# 8

# Milk feeding of calves

This chapter discusses the diversity of decisions that have to be made when planning the milk feeding program for replacement heifer calves.

### The main points in this chapter

- The nutrients from liquid feeds can be supplied though whole milk, colostrum (and transition milk) and/or calf milk replacer (CMR).
- If calves are to drink milk from a bucket or trough, they will have to be individually taught how to drink. Calves will instinctively suck from a teat.
- Automatic calf feeders are a new innovation in calf rearing, but are expensive and require a re-evaluation of pre-weaning calf management.
- The more milk fed, the less solid feeds consumed, the longer time to weaning and generally the more expensive the pre-weaning feeding program.
- Milk temperature, frequency of feeding, feeding mastitic milk and labour requirements are additional issues to be considered in planning milk feeding programs.
- Multiple suckling on nurse cows (continuous or restricted) is an alternative way to rear dairy replacement heifer calves on milk.
- Dairy farmers in Asia often successfully combine restricted suckling with hand or machine milking.

The diversity of climate, milk returns and concentrate costs throughout Asia have created a wide range of calf-rearing systems. The length of time, if at all, that calves remain housed, the method and level of milk feeding, the type of solid feeds offered and the age and weight at weaning therefore vary widely (see Figure 8.1).

The simplest rearing system involves putting young calves out to pasture, giving them access to trees or a simple shed for shelter and feeding them whole milk to appetite (*ad lib*) from a trough or feeding drum for up to 12 weeks of age, but with no additional concentrates. Such a system appears to work extremely well in temperate areas during warm, dry weather with calves grazing top-quality, spring pastures. In adverse weather conditions, or if pasture quality is sub-optimal, it can lead to older age at weaning and poor early post-weaning growth. Although labour and capital costs would be low, feed

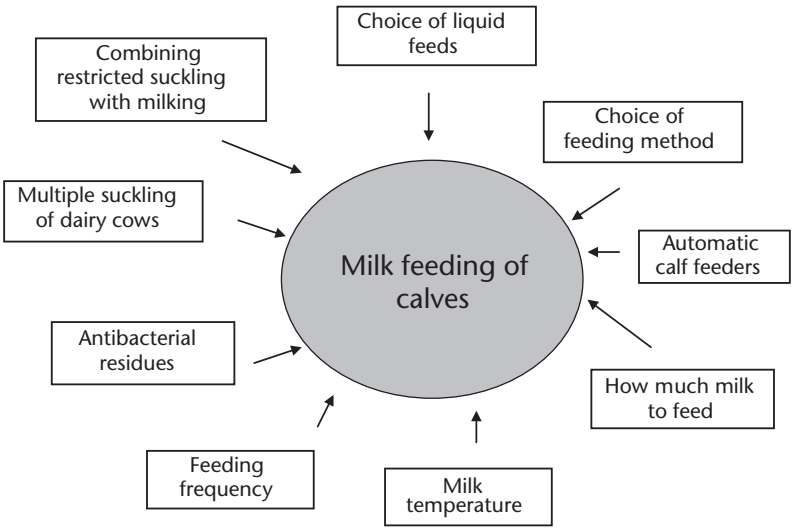


**Figure 8.1.** Decisions to make when considering milk feeding

costs are high, even if the whole milk has a low market value. Calf losses and disease costs may be acceptably low when the system operates effectively, but could be very high if it breaks down.

The other extreme would be to house calves for the first 2 months and feed them limited milk (or milk replacer), specially formulated concentrate mixes plus limited amounts of low-quality roughage. This encourages early rumen development and also achieves high pre-weaning growth rates. Following early weaning at 5–6 weeks of age, depending on concentrate intake, calves are still housed to allow greater control over nutrient intake. Once given access to forages, concentrates would be fed for several months to minimise stresses arising from the change in their basal diet to grazed pasture. Such a system maximises post-weaning growth rates and is the basis for achieving well-grown dairy heifers. Labour and capital costs are high, but feed costs are low or, at least, equivalent to the outside/pasture-only system. Calf losses and disease costs should be acceptably low, as long as the system operates effectively.

In both cases, it is the people who rear the calves, not the system (Moran 2002). The calf rearer teaches the animals to drink and decides on when and how the milk should be fed. This chapter describes many such systems, their advantages and disadvantages. It concentrates on practical issues, but these depend on the principles of calf growth and nutrition more fully described in previous chapters.

## 8.1 Teaching calves to drink

If calves are to be fed from buckets or troughs, they will have to be taught to drink. Because of their natural inclination, calves will instinctively learn to drink from teats, but will often need to be placed on the teat for the first few feeds.

A calf can be trained to drink from a bucket by backing it into a corner, standing astride its neck and placing two fingers, moistened with milk, into its mouth. As the calf

A slow way to introduce calves to milk.

starts to suck on the fingers, gently lower its mouth into the bucket of milk, taking care not to immerse the nostrils so it will not inhale the milk. Keep the palm of the hand away from its nose and as the calf starts to suck the milk, gently withdraw the fingers. Hold the bucket or have it supported about 30 cm from the ground.

This process should be repeated until the calf is drinking by itself or until it has drunk at least half a litre of milk. You may need to help the calf for several feeds. It is easier to train calves using warm milk, changing to cool milk only when they are drinking satisfactorily.

When training calves to drink from a teat, it should be attached to a tube that is filled with milk. As the calf starts to suck, lower the tube into the bucket of milk. The calf is usually able to keep up the supply by suction. It is easier for calves to learn to feed from self-closing teats, because milk remains in the tube between bouts of sucking.

