Examples of testing programs would include identification of cattle persistently infected with pestivirus, screening cows for evidence of exposure to *Brucella abortus* and testing bulls for *Trichomonas foetus* and *Campylobacter fetus venerealis.* Vaccines can enhance immunity to a number of pathogens including *Leptospira pomona*, pestivirus, Infectious Bovine Rhinotracheitis (IBR) virus and *Brucella abortus*. Brucellosis has been eradicated from Australia. In countries that have brucellosis, vaccination of livestock reduces the risk of disease in cattle and humans, similarly vaccinating cows against leptospirosis as it can affect cattle and humans.

Pathogens frequently implicated in reproductive loss in cattle include:

Viruses
Pestivirus
IBR

Bacteria
Brucella abortus
Leptospira pomona
Campylobacter fetus venerealis
Bacillus licheniformis

Protozoa
Neospora caninum
Trichomonas foetus

Fungi
Mortierella wolfii
Aspergillus fumigatus

Bulls should be tested for the venereal diseases *Trichomonas foetus* and *Campylobacter fetus venerealis* before entering the herd. Bulls should be routinely vaccinated for *Campylobacter fetus venerealis* (Vibrio) to further reduce disease risk should the bull be exposed to an infected cow.

Aborted foetus can be caused by infection with certain viruses and bacteria.

Non-infectious causes of foetal loss

Many toxins and plants may cause foetal loss; these include nitrate, alfatoxins, mouldy sweet clover, veratrum, locoweed, and zearalones. Investigating causes of abortion is expensive and often has a low diagnostic yield unless the problem is clearly defined with unique individual animal identification, early pregnancy diagnosis and good record keeping.

The first step is to determine what proportion of pregnancies are lost, 5–9% loss following early pregnancy diagnosis (40–50 days gestation) is considered 'normal'. As more pregnancies are lost during early gestation, less than 2% loss might be expected if cattle are pregnancy checked at the completion of their lactation. Veterinary advice should be sought should these thresholds be exceeded.

Culling decisions

It is normal for a proportion of cows to be difficult to get back in calf; the size of this group is largely influenced by the nutritional management of the herd, heat detection efficiency, and the expertise of the inseminators. From an economic perspective, farms need to establish guidelines as to when a cow is to be culled from the herd.

It is common for 20–30 % of a dairy herd to be replaced each year. In herds with good nutritional and reproductive management, most cows are culled because they are less productive than other cows or they have problems with recurrent mastitis or lameness. Voluntary culling of less productive cows leads to improvement in herd productivity.

Poor reproductive performance leads to forced culling of non-pregnant cows that are in late lactation but producing insufficient milk to pay the costs of maintaining them. In this case, cows with problems of mastitis or lameness are often retained to maintain herd size. Forced culling decisions are generally associated with static or declining herd productivity.

Herd-level factors that influence culling decisions include:

- herd expansion plans
- milk price
- feed costs
- cost of buying replacement stock
- historical reproductive performance and availability of home-bred replacement stock.
- value of cull cows.

Decisions on culling individual cows are influenced by:

- current milk production
- age
- previous milk production
- prior health history (mastitis, lameness)
- days since calving
- pregnancy status
- genetic merit.

Older, over-condition (too fat) cows in late lactation that have been bred numerous times are notoriously difficult to get pregnant.

Features of a successful reproductive program

- The farm has a plan for each stage of the cow's life cycle
- Good attention to detail
- Accurate records, particularly of all inseminations
- Consistent predicable work routines
- Established targets and monitoring program to assess performance
- Maintains a biosecurity program.

Useful resources

- Dairy Australia has developed many tools for reproductive dairy reproductive management. See the 'In Calf' program that may be accessed via the web http://www.incalf.com.au/ .
- A useful North American resource for reproductive management can be found at http://www.extension.org/pages/Dairy_Cattle_Reproduction.
- A resource useful for investigating potential causes of health problems in cattle is a program produced by Cornell University called "Consultant". This resource is particularly useful for veterinarians conducting disease investigations. http://www.vet.cornell.edu/consultant/consult.asp

6 Cow comfort

Key points

- When cows are confined, their level of comfort is determined by the facility and management. Good comfort equates with good production while poor comfort results in lower production and a higher incidence of disease.
- High-producing milking cows will lie down for 12 hours a day if they are provided with a comfortable place to lie.
- Cows provided with a clean dry place to lie have less problems with lameness and mastitis.
- Cows with no comfortable place to lie will spend more time standing; this reduces blood flow to the feet and can lead to lameness.
- Wet bedding material encourages bacteria to multiply and predisposes to environmental mastitis.
- Non-slip flooring will reduce the risk of injury and allow cows to show signs of oestrous.
- Dairy cows are sensitive to human and animal interactions. Adverse interactions reduce productivity and increase the incidence of lameness, injury, and mastitis.

Dairy and shed design

There are many housing options for dairy cows. Industry is tending toward the use of free-stall, tunnel, and compost barns with a move away from dry lot and tie-stall facilities. The best dairy design depends on the local climatic conditions, budgetary constraints and availability of bedding materials.

Facilities that use group bedding systems are generally cheaper to build; those that provide individual bedding stalls for cows are more expensive to build but may offer some advantages.

All systems have strengths and weaknesses with similar management principles but specific management requirements.

Group lounging systems

In open lounging systems such as dry-lot and compost barns, cows can lie down anywhere. As dry lot facilities house cows in open dirt lots, the costs of setting up a dry-lot dairy are less than for sheds to house cattle. Dry lot dairies are generally used in low-rainfall regions as they are vulnerable to rainfall; converting dry lots into mud lots leads to a high incidence of mastitis and lameness. In North America, there has been a trend away from dry-lot dairies to free-stall facilities.

In a dry-lot system, dry manure forms the bedding for the pen, and works well under dry conditions. Rainfall creates mud predisposing to mastitis and lameness. Shade must be provided in hot climates.

Cows in a wet loafing area. The teats are close to the manure and constantly wet feet are susceptible to injury.

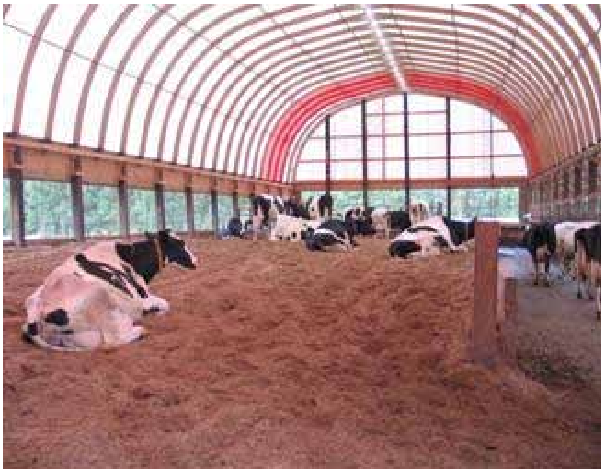
These cows find wet manure more comfortable than hard concrete. But wet manure increases the risk of environmental mastitis.

Compost barns

Compost barns are becoming more popular. Compost barns use sawdust in a large shed to create a comfortable place for cows to lie down. Affordable bedding material to compost must be available.

Recommendations for management of compost barns include:

- Provide at least 7.5–8m^2 per cow for Holsteins and similar-sized breeds and 6m^2 for Jerseys. Some producers provide 9m^2 per cow.
- Use fine, dry wood shavings or sawdust for bedding.
- Aerate the packed bedding twice daily 25cm or deeper to keep it aerobic and fluffy. Biological activity helps dry the pack.



Cows in a compost barns; cows can access the feed lane.

Source http://www.extension.org/pages/Compost_Bedded_Pack_Barns_for_Dairy_Cows#Compost_Dairy_Barns

- Have bedding material available to add to the bedding when it begins to stick to the cows.
- Enhance biological activity to generate heat to drive off moisture, and ventilate the barn well to remove the moisture.
- Prepare udders carefully at milking time to prevent problems with environmental mastitis.

With open lounging systems, compost or manure must be removed to avoid the build up of a manure slurry which would increase the risk of environmental mastitis and lameness.

A well managed tie-stall dairy with ventilation giving good air quality. Note the clean dry bedding

Individual loafing area dairy designs

Tie-stall barns

Historically, tie-stall dairies have been popular in cold climates where cows are housed during the winter months. There has been a recent shift away from tie-stall dairies because they are relatively labour intensive.

Cows in tie-stall dairies are tethered in a cubicle where feed and water is provided, and they are milked in place. A track behind the cows allows the manure to be scraped away to an effluent pond.

Heat detection is more difficult in tie-stalls as cows are not able to mount or be mounted by other cows.

Adequate bedding must be provided to avoid problems with lameness and mastitis.

Cows are tethered in place using a neck chain in a tie-stall dairy.

Free-stall barns

Free-stall facilities provide each cow with a cubicle, which she may enter and leave at will. Cubicles can be arranged in a single row, in more than one row with a central feeding alley, or with feeding alleys along the sidewalls.

The cubicles can be arranged with cows facing one another (head-to-head), head-to-side wall, or tail-to-tail.

The tail-to-tail arrangement has a central flush alley 2.2m wide between the cubicles; head-to-head cubicles have a flush alley behind each row. Usually one of the flush alleys is combined with the feeding alley behind the feed troughs.

Building a free-stall barn represents a significant investment and specialised engineering. It is cheaper to do the job properly the first time than it is to attempt fixing design problems once the concrete has been poured. Some people with little experience in confinement dairy farming try to save money by taking shortcuts on matters that they do not fully understand. The long-term cost is often significantly more than the short-term saving.

Examining different facilities and enlisting the services of a professional dairy designer is recommended to avoid costly mistakes.

The design and dimensions of free-stalls is important to achieve good cow comfort and function. The concept of free-stalls is to provide a comfortable place for cows to lay and at the same time control the position of the cow so that urine and faeces does not contaminate the bedding material which the cow lies on.

The dimensions of the free-stalls are important as cows will be reluctant to lie down if it is difficult to get into or out of the free-stalls. Comfortable bedding material is also important. A test is to drop from a standing position onto your knees ('knee test'). If this can be done comfortably, the beds are soft enough.

The recommended dimensions of free-stalls takes into consideration the size of the cows to be housed. Note that the dimensions in the figure and table are for specific classes and weights of cattle of Holsteins. Cows provide feedback about the adequacy of their facilities through their behaviour and by diseases and injuries they may sustain.

