

7

Cow comfort

This chapter discusses cow comfort, what it is and how it is influenced by shed design and other physical facilities on the farm.

The main points of this chapter

- There are various definitions of cow comfort and these range from the cow's comfort zone or zone of thermoneutrality, to their physical environment or ability to do what they want to do and when they want to do it. The most complete definition is the cow's overall wellbeing that takes into account their psychological as well as physiological needs.
- A comfortable cow is then 'at peace' with her perception of the world.
- Cow comfort for walking, standing, exercise and lying are the keys for healthy and mobile cows and studies have shown that up to 20% of the cow's potential is determined by how comfortable she is and whether her demands are met.
- Daily time budgets for productive milking cows should allow for 12 to 14 h resting, including at least 6 h rumination, 5 to 6 h eating with 9 to 14 meals per day and 2 to 3 h standing and walking in alleys.
- To achieve cow wellbeing, farmers must address the twin issues of housing and management, where management covers all the normal farm practices associated with dairy farming. Ideally, the farm's physical facilities should be optimised before putting the cows in the shed.
- One of the most controversial aspects when confining cows to a shed is the type of stalls they are provided with. Tie stalls are the most common

in Asia – they are purely for the convenience of the farmer. In more developed dairy industries free stalls are the most common for shedded cows, because cow comfort is given a higher priority (and this results in higher yields).

- With tie stall systems, each cow is restrained in a separate stall. Tie stalls restrict normal behaviour and the opportunity for social contact. They limit the ability for each cow to self-groom, and all too commonly are associated with poor hygiene and uncomfortable lying surfaces. Boredom and frustration often lead to abnormal stereotypic behaviours.
- Tie stalls are *not* appropriate for the optimum wellbeing of milking cows and these conditions can negatively affect milk yields and cow longevity.
- When well-designed and managed, free stalls provide the ideal system for intensively managing dairy cows off pasture as each animal is provided with a specific place to rest, their management (feeding, cleaning and relaxing) is potentially optimised and the system can operate efficiently with minimal labour.
- Stall dimensions (to match cow size), the base material, type of bedding and manure management are the key factors in optimising stall usage.
- Other important facilities to incorporate into cowsheds include fans and sprinklers, hospital and isolation pens for sick animals, calving down pens, bull holding and mating pens, cattle race and crush and footbaths.
- For larger-scale dairy farms, cow comfort can be improved with rotating cow brushes, automatic cow showers and self-locking gates.
- This chapter concludes with plans and pictures of two ‘animal friendly’ small holder cow sheds.

The challenge for modern dairy production is the maintenance of healthy, long living cows with a high level of performance. As cows produce more milk, they become more sensitive to their environment. If we succeed in transferring the natural conditions into the cowshed, which means adapting the cowshed to the animal and not vice versa, this is a step towards more profitable dairy production with healthier animals.

7.1 Introduction

7.1.1 What is cow comfort?

There are several definitions of cow comfort.

- To many people, cow comfort simply refers to the climatic environment or the ‘comfort zone’. This is the zone of a cow’s thermoneutrality and is defined as the range in ambient temperature in which there are no measurable

fluctuations in the cow's physiological processes. In this situation the energy input to output shows good biological efficiency with all the body processes functioning in their expected ranges. For the milking Friesian cow, this occurs between 6 and 18°C.

- Others consider comfort to be more related to the cow's physical environment, or their ability to do what they want to do and when they want to do it. In particular, it should allow cows to have their 12 to 14 h rest each day, undisturbed by other stock and in comfortable stalls or other resting spaces.
- Cow comfort should also take into account their appetites for both water and feed. With regard to feed, it should satisfy the requirements for their current levels of production (both milk and if pregnant, the needs of the growing foetus) but its nutritive quality, within reason, need not be taken into consideration. With regard to drinking water, ideally cows should be provided with a continuous supply of clean, fresh, quality water.
- It is generally agreed that cow comfort should also be extended to the cow's overall wellbeing, this means covering their psychological as well as physiological needs. Cows should not be continually fearful, which (as described by Klindworth *et al.* (2003) in Chapter 4) is their natural response to real or perceived threats, and serves to protect them from danger.
- Therefore, the complete definition of cow comfort addresses climatic stress, poorly designed and constructed housing, stock facilities and the potential behavioural stress from herd mates and stock people. It could simply be defined as a cow being 'at peace' with her perception of the world.

A comfortable cow is one that is at peace with her environment, and therefore should respond well to more intensive feeding and herd management. As a cow's appetite should not be limiting, any resultant higher feed nutrient intakes should produce more milk and achieve the positive energy balance required to conceive her next calf. The simplest assessment of cow comfort is her potential appetite, in that, generally speaking, if she is offered more she will eat it. As the marginal efficiency of utilising additional feed nutrients to synthesise animal products all too often decreases with increasing intake (Moran 2005), cow comfort cannot really be defined in terms of production response to any extra feed.

7.1.2 Physical cow comfort

Taking into account whether or not a cow feels comfortable walking, standing, exercising and lying down is vital for healthy and mobile cows and studies have shown that up to 20% of the cow's potential is determined by their demands on comfort. With well-designed laneways and resting stalls, supportive lying surfaces and non-slip walking surfaces, cows suffer less lameness, can behave more naturally and experience less stress, and therefore have higher milk yields and longer valuable lives.

Walking

The hoof structure allows the blood flow in the claw to work like a sponge. Load presses the blood out of the tissue and when the pressure is released, blood (hence the supply of nutrients to the claw) re-enters the tissue. As the anatomy of the cattle claw is ideally designed for soft floors, the activity of cows' hooves doubles when on soft floors compared to concrete. Less movement on a hard surface can result in reduced blood flow to the hoof which then results in inferior hoof horn quality. In addition, cows are more likely to allow bulls to mount them on soft rubber compared to concrete, this means they have a shorter time to first breeding and fewer days open.

Standing

Unlike when at grazing, where cows are continually moving and thus redistributing their weight on each foot, cows are forced to stand still while feeding in the shed. In addition, cows stand in laneways, in their stalls and in the collecting yard while waiting to be milked. Cows need to be able to stand undisturbed such as when stretching after a period of lying down or if they prefer to ruminate standing up.