## 8.2 The choice of liquid feeds

### 8.2.1 Colostrum and transition milk

The term colostrum is generally used to describe all milk not accepted by milk processors. However, transition milk is a more correct term for milk produced after the second milking post-calving. This milk no longer contains enough immunoglobulins to

provide maximum immunity to calves, but still contains other components, which reduce its suitability for milk processing.

Milk from newly calved cows should not be put into the bulk milk vat for up to 8 days after calving. Regulations vary between countries and between different situations. During this period, a cow will produce considerably more colostrum or transition milk than that consumed fresh by her calf. If only rearing heifer replacements, the colostrum produced by cows that have given birth to bull and cull heifer calves, would then be available for milk feeding.

Using a 25% heifer replacement rate and 45 L of colostrum and transition milk per cow available for heifer rearing, this can provide up to 180 L of milk available per reared calf. These calculations take into account any milk used for early feeding of bull and cull heifer calves. There should be little need for dairy farmers to buy milk replacer or use marketable whole milk to rear their heifer replacements. Dairy farmers can save considerable money through modifying their transition milk storage systems to minimise the need to feed marketable milk or milk replacer to their heifer calves.

Transition milk has the greatest value when fed fresh or within a day or two of milking. It can be stored in a refrigerator for a week or so, or in a freezer for up to 12 months. In most farm situations, neither method is very practical for routine storage, except for a small supply of frozen colostrum for emergency use with newborn calves.

There is little difference in the immunoglobulin (Ig) levels in frozen compared with fresh colostrum. Only the first few litres of colostrum produced immediately after calving from older cows should be frozen for later use as a source of Ig. The ideal method to freeze the colostrum is in 1 L plastic bags placed in flat trays. This will produce wafers of colostrum about 2–3 cm thick, which can be rapidly thawed in lukewarm water. Very hot water should not be used to thaw the frozen colostrum because it can reduce its effectiveness in providing Ig.

Extremely bloody colostrum or colostrum from cows freshly treated for mastitis should not be stored, although it can be fed fresh to calves that are not to be sold.

Natural fermentation is an excellent way for storing transition milk for feeding as a source of cheap nutrients. It must be handled in clean containers to prevent contamination and should be kept in plastic or plastic-lined containers with lids. Old stainless steel milk vats are also ideal. If stored below 20°C, the natural fermentation will acidify the milk, stopping spoilage for up to 12 weeks. In warm conditions, preservatives may need to be added. These include propionic acid or formalin. The stored milk should be stirred every day to maintain uniform consistency and fresh milk should be cooled before adding. The preserved liquid will develop a characteristic odour, but calves will continue to drink it provided they are not abruptly switched from fresh milk or milk replacer to stored milk. They may refuse to drink it if it becomes too acidic. In this case, its palatability can be improved by neutralising it with sodium bicarbonate or baking soda at the rate of 10 g/L of milk.

Fresh colostrum has a slightly greater feed value than whole milk, so less can be fed or small quantities of warm water can be added to feed at the same rate as whole milk. When teaching calves to drink stored transition milk, it may be easier to begin feeding it warm – diluted with warm water (hot water will curdle it) – and then gradually change

to cool, stored milk when calves are drinking more confidently. Calves will continue to drink such stored milk long after the rearer can't bear to get too close to it.

When the supply of stored transition milk begins to run out, fresh milk or milk replacer should gradually replace it over a week or so to give the calves time to accept their new diet. Changing from fresh milk or milk replacer back to stored transition milk can reduce intakes and lower growth rates.

### 8.2.2 Whole milk

Whole milk is the ideal food for calves. It has a high energy value and the correct balance of protein, minerals and vitamins for good calf growth and development. Health problems are generally lower when feeding whole milk compared with milk replacer because there is guaranteed quality control of the sources of protein and energy and there is no need to follow recipes to ensure the correct strength for proper feeding. Whole milk can either be the commercial milk being sold or it can be waste milk: that is, milk from treated cows or mastitic milk that cannot be sold.

Calves fed whole milk are less prone to scours than those fed milk replacer. Although it is common practice to feed mastitic whole milk to heifer replacement calves, recent evidence suggests that this could lead to an increased incidence in herd levels of mastitis in later years.

Whole milk and milk replacer can both be preserved by acidification for easier feeding management. Formalin can be added at the rate of 1–5 mL/L of milk or hydrogen peroxide at the rate of 5 mL/L of milk. Acidification can be achieved through adding 1.5 g citric acid/L of milk or including a buttermilk culture (or non-pasteurised yoghurt) to ferment the milk. If the milk is made too acid, calves daily intake will be reduced.

### 8.2.3 Milk replacer

To many producers, the decision on whether to feed whole milk or calf milk replacer (CMR) during rearing depends largely on cost. Sourcing a consistent quality of the milk replacer and its convenience for feeding are other factors influencing its use. Some farmers are concerned with the marked variation in milk replacer quality from batch to batch. Even though whole milk may be cheaper, it may not always be readily available for feeding to calves. For example, the calf feeding area may be some distance from the milking parlour. The composition of calf milk replacers and their feeding value relative to whole milk is discussed in Chapter 9.