Cows in confinement facilities should be observed for the following evaluations:

- Surface cushion – Does the surface pass the 'knee test' and supply traction?
- Body resting space – Is there adequate space for resting body?
- Lunge space – Can the cow successfully 'lunge' to the front or side?

The cows on the left are standing half in and half out of the bed. This 'perching' indicates a problem related to the bedding softness as cows on the right are lying down on newly laid rice hulls. Free-stalls should be topped up with bedding twice a week and raked daily to keep the bedding material soft and dry.

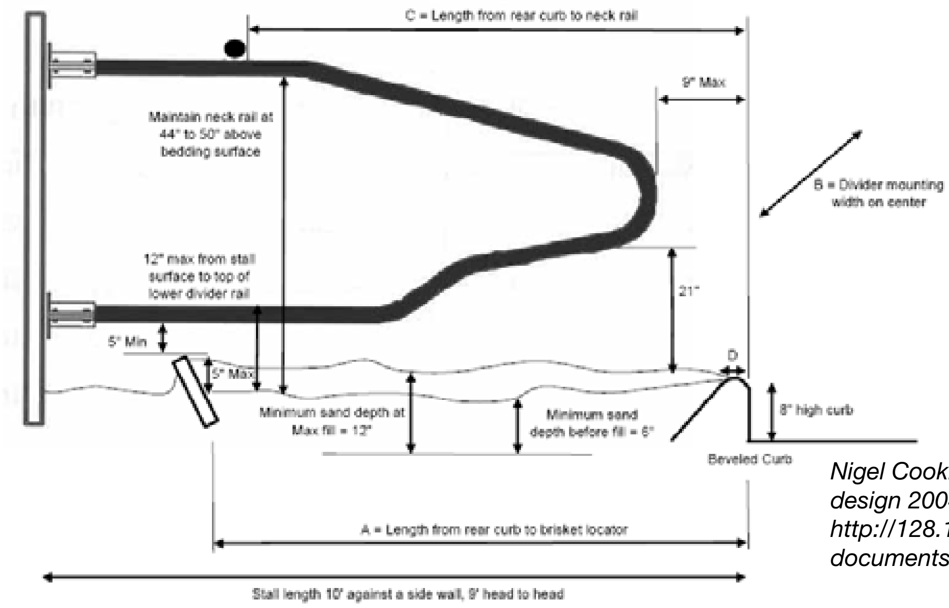
- 'Bob' space – Can the cow 'bob' her muzzle at end of lunge?
- Rising room – Can the cow rise without hitting the neck rail?
- Surface moisture – Is the bedding dry?

Indices used to assess free-stall use include:

- Stall use index (SUI) = [(# cows lying in stalls) / (# cows not eating)]*100 (Recommended >75% following morning milking)
- Stall standing index (SSI) = [# cows standing or perching in stalls / all cows in stalls]*100 (Recommended <20% 2 hours after morning milking)
- Cow comfort index (CCI) = [(# cows lying in stalls) / (# cows lying + # cows standing in a stall)]*100 (Recommended 80–85%, 2 hours following morning milking)

The cubicles can be arranged with cows facing one another (head-to-head), head-to-side wall, or tail-to-tail.

Figure 6.1 Dimensions of free-stall cubicle



Nigel Cook. Notes on Free-stall design 2004 http://128.118.11.160/dairynutrition/documents/cookFree-stalldesign.pdf

Note: The measurements in Figure 6.1 are in inches and feet; those in Table 6.1 are in metres.

Table 6.1. Dimensions for free-stall cubicles for Holstein cows of different size

Stall dimension (metres)	Recommendations		
	First lactation (635kg)	Mature cow (725kg)	Pre-Fresh (820kg)
Total stall length facing wall	2.74	3.05	3.05
Head to head platform	5.18	5.49	5.49
Stall length from rear curb to brisket board	1.73-1.78	1.78-1.83	1.83
Stall divider placement on centre (width)	1.22	1.27	1.37
Height of brisket board	0.1	0.1	0.1
Height of lower divider rail (maximum)	0.3	0.3	0.3
Height below neck rail	1.22	1.27	1.27
Horizontal distance between rear curb and neck rail	1.73-1.78	1.78-1.83	1.83
Rear curb height	0.2	0.2	0.2

In a well-designed free-stall barn, cows should be eating, lying down, drinking or moving between these activities. There should be few cows just standing about or lying in the flush alleys.

Maintaining bedding

Sand is generally considered the optimal bedding material as it stays cool in the summer and, being inorganic, minimises bacterial proliferation and the risk of environmental mastitis. Dry composted manure is a good bedding material—but must be kept dry.

Packed bedding can be aerated with a rake that opens and turns the pack.

Sand beds can be raked by driving a 'bobcat' fitted with a low-placed and offset bar carrying scarifier points down the flush alley.

Shed design and management

Good dairy sheds have many simple design features to improve cow and farmer comfort. These include:

- good ventilation
- non-slip flooring in lane ways
- good effluent management
- adequate space for water and feed.

Good shed design makes the best use of natural ventilation, having open sides, and a high and well-pitched roof with an open top vent to allow heat to escape during the hotter months.

Side curtains are used in sheds in colder climates. They can be raised in summer and lowered in winter.

A free-stall barn with side curtains closed to keep the barn warm. The flush alley has a rubber matt running the length of the barn for the cows' comfort and reduced wear on the cows' feet.

Grooving concrete reduces the incidence of injury from slipping. The best grooving pattern is a diamond cut with diamond oriented in the direction of cow flow.

In flush alleys, concrete is grooved in the direction of cow and effluent flow.

Slippery floors can lead to dislocated hips from cows doing the splits and ruptured cruciate ligaments from cows slipping when they turn corners.

Cows should always be moved quietly and calmly over concrete floors.

Examples of poor design of free-stalls

These free-stalls are short and the cows have nowhere to lung forward or to the side when they attempt to stand up. There is insufficient bedding and the bedding that is present is hard. Not surprisingly, all of the cows chose to lie outside in a muddy yard.

High incidence of lameness or mastitis could indicate problems with stall design or maintenance.

Cows that have to lie on concrete tend to develop abrasions on the outside of the hocks and sometimes on the knees. Poor bed comfort also increases the time cows spend standing which leads to more lameness.

Cow behaviour indicating a problem with the free-stalls. Note that most of the cows are standing, with one lying down in the flush alley.

Effluent management and disposal

Effluent can be directed into a separating pond or run over a solids separator to harvest the solids for use as fertiliser.

Flush alleys should slope in the direction of the effluent flow with a 3% slope to allow quick and free drainage of effluent.

Composting

Composting accelerates the breakdown of solids and makes a product that can be used as a fertiliser or for bedding free-stalls.

Composting makes a product that can be used as fertiliser or for bedding.

Screening dried compost

Access to water

Cows must have access to clean drinking water at all times, especially after milking.

Adequate watering troughs are required to ensure this and to prevent dominant cows from preventing younger or less assertive cows from drinking.

Troughs should be fed from large diameter pipe and use large float valves for rapid and automatic filling.

When water trough space is inadequate, dominant cows will stand over the water trough preventing others from drinking.

Useful resources

- The Victorian Department of Primary Industries has developed resources for making decisions on the installation of feed-out facilities. http://new.dpi.vic.gov.au/agriculture/dairy/feeding-and-nutrition/feedout-checkout/manual
- Guidelines for the design of feed pads and feed stalls can be found at http://www.dairyextension.com.au/edit/resources_nrm/feedpads%20and%20Free-stalls.pdf
- Notes on free-stall design written by Nigel Cook can be found at http://128.118.11.160/dairynutrition/documents/cookFree-stalldesign.pdf
- Information regarding compost barns can be found on http://www.extension.org/pages/Compost_Bedded_Pack_Barns_for_Dairy_Cows#Compost_Dairy_Barns

7 Heat stress

Key points

- The comfort zone of milking Holstein and Jersey cows is between 6 and 18°C.
- Cows have a large body mass to surface area making them inefficient at dissipating heat. Heat stress depresses dry matter intake, milk production and reproductive efficiency.
- During hot weather, milking cows must be provided with means of dissipating heat.
- Cooling measures for milking cows include designing sheds for maximum ventilation, sprinklers, fans, and modifying feeding management.

Comfort zone

The comfort zone for milking Friesian and Jersey cows is between 6 and 18°C. Between –5°C and +5°C, appetite will be stimulated. Above 24°C, dry matter (DM) intake decreases by about 3% for every rise of 1.2°C; then,at the upper level for discomfort above 27°C, appetite is depressed and both biological and economic efficiencies decline.

As cattle have a limited ability to sweat, and have to lose heat mainly through evaporative cooling from the respiratory tract. They increase their breathing rate to increase movement of air over the moistened surface of the mouth and the nasal passages. However, if humidity levels are high, this evaporative cooling is less effective, and cattle may be unable to dissipate accumulated body heat.

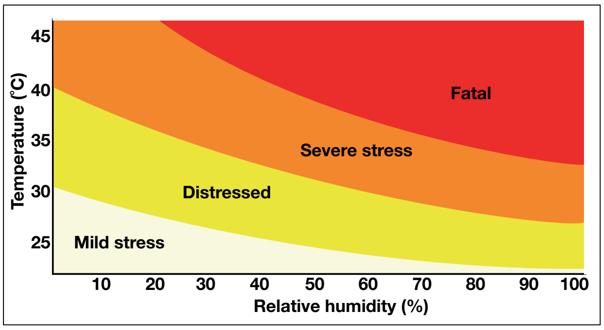


Figure 7.1. Degree of heat stress is related to the ambient temperature and the relative humidity.

Sources of heat

- Environmental conditions
- Fermentation of rumen contents
- Body heat from other cows

Normally the degree of heat stress is dictated by both the ambient temperature and humidity although fermentation of feed in the rumen also generates heat. Stressed cows are not likely to want to eat as much because it further contributes to their discomfort.

More heat can come from body heat from other cows when they are all clustered together in yards as occurs before milking. The movement of cows into a holding yard before milking can therefore exacerbate heat stress if there are no cooling systems in place.

Heat stressed cows eat less, produce less milk, and are more difficult to get pregnant.

Symptoms of heat stress

Cow behaviour consistent with mild to moderate heat stress includes:

- body aligned with direction of solar radiation
- seeking shade
- refusal to lie down
- reduced feed intake and/or eating smaller amounts more often
- crowding over water trough
- body splashing
- agitation and restlessness
- reduced or halted rumination
- grouping to seek shade from other animals
- open-mouthed and laboured breathing
- excessive salivation.