Exercise

Exercise decreases the incidence of leg problems, mastitis, bloat and for young stock, calf-related disorders. Outdoor exercise improves bovine health and wellbeing regardless of tie stall or free stall housing. Free stall housed cows with outdoor exercise have better claw health, suffer less from lameness, tarsal joint lesions, teat injuries and require fewer medical treatments. Providing a portion of the daily ration in an outdoor exercise area effectively doubles the amount of time cows can spend outdoors. Even small amounts of exercise can improve fitness via reductions in heart rate and plasma lactate levels. The rate of detection and the duration of oestrus are higher for cows on dirt yards or pasture than they are for cows on concrete.

Surface

A good surface provides even pressure distribution and good grip. On such a surface, cows take large strides, where their hind hoof steps into the print of their front hoof and their hooves rotate correctly while walking. On a good surface, animals do not slip easily and this makes them more peaceful and confident. They know that they can fight and flee safely. Being on a non-slip surface means that the cows more readily show signs when they are in oestrus. Their feed and water intakes will be better, as will their visits to the feed trough, stalls and to the milking area. They have less trouble with chronic hoof problems.

Lying

Cows should rest for 12 to 14 h per day in natural long lying bouts. It gives the hoofs a chance to dry out, which suppresses infections. Resting cows are out of the way, giving other cows more space to get to feed. Reduced total lying time or elongated lying periods are signs of inadequate lying comfort. Softer lying material (thick mattresses v thin mattresses and concrete) increases both lying time and milk yield. Cows that are lame have excessive lying times (> 14.5 h) and elongated lying bouts (> 90 min per bout).

Tethering

Tethering restricts the time cattle spend lying down for the first few weeks, when they display more intention movements but few actual bouts of lying. In the long term, the time spent lying may increase with tethering due to the forced inactivity. Compared to free stall and loose housing, stress levels are increased by tethering. The increased lying time is likely to stress the joints of tethered cattle and a significant proportion show swollen joints. Cubicle systems for loose housing are less damaging to cattle welfare than tethering systems, but the time that cows spend lying in cubicles is still less than in pens with deep straw bedding. High stocking rates of loose cows in straw yards or open yards should be avoided as they prevent cattle both synchronising their lying behaviour and lying for their preferred time.

Cows seek their own level of comfort and they should be provided with a relatively clean dry area in which to lie down. It should be conducive for cows to lie for as many hours of the day as they desire. There should be enough stalls or space so cows do not have to wait when they want to lie down. For every hour resting above 7 h, cows can produce up to an extra 1 kg milk. Blood flow to the udder, which is related to the level of milk production, is substantially higher (20 to 30%) when cows are lying down than when they are standing.

A daily time budget for a typical milking cow in a free stall shed in the US is:

- Eating: 5.5 h/day with 9 to 14 meals/day
- Resting: 12 to 14 h/day, including 6 h rumination
- Standing or walking in alleys: 2 to 3 h/day, which includes grooming, rumination, socialising and other activities
- Drinking: 0.5 h/day
- Total time needed: 21 to 22 h/day.

This indicates that cows have little time to spare, so time away from the pen should be minimised and this includes visiting the milking parlour generally twice daily.

Heat stress affects cow comfort and productivity. Milk production during hot weather can be improved by installing sunshades, sprinklers and fans, as well as by

dietary modifications. Within temperate dairy breeds, Jersey and Brown Swiss tolerate heat stress better than Friesians. In one free stall shed in Indiana, in which sprinklers and fans were activated at 21°C, cooled cows produced 36 L/day of milk compared to only 32 L/day in uncooled cows.

7.1.3 Building for the cow

It is essential that when designing housing systems, farmers keep the following key principles in mind:

- To achieve cow productivity, farmers must address the twin issues of cow comfort and health, where health is the freedom from infections, injuries and metabolic problems.
- To achieve cow wellbeing, farmers must address the twin issues of housing and management, where management covers all the normal farm practices associated with dairy farming.
- Addressing cow comfort and housing means that the farm's physical facilities must be optimised before putting cows in sheds.

Cows grazing in a paddock have access to forage matter virtually all the time and to concentrates at least twice per day, at milking. These feeding goals should also be the aim when cows are maintained in sheds. They should be encouraged to make at least 12 trips each day from their place of rest to the feed and water troughs. This will only occur if cows 'feel good', have healthy legs and feet, and the route is safe and comfortable.

There are six key housing aspects of cow health and wellbeing, namely:

1. Access to clean, palatable water at least 21 h/d
2. Light with at least 6 h/d of darkness
3. Fresh and clean air
4. Rest, with a dry and comfortable place to lie down for at least 12 h/d
5. Space so cows can walk to feed and water troughs from their free stalls without fear
6. Palatable and well formulated feed, on offer for at least 21 h/d.

The remainder of this chapter discusses the physical aspects of ensuring cow comfort. Details of housing systems have been presented in a previous book (in Chapter 13 of Moran 2012a) so this chapter will concentrate on the stock welfare aspects of cow housing and present some examples of 'animal friendly' small holder cowsheds.

7.2 Stalls for shedded cows

One of the most controversial aspects when confining cows to a shed is the type of stalls they are provided with (see Figure 7.1). Tie stalls are the most common in



Figure 7.1: A traditional small holder dairy shed in Indonesia.

Asia, purely for the convenience of the farmer whereas free stalls are the most common in more developed dairy industries, because cow comfort is given a higher priority. Although they are usually associated with very large farms, free stall sheds can be designed for herds of any size as described later in this chapter. There are two basic types of housing systems, tie-up housing (tie stalls) and loose housing, which can either be with or without access to free stalls.

7.2.1 Tie stalls

With tie stall systems, each cow is restrained in a separate stall. Feed is delivered in a trough in front of the cows. Milking usually takes place individually in the stall, by hand or machine, the latter using either a bucket or a pipeline system. Manure is collected in a gutter behind the animal. With cows tied up all year round, they can suffer from foot problems and become stiff. Therefore, they should be provided with an easy to clean, soft surface on which to lie down, such as rubber mats or straw. Heat detection demands more attention in tie stalls and a high incidence of trampled teats can become another problem.

As far as the cow is concerned, tie stalls:

- are extremely uncomfortable and often have a hard surface.
- cause pain, with risk of inflammation of knees and hocks.