## 8.3 The choice of feeding methods

To easily identify animals requiring extra assistance when drinking, young calves should be run together in small groups of no more than six calves. Some producers like to crate or tether their calves individually for the first few weeks to ensure all animals are drinking and for ease of observing signs of disease or poor performance. This also prevents the spread of disease between animals and, more importantly, between older and younger calves. This will also reduce the incidence of pizzle (or ear, navel and udder) sucking, which often occurs in very young calves run together in groups.

Running calves into individual stalls just for bucket feeding eliminates any problems of fast drinking calves poaching milk from other buckets. The use of self-closing yokes is an alternative method. Small or timid calves should be given the same opportunity to drink similar volumes of milk as bigger or more aggressive animals.

There are a variety of systems used for feeding whole milk or milk replacer. All will produce good calf growth and weaning weights if followed correctly. The major difference between any two systems is usually the result of the calf rearer rather than the system. Calves can drink from individual buckets or from communal troughs with or without rubber teats.

Buckets remove competition between calves for drinking space. By using one bucket per calf, each animal can receive a measured volume of milk, thus ensuring even milk intakes and calf growth rates. Small calves and timid drinkers can be given preferential treatment. However, labour requirements are higher and it is more time consuming than communal troughs.

To ensure the oesophageal groove will function properly and direct the milk to the abomasum, place the base of the bucket at least 30 cm above ground level where the calf is standing.

Troughs allow for feeding anywhere on the farm and not just in calf sheds. However, there is less control over individual milk intakes because calves drink at different rates and more aggressive calves have the advantage. Calves should be started on buckets then confined to a small yard to feed for a few days until they get used to trough feeding. Groups of calves will have more uniform growth rates when matched for drinking speed than for age or size. Each animal should be allocated a feeding space of 35 cm or, if using rubber teats, one teat per calf.

One innovative calf rearer in northern Victoria has modified 45 cm metal pipes into a series of troughs to ensure calves drink the same quantity of milk. He uses individual feeding stalls to allow only one calf per 35 cm space. Metal partitions have been welded into the pipe, limiting the volume of milk available to 4 L/calf (for once daily feeding). The trough rotates, so that when the milk is poured into it, it fills each compartment very quickly. He then rotates the trough upwards into the feeding position with a handle so the calves can drink their share of milk in whatever time it takes them. He has four feeders, allowing him to feed 80 calves in just 4 min. The troughs are easily cleaned with water and then rotated to empty and dry out.

Rubber teats give no additional nutritional benefit over bucket feeding because the speed of drinking milk has little effect on its utilisation. However, the production of saliva is greater in teat-fed calves and it may help maintain fluid intake in scouring calves. Teat feeding has also been shown to reduce the incidence of pizzle sucking in calves housed in groups. More capital is required in setting up the system and more labour is required for feeding and cleaning. Farmers often needlessly replace worn teats, but, as long as the teat can be kept clean, it does not matter if the end has been chewed off.

Farmers often prefer using teats into buckets because of the ease with which calves will learn to drink from teats. To many calf rearers, it seems illogical to provide both a teat and a bucket for each calf during milk rearing, because it doubles the cost of feeding equipment, greatly increases the time calves take to drink their allocated milk, then

requires more labour to clean the equipment after use. Furthermore, it is easier for faster drinking calves to poach milk from their pen mates simply by pushing their mouth away from a teat than pushing their head out of a bucket. Calves can consume 4 L of milk from a bucket in less than 30 seconds compared with more than 1 or 2 min if using teats.

One way of feeding calves in groups using teats is with a suckle bar. This can be made from 50 mm PVC piping fitted with milk line entries and self-closing teats. Milk is poured into one end and sucked out by the calves. It saves carting milk and is easy to wash.

'Calfeterias' and feeding drums are used with rubber teats and can feed large numbers of calves quickly. Because the milk can always remain covered they can be fed away from shelter. The calf controls the amount of milk taken per feed so scouring is usually reduced as long as the total milk provided is consistent. They can then be used for *ad lib* feeding.

With calfeterias, the teats are either positioned in a metal frame, which is attached to the top of the milk reservoir with plastic tubes to draw milk from inside the reservoir, or the milk reservoir allows the milk to run into the teats by gravity. Modern calfeterias are made from moulded plastic to provide a reservoir of 2 or 4 L per teat. The teats in feeding drums are positioned around the top of the drum, while the plastic tubes nearly reach the bottom of the drum. The residual milk that cannot be sucked up into the tubes is usually left to ferment naturally.

Provided the milk is regularly stirred, the feeding drum only requires cleaning out once or twice each week. Even if the milk becomes excessively thick, cutting the ends off the teats will allow the calves to continue to suck up the milk. The milk must be stirred every day to ensure that it does not separate into a watery layer at the bottom with most of the protein and fat floating on the top. The tubes must also be regularly checked for blockages and build-up of milk deposits.

It is preferable to provide one teat per calf, although one teat for every two to three calves can be used with *ad lib* milk feeding. It is important to group calves on age and size to reduce competition if providing fewer teats than calves. Carefully watching of calves at feeding will soon identify the dominant animals and whether there are sufficient teats available. Poor 'doers' can be moved back to a lighter group of calves to improve their competitive ability. Groups should not exceed 20 calves (if using a 200 L drum) and the age range should be no more than 3 weeks.

Some calves, particularly younger ones, may lose interest and stop sucking before they get any milk. This problem can be overcome with self-closing teats or providing a pressure head of milk behind the teats; for example, the drum could be mounted on a stand and some teats positioned part way down the drum.

Suckling of milk directly from cows will be discussed later in this chapter.