The severity of heat stress is influenced by many factors including:

- temperature and humidity
- length of the heat stress period
- degree of night cooling available
- ventilation and air flow
- cow breed and size

- level of milk production and dry matter intake prior to heat stress
- housing type
- overcrowding
- water availability
- coat colour, if exposed to sun
- hair coat depth

Signs of heat stress

The following signs can be used to assess the degree of heat stress:

- Mild heat stress: drooling, increased respiration to 80–100 breaths/minute.
- Moderate heat stress: drooling, respiration of 100–120 breaths/minute and occasional open-mouth panting.
- Severe heat stress: drooling, respiration rate greater than 120 breath/minute and open-mouth panting with tongue out. Cattle also have an agitated appearance, hunched stance and will often have their head down.
- Cattle can move from mild to severe heat stress very quickly, within 30 minutes to a few hours. Therefore extra vigilance is required once mild heat stress is detected.

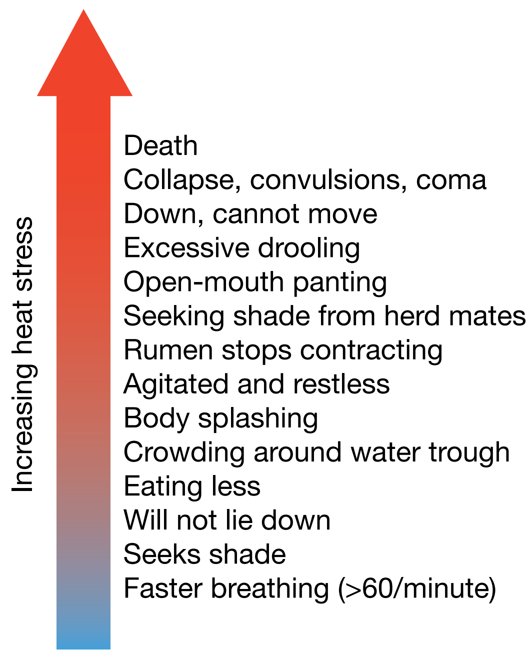


Figure 7.2. Signs of heat stress

Cooling strategies

Milk yields can be increased by up to 3–5kg/day through effective cooling strategies.

Shed design

In a hot climate, maximum use should be made of ventilation by using open-sided sheds.

Good orientation of the shed allows early morning and late afternoon sunlight to reach and dry out the floor while protecting cattle from the hot mid-day sun. Roof slope allows hot air to rise and escape through ventilation along the top of the roof. The roof slope should be greater than for feed sheds, namely 3–4° per 2.3m, with the opening at least 50cm wide for the full length of the shed.

Another design has a roof slope of 33° (4 in 12), with a vent at the top of 30cm plus 50mm per 3m of width for sheds more than 6m wide. The lowest point of the roof should be at least 3m from the ground. The steeper roof pitch increases air flow across and above the roof, thus creating negative pressure over the opening. This hastens the flow of air out the top as well as creating turbulence of air movement around the cows.

The ideal orientation for ventilation would allow the prevailing winds to hit the shed perpendicular to the side. This allows the wind to travel the shortest distance before exiting the shed so improving the rate of air exchange and providing the cows with fresh air. This is especially important with long sheds. Other factors to consider are exposure of the outside stalls to sunshine, future expansion plans, cow flow, traffic flow and manure flow.

The shed should be sited so that the prevailing wind is not blocked by obstacles or other buildings. There should be a minimum of four times the height of the nearest wind barrier as a horizontal separation. Ideally, the shed should be on the highest ground possible, which will also be good for drainage of effluent, with other buildings located downwind.

A north–south orientation is preferable to allow the sun to dry underneath both sides of the shed. Trees should be planted on the western side of the shed to reduce solar radiation. Shade cloth that blocks 80% of the light

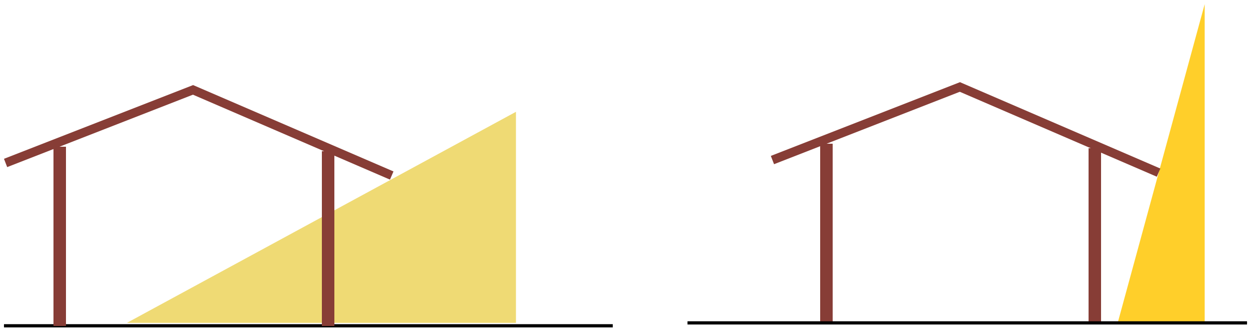


Figure 7.3. Shed orientation and roof overhang should allow entry of morning sun to dry the floor.

can also provide protection provided it does not interfere with ventilation within the shed. Eaves that extend one third the side height will provide good sun protection.

White painted buildings reflect the solar radiation better than dark-painted buildings. Reflecting roof materials such as galvanised or aluminium are good long-term investments. Insulation under the roof can reduce the heat load.

The low height and shallow pitch of this roof would make the shed very hot in summer and contribute to heat stress.

Loafing yards

Loafing yards should be provided with shades in a north-south orientation The cows will move as the shadow moves and this will spread out the manure and urine reducing the build up of moist areas. Water or moisture should not be allowed to build up under shade structures as cows will seek out the moisture for coolness increasing the risk of mastitis. There should be sufficient shade for all cows to prevent cows crowding and sometimes stepping on another cow's udder. This will be reflected by fresh blood in the milk.

Well-maintained loafing yard with provision of shade. Ideally sunlight should be able to reach all areas under the shade at some point of the day to help keep the surface dry.

Cooling cows

Wetting cows

Evaporative cooling is an efficient way of cooling cows. Heat-stressed cattle can be cooled by applying water to the head and back so it runs down their sides.

Sprinklers work well in hot dry weather but are less effective in humid conditions without forced ventilation to promote evaporative cooling. Sprinklers are placed above feedbunks positioned to wet the neck and back of the cows without wetting the feed. Large droplets are more effective than small while misters tend to increase the humidity without forced ventilation. A filter should be installed at the beginning of the waterline and the sprinkler nozzles should be easily removable for cleaning. The nozzles should be directional so that they can be adjusted to reduce wetting of feed under seasonal shifts in the prevailing wind.

Applying water to cows every five minutes reduces heat stress more than applying every 10 or 15 minutes. Ideally, cows should be sprinkled for 1-3 minutes, applying 1–2mm of water per 15 minute cycle. Pipe size depends on the length and area of the shed to be sprinkled, the number of sprinklers and the flow rate. Pipe diameter should be 32mm for up to 30 metres length or 51mm diameter pipe for 60 to 150 metre length. Nozzles should be spaced at twice the radius of their throw, for example, every 2.4m for nozzles with a 1.2m radius.

Sprinklers wetting the backs of cows at the feedbunk. This system is controlled by a thermostat and timer.

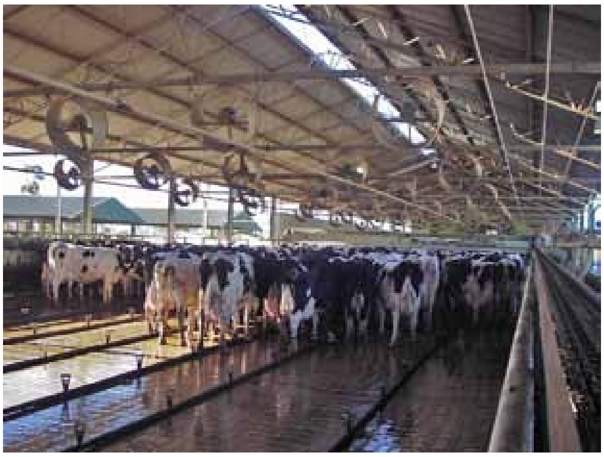
Installing sprinklers and fans is expensive. The best return on investment is in the holding yard for cows before milking.

Cows can be hosed down at the same time as their udders and teats are cleaned in preparation for milking, but this should occur at least 30 minutes before milking so that the udders and teats are dry at milking.

Cooling fans

A cooling fan increases the rate of cooling. Permanent ceiling fans can be arranged in many ways. A 0.38KW, 0.91m diameter fan rated at 5–6 cu m/min will blow a distance of 9 metres, while a 0.75KW, 1.21m diameter fan rated at 9–10 cu m/min will blow a distance of 12 metres. Fans should blow with the prevailing wind.

In wide sheds, 0.9m fans should be spaced side-by-side about 6m apart; 1.2m diameter fans should be spaced 9m apart. Fans should be positioned about 2 to 2.2m above the floor, and tilted to blow down to the floor directly under the next fan (about 30° from the vertical).



Cows in this holding yard are cooled through the combined action of sprinklers that wet the back of the cows and fans that promote evaporation. The sprinklers under the cows contribute to cooling but their primary function is to clean the udder and teats before milking.

Feeding management

When given continual access to feed, cows actively seek it from 5 to 9 in the morning and again from 5 to 7 pm. Milking should be finished before 6 am and 6 pm. Cows prefer to eat and drink following milking, after which they should be offered a dry surface on which to rest. They should stand for at least 30 minutes after milking so the teat end can close to protect the teat canal from bacterial invasion.

> Hot cows eat less as fermentation of the feed in the rumen generates heat.

The cooler the drinking water, the better for both intake and temperature balance in the body. Feed the best quality forages at night and feed more concentrates during hot periods. Offer more salt to replace the minerals lost in sweat.