- are frustrating, because lying down with the head constrained is more difficult and the animal cannot lie down with a stretched foreleg or with its head tucked into its front legs.
- are boring, because they restrict any opportunity for social contact or interaction and foraging.
- restrict the ability for each cow to self-groom, particularly if the tether rope or chain is too short.
- reduce lying and resting time, which can lead to increased lameness.
- can lead to abnormal behaviour, such as swinging from side to side and shifting/moving back and forth. Many cows often stand in a dull state if not eating or otherwise stimulated.
- can lead to more frequent occurrences of stereotypical activities, such as bar biting or tongue rolling, which disappear when animals are transferred to loose housing.
- remove the ability for stock to find the best location in the shed for reducing climatic stresses.
- reduce the quality of the microclimate (higher relative humidity and air ammonia concentration and lower air movement), which can lead to reduced cow comfort and performance (Keidane 2007). As an example, one study (Kate Blaszac, personal communication) reported relative humidities of 94% in tie stalls compared to 74 to 84% in free stalls.
- are all too commonly associated with poor hygiene, meaning that the cow is forced to lie in her own manure, thus creating additional problems with animal health and milking hygiene, such as mastitis.
- can adversely affect reproductive performance, partly because cows cannot move freely and assist in identifying other cows on heat.
- can lead to higher teat injuries due to physical damage.
- can have dimensions that may influence cow behaviour, cleanliness and wellbeing.

If circumstances require that the animal is temporarily tethered, she should be tied with a halter and released as soon as possible. Nasal tying, that is threading a rope through a hole in the nasal septum, can cause irritation and infection. A temporarily tied or single housed animal must always be able to keep at least visual contact with her herd mates to lessen stress reactions. A mirror may even substitute for other cows, for a short time. Some behavioural scientists argue that cows in tie stalls are considered to have had regular exercise if they are released for just one hour per day for two days per week. But one could likewise argue that 'the more exercise the better'. The scoring system we have developed for cow welfare, described in Chapter 8 and Appendix 5, only provides points for good cow welfare if cows are allowed to move freely at least once each day.

If farmers persist with tie stalls, they need to pay closer attention to stall dimensions. Zurbrigg *et al.* (2005) noted that:

- shorter stalls are associated with more cows with dirty hind limbs and rotated hind claws. This is very apparent from several pictures in this book.
- low tie rails can lead to more cows with neck lesions and broken tails, the latter resulting either from the tail being stepped on or forceful manipulation by the farmer.
- short tie ropes or chains can lead to more swollen hocks and dirty hind limbs with cows struggling to stand and lie down easily.

In summary, tie stalls are *not* appropriate for the optimum wellbeing of milking cows and these conditions can negatively affect milk yields and cow longevity. Tie stalls have been the traditional method of maintaining dairy cows in some European countries for many decades. This has created so much public concern that certain countries, such as Norway, have recently legislated against their future use in preference to loose housing.

7.2.2 Loose housing

With loose housing, cows are not tied up and can walk around freely. Such systems usually have a loafing area and a lying area, with the feeding area separated from the lying area. As the cows are forced to walk frequently, the manure is spread over a large floor area so has to be collected by scraping the dung by hand (or sometimes mechanically) into a manure pit. With adequate water supplies, rapid flushing of large amounts of water can clean alleys, directing effluent into a pond. Milking is usually carried out in a specific milking parlour or area in the shed. The feed trough is separated from the loafing alley by either a feeding rack or wire rope.

Loose housing can be of two types, either with a common lying area with open lounging or with cubicles or free stalls.

- In open lounging systems, cows can lie down anywhere, although they are usually allocated a particular place to rest. The floor can be earthen or cement, generally with bedding material, the base being well drained. In dry climates, earthen floors without bedding can be used so long as the dry manure is frequently removed. The loafing area behind the feed troughs should be cement and at least 3 m wide. Each cow should be allocated at least 9 m² resting area.
- Open lounges create their own problems of regularly removing and cleaning the bedding and ensuring all cows will use it in preference to lying on dirty cement walkways, which increases the potential for mastitis problems.
- ‘Compost barns’ are becoming popular in which the fresh manure is removed at least daily and the dried manure is regularly turned over to create a type of compost bedding which remains dry and relatively free of pathogens.

7.2.3 Free stalls

A free stall shed is essentially a feedpad with the addition of specific bedding areas where the stock can lie down. It is generally a covered shed and may include a loafing area for cattle to also be loose housed where they can stand, ruminate or idle. In these sheds each cow is provided with a stall that she may enter and leave at will.

When well designed and managed, free stalls provide the ideal system for intensively managing dairy cows off pasture as each animal is provided with a specific place to rest, their management (feeding, cleaning and relaxing) is potentially optimised and the system can operate efficiently with minimal labour. However, they are relatively expensive to construct and can become very unprofitable if cows suffer from poor welfare, animal health issues and reduced milk quality due to poor feeding and herd management. If there is at least one comfortable stall available per cow, weaker and low status cows will have fewer problems with feed intake, water intake and lameness.

Stalls must allow enough room for the largest cow to freely enter the stall, lie down, rest comfortably and easily get to her feet to exit the stall. To do this, stalls should take into account the cow's normal desire to rest facing uphill slightly and change resting positions or stretch while lying down. In addition, there needs to be sufficient room at the front of the stall as cows need to lunge forward to lift their hindquarters first when rising.

Free stalls should be seen as individual cow bedding cubicles where partitions orientate stock for comfort and sanitation, providing each cow with a dry and comfortable place to lie down and rest and ruminate. Free stall sheds should have one stall for each lactating cow. Some farmers provide additional stalls to allow for herd growth and to provide areas for subordinate animals to move away from more aggressive herd mates.

Stalls can be arranged in a single row or in more than one row with a central feeding alley or with feeding alleys along the sidewalls. They can be arranged with cows facing one another (head-to-head) or the other way around (tail-to-tail). With the tail-to-tail arrangement, a central cow alley, 2.2 m wide between the cubicles is needed. If the stalls are head-to-head, two cow alleys behind each row are necessary. Usually one of these alleys is combined with the feed alley. Free stalls are usually laid out in modules with crossovers providing access to the feeding alley. These can provide multiple routes between cubicles and feeding area and so minimise the adverse effects that dominant stock can have on the eating behaviour of submissive stock.