### 8.3.1 Automatic calf feeders

In recent years, automatic calf feeding (ACF) machines have become popular on many large-scale calf-rearing operations. Calves can enter and leave the milk or concentrate feeding station at will, but their feeding regime is controlled by computer technology. Each ACF machine can handle four teats and/or concentrate dispensers, thus allowing up to 100 calves to be reared in a single group. They are promoted as labour-saving devices

that can provide for a more carefully controlled milk feeding program. Each calf is individually identified to allow its milk feeding regime to be controlled by pre-determined programs of daily milk allocations. Some machines also allow for controlled concentrate feeding as well. The pros and cons of ACF are summarised in Table 8.1 (Moran 2006).

ACF technology is not cheap, because, as well as the initial capital investment of the machine and associated computer software, each calf will require an electronic ear tag and the calf-rearing shed has to be modified to hold larger groups of calves. Because calves can be reared in large groups, extra surveillance is also required to minimise issues with animal health and behaviour. The costs and benefits of ACF are summarised in Table 8.2. Their potential for integrating into calf-rearing systems in tropical Asia will be limited by the relatively low cost of farm labour and the need for extra management skills.

## 8.4 How much milk to feed

The major aim of calf rearing is to develop the rumen by manipulating intakes of liquid and dry feeds to the stage where calves can make efficient use of forages. The quantity of milk fed and the rearing system adopted should take this into account, while maintaining a balance between acceptable growth, cash cost and labour input.

As discussed in Chapter 3, the more milk fed to calves, the less solid feed and the slower the rate of rumen development. Because milk is a high-quality feed, the more milk drunk, the faster the growth rate. However, the efficiency of converting this milk to live weight declines as intakes increase. When fed *ad lib,* 6-week-old Friesian calves can drink up to 12 L/day, and Jerseys up to 9 L/day, of whole milk. By the time the calves reach 6 months of age, any live weight advantage in calves previously fed *ad lib* milk, compared with restricted milk, is lost.

With access to concentrates and good-quality forages together with once or twice daily feeding of 4–5 L of whole milk/day, Friesians should reach a suitable weaning weight (70 kg) in 9 weeks and Jerseys (60 kg) in 10–12 weeks. Many farmers still use live weight as their major criterion for weaning, often feeding more milk than is really necessary.

Although *ad lib* milk feeding is more expensive than other rearing systems, this system is often justified through faster growth rates and lower labour requirements, if using drum feeding. Earlier weaning compensates for the greater milk intake of *ad lib* fed calves and advocates of this system argue that it uses only slightly more milk over the whole period compared with restricted milk feeding. Provided that there are no setbacks to growth, weaning can occur at 6 weeks of age. Some farmers claim to be able to wean such young calves directly onto pasture, but it unlikely that rumen development would be sufficient and a severe growth check would be likely. If considering such a rearing system, calves would have to be fed 0.5–1 kg/day of concentrates at least until they are 10 weeks old.

Many experienced calf rearers in Australia initially feed milk twice daily at 10% the calves' live weight for the first few weeks and provide fresh concentrates and drinking water each day within the first week of age. This ensures each calf has a 'good start to life', with high immunity to diseases and a positive energy balance. Only then will the

**Table 8.1.** Pros and cons of automatic calf feeding (ACF) machines

| Pros | Cons |
|---|---|
| **Cost and labour issues** | |
| Reduces labour input for milk feeding calves | Are expensive to purchase |
| Reduces area required for housing calves | Requires reliable supply of clean water |
| Rearer not faced with many hungry calves on entering shed each morning | Requires water-resistant power outlets (up to three per feeding unit) |
| Calves don't crowd around rearers when they enter yards | Requires good floor surface and drainage around feeding units |
| Less physical work involved in calf rearing | Labour still required for daily operation, cleaning and maintenance of ACF |
| Evens out work load during day | Need calibration with every new batch of CMR |
| Reduces human error in calf rearing (milk volume, temperature and concentration) | Need correct program settings |
| ACF machines generally feed calves more accurately than humans | |
| **Rearing management** | |
| Provides flexibility with milk feeding program, such as reducing intakes of milk or pellets at pre-determined stages | Calves are in larger than optimal group sizes |
| Can identify many (but not all) sick calves from reduced milk intakes | Requires greater surveillance of symptoms of poor calf health |
| Provides good performance data on each calf | Sick calves can more easily spread infections through contaminating teats |
| Can automatically weigh calves | Sick calves can more easily spread infections because of larger group sizes |
| Do calves really need warmed milk? | Must group calves on age or size |
| Allows easy tracking of calf performance, particularly important with employed labour | Must still routinely check calves several times each day |
| Can feed different levels of milk in same pen | Because calves are never fed to appetite at one feeding, rearer may become unduly concerned about calf appearance |
| **Managing the weaning process** | |
| Can computerise (hence standardise) weaning process based on pellet intakes | Some calves may be less inclined to eat pellets because they never really become hungry |
| Most calves more readily eat pellets than when teat fed (same when comparing manual bucket versus teat feeding) | Very young calves may not take to pellet dispenser easily, hence require pellet trough in pens as well |
| Calves may reach target pellet intakes for weaning earlier than in current system | Some calves may not reach target pellet intake for weaning until later than in current system |
| Individual calves can be weaned on their own performance | |
| **Specific ACF issues** | |
| Allows non-dairy farmers to enter calf rearing | Some computer skills required for correct usage |
| Once established, ACF technology makes it easier to rear more calves, hence potentially value add to a wasted resource (namely bobby calves) | Must routinely calibrate ACF for correct water and powder dispensing |
| | Powder measured in volume not weight, therefore could be inaccurate |
| | Some brands do not self clean, so extra time required for cleaning |
| | Need to train calves to take to teats without coaxing |
| | Rodents may live in ACF when not in use |

