

13

Housing systems

This chapter describes the key features of well-designed dairy sheds.

The main points in this chapter

- Sheds should be located to maximise natural ventilation.
- Cement floors should be sloped for manure management and be non-slip for cows' comfort.
- There should be sufficient watering points or troughs for all stock.
- Cows can be maintained in tie stalls or be loose housed. They can be provided with free stalls or have an open lounging area.
- Additional health facilities should include treatment areas for sick stock and a calving area to permit close attention.
- Young stock should be housed according to age.
- Access to an outdoor area provides for more effective night-time cooling.
- A separate milking parlour will aid in milking hygiene.
- Good sanitation is very important for both cow cleanliness and effluent disposal. Recycling effluent will reduce necessary fertiliser inputs to forage production areas.

It is essential to provide good housing and farm layouts for rearing and milking dairy stock in the tropics to reduce the extreme effects of air temperature and humidity. Such control improves milk production by reducing stress and disease hazards and also making herd management easier. Environmental control includes sanitation and effluent management.

This chapter discusses housing for non-grazed dairy herds. Housing requirements for milking herds with access to pasture for grazing are simpler because they only require sheds for milk harvesting and for milk rearing calves. The features of shed design specifically to minimise the adverse effects of heat stress were discussed in the previous chapter. This chapter concludes with a detailed checklist for planning dairy shed design.

Good dairy sheds have many simple design features to improve cow and farmer comfort, hence cow performance and farm profitability. In hot climates, the following features are particularly important:

- sufficient yard space
- plentiful supply of drinking water

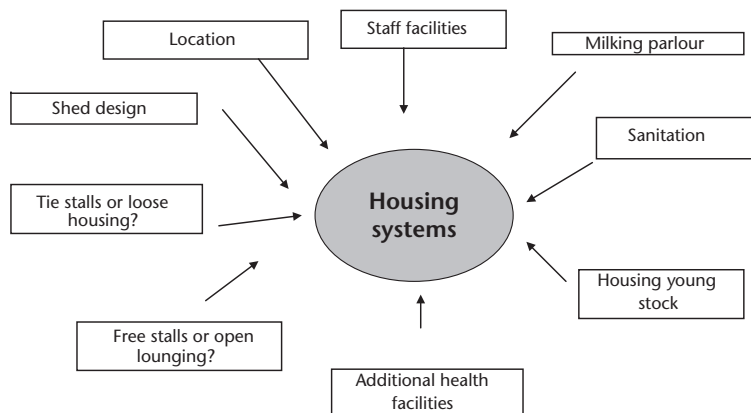


Figure 13.1. Considerations when developing housing systems for tropical dairy farms

- sufficient feeding trough space for each cow
- shade over the feeding, as well as over the loafing, area
- wire fences instead of solid walls to avoid restricting air flow
- planting trees on the western side to lower air temperatures
- sowing grass or other forages in the area surrounding the shed for stock feed
- painting buildings white to maximise reflection
- ensuring sufficient space between buildings (four times their height)
- shading over drinking troughs to keep drinking water as cool as possible
- orientating buildings to maximise winds and shade
- orientating buildings north–south to allow the sun to dry the shed
- being very wary of steep slopes.

The checklist at the end of this chapter can be used when assessing the specific requirements for shed design of particular farms.

13.1 Housing the milking herd

13.1.1 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 consider 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 look at 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 forages virtually all the time and to concentrates at least twice per day, at milking. This should also be the case 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 the cow ‘feels good’, has healthy feet and the route is safe and comfortable.

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

1. **Water**, with access to clean, palatable water at least 21 hr/day.
2. **Light**, with at least 6 hr/day of darkness.
3. **Air**, that is fresh and clean.
4. **Rest**, with a dry and comfortable place to lie down for at least 13 hr/day.
5. **Space**, so cows can walk to feed and water troughs from their free stalls without fear.
6. **Feed**, in that cows can eat a palatable and well-formulated feed for at least 21 hr/day.

13.1.2 Location

Factors to be considered when choosing land for dairy farming are fertile soils, no evidence of flooding during the wet season, convenience for transportation, proximity to milk collection centres, access to supplies for farming and, of greatest importance, year-round supplies of sufficient clean water. Distance from factories (which may release bad odours or lead to pathogenic infections) and to urban areas (where pollution from farm effluent will not be tolerated) should also be key influences on location.

13.1.3 Shed design

This has been covered in some detail in Chapter 12. The essence of good shed design is making the best use of natural ventilation, with open sides, a high and well-pitched roof together with an open vent along the top.

Concrete alleys of loose houses should slope in the direction of the movement of manure, with a 3% slope down the shed, but level from side to side. They must be easy to clean and concrete makes a smoother surface than bricks. It must allow for quick and free drainage, with all effluent directed towards a tank, either for biogas or recycling as fertiliser. In countries where dried manure is a value-added product for kitchen fuel, floor designs may differ slightly to those in other countries, where all effluent is directed to open drains.