Stall dimensions should be based on the largest 25% of the herd to allow for increase in cow size through improved feeding and genetics over time. They should also provide for adequate lying down as well as necessary forward and sideways

lunging to stand. Typical Friesians require about 240 cm long × 120 cm wide lying space with a further 60 cm forward lunging to allow for normal standing behaviour. Forward lunging space can be shared where two rows of stalls face head to head.

The size of the cubicles depends on cow size. For cows:

- weighing 400–500 kg, they should be 104–109 cm wide and 198–208 cm long
- weighing 500–590 kg, they should be 109–114 cm wide and 208–218 cm long
- weighing 590–680 kg, they should be 114–122 cm wide and 229–244 cm long.

Stalls that are too long or wide allow the animal to move forward, in which case faeces and urine can be deposited within the stall and not in the alleyway. To further prevent cows from soiling the cubicles, shoulder and neck rails are needed to force cows backwards when they stand up. The distance of the adjustable shoulder rail to the back of the cubicle, measured diagonally, should be about 1.8 m, and the height to the cubicle floor may vary between 0.9 and 1.05 m. Cow trainers, electric wires above the stalls are sometimes installed to train cows not to soil their stalls.

The stall curb separates the stall area from manure in the walkway. It should be high enough to prevent manure from entering the stalls, but low enough to allow cows to enter and exit the stalls easily. Recommended maximum curb heights are 20 cm or, if a mattress or mat is used, 30 cm.

The condition of the bedding is most important to encourage cows to use the stalls. The free stall base and bedding should provide a comfortable conforming surface to cushion the cow as she drops to a resting position or while resting (Graves *et al.* 2009). When cows are forced to lie on hard surfaces, they do not lie down for long, are more unsettled and may develop knee and hock lesions and swelling. All base types need loose bedding material on top for further cushioning, moisture absorption and to reduce friction. If the stall base provides good cushioning, less bedding is needed on top. To be comfortable, the base and bedding layers should cushion the contact areas for hock, knees, hips, brisket and shoulders. It is best to provide cushioning using a thick layer (15 to 20 cm) of bedding on a firm base or by an intermediate layer, cushioning mat or mattress and 3 to 5 cm of bedding. Ideally, if only using a rubber mattress, it should be 5 cm thick for optimum comfort. Rubber mats are common and can vary in thickness for < 10 mm to > 25 mm. The thicker the rubber mat, the greater its degree of flexibility (and presumably comfort) for the cow when she lies down. Mattresses are made by putting a resilient fill material such as crumb rubber, foam or liquid inside a woven polyethylene or felt-type geotextile textile material.

Hard rubber mats provide little cushioning, particularly if very thin, and they may be slippery. Soft rubber mats provide the same features as mattresses. Attachment methods, surface texture and compaction of the mat or mattress

material are all issues to consider when selecting and installing mats or mattresses. Bedding is required on top of mattresses and mats to help to maintain clean dry conditions.

In addition to preventing injury and providing comfort for cows, free stall bases should only require minimum maintenance. Materials used for bases vary from stone-free earth fill, available on site, to sand, to concrete. Earth fill requires the most maintenance as cows getting up and down will disturb and hollow out the surface. It is essential to select a material that does not contain stones or other solid particles that can be kicked into walkways, potentially causing injury or discomfort to cows' hooves.

Sand is the most favoured bedding as it reduces pressure on the joints, distributes weight over the area and provides unparalleled traction. It must not be too fine and should be free of rocks and pebbles. Sand-filled stalls need to be kept full to encourage their maximum usage. Sand is easily pushed around by cows, it has a high labour requirement for manure handling and can quickly contaminate walkways and so fill up manure storage tanks. Being very abrasive, it can damage manure pumps, so it should not be used with mechanical or liquid manure handling systems. Although hard surfaces such as concrete and hard rubber mats do not hollow out, they are less comfortable and so reduce lying times, can increase the chance of injuries (such as lameness, hock damage and pressure sores), and will lead to stall refusal.

Common base materials include:

- hard packed earth
- sand
- concrete
- mattresses
- hard and soft rubber mats.

Regardless of base material, a layer of bedding material is needed. This provides additional cushioning, absorbs moisture, helps keep cows clean and restricts bacterial growth. Low cost and ease of handling are desirable. Mixtures of different bedding materials should also be considered. Various organic and inorganic materials are used for bedding such as:

- organic: rice hulls, sawdust, straw, hay, wood shavings, cornstalks, peanut hulls, chopped or shredded paper, recycled manure solids
- inorganic: sand, limestone screenings, field lime, gypsum
- waterbeds seem to be the most preferred bedding in temperate winters, probably because of their warmth when artificially heated.

Manure and wet bedding should be removed and replaced with dry bedding material each day. Cleaning should be frequent enough to keep the back of the stall

clean because this is where the cow's udder and teats are in contact with the bedding when she lies down. Organic bedding should be added every 1–3 days, especially on mattresses and rubber mats, as it is hard to keep bedding on these surfaces.

Dirty cow alleys will result in dirty beds and udders, weakened hoof horn and potential mastitis. Cow and feed alleys should be kept clean by manual scraping, automatic scrapers or flood washing. Although cows can still be in their stalls, it is better to time flood washing during milking when they are away from the shed.

Care should be taken to ensure the stall construction or installation does not interfere with either the natural movements of the rising and reclining cows or the ventilation of the shed. Consider the effects of the stall structure on air flow at cow level. For example, using smaller dimensional steel rather than larger wooden planks when constructing the stalls, can result in a more open area for better ventilation.

The free stall environment should be made safe for the stock through ensuring they cannot put their heads through gates and fences or get stuck under stall divisions and barriers. There should be no projections, such as broken boards or rails or rough, sharp edges on the concrete. Rails should be strong enough not to break when cows lean on them. Walking surfaces can be grooved to minimise slips and falls and so encourage normal oestrus activity.