Heat stress can lead to higher incidences of lactic acidosis. Depressed feed intake will reduce saliva production, which buffers the rumen against rapid changes in pH, and then reduce rumen contractions and the movement of digesta out of the rumen. Rapid respiration rates for lengthy periods can reduce the concentration of sodium bicarbonate in the saliva, reducing its buffering capacity further. As feeding cows so that their heads are low increases saliva production by 17 per cent, it is preferable to feed cows at this level rather than feeding with their head in a horizontal or raised position.

During hot weather, cows may preferentially select concentrates and reject forages, predisposing them to acidosis. Sodium bicarbonate is often added to the ration to provide additional buffering during hot weather.

Reduced forage intake can decrease milk fat contents, while milk protein (or SNF) contents may fall because of lower dietary energy intakes. Heat stressed compromises the cow's immunity which may be reflected by higher levels of somatic cells in the milk.

Useful resources

Dairy Australia has developed the 'Cool Cows' resource to help dairy producers implement strategies to minimise heat stress in Australian dairy herds. This resource can be accessed at http://www.coolcows.com.au/Infrastructure/Dairy%20yard/sprinklers-and-fans.htm

Monsanto developed a useful article regarding heat stress that provides specific guidelines regarding sprinkler and fan design and setup. This can be found at http://www.rennut.com/bucknell/Bucknell2006/BOOK/Heat%20Stress%20Relief%20-%20Monsanto.pdf

8 Milk harvesting

Key points

- Milk harvesting involves interaction between cows, people and equipment. Efficient dairies have facilities designed for the comfort of the cows and the people who work with them.
- If milkers operate in a positive manner, the cows will respond providing for a safe and productive working environment.
- During milking, cows should be comfortable and relaxed, milking equipment should be applied to a clean dry teat and teats dipped with an antiseptic following milking.
- Good cow handling and flow through the milking parlour will maximise cow comfort and milk letdown. It will also minimise adverse health impacts, particularly lameness.
- Good cow comfort involves the harvest of milk without damaging the cow's teats or introducing bacteria into the udder. For this, the milking equipment needs to be:
  – functioning properly
  – clean
  – correctly applied and removed.
- When machines are used to harvest milk, they must be tested and maintained regularly.
- The basics of good cleaning of milking equipment can be summarised as WATCH—Water, Action, Time, Chemicals and Heat.
- Hygiene includes health and personal hygiene, environmental hygiene, milking procedures and milk handling, and post-milking procedures.

Milk harvesting involves interaction between cows, people and equipment. The behaviour of the cows is determined by their interaction with the milkers and the equipment. The milkers work rate is determined by cow flow, facilities and equipment. The design of the facility influences how milkers and cows interact with the equipment. Efficient dairies have facilities designed for the comfort of the cows and the people who work with them. The response of cows to people and facilities is influenced by how people manage them. If milkers take care to operate in a positive manner to the cows, the cows will respond by being more relaxed providing for a safe and productive working environment.

Cattle handling

Cows respond well to positive consistent routines; good stock handlers manage cows in a quiet positive manner to maintain good cow flow, low levels of fear, good milk let-down and high levels of milk production.

Sudden changes in facilities or routines can make the cow overly fearful of people or a specific location, and this fear makes cow handling more difficult, dangerous and time-consuming. Milk let-down is compromised; milk yield declines and cow injuries become more frequent.

Positive stock handling behaviour includes interactions such as stroking, rubbing, resting a hand on the cows back, slow and deliberate movement and talking. Negative stock handling behaviour includes hits, slaps, tail twists, quick or sudden movements and shouting.

Strategies to reduce fear in cows include:

- Keep the milking routine calm and consistent.
- Allow cows time to learn changes in the milking routine or environment.
- Use positive interactions such as stroking and talking when working with cattle.
- Use slow and deliberate movement and talking.
- Avoid shouting.
- Minimise loud noise such as banging gates.
- Do not stare at a cow directly for a long period.

- Move cows by working on the edge of their flight zone.
- When possible, avoid painful procedures in the dairy.
- Move cattle as a group rather than individually when possible.
- Use rewards such as feed and positive interactions to minimise unpleasant experiences.

Gathering cows for milking

Milking typically starts when cows are collected from a pen or paddock. When they are relaxed, cows walk with their head down watching where they are going to place their front feet. If they are walking comfortably, the hind foot will land in the same place as the front foot. Given the choice, they will avoid stones and adverse surfaces to avoid the pain associated with sole bruising.

On a good laneway, cows will walk at 4.5kph, but will slow down to avoid injury if the surface is rough or irregular and when concrete surfaces are littered with loose stones.

When walking, cows like to focus on foot placement and prefer little physical contact with other cows. Pushing cows to make them move quickly causes them to lift up their heads and not watch the safe placement of their feet; this increases the risk of foot bruising. Bunched cows shorten their stride causing the back feet to land in a different location to the front feet increasing the risk of foot trauma.

It is important to understand cow behaviour when moving cows as it determines cow flow. Cows maintain a social group. When the herd is walking, dominant cows tend to position themselves in the middle of the herd. When a dominant cow stops, less dominant cows behind her will also stop and avoid walking past her. Pushing the tail of the mob causes bunching at the back of the mob, but does not necessarily increase the speed of the whole group.

The design of laneways and gateways has a significant impact on cow flow and the risk of lameness and mastitis. Gates need to be wide enough to avoid bottlenecks in cow flow. Right-angle turns should be avoided where possible as they slow cow flow.

A good laneway surface will reduce the risk of foot injury and soiling of teats. Dirt laneways in a paddock and loafing areas should be made with a foundation of compacted soil or rock base. The lane surface should have efficient drainage and a camber of 5–10% to shed water but more than 10% will cause the cows to walk only on the centre and edge of the laneway. The junction of dirt laneways and concrete holding yards are prone to break up, spilling stones onto the concrete and building up manure. The easiest way to drain water away from the junction is to make it the high point. A 150mm kerb at the junction helps to keep the laneway dry and stop stones going onto the concrete, as will placing sawdust on the last 50 metres of lane before the junction.

Facilities

Well-designed facilities take into account the anatomy and behaviour of cows. Cow-flow is enhanced by entries and exits which allow cows to clearly see and follow others.

Cow flow is promoted by:

- Wide, clear well-lit pathways
- Visual contact with cows ahead of them
- Consistent floor and wall surfaces.
- Avoid:
  - loud noises
  - flapping objects
  - solid projections in the path of cows that may cause injury.
  - large changes in lighting.

Minimise distractions:

- The sight of stationary cattle next to a race will slow movement; the race wall should be screened.
- Paint all walls one colour to avoid contrasts.
- Ramps with covered sides will not allow animals to judge height so they will move better.

Cow flow in the milking parlour

The order cows enter the holding yard impacts flow into the dairy. Cows sort themselves into dominance groups as they leave the paddock or pen, and disturbing this order means they have to reorganise in the yard. The best entries to the milking yard are at the back or back corner of the yard.

The size of the holding yard depends on the average size of the cow and the maximum number of cows—small cows need 1.2m^2 per cow and large cows 1.5m^2. Training heifers to enter the dairy is facilitated if they are well-grown and able to compete with herd mates. Training should follow a consistent routine and give the heifers time to become familiar with the environment. Ideally, heifers should be given an opportunity to become familiar with the dairy environment before they need to be milked. Heifers normally take two weeks to become familiar with milking routines.

Cows can be encouraged to enter the dairy by offering feed in the bail and or by installing a backing gate, but neither aid should be essential. Feeding in the bail can promote bullying by dominant cows and make cows reluctant to leave the milking platform after milking. Problems associated with feeding in the bail can be overcome by using an entry race, stall gates or individual feeding stalls in the dairy.

Backing gates reduce the size of the yard as the number of cows declines during milking; they keep the remaining cows close to the dairy entrance but are not designed to physically push cows into the dairy. Backing gates are less important on dairies with good entrance design and cattle handling skills. Backing gates should move only at 10–15m per minute with audible, but not loud, alerts warning cows that the gate is advancing. Movement of the backing gate should be observable and able to be activated from the milking pit. Automatic moving of backing gates is potentially dangerous; electrification is not recommended as it punishes the least dominant cows.

Yard surface

The surface of the yard needs to provide traction in all conditions to minimise injuries associated with cows slipping. The concrete surface should be textured or grooved but not so abrasive or uneven as to cause excessive wear or bruising of the cows' feet. A simple test of the yard surface is that it should be comfortable to walk on with bare feet.

Diamond-shaped grooving should be 12mm wide by 12mm deep with a long axis of 100mm and a width of 75mm. The long points of the diamond point up and down the slope to facilitate washing.

Excessive wear of cow's feet that may occur where they have to turn can be reduced by installing cushioned rubber floor mats. These should have a textured surface so that they do not become slippery when wet or soiled with manure. Recycled conveyor belts are sometimes used but tend to be slippery when wet.

The slope of the holding yard affects cow flow, washing and drainage. Upward slopes of 3–4 % encourage cows to face the dairy and facilitate drainage and washing. Cows are often reluctant to go down slopes greater than 5%, and slopes greater than 4% at the yard platform junction lead to excessive wear contributing to smoother concrete and an increased risk of slips and falls.

In hot climates, shade and cooling should be provided in the holding yard. Sprinklers for cooling should be turned on before the cows enter the yard to cool the concrete. Large-droplet sprinklers will wet the cows whereas misting sprinklers increase the humidity making them less effective. Sprinklers should be installed above the cows to avoid wetting the udders and the risk of environmental mastitis. Installing fans to promote evaporative cooling improves the effectiveness of sprinklers.

Dairy entrance design

The interface of the holding yard and the dairy should encourage cows to enter the dairy. Important considerations include footing, lighting, and space or width. Safe reliable footing will give cows confidence to enter the dairy. Cows will pause before crossing sharp, dark shadows slowing cow flow so the dairy should have good lighting. Clear cow entrances and exits and wide clear platform areas are best with straight in and out pathways quickest and easiest.

Milking parlour

There are many different types of milking parlours and milking system. The choice is largely influenced by individual preferences.

Factors to consider include:

- How many cows are to be milked
- How many people are available to milk the cows
- How many times a day the cows are to be milked
- The amount of time available for each milking
- Milk production at peak and average milk production
- Calving pattern
- Personal preference.

In Australia, from most to least common dairy designs are herringbone-swingover, herringbone-double up, rotary and walkthrough dairies.

The advantages and disadvantages of each design are described.