There are several options for constructing the roof, such as iron, bricks or even bamboo/mud in a low rainfall area.

It is important to construct wide laneways to include the feeding area. By raising the walkway, building costs would be reduced and farmers will get a better view of their stock, which would be below walkway level.

13.1.4 Tie stalls or loose housing?

There are two basic types of housing: tie-up housing (tie stalls) and loose housing.

- With tie stalls, each cow is restrained in a stall. Feed is delivered in a trough in front of the cows. Milking takes place individually in the stall, by bucket or machine (bucket



Good ventilation and grass supplies are important in tropical dairy systems (Malaysia).

or pipeline milking). Manure is collected in a gutter. When cows are tied up all year round they may get feet problems and become stiff. Heat detection demands more attention. A high incidence of trampled teats can be another problem with tie stalls.

- 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. The cows are forced to walk frequently. The manure is spread over a large floor area so is collected by scraping the dung by hand (or using machinery) into a manure pit or a channel. With adequate water supplies, rapid flushing of large amounts of water can clean alleys. Milking is usually carried out in a milking parlour. The feed trough is separated from the loafing alley by either a feeding rack or wire rope.

Throughout Asia, dairy cows have been traditionally housed in tie stall sheds, but this is gradually changing as SHD farmers realise the benefits of providing stock with space to move around.

13.1.5 Free stalls or open lounging?

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

- In open lounging systems, cows can lie down anywhere. The floor can be earthen or cement, generally with bedding material, with the base being well drained. In dry

climates, earthen floors without bedding can be used as long as the dry manure is frequently removed. The loafing area behind the feed troughs should be cement and at least 3 m wide.

- With free stalls, each cow is provided with a cubicle, which she may enter and leave at will. Cubicles 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. The cubicles 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 loafing alley with a width of 2.2 m between the cubicles is needed. If the cubicles are head-to-head, two loafing areas behind each row are necessary. Usually one of the loafing alleys is combined with the feeding alley behind the feed troughs. The total housing area needed in this case is no larger than the tail-to-tail arrangement.

13.1.6 Free stall layouts

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.

The surface of the free stall should have a consistent fall of 2%. It should:

- be comfortable to the cows to encourage high occupancy
- prevent hock damage and other injuries
- be easy to clean and be durable
- be cost effective to install.

The ideal lying surface is soft, absorbs moisture and does not promote the growth of bacteria. When cows are forced to lie down on hard surfaces, they do not lie down for long, are more easily unsettled and may develop knee and hock lesions and swelling. The floor of the cubicles can be earthen with a thick layer of bedding, or can be solid, with a soft top layer. The simplest bedding is packed earth or sand, this being inexpensive but requires care to maintain a flat surface. Sand is quickly pushed around by cows, so it should not be used with mechanical or liquid manure handling systems because it fills up storage tanks and is very abrasive, damaging equipment such as manure pumps.

A concrete foundation with a disposable bedding of chopped straw, sawdust, wood shavings or crushed corn cobs is more common in Europe, because rice hulls are not readily available. Rice hulls would make ideal bedding for free stalls but their high silica content could damage liquid manure handling equipment. Hard surfaces should have a slope of at least 1% so that urine will drain into the alleys.

Rubber mats and cow mattresses are new innovations for free stalls but the thin ones (10 mm or less) have short life spans. Thicker ones (25–30 mm), although more expensive, are likely to be more cost effective in the long term.

The front of the cubicles with thick bedding should be 1.2 m high and the back 0.85 m. In cubicles with solid floors, these measurements are 1.1 and 0.75 m, respectively.

To prevent the cow from soiling the cubicle, shoulder and head rails are needed. This provision will 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; the height to the cubicle floor may vary between 0.9 and 1.05 m.

13.1.7 Making the choice

The choice of free stall versus open lounging is an important decision to make because the pipework in free stalls is very expensive. In virtually every feedlot shed I have seen in SE Asia, cows are provided with free stalls rather than an open lounging area. Ideally, comparisons should be made of the two housing systems in countries where labour supplies (and costs) are less of an issue. The bedding of free stalls and open lots could be rice hulls, in plentiful supply throughout Asia. Considerations when planning free stalls are summarised in Table 13.1.