The free stall facility should be designed to ensure smooth and quiet cow flow. There should be no sudden changes from light to dark, reflections or drains across the cow alleys. Cows will move more smoothly along curved races, up a slight incline and where they have 'sure' footing. Gates could be muffled by attaching rubber strips to prevent excessive noise. Yards must be designed for easy drafting of targeted cows as this activity causes stress. Stock should only be moved around using 'flappers' (leather strips attached to a cane, sometimes known as cattle talkers) rather than using wooden or metal pickets or pipes. Excessive twisting of an animal's tail is unacceptable and electric prods should only be used in emergencies.

Proper selection of stall dimensions, partition, design, stall base type and bedding material is essential in encouraging their daily use but regular management and maintenance are necessary to assure clean, comfortable cows. Check stalls at least three times daily (at milking and feeding), remove manure and wet material and rearrange bedding, if necessary, to provide a uniform surface. Adding large amounts of bedding material less frequently is not economical. It can lead to increased bedding waste – the material can be soiled or wet soon after spreading in the stall which can reduce cow comfort and lead to undesirable cow positioning before the next bedding application.

As organic bedding can more readily support bacterial contamination than can inorganic material, it should be replaced more frequently, with soiled organic

material removed from the rear third of the stall every day. The first step a cow takes into the stall is the place the udder and teats will rest as she settles down into her lying position. The regular cleaning of walkways can reduce manure tracked into the stall. Depending on the frequency of milking and on the movement of the cows, cleaning the walkways up to three times a day can be appropriate.

7.2.4 Monitoring free stall use

The cow is the final inspector of free stalls and if cows are not successfully and regularly using them, or they are dirty and show signs of injury, action is required. There are a variety of ways to monitor the cows' use of free stalls and free stall sheds, such as:

- Do cows appear comfortable when standing or lying? If not, stall dimensions and bedding may need attention.
- Do cows have to push, bang and/or bump against stall components to lie down, get up or change positions?
- Do cows lie backwards in the stalls or in the alleys?
- Do cows stand half-in or half-out of the stalls? This can occur when the stalls are too short, the neck rail is too far back or when the stalls are otherwise uncomfortable.
- Do cows stand in the stalls in an angular fashion? This indicates the stalls are too wide.
- Are all stalls used equally? If not, there would be a reason why some are not chosen by the cows.
- When cows normally rest (between 10 p.m. and 4 a.m.) are more than 20 to 30% of the herd standing in the stalls? If so, stall comfort may be questionable.
- Are cows' udders, tails or hindquarters dirty? This could indicate dirty bedding but may also be due to low fibre diets and very loose manure.
- Are there patches of rubbed off hair or visible injuries to hocks and knees? These are signs that cows rub excessively on stall partitions or neck rails when rising or lying down.
- Are cows walking very slowly, or timidly, with rear feet spread wide? This could be a sign of poor traction or laminitis.
- Are some cows slipping and falling in the shed? This could also be a sign of poor traction.
- The comfort of the stall bedding can be assessed by the
 - Wet knee test, which involves kneeling in the stall for 10 s and if the knee is wet, the stall bedding is not dry enough.
 - Drop knee test, which involves crouching and then dropping to your knees in the stall. Any pain reaction in your knees will quickly tell you how truly comfortable the stalls are.

- Do more than 20% of the cows defecate in the milking parlour? This could indicate discomfort or uneasiness in the free stall shed.
- Are cows bellowing excessively or exhibiting abnormal behaviour? This also requires attention as discussed in Chapter 4.

7.2.5 Straw yards

A straw yard offers cows a very comfortable bed provided the yard is well managed and used properly. This means no overcrowding and making sure the bed is firm and dry. The quality of the straw yard depends on:

- Straw management: the bed should support the cow's weight as she walks. Absorbent, clean and dry straw should be added at least once each day and mouldy or dusty straw should be avoided.
- Fluids: how much is added with urine, dung, water spillages and rain and how much is removed as slurry, evaporation and other ways?
- Stocking density and cattle movement: how often do cows stand and walk in particular areas as busy areas get wet?
- At least once each day add 1 kg straw/m² and double this amount after cleaning out the yard. Another way of calculating is 1 m² of bedded straw per 1000 L annual milk production with 6 kg per cow per day as the minimum.
- Straw yards can be monitored by assessing how dirty the cows are or by counting the number of udder wipes needed during milking.
- The amount of dirt (dung) on the cow gives an idea of the level of hygiene in the straw yards.

7.3 Other cowshed equipment

7.3.1 Cow cooling equipment

This has been discussed fully in other books written by the senior author, as in Chapter 19 of Moran (2005) and Chapter 12 of Moran (2012a).

7.3.2 Facilities and equipment for young stock

These have been described in detail in Chapter 7 of Moran (2012b).

7.3.3 Facilities and equipment for additional health care

To ensure good health care, sufficient health facilities are needed and cowsheds should include additional stalls for such purposes. These and other stock handling aids are included in the following list:

- Treatment area, for confining animals on heat, artificial insemination, routine health checks, pregnancy diagnosis and examining sick cows. As animals are usually separated when they leave the milking parlour, it should be located

close to it. The width of this treatment area should be at least 0.7 m per cow and the length 3 m. It is convenient to store equipment in a specific veterinary drug box in this treatment area for treating hoof problems, for trimming hoofs, taking blood samples etc. There should be one treatment stall for every 20 cow stalls (with a minimum of two stalls).

- Separation area or hospital pens, to treat sick cows properly and prevent the spread of disease. It should be located close to the milking parlour. Drinking water should be available, with concrete floor and gutters to allow for frequent cleaning and sanitising. Ideally it should also have a shelf above ground level for storing medicines and other cow health-related equipment. There should be one treatment stall per 30 stalls (with a minimum of two stalls). With tie stalls, there is little need for a special separation area.
- Calving area, to permit proper attention at this critical time. With loose housing, cows may need to be tied up in stalls and should calve down away from the milking herd and close by the calf pens. As with the separation area, ease and thoroughness of cleaning and sanitation are key features. There should be one calving stall per 30 stalls (with a minimum of two stalls).
- Separate bull and mating pen. If using natural mating, bulls must be isolated from other stock except when mating. In fully stocked cowsheds, it may be preferable to bring the cow on heat, once identified, to the bull and so provide room for mating activities in the bull pen rather than let the bull mate in the laneway or a free stall.
- Cattle race, crush and/or head bales or other ways of immobilising stock are important both for the stock (to reduce stress) and the staff (to reduce injury). A cattle race allows stock to be separated out and immobilised when requiring additional attention such as insemination, veterinary treatment or foot trimming. Cattle crushes and head gates should be well designed to ensure that stock can be examined without fear of injury. Head bales should be made of pipes with sufficient robustness to hold a large unsettled animal.
- Footbaths should be available for routine hoof treatment, at least 2 to 3 m in length and 0.15 m deep. The width should be the same as the passage to prevent cows from bypassing the bath without using it. Double footbaths are better because they allow dirt to be washed off before treatment. The first bath tends to activate the dunging reflex which allows the solution in the second foot bath to stay effective for longer. A solid platform of 3 m between footbaths will help get rid of some of the wash solution from the first footbath. Emptying and refilling them should be quick and easy. Hulsen (2013) recommends that footbaths should contain 4% formalin or 38% commercial formaldehyde solution. Each cow should walk through them once each week. The frequency should vary depending on hoof cleanliness and dryness and how much they show evidence of horn erosion or digital dermatitis.