Herringbone-swingover

For

- Most affordable
- Minimal cluster idle time
- Highest cows per cluster per hour rate – cows enter and exit while the other side is milking
- Narrow shed compared to a double up
- Fewer clusters so cheaper to automate
- Time from cows entering to cluster attachment is longer – this can lead to better milk let-down

Herringbone milking parlour

- Cows are in full view of the milker while in the dairy for the duration of milking.

but

- The milk line has to be a highline or midline - higher teat end vacuum can potentially lead to teat end damage.
- Can be a cluttered milking environment, particularly if workers are tall.
- Cows are frequently over-milked
- Swing-over dairies are not ideally suited to automatic cup removers (ACRs), and their installation is more complicated.
- It may be difficult to align cluster well because of the drag of the milk line, particularly if cows are not standing in the correct place.
- Slow milkers slow down the milking of all cows.

Herringbone-double up

For

- Usually a more spacious, uncluttered, brighter pit
- Shorter shed for the same number of clusters compared to a swing-over design with the same number of clusters
- Can be a low-line milk line
- Lower vacuum levels than swing-over design
- Ideally suited to ACRs
- Cows in full view of the milkers.

but

- More cluster idle time compared to a swing-over
- Higher capital investment (more clusters) for the same number of cows per hour compared to a swing-over dairy
- Slow milking cows can slow down one side of the dairy.

Some herringbone dairies are set up with rapid exit where a bar lifts up and the cows step forward rather than having to wait for all the cows to walk the length of the barn to exit. This system improves cow flow and throughput but increases expense as the dairy building has to be wider to allow the cows to step forward.

Rotary dairies

For

- Cows come to the milker, nil entry and exit times if the system is working well
- Low-line milking system
- Little walking is required by the milker
- Slow cows do not hold up more than one cluster
- Platform speed sets the milking rate
- Platform speed can be varied with the herds level of production
- Automatic ID and feeding easy to install
- Generally bright airy working environment
- Cows generally like to get onto the platform
- Easy to delay cupping until after milk let-down.

but

- Expensive to build and automate due to number of clusters
- More moving parts needing maintenance
- Occupational health and safety issues associated with the repetitive task of attaching cups in a single location
- Difficult to see cows during much of milking
- Without automation, two milkers are required
- Using automation, a one-milker operation may be possible, but then cows are not checked after cup removal and herd health problems may not be detected.

Rotary dairy

- Cows frequently milked out before they get to the cup removal station
- If much udder preparation is required, platform throughput can suffer.

Milking machines for smallholders

Small dairy farms in South-East Asia cannot afford the type of milking parlours suitable for the large commercial or state-run dairies.

These farms can use units on a common vacuum line but with dedicated milk buckets, or even single self-contained units running an electric motor from an extension lead.

These self-contained units can also be used in large dairies to prevent milk from a mastitis or antibiotic-treated cow contaminating the bulk milk in a large parlour.

Separate milking machine with a common vacuum line.

A self-contained milking machine with an electric motor can be used to keep milk from a contaminated cow entering bulk milk storage.

Milking machine function

The most common problems with milking machines are caused by inadequate routine maintenance of mechanical components and the rubber ware. A routine of daily, weekly and monthly checks guides preventative maintenance and keeps the equipment functioning properly.

Daily checks

1. Check the air admission holes (air vents) on the cluster. If vent is blocked, the claw bowl fills with milk and leads to more cup falling, slow or incomplete milking, and difficulty removing clusters. Remove any debris with the probe designed for the task – avoid using drill bits or other tools that may enlarge the holes.
2. Check the milk vacuum.
3. Listen to pulsators. The sound of air entering the external air port should be both regular and intermittent. It should be the same sound for all pulsators.
4. Watch milk entering the receival can for an even flow.
5. Check teats as the cups come off at the end of milking. Look for discolouration (reddish, bluish or purplish teat skin colour). Look or feel for swelling or hardness at the top, middle or end of the teats.
6. Examine teat openings for signs of cracking, sores or teat canal lining pulled out of the opening.
7. Check cow behaviour. Are cows nervous and uncomfortable when teat cups are put on or removed from teats, or during milking?

Weekly checks

1. Check for twisted liners. Align marks on mouthpiece and stem of liner, or place your thumb in each liner.
2. Check liner condition for cracks, splits, and distortion of the mouthpiece.
3. Check filters on pulsator airlines.

Monthly checks

1. Measure completeness of milking and milking times.
2. Count cup squawks and slips requiring correction by milker. There should be no more than 5 cup slips per 100 cows during 15 minutes of milking (exclude cows with very poor udder conformation which always have cups slip).
3. Check for under milking. Hand stripping of at least 10 cows should give an average residual milk volume of less than 250 mL/cow.
4. Note average milking time. With good milk let-down (teats plump with milk) and correctly adjusted milking equipment, 95% of cows giving:

   10 L/milking should milk in 5 minutes (+/– 1 minute)

   15 L/milking in 6 minutes (+/– 1 minute)

   20 L/milking in 7 minutes (+/– 1 minute)

Routine maintenance

Change liners at regular intervals. Teatcup liners are designed to flex and squeeze the teat during each pulsation. This is essential to massage the teat and maintain its blood supply. As soon as they start work, liners begin to lose tension, absorb fat and hold bacteria. After 2000–2500 cow milkings, the deterioration is sufficient to reduce the speed and completeness of milking, increase teat end damage, and increase spread of bacteria, and liners should be changed. Some manufacturers recommend 4–6 months as maximum life for liners.

Cleaning and sanitising dairy equipment

Cleaning milk harvesting equipment is a separate operation to sanitising. Both operations are needed to ensure minimal bacterial contamination. Cleaning removes residual milk and dirt from surfaces while sanitising removes bacteria from cleaned surfaces.

The general guide to cleaning is to:

- Remove all loose dirt and debris, and rinse or wet the equipment with cold or warm (not hot) water.
- Hot-wash using detergent solution to remove surface deposits.
- Rinse with cold water and drain.
- Apply sanitiser to contact surfaces and allow to dry.

The equipment that contacts the teats must be clean. If cows defecate during milking, the manure must be rinsed off before applying the cups to the next cow.

The basics of good cleaning and sanitising dairy utensils can be summarised as **WATCH**:

- **W**ater quality – how dirty is the water?
- **A**ction: mechanical action (with pumps or vacuum) to encourage agitation, or manual cleaning, such as using a brush.
- **T**ime: Time should be long enough for the chemical to work but not too long for redepositing of soils. The longer a surface is manually cleaned, the better. Cleaning-in-place (CIP) systems are best as they require the least physical effort.
- **C**hemicals: Match the chemicals for the job, use them at the recommended dilution rate and in the right sequence. Wear protective clothing if necessary.
- **H**eat: Chemical activity doubles for every 10°C over 50°C. Excess heat can denature some sanitisers.

Different types of detergents have different roles. Neutral detergents are the most convenient to use as they require no skin protection. Alkali detergents remove protein, fats and carbohydrates, whereas acid detergents are best at removing milk stones and hard-water scale. Good cleaning practices require regular use of both alkali and acid detergents, but they may be less effective when used in cooler water.

Milk stones are hardened deposits, formed from residual milk, that bond to metal, rubber and plastic surfaces; water high in dissolved minerals (hard water) will form a hard-water scale. Both residues provide a suitable environment for bacteria which can contaminate any milk coming in contact with them.

Milking procedure

Calm and relaxed. Cows should be calm and relaxed during milking. This will occur only if the cows are handled gently, routines are consistent, the milking equipment is functioning properly and the equipment fits the cows been milked. Calm cows manure less frequently, kick the cups off less frequently and have better milk let-down.

Legs tied together suggests that the cows have a history of kicking and that the cows associate milking with pain. This indicates a need to evaluate the milking procedure and function of the milking equipment

Fore-strip. Good milkers take care to avoid getting milk on their hands as this can spread bacteria from teat to teat. An effective technique is to squeeze the base of each teat between the thumb and the first two fingers, then pull gently downwards. If no clots, flecks or other abnormalities appear in the first two squirts, move to the next teat. The risk of spreading mastitis is reduced by milkers wearing disposable rubber gloves

Clean and dry. Ideally, teat cups should only go onto clean and dry teats. Milking wet teats increases the risk of mastitis and contaminates the milk with bacteria. If the teats are wet, dry them with a disposable paper towel first. If the teats are dry, avoid wetting the udder.

Pre-dip. Pre-milking teat disinfection (applying a sanitiser before attaching the milking machine) is an effective way of decreasing mastitis due to environmental bacteria. Use only a product approved for pre-milking disinfection, and apply according to the label directions. The teats should be clean and dry before applying sanitisers as organic material will neutralise their effectiveness and moisture will dilute the product. The sanitiser should remain in contact with the teat for 30 seconds, and then removed with paper towels or suitable woven cloths to avoid contaminating the milk. Each cloth must be used for only one cow per milking. Cloths should then be placed in disinfectant solution, washed and dried before the next milking.

Using the same cloth and dirty water to wipe teats on multiple cows before milking can spread bacteria through the herd.

Good milking hygiene practice, with separate cleaning towels for each cow.

Contamination on the udder can be reduced by trimming or flaming hair on udders, trimming the long hair on the end of the tail and by maintaining laneways and beds so that cows do not need to wade through, or lie in, mud.

Milk let-down. The optimum time to apply teat cups is immediately after milk let-down, seen by the teats becoming plump with milk. Putting the cups on too soon may result in them crawling during the first minute of milking, and constricting the base of the teat; this leads to prolonged incomplete milking. Milk letdown usually occurs 60–90 seconds after the cow's teats and udder are first touched by the milker, or is stimulated by the sights and sounds of milking and the predictability of a calm, consistent milking routine. Attaching machines within two minutes after first stimulation makes maximum use of the let-down effect.

Application. Air leakage through the teat cups during milking should be minimised by first checking that the teat cups hang over the claw correctly. The cluster should be balanced, each teat cup lifted with a 'kink' in the short milk tube until the moment of attachment, and then the units adjusted for proper alignment.

Detachment. At the end of milking, the vacuum to the cluster should be cut by kinking the milk line so that the teat cups release. Pulling the unit off the cow without cutting the vacuum can damage the teats.

Confirm. Check the cow after milking to avoid under- and over- milking.

Teat dip. Disinfect each teat after milking with a spray or dip.

Teat should be disinfected after milking.

Bacteria in milk from infected quarters may contaminate the skin of other teats during milking. For example, after a liner has milked an infected quarter, bacteria may be transferred to the next 5–6 cows milked with that cup. After milking, these bacteria multiply on the teat skin and may extend into the teat canal.