**Table 8.2.** Associated costs and benefits of automatic calf feeding (ACF) machines

| Costs | Benefits |
|---|---|
| Capital cost of basic ACF machine | Savings on labour costs |
| Capital cost of additional features | More controlled, easier weaning process |
| Durable flooring and drainage around each unit | Reduced shed space |
| All weather power supplies to processor, teat and concentrate feeders | Reduced purchases of manual milk feeding equipment |
| Increased cost of CMR and milk (if greater) | Reduced costs of CMR and milk (if less) |
| Higher animal health costs (if greater than with manual rearing) | Reductions in animal health costs (if lower) |
| Long-term adverse effects of poor calf performance (if poorer) | Long-term benefits of good calf performance (if better) |
| Cost of electronic ear tags (now compulsory with calf rearing) | |
| Annual maintenance costs of ACF equipment | |

farmers restrict the milk or feed it once each day, which will stimulate concentrate intake and allow for a successful early weaning program.

As the sale value of whole milk or the purchase cost of milk replacer rises, there is increasing pressure for low-milk-feeding systems that still maintain good growth rates to achieve early weaning. This is possible by feeding only 4 L of milk/day, *ad lib* concentrates from the first week of age together with low-quality roughage. When calves are eating 750 g to 1.0 kg/day of concentrates, milk feeding can cease. This can occur between weeks 5 and 6. As with any system, milk feeding can be stopped abruptly or reduced steadily over the last week.

The quality and the palatability of the concentrate is the most important single factor in this system. It should be coarsely ground or pelleted. Inclusion of molasses or a sweetening agent can improve its palatability. To encourage early consumption, a handful of the concentrate should be placed in the bucket once the calf has consumed all the milk.

Ideally, calves should be individually penned until weaning because every calf should drink only 4 L of milk every day and increase concentrate intake to about 750 g to 1.0 kg/day before it can be weaned. If the calves are group fed such that the dominant calves consume more than their allocation of milk, they will appear more developed, but their rumen will be smaller and they will eat less concentrates than other smaller calves only drinking their milk allocation. Therefore group feed intakes are not a reliable indication of individual intakes.

After weaning, consumption of concentrates should increase to 2 kg/day until the animals are 3–4 months of age. Concentrates can then be gradually withdrawn, provided good pasture or forages are plentiful. This early weaning system is low cost and has minimal labour requirements once milk feeding ceases.

The total amount of whole milk fed during rearing can vary from more than 550 L of milk with *ad lib* feeding with no concentrates down to only 150 L plus 80 kg of concentrates with restricted once daily feeding. The implications of the threefold range in milk intakes at various milk prices will be discussed in Chapter 15.

### 8.4.1 Benefits of feeding large quantities of milk

Despite the more rapid gains achieved with feeding higher amounts of milk or milk replacer, there is little economic benefit from the more rapid growth rates and higher feed conversion efficiencies (Davis and Drackley 1998) in dairy heifers. In animals raised for meat production however, this can reduce time to market weight, hence improve economic returns. Such 'accelerated growth programs' also have a goal of earlier calving age (say at 18–20 months of age), but these programs rely on exceptional management.

### 8.4.2 Specific decisions for the tropics

Decisions on the most suitable milk-rearing systems for calves often depend on local circumstances. For example, in regions where ghee or butter is produced, skim milk and milk substitutes are becoming increasingly available in the tropics as livestock feed industries develop. What must be remembered is that the environment in most tropical countries is more hostile for the dairy calf than in temperate regions and that it is more economic to spend additional money on calf rearing in order to reduce calf mortality and increase live weight gains. It must also be remembered that most dairy calves in the tropics, whether from *Bos indicus* or *Bos taurus*, are smaller at birth and grow more slowly than they would in the temperate zones. Thus temperate feeding standards are not completely applicable in the tropics and, if adhered to, may lead to some overfeeding of calves.

Typical tropical dairy calves would weigh 20–27 kg at birth and during their first week should be fed no more than 2–3 L of milk/day. By the fourth week, this can be increased to 3–4 L of milk/day. Heavier calves should be fed correspondingly larger quantities. However, it is likely that the amount of milk should never exceed 4–5 L/day, because calves will begin to eat concentrates and forages in increasing amounts as they grow older. Calves should have continual access to good-quality drinking water.

A calf suckling her dam prior to it being milked.

In the tropics, it is probably more economic to feed calves on additional milk than to attempt to early wean them at say 5–6 weeks of age. There are obviously many compromises with managing dairy calves in the tropics and 10 or even 12 weeks of milk feeding is more the norm.

## 8.5 Weaning age

The optimum age to wean calves off liquid feeds depends on many factors. These have been discussed above and in previous chapters. The most important factor is to ensure calves will continue to grow well once the primary site of feed digestion changes from the abomasum (for milk) to the rumen (for solid feeds). In other words, the calves have become fully functioning ruminants.

The age when milk is no longer fed should also depend on the quality of feeds available post-weaning. For example, Ibrahim (1988) suggested calves should be weaned at:

- 2 months, when the quantity and quality of roughage and concentrates are good
- 4 months, when the quantity and quality of roughage and concentrates are average
- 6 months, when the quantity and quality of roughage and concentrates are poor
- 8 months, when suckling and cows are dried off.