- Electric cow trainers. These consist of wires positioned above stalls that carry electricity and are used to teach cows to step backwards when their back is arched before defecation and urination. They then alter behaviour and keep cows and stalls cleaner. They are, however, risk factors for silent heats, clinical mastitis, ketosis and culling, with herds not using cow trainers having fewer of these issues. In some poorly designed stalls, cows prefer to stand and so do not have to experience the pain associated with lying and rising. When they are moved to better designed stalls, the cows use the trainers.

7.3.4 High cost equipment

This book is primarily about small holder dairy (SHD) farmers but this section covers some larger-scale investments in improving cow comfort on bigger farms. Such items will improve cow comfort and can become important factors beneficially influencing herd contentment in large sheds where there is likely to be increased competition between cows. There are considerably more antagonistic interactions within a herd of several hundred dairy cows than within a 5 or 10 cow dairy herd, so having this sort of equipment can reduce negative interactions.

- *Rotating cow brushes* are sometimes provided to allow cows to groom and scratch themselves. It may also reduce frustration or stress due to boredom. Cows can be very vigorous in their use of brushes so they need to be quite robust. Generally cows need little behavioural enrichment because feeding, ruminating and resting occupy most of their time and they can rely on other cows for social stimulation. Some of the brushes automatically start rotating when an approaching cow is detected. Generally cows use brushes to scratch their backs rather than their heads so they should be positioned at the right height.
- *Self-locking gates* are designed to restrain cows as they put their head down to eat from the feed bunk. Some free stall sheds have self-catching lockable feeding head-stalls along the feed line to allow animals to be caught for veterinary attention, insemination or even locked away from the feed.

These confine the cow in order to facilitate closer observation or individual management. In addition, they reduce aggressive interactions and displacement of socially subordinate cows while eating. When they have an option, cows do not choose these self-locking gates. Despite this, when forced to use them, they have little impact on daily feed intakes, milk yields, levels of mastitis and signs of stress.

- *Cow showers* can be designed to be activated either manually or automatically. In the latter, the showering and interval cycles are triggered only when the dual motion sensors detect an animal is present and the air temperature is above a specified threshold. As air temperatures increase, the interval time

automatically decreases, thus giving animals more frequent shower cycles to reduce heat stress. By using a high capacity, coarse droplet shower nozzle, enough water can be applied to fully wet the cows to the hide. Mist and fogging nozzles work by cooling the air around the cows and the disadvantage is that the mist can be easily blown away under windy conditions, or when used with fans. If a mist or fog builds up on the cow's hair coat, it can also trap a layer of air between the skin and the water, which holds in body heat. In comparison, soaker nozzles produce a coarse droplet spray, which penetrates the hair and wets the cow's hide.

There should be a continuous flow of air over the backs of the cattle any time the cooling system is in operation. This causes the water to evaporate, which takes the heat away from the cattle in the process. Fans can be controlled separately from the cooling system, and are set to operate continuously above a temperature of 21°C.

Normal recommendations are to shower the animals for a short period of time, 0.5 to 3 min, to soak the hide. After the shower shuts off, fans evaporate the water off the cattle by blowing across their backs for 5 to 15 min, before repeating the shower cycle. Common locations for installing a shower cooling system are in the holding pen area, where cows are crowded together tightly, and in the feed line area, but not so it will spray into the feed line or a stall.

7.4 Examples of complete cow housing systems

Many SHD farm systems and cowsheds are not purpose built but evolve over time, often without adequate long-term planning. They are frequently constructed out of the cheapest materials available and, all too often, without consideration of the long-term ramifications of using such poor quality materials. Additional inputs include the need to eventually purchase better quality materials and the time and labour required to renovate poorly constructed sheds. Therefore, careful planning and discussions with other farmers and service providers are time well spent when constructing or renovating a cowshed. When visiting other farmers, one good question to ask is *What would you have done differently, with hindsight, now that your shed is up and running?* The reader is directed to the following chapter (Section 8.2.2) that reports the recent study of Nguhiu-Mwangi *et al.* (2013). They found that poor cow welfare could be directly attributed to poor planning and construction of sheds on SHD farms in Nairobi, Kenya.

The following are plans and pictures of well designed and constructed SHD sheds. Many small holder farmers start with one or two cows and become 'part-time' dairy farmers depending on other off-farm or farming enterprises to provide additional income streams. In SE Asia, it is generally considered that to become a

full-time dairy farmer in which incomes originate completely from the dairy enterprise, farmers require 8 to 10 milking cows, plus the necessary replacement stock. Therefore, it seems logical to construct a cowshed to house such a number of milking cows and young stock. If the resources do not allow for its construction at the one time, at least space should be left for expansion at a later date.

Loose housing with free stalls and an outside exercise yard for night-time resting would provide the basics of a well managed and ‘cow friendly’ system. The following examples are of eight cow (Sri Lanka) and six cow (Vietnam) free stall sheds but their slightly modified construction could increase their capacity to house 10 or more milking cows.

7.4.1 Sri Lankan example

Figure 7.2 presents the plans for an eight milking cow free stall shed with a separate milking parlour and calf and heifer facilities. There is also an outside sand yard for night-time resting. This plan was developed by our colleague Jim Burrell.