Teat disinfection after milking reduces by 50% new infections due to cow-associated or 'contagious' bacteria. Teat dips include an active ingredient to kill bacteria and an emollient to keep the teat skin healthy.

To be effective, the ingredients have to be mixed at the correct concentration with clean water. Water with high organic matter or mineral content will deactivate the disinfectant.

All the teat surface touched by the teat cup liner must be covered—a drop of teat disinfectant seen at the end of the teat does not indicate adequate coverage. Failure to cover the whole teat of every cow at every milking is the most common error in teat disinfection. Dipping uses about 10mL per cow per milking.

Teat dip can be applied with a dip cup refilled from a bottle. The white bucket here contains clean cloth towels used to wipe teats before milking. Each cloth is used to wipe only one cow.

Teat spray. Spray upwards from beneath teats, not from the side. Sprays should use about 20mL of prepared teat disinfectant per cow per milking.

Teat spray should cover all teat surfaces. Check with a paper towel or look at the front of the teats as the cow walks out of the milking parlour.

Milking hygiene

Bacteria are present in milk from any infected quarter, and can be spread between cows during milking by milkers' hands, teat cup liners and cross flow of milk between teat cups. Milking cows with mastitis last reduces the risk of spreading infection to healthy, young cows. If clinical cases of mastitis are not milked last, using a separate cluster for mastitis cows on the test bucket also reduces the risk of spread from contaminated liners.

Clots of milk in this collection bowl indicate that the previous cow had mastitis which would contaminate other cows. Ideally cows with mastitis are milked last so that the bacteria are not transferred to clean cows. Cleaning equipment will avoid spreading mastitis.

Early detection and treatment of clinical mastitis reduces the risk of severe disease, disease transmission, and progression to chronic infection. Gloves, liners and other equipment should be cleaned with running water and disinfectant solution to remove infected milk. Rinsing with running water for about 30 seconds provides a physical wash followed by a sanitising dip in disinfecting solution such as 1% Iodophor. Disinfectants take time to kill bacteria, any other unit or cow should not be touched for at least 20 seconds. Drying hands on a paper towel after this will also help reduce the bacteria that remain. Do not dip clusters or hands unless you have rinsed them first because progressive contamination of the bucket leads to a soup of bacteria.

Early detection and treatment of mastitis are essential.

Drying cows off

After each lactation, all cows require a dry period of six to eight weeks to allow the udder tissue to repair and rejuvenate before calving. Udder infections during the dry period can be minimised by management at drying-off. The aim is to shut down milk secretion and seal the teat canal as rapidly as possible–this sealing usually takes about two weeks. Nearly all new infections occur in quarters where the teat canal has not sealed.

During the first two weeks after drying-off, the number of bacteria that contaminate the teats should be minimised by teat dipping after the last milking and making sure the areas where the cows lie is dry.

With higher-producing cows, it is beneficial to reduce milk yield to 5–12 litres/day before drying the cow off. One week before the final milking date, no more concentrates are fed, then four days later, the cow is put on a maintenance ration of 7–8kg hay (for a cow weighing 500kg). Water should be available at all times. At the last milking, the cow is milked out completely, and each teat is dipped in freshly prepared teat disinfectant.

Dry cow therapy

The cows should be placed in a clean dry pen or paddock for 3–4 days well away from the milking herd and the milking area, so they do not have the stimulus to let down milk. The maintenance diet should be continued over this time. To minimise milk and antibiotic leakage, cows should not be walked long distances for 3–4 days after drying off.

Cows are susceptible to new infections during the first week of the dry period before their teats have sealed, and these infections must be identified and treated so that they do not persist and create problems after calving. If suspicious, treat as a clinical case. Do not remove milk or secretion from adjacent normal quarters. Treat clinical quarters by stripping out completely and using a full course of lactation antibiotic.

Dry Cow Therapy is used to:

- treat existing infections which have not been cured during lactation
- reduce the number of new infections which may occur during the dry period.

Treat again with Dry Cow Treatment following the course of lactating cow therapy. Dry Cow Treatment is a formulation of antibiotic for administration into the udder immediately after the last milking of a lactation. It is designed to remain in the udder in concentrations high enough to kill mastitis bacteria for a period for 20–70 days depending on the product used. The prolonged time of exposure to antibiotic and the formulation enhance penetration and increase the chance of curing infections embedded deep in the udder. Dry Cow Treatment products do not protect against some environmental bacteria which may be introduced into the udder if the treatment is not done cleanly. These environmental bacteria may cause severe clinical mastitis.

Entry of bacteria can be prevented by forming a physical barrier using a product called Teat Seal® from Pfizer Animal Health.

Post-harvest milk quality

Milk filtering. With hand milking, immediately after milking, the milk should be filtered into a clean, sterile storage container. The filter cloth should be thoroughly cleaned in detergent and sanitiser, then dried in the sun.

Milk cooling and storage

Milk must be chilled to below 3–4°C as soon as possible after milking.

Milk transport

For smallholders without refrigeration, milk needs to be transported carefully and as soon as possible after the completion of milking to be cooled at the Milk Collection Centre. Heat, light, excessive movement and time all cause warm milk to deteriorate. Transport containers should be made of food-grade materials, which are capable of being cleaned and sanitised properly, and able to be sealed with lids.

Useful resources

The information regarding facilities and cow flow is largely based on material sourced from the Dairy Australia Cowtime program. Further detail can be found on the Cowtime webpage at http://www.cowtime.com.au/Main.asp?_=Home

An excellent resource regarding animal behaviour and animal handling that can be found at http://www.grandin.com/index.html.

Dairy Australia has developed a comprehensive resource for dairy farmers called Countdown Downunder. This site includes useful information regarding milking procedures and strategies to prevent, manage, and treat mastitis. http://www.countdown.org.au/

Milking parlour

(Source: http://www.cowtime.com.au/Main.asp?_=Home)

9 Common disorders in dairy cattle

Key points

- Good treatment outcomes for sick cows is strongly influenced by the facilities available to manage them.
- Mastitis is the most costly disease of dairy cows. Infections are classified as contagious if infection spreads from cow to cow, or as environmental if derived from the cow's environment.
- Clinical mastitis is treated with intra-mammary infusion of antibiotics during the lactation. Sub-clinical infections are treated by antimicrobial therapy during the dry period.
- Strategies that are designed to prevent mastitis promote teat health and minimise microbial challenge to the teat end.
- Key control strategies for the management of contagious mastitis include biosecurity, milking procedure, milking equipment function, post-milking teat dip, treatment of clinical and subclinical infections and culling of chronically infected cows.
- Strategies for the control of environmental mastitis include environmental management to minimise the exposure of the teat end to mud and manure and the use of a pre-milking teat dip.
- Lameness is the second most costly problem of dairy cattle, and significantly compromises animal welfare.
- Risk factors for lameness include excessive time standing on concrete, abrasive surfaces, stones on concrete, excessive turns, inadequate bedding, excessive moisture, poor stockmanship, inadequate foot care, slippery surfaces and poor nutrition.
- Eighty percent of lameness is associated with lesions in the foot, and 80% of foot lesions occur in the back feet. Treatment involves paring out the lesion and relieving weight bearing on the affected claw by applying a block on the healthy claw.
- Eighty percent of health problems in dairy cattle occur during the first 60 days after calving. Metabolic disorders are commonly associated with energy and calcium balance.
- Clinical and subclinical ruminal acidosis may occur during early lactation following changes in the energy content of rations including an excess of rapidly fermentable feed. Ruminal acidosis contributes to the risk of abomasal displacement and lameness.

Facilities to manage sick and lame cows

The likelihood of a cow recovering from health problems is influenced by the facilities available to treat and house the cow. Sick cows are particularly vulnerable to heat stress as they are more likely to be recumbent and can have problems regulating their body temperature. Recumbent cows are also vulnerable to muscle damage if there is inadequate bedding.

Sick cows need:

- Pens or a location with good footing and adequate bedding — slippery floors may lead to secondary injuries.
- Access to shade
- Ready access to water and feed
- Hay – as sick cows often prefer forages to mixed rations
- Location close to the milking area so they do not have far to walk
- A means of safely catching and restraining the cow.

A crush or stanchion that provides good restraint facilitates examination and treatment of cows, and provides a safe work environment.

Cow in the hospital pen following surgery. Note the clean and thick bedding so that the cow can lie down comfortably. The red paint on the back and the legs indicates antibiotic treatment so that her milk is not sold for human consumption.

Mastitis

Mastitis is an inflammation of the udder caused by any of 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 the environment—the floor, faeces, soil, feedstuffs, water, plants and milking equipment and utensils.

The economic impact of mastitis is through reduced milk production, culling and treatment costs.

Subclinical mastitis reduces milk production, adversely affects milk quality and constitutes a reservoir of mastitis organisms that may spread to other cows in the herd.

At low levels of infection, subclinical mastitis may go unnoticed, but may cause changes in the milk, mammary gland, and occasionally the cow. As long as it persists, infected quarters can lose up to 25 per cent of their potential milk production and produce poor-quality milk. If the infection is not cleared up, it may develop into chronic mastitis.

For each case of clinical mastitis in the herd, there will generally be 15 to 40 subclinical cases.

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.

Most mastitis may be attributed to poor management, improper milking procedures, faulty milking equipment, inadequate housing, but also the climate, season, type of housing, nutrition and stress. These all interact with genetic and physiological factors such as stage of lactation, milk yield, milk flow rate and pregnancy.

More than one hundred types of microbes can cause mastitis; they can be grouped into two main types:

- **Environmental** bacteria, commonly present in the cow's environment.
- **Contagious** bacteria that spread from infected quarters to other quarters. Contagious pathogens may be introduced into a herd through the introduction of infected stock.

Environmental mastitis

The keys to controlling environmental mastitis are good udder hygiene, correct use of good milking machines, pre-milking teat disinfection, dipping teats after milking and dry cow therapy. The order of milking is heifers first, then uninfected cows, and infected cows last.

Despite good preventative procedures, new infections will occur while cows may sometimes recover spontaneously. Infection with environmental bacteria can cause severe mastitis

Drug therapy is the main treatment, and involves drugs reaching all sites of infection in the affected quarters, and remaining at adequate therapeutic levels for sufficient time to kill all infecting microbes. Chronic cases that resist antibiotics should be culled.