## 8.6 Other aspects of milk rearing

### 8.6.1 Milk temperature

The most natural way to feed calves is to teat-feed the milk at 39°C twice daily. Milk temperature is not important provided it is consistent from day to day. One exception to this would be feeding sick calves in winter, where they would have to use their own limited body reserves to reheat the milk in their digestive tract. It is certainly easier to train young calves to drink warm milk, after which it could be changed to cool milk. Very cold milk, removed directly from the milk vat, should be warmed, but only using small volumes of hot water prior to feeding. If the milk is too diluted, it may not clot in the abomasum, thus leading to digestive problems and possibly nutritional scours. If the milk is diluted, ensure that the calves are still offered the same quantity of whole milk.

### 8.6.2 Feeding frequency

Twice daily feeding is still the normal routine on many Asian dairy farms, but once daily feeding commencing after the first few weeks of life is adequate. Calves grow equally fast on either frequency when fed the same level of milk each day. Because the competition for milk may be stronger with once daily milk feeding, it is essential that each calf gets its fair share of milk. Correct grouping of calves is very important if feeding from a communal trough, as is at least one teat per calf if using rubber teats.

It is important to provide access to concentrates within the first week and to ensure it is fresh each day. Clean water must also be on offer because calves will drink more water

than when fed twice daily. It is possible to strengthen milk replacer mixtures (that is, use less water in their formulation) to ensure smaller calves can still consume enough nutrients when fed the larger volumes once daily.

Calves fed only once each day will eat more concentrates at an early age because they have more time to get hungry and seek out other feed. Furthermore, calves can be fed at the most convenient time of the day, rather than after morning and afternoon milking, as is necessary when feeding twice daily. Once daily feeding should not reduce the frequency with which calves are inspected.

### 8.6.3 Milk dilution

Farmers sometimes dilute milk, either to warm it or as part of a treatment for scours. Dilution of milk or milk replacer reduces the intake of nutrients due to the calves' limited gut capacity. Some farmers even dilute milk when weaning calves so the animals will have the same volume but less milk solids. Calves can, in fact, be abruptly weaned off milk with no serious after effects.

The clotting of whole milk in the abomasum can be reduced in calves fed very diluted milk. Apart from warming very cold milk prior to feeding sick calves, there seems to be little benefit for calf feeding in diluting whole milk or reducing the concentration of CMR below that recommended on the bag.

### 8.6.4 Antibacterial residues

It is essential that calves sold for slaughter do not contain any antibacterial (or antibiotic) residues. Baby calves destined for slaughter at a week of age should not be fed milk from cows treated with antibiotics unless the required withholding period for each chemical is strictly observed.

The withholding period is the time following treatment, during which products derived from any treated animal should not be used in food production. This varies for particular drugs, with the route of administration into the cow (injection, oral or intramammary) and the dose rate. For most antibacterials, the withholding period for sale of milk is considerably shorter than that for sale of meat, which can be up to 30 days from administration. To be on the safe side, consider 30 days as the minimum withholding period for calves fed milk from cows given intramammary drug treatment.

Antibacterial compounds get into calves from four main sources:

- sick calves that have been treated, usually for scours
- healthy calves that have been fed using equipment contaminated with antibiotics
- calves suckling cows that have been treated with intramammary preparations or by injection
- calves consuming antibiotics through suckling cows that still contain 'dry cow therapy' preparations at calving, usually due to failure to massage the preparations into the udder when initially administered, or if the cow has only had a short dry period.

Calves that are intended to be reared as replacement heifers, but fail to thrive, are often sold along with other bobby calves. These calves are a particularly high risk group for antibacterial residues because they will often have been treated for some illness.

Calves are often sent to slaughter within days of being treated for scours with antibiotics or sulphonamides. In many cases, treatment with an antibacterial drug may not be necessary. Electrolytes, glucose and fluid replacement are the important components of an effective treatment for scours in calves. Antibiotics and sulphonamides should only be used on the advice of veterinarians, and withholding periods are as long as 28 days for some sulphonamide calf scour tablets.

### 8.6.5 Feeding mastitic milk

Milk from cows after antibiotic treatment for mastitis or other bacterial diseases cannot be sold and must be discarded. Estimates in the US are that this can amount on average from 20 to 60 L/cow. With the high incidence of mastitis in tropical small holder systems, this volume would be even higher in Asia. Feeding this milk to calves is one way to capture some economic value from an otherwise wasted resource. This milk is sometimes called 'blue milk', because of the blue dye used in intramammary mastitis treatment to colour the milk as an additional reminder that it is contaminated and should not be mixed with the market milk.

Controversy still exists as to whether feeding this milk to replacement heifer calves increases their likelihood to mastitis in later life. If calves are individually penned, there is no evidence of increased mastitis. The antibiotic does not adversely affect milk digestion, increase the likelihood of greater antibiotic resistance in future disease outbreaks nor have any long-term detrimental effects on production or health. There is conflicting evidence on the potential of mastitis bacteria to increase the incidence of future mastitis in group-fed calves that can suck the developing mammary glands of other heifer calves. For this reason, farmers may wish to discard it or feed it to male calves.

Mastitic milk should not be fed to sale calves without due regard to the withholding period of the antibiotic. Calves should not be fed milk from cows with mastitis caused by *E. coli* or *Pasteurella* unless it has been pasteurised.