The dairy design is flexible and able to be extended through the body of the dairy as the numbers of milking cows expand. Dry cows and adult heifers can be accommodated in another simple shed as an annexe to the sand yard if needed.

7.4.2 Vietnam example

Figures 7.3a–e are of a durable six cow free stall shed in Vietnam while Figure 7.3f is of an associated calf and heifer shed. Considerable use has been made from local materials. The uprights, roof beams and two of the free stalls are made from treated wood, although they may not be longlasting in regions severely infested with white ants, while the roof is made from local palm fronds. Each day, the manure can be easily cleaned from the outside sand yard.

More conventional longlasting materials used include rubber mats for the free stalls, concrete for the floor and water trough, and pipes for the feeding gates and some of the free stalls. Figure 7.3f of the calf and heifer shed includes a small horizontal feed mixer into which machine-chopped grass is incorporated with concentrates to produce a total mixed ration for all the stock. Depending on its location, cow comfort in this shed would benefit from the installation of fans, and even a sprinkler system.

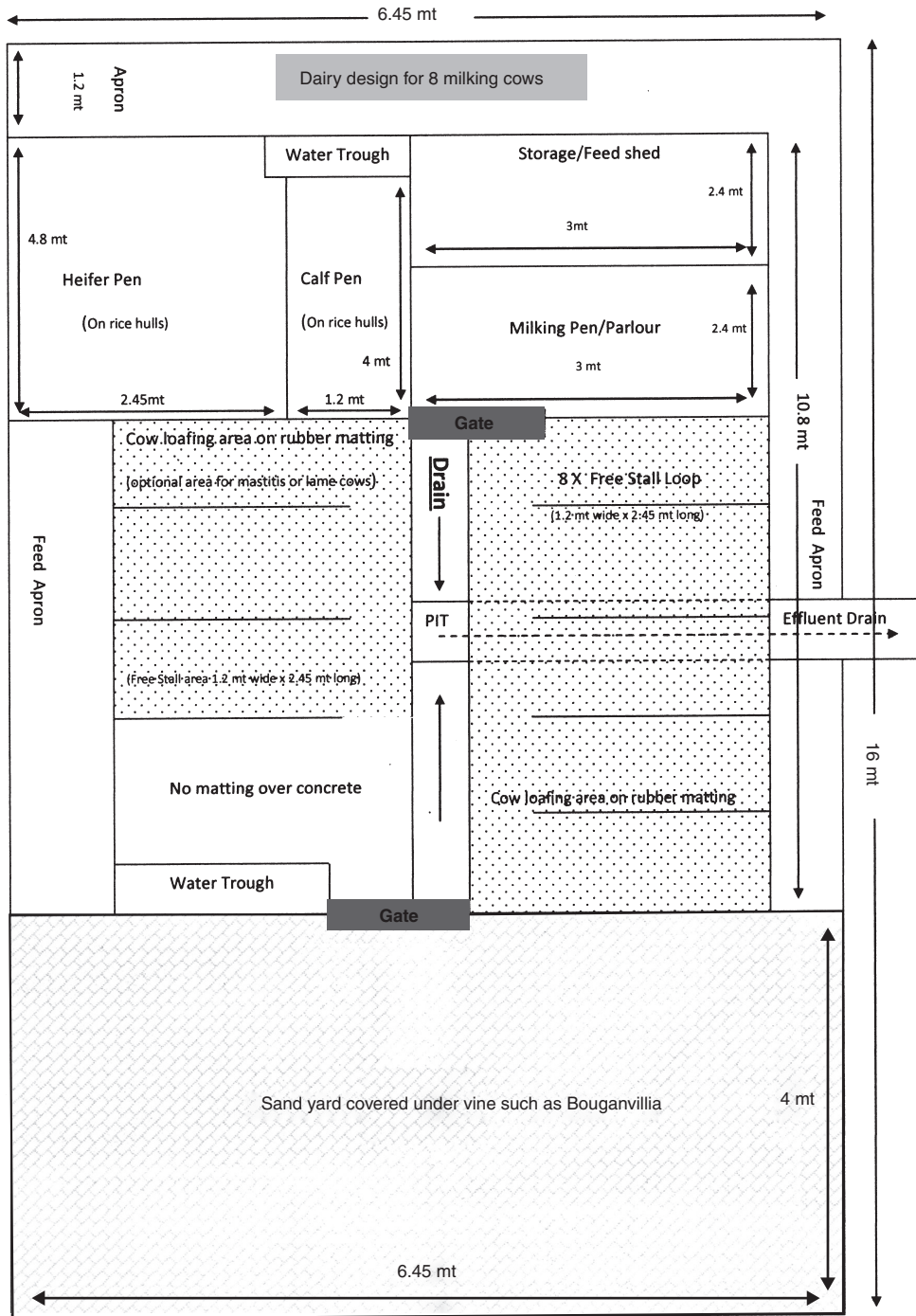


Figure 7.2: Floor plans for an eight cow free stall.