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, and are spread 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.

Spread of contagious 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.

Treatment of clinical mastitis

Cows should be treated for mastitis when there is heat, swelling or pain in the udder, or there are changes in the milk (wateriness or clots) that persist for more than three squirts of milk. Particular attention should be paid to swollen quarters that do not milk out. Stripping foremilk involves squirting more than three streams of milk—preferably onto a black surface—to look for clots, watery or discoloured milk. Quarters with a few small flecks only in the first three squirts may be left untreated and checked again next milking. Milk containing infection may be spread during this procedure, so avoid splashes or sprays of milk, and always use gloves.

It is easy to introduce bacteria into the teat with a treatment nozzle if the teat end has not been disinfected. Operators can be injured by cows when administering intramammary treatments. It is important to take time and have help; more than one person is often needed to do the job well, especially if cows are not used to having their teats handled.

The steps involved in intramammary infusion include:

1. Restrain the cow.
2. Milk the quarter out completely.
3. Ensure that your hands and the teats are clean and dry.
4. Put on disposable gloves.
5. Completely disinfect the end of the teats to be treated. **This is critical.** Disinfect by vigorously scrubbing the teat opening with a cotton ball and alcohol (or teat wipes) for a minimum of 10 seconds.
6. Check the cotton ball. If there is any dirty colour, repeat the scrub using a clean cotton ball until there is no more dirt seen.
7. If treating more than one teat, treat the nearest one first, then the more distant teats to reduce the risk of unintentionally contaminating an already disinfected teat.
8. Remove the cap of the tube of antibiotic and, without touching its tip, gently insert the nozzle into the teat canal.
9. It is not necessary to insert the nozzle to its full depth as this can dilate the teat canal excessively and predispose the cow to mastitis.
10. Squeeze the contents of the tube into the teat. Massage it up the teat into the udder.
11. Teat dip treated quarters with freshly made-up teat dip immediately after treatment.

Table 9.1 Controlling mastitis

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; keep records of treatment
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

Controlling mastitis

Mastitis is best viewed as a problem with the herd rather than with individual cows. The level of infection in the herd must be known to be able to assess seriousness, and source and risk of spread of infections.

Regular monitoring will indicate the level of infection, and the proportion of cows or quarters infected. 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 no new infections occur.

To keep mastitis at a low level, new infections must be prevented, and the duration of those that do occur must be shortened, then eliminated. Table 9.1 summarises an effective approach to controlling mastitis.

Culling infected (particularly older) cows is a key strategy in mastitis control by removing bacterial challenge to clean cows. These older cows with chronic infections are difficult to cure, and some types of bacteria are resistant to treatment. However, culling is an expensive option and will not resolve herd mastitis problems if steps have not been taken to prevent new infections.

Cull persistently infected cows.

Teat sores and cracks

Bacteria multiplying in teat sores increase the risk of mastitis. Painful teat sores lead to poor cow behaviour and poor milk let-down.

Teat skin health is affected by extreme cold, exposure to mud and water, flies, and milking machine factors.

Investigating possible causes of teat sores involves assessing:

- Teat skin and teat ends at milking; discolouration (red, blue or purplish) suggests teat end damage from faulty machine function.
- The cow's environment. Reduce mud problems by maintaining dry trough and loafing areas, laneways, and entrances and exits to the dairy area. Minimise use of water on cows in the dairy. Ideally, teat cups should go only onto clean, dry teats. Use clean, low-pressure water to wash dirty teats but avoid wetting the whole udder. Cow behaviour. Biting flies will cause cows to bunch together and swish their tails.

Lameness

Diseases of the foot account for most lameness in dairy cattle. Eighty percent of lameness is seem in the hind feet and eighty percent of this is in the lateral claw.

The number of lame cows in the herd can be assessed by watching cows walking to and from the milking parlour. Lame cows may walk with an arched back and often come in last.

Factors that can contribute to lameness include:

- inadequate bedding leading to excessive time standing

Lame cow, notice the arch in her back.

- poor nutritional management leading to subclinical acidosis
- cows standing in mud or manure slurry—the feet become soft and more prone to bruising.
- abrasive or rough laneways that increase foot wear and foot bruising. Stones may abrade the skin between the claws allowing bacteria to invade and cause foot rot.

Muddy roadways may contain stones that damage the cow's feet.

- excessive turns on rough surfaces leading into and out of the milking parlour. The soles of the cows' feet are abraded when they pivot to turn. Thin soles increase the risk of bruising.
- poor stockmanship. Cows are normally careful as to where they place their feet. When cows are harassed, they lift their heads and do not watch where they place their feet and are more likely to step in holes or on stones.
- inadequate hoof care. Confined cows should have their feet trimmed every 6 months.

Hooves of cows that do not walk much need to be trimmed regularly. With little wear from walking, the toes become long and the cow's weight is shifted abnormally toward the heel.

Strategies to prevent lameness include:

- Design yards to keep cow flow as direct as possible with minimal turns.
- Move cows gently without pressure.
- Maintain surface quality of laneways.
- Limit the time cows spend standing on concrete.
- Provide cows with a comfortable place to lie down.
- Acclimatise heifers to facilities before they start being milked.
- Maintain routine foot care.
- Install foot baths to medicate feet (5% formalin, 5% copper sulphate or 10% zinc sulfate). Foot baths are useful for treatment of footrot and foot warts and 5% formalin can be used to harden the claw.

Note the use of two footbaths—the first is to wash off dirt and the second to medicate the feet.

Foot baths should be the same width as the passage, at least 3m long and 15cm deep.

A foot-trimming crush with belly bands to support the cow and winches to lift the feet makes trimming overgrown feet easier. .

Portable foot-trimming crushes allow their cost to be shared across farms.

Cow's hind foot restrained in a hoof-trimming crush.

A green plastic block has been glued onto the claw opposite the one with a sole ulcer. This relieves the pain from weight on the diseased claw, and allows the damaged part of the hoof to heal.

The footbath medication should be changed after 200 cows have walked through as the manure neutralises the active ingredients.

Foot injuries can be painful. Corrective trimming removes excessive horn to align the foot for normal weight bearing and to relieve pressure on the site of the injury. Pressure can be relieved by gluing a wooden or plastic block on the healthy claw on the same foot.

Metabolic disorders

Hypocalcaemia (Milk fever)

Milk fever is typically seen in cows around the time of calving. Clinical signs start with a brief stage of excitement and muscle tremor of the head and limbs that is often missed when cows are found down and unable to stand. Affected cows tend to be quiet, and turn their head to the flank, the nose is dry and extremities are cool (unless environmental conditions are hot). The heart beats weakly at 90–100 beats per minute. If not treated, the cow may progress to lie lateral and die.

Recumbent cows are treated by intravenous infusion of calcium gluconate administered slowly to reduce the risk of death from rapid or excessive administration of calcium. Five hundred mL of 23 % calcium gluconate (10g of calcium) is typically adequate to restore blood calcium levels. To avoid recurrence, an additional 300mL of calcium gluconate may be given subcutaneously, or calcium chloride or calcium proprionate may be administered orally.

Favourable responses to calcium administration include: belching, muscle tremor, decrease in heart rate and increase in strength of contractions, sweating of the muzzle, defecation, and urination. If cardiac arrhythmias are noticed during intravenous administration of calcium, the rate of infusion should be slowed or stopped. If cardiac irregularities are encountered on repeated attempts to administer the calcium intravenously, the remainder of the infusion may be administered subcutaneously. Oral administration of calcium salts may rapidly correct serum calcium levels.

The need to treat cows for hypocalcaemia reflects failure of prevention strategies during the transition period. Well-managed dairies commonly keep the incidence of clinical milk fever below 2%.

Hypomagnesemia (Grass tetany)

Hypomagnesemia or low blood levels of magnesium may be seen following a sudden change in diet, especially when cattle are put on rapidly-growing, young spring pastures. The amount of magnesium present in these grasses may be normal suggesting that hypomagnesemia does not always simply reflect dietary magnesium deficiency. High potassium diets reduce magnesium absorption from the gastrointestinal tract. Weather, pasture growth, and the concentration of magnesium, potassium, and sodium in the diet dictate the risk of disease. Disease is most commonly observed in older cows grazing cereal crops or lush grass-dominant pasture during or following inclement weather. Hypomagnesemia may also be observed in 2–4-month-old milk-fed calves that have restricted access to grain or forage.

Clinical signs observed with hypomagnesemia include: poor coordination, restlessness, muscular spasms, convulsions and death.

Treatment involves the administration of magnesium or a combination of magnesium and calcium solutions intravenously or subcutaneously, but the response may be slower than that with hypocalcaemia, and the margin of safety is less. Subcutaneous administration of magnesium may be less stressful than intra-venous administration and avoids precipitating seizures.

Prevention is achieved through grazing management and magnesium supplementation. Pastures fertilised with high levels of potash and nitrogen represent a higher risk, and grasses and cereal crops are a greater risk than legumes. Cold wet windy conditions increase risk.

Ketosis and fatty liver

The late-gestation dry cow has a rapidly increasing requirement for energy because of foetal growth at a time when her appetite is falling. During the last week of gestation, dry matter intake (DMI) is typically 50–70% of earlier intake. Cows typically have a larger decline in DMI than heifers, and may eat only 8–10kg per day in the last few days before birth. Over-conditioned cows have a greater drop in DMI at calving and more health problems. Rapid increases in energy concentrations of the ration at this time may contribute to sub-clinical rumen acidosis and ketosis during early lactation.

Ketosis and fatty liver are usually seen shortly after parturition—well before peak milk production. Cows with clinical ketosis typically display diminished appetite, frequently have hard dry faeces, decreased milk production, loss of body weight, and may display neurologic signs.

Treatment of ketosis is directed at promoting glucose availability and synthesis, and appetite. Treatment options include intravenous glucose (300mL of 50% glucose IV), oral drenching with propylene glycol (240–300mL orally daily for 3 days) and intramuscular administration of 5–20mg of dexamethasone. Sick cows are more likely to eat hay in preference to mixed rations and providing sick cows with a range of feedstuffs may help to get them back on feed.

Risk factors for ketosis include increasing parity, a prolonged previous calving interval, excessive body condition at parturition, heat stress, cold stress, inadequate bunk space, high levels of butyrate in forages, and inadequate housing and free-stalls.