Concerns about viable pathogens in waste milk have led to large dairies in the US installing pasteurisation plants to treat all whole milk to be fed to calves. An assessment of the costs and returns indicates that such plants would need to be used to feed 300–400 calves before becoming economically feasible.

### 8.6.6 Labour

One of the major factors influencing the choice of feeding method is its labour requirement. The time taken in milk feeding and washing can vary from half to 3 min per calf per day and even longer in inefficiently run systems (Moran 2002). One of the quickest systems involves *ad lib* feeding of naturally fermented whole milk from a series of feeding drums or troughs for large numbers of calves run together in a paddock or pen. In contrast, twice daily bucket feeding of milk replacer for small groups of calves in a shed is one of the slowest.

If feeding time can be reduced by 1 min per calf on a farm rearing 60 calves, that amounts to 1 hour less labour each day of rearing. Remember that reducing milk feeding to 5–6 weeks rather than the more usual 8–10 weeks also considerably reduces the total rearing time per calf.

### 8.6.7 Pizzle sucking

The problem of pizzle sucking can be common among artificially reared calves. Young calves are instinctively curious and, as well as drinking, eating and ruminating, they use their mouths for all sorts of apparently abnormal behaviour such as licking and chewing inedible (or unswallowable) objects, sucking the ears, navels, teats, tails and pizzles of neighbours, and even drinking urine.

Cross-sucking is a potentially dangerous way of spreading infection, while urine drinkers tend to show abnormalities of rumen development. In intensive rearing systems such as group-fed veal production, these calves invariably show slow growth and poor feed efficiency.

The incidence of calves sucking each other can be reduced by providing greater opportunity for them to satisfy this desire, such as feeding with rubber teats rather than buckets and using *ad lib* feeding drums or automatic milk feeders to give calves continual access to milk.

Hanging a piece of chain in the pen of group-housed calves may also be effective. Pizzle-sucking calves can be individually penned or tethered during milk feeding then offered concentrates immediately they have finished their milk allocation.

### 8.6.8 Trying out a new system

Whenever farmers visit other farms, they generally look to see how 'things are done' and may consider changing their practices to include any potential improvements they have seen. This is fine as long as they can be confident it will improve productivity and profitability on their farm, or maybe even 'make life easier'.

When considering changing some aspect of calf rearing, rearers have an ideal opportunity to closely compare the 'old' with the 'new'. They should be encouraged to change practices in just one or two pens and see how the calves perform in comparison with their existing system. But they must make sure they are comparing 'apples with apples'. For example, if changing to an early weaning system, it would seem logical not to compare calves at different weaning ages, but at the same age, when their rumens are fully functioning. Using live weight at 12 weeks, or even older, is the best way to compare different milk feeding practices.

## 8.7 Multiple suckling using dairy cows

The cheapest way of feeding whole milk to calves is to allow them to harvest it themselves by suckling cows. The ratio of suckler or nurse cows to calves should be adjusted so that each calf receives at least 4 L/day of milk. The milk production of the nurse cows should then be checked to ensure adequate milk supply for her calves.

Once one batch of calves is weaned off the cows, another batch can be multiple suckled. Growth rates of suckled calves are as good as, or even better than, those achieved with artificial rearing but they can be more variable because there is less control over individual calf intakes. There is a serious risk of infecting calves with certain diseases carried by cows. Multiple suckling should not be used for rearing heifer

replacements on dairy farms where Johne's disease has been identified or where there is a high threat of the disease. *Coccidia* and *Salmonella* organisms can also be transferred to calves through close contact with mature cows.

Obviously, cows with active mastitis infections should not be suckled because calves can transfer the mastitis-causing organisms to other teat quarters and also to other cows. However, mastitic cows destined for sale could be used to foster bull calves for meat, provided the infected cows are isolated from other cows.

Nurse cows and heifers generally produce more milk, while heifers can reach peak milk yields quicker than if hand or machine milked. Research has shown that cows foster rearing two or three calves for the first 8–12 weeks of lactation often produce more milk when returned to the milking herd than cows run in the herd from calving. Nurse cows also seem easier to break into the shed routine after a short period of suckling.

There are two types of systems for multiple suckling: continuous or foster suckling and restricted or race suckling.

### 8.7.1 Continuous suckling

This involves fostering extra calves with the cow's own calf. All calves should be matched for age, size and vigour. A proportion of cows will not adopt other calves, and such calves will steal milk from more cooperative cows. This will reduce their milk supply to their own foster calves and can lead to variable growth rates in both groups of calves. In one instance, nurse cows rejected foster calves and, probably due to an increase in milk supply, her own calf died from scours.

For continuous suckling to work, each cow and her adopted calves must become bonded as a family unit so that the nurse cow will accept all her own foster calves, but still reject others. Once this bonding has been established, it is difficult to introduce a new calf into the family, for instance, to replace one that had died.

To help develop this bonding, the cow and calves should be kept together in a small paddock for about 10 days and the cow should be restrained in a race or bail daily for 3 days at feeding to make sure all her calves have been accepted. It is sufficient to starve the foster calves for about 24 hr and then constrain the cow, unmilked for about 12 hr, with the calves for an hour each time. Other mothering systems involve keeping the calves in small pens, then locking the cow in with her calves for an hour or so every day for the first week.

It can help if the nurse cow becomes confused after calving about which is her own calf. It can be removed and replaced with other calves that have been smeared with a strong smelling substance, such as neatsfoot oil, which has been placed on the cow's muzzle and also on her own calf. Some farmers use rope or a swivel chain and collars to tether one or two foster calves to the cow's own calf for a few days; in this case, the calves should be no more than 30 cm apart.