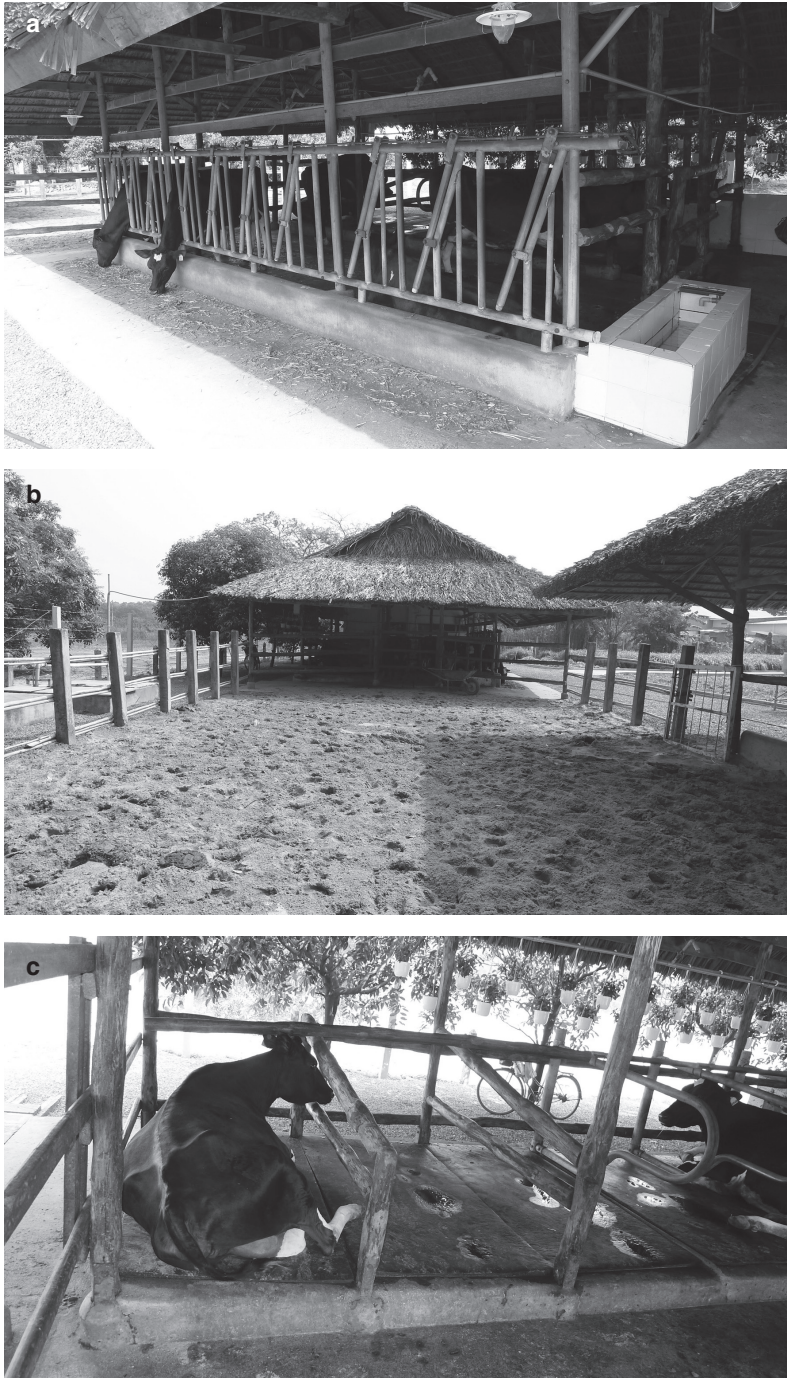


Figure 7.3: A six cow free stall shed in Vietnam. a) The feeding face. b) The outdoor sand yard for night-time resting. c) A cow lying in one of the free stalls. d) Inside the shed. e) Inside the shed. f) Associated calf and heifer shed.

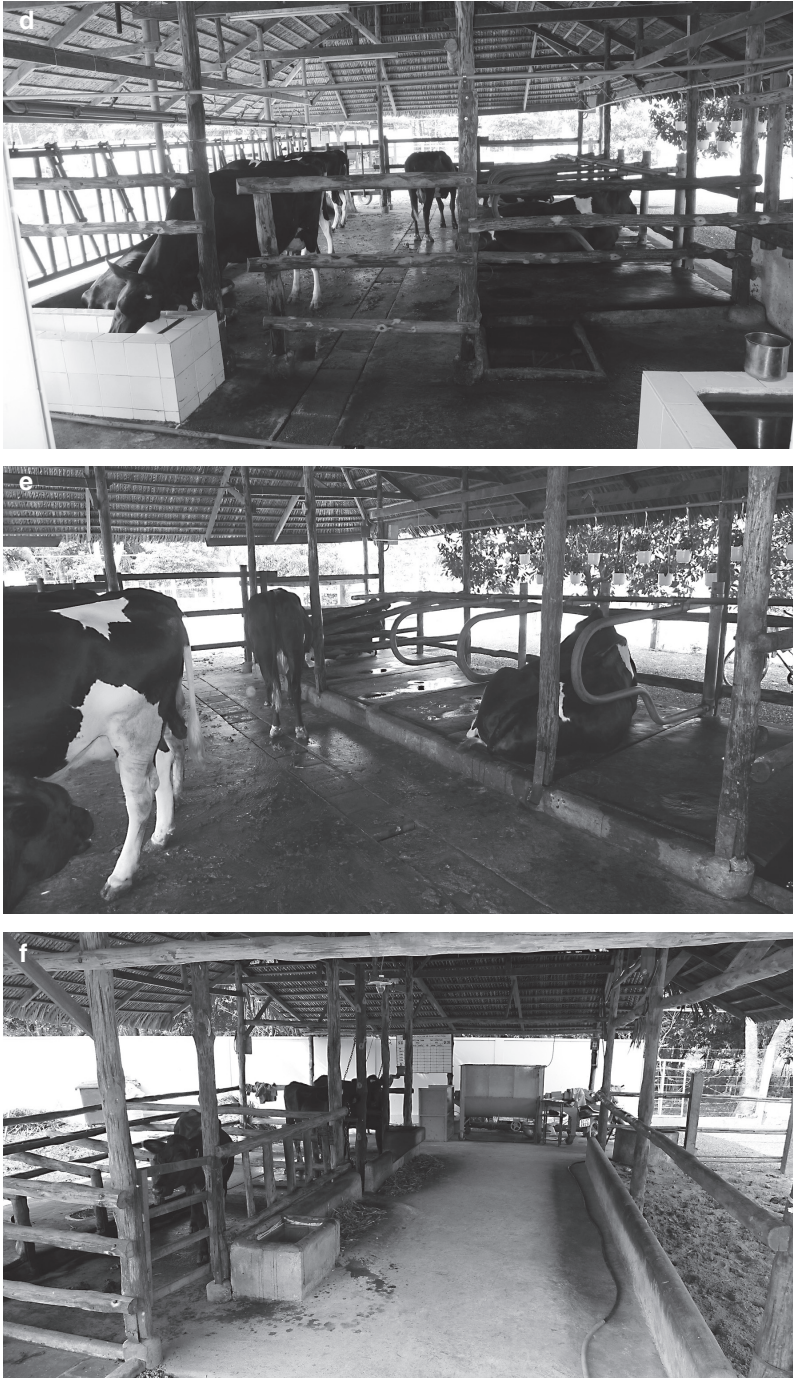


Figure 7.3: Continued