Cows with ketosis have an increased risk of developing metritis, retained placenta, mastitis, and abomasal displacement. Conversely metritis, mastitis, and abomasal displacement may lead to ketosis through depression of appetite. Subclinical ketosis is more common than clinical ketosis. Milk fat percentage is increased in cows with subclinical and clinical ketosis, and milk protein percent may be lower in cows with sub-clinical ketosis. This may be the result of a reduced energy supply because milk protein percent is positively associated with net energy balance. First test milk components may be used as a herd-screening test for negative energy balance through the transition period. A large number of cows with a first test fat percent >5% reflects a negative energy balance during late gestation. Problems with the transition period are also reflected by poor production during early lactation.

Because ketosis occurs in early lactation, recommendations for prevention focus on the nutritional management of the dry and transition cow. The dry period is divided into two feeding groups: far-off and close-up. The goals of the transition diet (close-up) fed to cows during the 21–28 days prior to calving are specifically designed to prevent sub-clinical ketosis by maximising dry matter intake and providing adequate energy density.

General principles relevant to preventing ketosis and feed additives purported to help prevent ketosis are:

- Avoid ketogenic feedstuffs (silages high in butyrate).
- Feed concentrates in the close up period.
- Avoid over conditioning cows during late lactation and the early dry period.
- Monitor dry matter intake and DCAD in the close up ration. Excessive use of anionic salts can depress palatability and dry matter intake.
- Niacin fed prior to calving at the rate of 6 to 12 grams per day may be helpful in reducing blood levels of BHB.
- Propylene glycol requires repeated daily oral administration (240–300mL).
- Inclusion of monensin (300-450mg/day) in the lactating cow ration during the first 28 days postpartum.

Ruminal acidosis

Ruminal acidosis occurs when animals are fed an excessive amount of digestible carbohydrate. Common scenarios include animals breaking through fences and consuming grain, accidental overfeeding, and introduction to new commodities. Offending feeds include anything that contains an abundance of highly digestible carbohydrate such as grain, bread, brewers grain, molasses, potatoes, and bakery by-products. The condition often reflects a failure to acclimatise animals to a ration or disruptions in feeding routine. The amount of feed required to cause illness depends on the nature of the feed, the prior diet of the animal, nutritional status of the animal, and the nature of the rumen microflora.

Sub-clinical acidosis

Sub-clinical ruminal acidosis is a less severe but economically important manifestation of the disease. Sub-acute ruminal acidosis may be a problem in dairy cattle when they transition from a relatively low energy ration during the dry period to a high energy ration after calving. Problems associated with sub-clinical ruminal acidosis include depressed and variable feed intake, depressed milk production, and an increased incidence of lameness secondary to laminitis. While engorgement with wheat has been shown to decrease rumen pH to 4 or less and to result in critical systemic disease, pH levels less than 5.5 are sufficient to predispose to subclinical rumen acidosis. Low-fibre high-starch diets are associated with an increased incidence of laminitis and greater severity of corium lesions. Reduced particle size also exacerbates acidosis through increasing the ruminal digestion of starch.

Ruminal microflora and papillae take approximately 3–5 weeks to adapt to the change from a forage-based ration to a high-energy lactating cow ration. The net energy of a ration can be safely increased at 10% increments. Adaptation to the lactating cow ration may be achieved in part by feeding a transition ration to cows prior to calving. This ration has an energy level in between the dry cow and lactating cow rations and may also be formulated to help prevent milk fever.

If affected animals are examined within a few hours of engorgement, ruminal distension and occasionally abdominal discomfort (kicking at the abdomen) may be the only abnormalities observed. In mild cases, cattle are anorexic, but fairly bright and alert and have soft faeces. Rumen motility is depressed but not absent. Affected cattle do not ruminate for 2–3 days but will begin to eat by the third to fourth day without treatment. In outbreaks of severe engorgement, animals will be recumbent within 24–48 hours, some will be staggering and others standing quietly, separated from the herd. Affected cattle have depressed or no rumen motility, fluid-filled distended rumens, diarrhoea, sunken eyes, depressed mentation, and may grind their teeth. When acidosis is secondary to grain overload the faeces usually contain incompletely digested grain. The diarrhoea is profuse and the faeces have a foul odour.

Treatment

When animals are found engorging themselves they should be removed from the feed, given access to good quality palatable hay, be held off water for 12–24 hours, and be encouraged to exercise every hour for 12–24 hours. Animals that have consumed a toxic amount of grain will become depressed and anorexic in 6–8 hours; these animals should be treated individually.

Moderately affected cases may be managed by administering 500g of magnesium hydroxide or magnesium oxide in 10L of warm water. Veterinary attention will be required for more severely affected animals.

Prevention

Prevention of ruminal acidosis is achieved by preventing accidental access to grain and through controlled gradual introduction of ruminants onto highly digestible carbohydrates. Feeding grain in a Total Mixed Ration with forages is one of the most effective ways of avoiding problems with ruminal acidosis. If grain is to be fed separately to forages, problems may be avoided by small incremental increases in the amount of grain fed. When feeding grain separate to forage, it is important to consider the social behaviour of cattle and to provide sufficient feed bunk space so that the dominant cattle are prevented from eating a disproportionate percentage of the grain fed. Sodium bentonite (2%) and limestone (1%) are buffers that may be added to grain for the first two weeks of feeding. Ionophores alter rumen fermentation and help prevent acidosis by reducing the relative production of lactic acid. Virginamycin (Escalin) may be added to the ration to reduce the number of acid-producing bacteria in the rumen.

Left-displaced abomasum

Left-sided displacement of the abomasum occurs most commonly in concentrate-fed, large-sized, high-producing adult dairy cattle during the first four weeks of lactation. A left-displaced abomasum may be caused by many factors; anything that causes a cow to go off feed or abruptly change dietary intake just before or soon after calving is a potential cause. Risk factors for abomasal displacement include pre-partum negative energy balance, hypocalcemia, a high body condition score, winter season, and low parity. The gas-filled abomasum becomes displaced under the rumen and upward along the left abdominal wall. Eighty percent of displaced abomasa occur within the first 3 weeks following parturition. Clinical signs include depressed appetite, reduced milk production, ketosis, reduced rumen fill, with 'sprung' ribs, faeces range from scant pasty to diarrhoea. On palpation of the rumen, it is difficult to feel the doughy dorsal sac in the paralumbar fossa as it is displaced medially. Percussion using a flick of the finger and simultaneous auscultation over an area between the upper third of the 9th and 12th ribs of the abdominal wall commonly elicits a characteristic high-pitched 'ping'.

When a high incidence of displaced abomasa is observed, the rations of dry, transition, and lactating cows should be evaluated. If possible, dry matter intakes for each ration should be determined. Check for mouldy hay and silage. The neutral detergent fibre of forages should be checked to determine if levels are too low (insufficient roughage) or too high (limiting dry matter intake). The possibility of overcrowding should be investigated and the as-fed ration should be examined to check for mixing errors and sorting. If anionic salts are fed to eliminate or reduce milk fever, urine pH should be checked. In the week before calving, the urine pH of Holsteins should be 6.2–6.8 and, of Jerseys, 5.8–6.3. Urine pH below 5.8 suggests excessive anionic salts which are likely to depress dry matter intake. The ratio of milk protein to fat may be used as an indicator of negative energy balance during early lactation. Ratios less than 0.71 are associated with a 2:1 odds ratio that an abomasal displacement will occur within the following three weeks. Negative energy balance is also reflected by loss in body condition.

Treatment requires correction of the abomasal displacement. This may be achieved by rolling the cow (roll from right lateral recumbancy to dorsal and then left lateral recumbancy). Approximately 40% of cows will re-displace following rolling. Alternatively the abomasum can be repositioned surgically and sutured into the correct location. Supportive treatments include oral fluids supplemented with 100g of lite salt (NaCl/KCl mix), 240–320 mL of propylene glycol orally daily for three days and an intravenous injection of 400mL of 50% dextrose.

Metritis

Metritis results from uterine contamination with bacteria during parturition. In the majority of cattle that experience a normal parturition, this infection is resolved spontaneously. Lochia, or normal postpartum uterine fluid, is normally mucoid and light yellow to brown or red. Passage of lochia begins three days postpartum, and all of the fluid is normally expelled by 18 days' postpartum. With uterine infections, the uterine fluid develops a foul odour, becomes more abundant and watery. Clinical signs include fever, depressed mentation, anorexia, and reduced milk production. Rectal examination reveals a large thin-walled uterus that contains a foetid watery uterine discharge.

Therapeutic options for uterine infections include hormonal manipulation to promote oestrus, anti-inflammatories and antimicrobial therapy. The objective of hormonal therapy in resolving postpartum metritis is to induce oestrous cycles, thereby increasing oestrogen levels. Oestrogen stimulates uterine tone aiding evacuation of abnormal uterine contents and increases production of mucus that contains host defence compounds.

Prostaglandin treatment of cows with peripartum health disorders, including RFMs, dystocia, or both, is likely to benefit their reproductive performance. However, blanket treatment of all postpartum cows with prostaglandin is not recommended. Antimicrobial therapy is indicated for the treatment of invasive metritis in which affected cows are systemically ill. Antimicrobials may be administered by intrauterine and or systemic routes. Intrauterine antimicrobial drug use achieves a high concentration of drug in the uterine lumen and on the lining of the uterus but an inadequate concentration of drug in the deeper tissues. Intrauterine therapy alone is unlikely to achieve good therapeutic outcomes, and systemic treatment of metritis is more efficacious as it provides better drug distribution to all layers of the uterus and ovaries. Veterinary advice should be sought to guide antimicrobial drug use.

Useful resources

- The Dairy Australia website 'Countdown Downunder' - investigating and managing mastitis problems in dairy cattle. http://www.countdown.org.au/
- Lameness in dairy cattle – Dairy Extension Centre: http://www.dairyextension.com.au/Main.asp?_=Lameness%20and%20Laneways
- Merck Veterinary Manual at: http://www.merckvetmanual.com/mvm/index.jsp and the Cornell Consultant http://www.vet.cornell.edu/consultant/consult.asp.

MEAT & LIVESTOCK AUSTRALIA
Level 1, 165 Walker Street
North Sydney, NSW 2060
Australia
Ph: +61 2 9463 9333
Fax: +61 9463 9393
www.mla.com.au

LIVECORP
Suite 202, 32 Walker Street
North Sydney, NSW 2060
Australia
Ph: + 61 2 9929 6755
www.livecorp.com.au