To maximise growth and rumen development, the calves can be given access to quality feed (grass and/or supplement) by creep grazing using electric fences. When weaning some calves early, they must be the adopted calves because the nurse cow could reject them if her own calf was removed first.

Foster suckling has the advantage that the cows can be run away from the dairy, leaving closer paddocks for the milking herd. It also allows the continued use of good

breeding cows past their prime as milkers, low-testing cows or cows that do not fit the daily routine (for example, because of temperament or milking speed). Such cows have been known to milk for 18 months and rear a dozen or more calves. However, their calves tend to become wild because of lack of regular human contact and they may be difficult to train for milking. Nurse cows are less likely to cycle and this increases the spread of calving in seasonal calving herds.

### 8.7.2 Restricted suckling

The second system involves separating the calves from the cows, except at milking time when they are brought together in a small yard or in a suckle race. Up to four calves can suckle any one constrained nurse cow. A suckle race will restrict movement of cows better than a yard and hence allow smaller calves better access to available teats. The race can be made of 50 mm galvanised pipe construction, 75 cm wide, with one rail each side 76 cm off the ground. Moveable pipe barriers can be inserted into the race every 1.8 m to separate the cows. The floor should be concreted for at least 1 m outside both sides of the race to prevent the ground from becoming boggy.

To minimise teat damage, suckling should be limited to 15–20 min per session and cows should only be suckled for 3–4 weeks at a time. All quarters of each nurse cow should be suckled dry. Scours can be more of a problem with suckled calves because of the increased likelihood of overfeeding. Hygiene problems are all eliminated because the milk is harvested directly from the cow. It is important to group calves on age and size to reduce competition. With very high-yielding cows and large numbers of calves to rear, it is possible to divide the calves into two groups and feed each group only once each day.

There may be little saving in labour compared with artificial rearing because calves have to be brought from the paddock or calf shed to the milking parlour each time. Cows have to be selected – such as mastitic and freshly calved cows – and then drafted from the rest of the herd. Some cows are difficult to train to accept calves, such as those that continually kick. Others are better suited for restricted suckle rearing than for machine milking, such as cows with three functional teats, poor udders or slow milkers. Cows can also be rotated between the dairy and the suckling race and still run together in the milking herd. Because nurse cows produce more milk, they could lose more weight in early lactation and hence may require better feeding than those being machine milked.

Variations to this system are to allow the cow's own calf to suck her dry after each machine milking for the first week after calving. Alternatively cows and heifers can be race suckled each afternoon by fewer calves and then machine milked each morning. These variations prevent milk accumulation in the cow's udder, which can have a detrimental effect on yields later in lactation, while rearing several calves. The improvement in milk yield after these calves are weaned generally compensates for the milk previously taken by the calves.

Nurse cows do not begin to show oestrus after calving as soon as cows that are machine milked. To maintain a 12-month calving interval, calves should be removed from the cow for 24 hr about 8 weeks after calving. Cows will normally show signs of oestrus within the next 7 days and can be mated at this or the next oestrus 21 days later.

Early weaning requires strict rationing of milk, so it may be difficult to combine this with multiple suckling. However, this can be done successfully by 5 weeks of age by

gradually reducing either the time of access to the cows or the number of nurse cows. Calves should be weaned onto good-quality pasture together with 1–2 kg/day of concentrates. The protein content of the available pasture should determine whether the concentrate is boosted with additional protein or is basically an energy supplement.

### 8.7.3 Combining restricted suckling and hand or machine milking

This is a popular way to rear calves in many tropical countries, particularly those in Central and South America. It is common for farmers to use dual-purpose cows and bulls to provide farmers with a good milk income as well as rearing a beef type calf with a good market value. On small holder farms in Thailand and Africa, calves milk reared with restricted suckling grew faster, used their milk more efficiently and had fewer health problems than did those bucket reared. Furthermore, the suckled cows produced more milk and had less mastitis than cows milked out by hand or machines.

However, this practice can be associated with an increased number of days between calving and first oestrus. It is often considered that milking cows with a relatively high degree of Zebu breeding require the presence of a suckling calf to initiate milk let-down. Therefore, there seem to be many benefits of rearing calves using restricted suckling. Indeed, this is often the norm on South American dairy farms, where dual-purpose cows are milked.

However, there are high labour requirements to match up cows with their calves prior to milking and the commercial value of whole milk is generally higher than for CMR. This means that suckle rearing is less practical on most Asian SHD farms, where many of the milking cows are grade Friesians that can easily let down their milk without the presence of a suckling calf. Even with purebred Zebu milking cows, it is possible to machine or hand milk them in the absence of a calf, through training the cows and culling those cows (say at the end of their first lactation), which will not let down milk without a calf present. Concern about poor milk let-down in the absence of any suckling calf has led farmers to use oxytocin injections routinely at every milking.

### 8.7.4 Pros and cons of restricted suckling versus artificial rearing

Pros:

- more milk is extracted with suckling
- the milk has a higher milk fat content
- reduced mastitis
- calf behaviour is considered to be more ‘normal’
- will this milk be otherwise extracted and sold?

Cons:

- delayed oestrus unless better feeding management (due to live weight loss/reduced body condition or entirely nutritional)?
- increase in daily labour and management
- because calves are generally grouped, rather than individually reared, they require increased disease surveillance.