Table 13.1. Considerations when planning free stall sheds

Elements	Considerations
System design	Allow for easy cow movements around the shed
	Stalls should be comfortable and clean
	Should allow for regular manure removal
	Provide easy access for machinery to feed out
	Allow for multiple routes from stalls to feeding area, to overcome dominance within herd
	Feeding space and free stalls should be proportional
	Stalls, feeding and watering spaces should be arranged in modules
Modular design	No more than 60 stalls per module
	Modules can be manipulated to match site constraints
Stall sizing	Depends on cow size (weight and body dimensions)
	Size based on largest 25% of cows in group
	Provide adequate room for lying down, as well as necessary forward and sideways lunging to stand
Stall slope	4% slope from front to rear
	3% lateral slope, so cows lie in same direction facing down slope, to minimise teat injuries
Stall curb	Minimum of 200 mm above alley way
Alley width	3–3.6 m wide avoiding sharp turns
Crossovers	Locate every 20–25 stalls, that is every 24–30 m
	4.5–4.8 m wide, so one cow can drink and two cows pass behind
	Elevate floor slightly above stall curb, allow crossover to drain into alley
Bedding material	Inorganic (sand or rubber)
	Organic (sawdust, straw, hay, composted manure or rice hulls). At least 100 mm thickness of rice hulls, sawdust shavings or sand.
	Consider hygiene, degree of compression when cow lies down, performance over time, how it will interact with effluent disposal system

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, and hence increasing potential mastitis-producing areas.

13.1.8 Considerations in flooring

The required floor slope depends on the cleaning method adopted and the natural slope of the site. A minimum slope of 0.5% (1 in 200) is required to prevent pooling of water. Steep cow alleys (greater than 1 in 15) will result in cows not standing perpendicular to the feed trough, but standing uphill. Flood washing of the cow alley ideally requires a slope on between 2.5% (1 in 40) and 3.0% (1 in 30), to achieve acceptable wash with minimum amounts of water. If the slope is less than 2.5%, the volume of flood wash water required increases to get extra water depth to compensate for the lack of slope. There should not be any sideways slope on cow alleys with flood washing. If flood washing is not used, the cow alley should have a 2.5% slope away from the feed trough. Hose washing and dry scraping are not slope sensitive, so the site slope will influence the alley slopes. The feed alley needs a concave floor (with 50 mm fall) sloping away from the feed to the centre of the alley to prevent run-off water mixing with the feed. The long-ways slope should be the same as the cow alleys.

Cows can be standing or walking on shed floors for up to 10 hr/day. In tie stalls, cows should be provided with rubber mats to cushion the hard concrete floors. With loose housing, concrete floors should be roughened to reduce slippage, but not too rough to wear out hooves, leading to lameness problems. Another alternative is to install grooves or patterns in new concrete floors. These can even be cut into old concrete floors.

Grooves should be positioned so that at least one of the four feet lands in a groove whenever cows put their feet down to stop slippage. Parallel grooves should be spaces about 15 cm apart, 12 mm wide and 12 mm deep. Although placing grooves perpendicular to the length of the alley will maximise their effectiveness, they may compromise removal of shed effluent, so they should be located parallel to normal alley-way cow flow.

Anti-slip aggregates mixed in with the top layer of concrete or epoxy floor coatings can be applied to existing floors. Another alternative in areas of high cow usage, such as in feeding alleys, is construction of synthetic rubber floors such as those used on athletic tracks.

13.2 Feeding the milking herd

13.2.1 Water troughs

Stock must be provided with sufficient drinking water at all times and the system should be able to supply at least 20 L/cow/hr to meet likely peak demand. The optimum temperature for drinking water is 15–17°C. Water troughs should be well separated (but within 15 m) from feed troughs, with the same water trough servicing adjacent pens. Trough design should allow for regular, easy cleaning with a removable bung for complete drainage.

Each cow should be provided with 75 mm of linear watering space in free stall sheds, while for circular water tanks, one watering space (60 cm of tank perimeter) should be available for every 15 to 20 cows. A water depth of 15–20 cm helps keep water cooler, fresh and easier to clean because less debris accumulates. The optimal trough height is 60–90 cm from the ground to the top of the trough.

If cows are tethered, it is possible to install individual cattle drinkers, with two animals sharing one drinker. To ensure water is freely provided, troughs need to have float valves, rather than depend on a hose whenever the farmer decides to refill it. A single watering trough system can control water levels in up to 10 small troughs just by one float valve in a central reservoir with syphon pipes leading to all the troughs.

13.2.2 Feed troughs and feeding strips

It is important that all stock can eat comfortably with minimal competition. Whether feeding into troughs or onto cement feeding strips, 70 cm of feeding space should be allocated per mature cow. For a feeding strip or trough when cows eat from both sides of the strip, hence face each other to eat, this equates to a total feeding strip allocation of 35 cm/cow. Trough space can be reduced to 45 cm/head for 6-month-old cattle, or to 55–60 cm/head for stock 18 months old.

With feed troughs, the width should be related to the reach of the animals, which is up to 80 cm for mature dairy cows eating from the base of the trough 30 cm above ground level. The base of the trough should then be raised 10–30 cm, with the front 50 cm above this. Cows in tie stalls are likely to have restricted reach.

Feeding strips should be positioned 7–15 cm above cow feet level, with a nib wall 40–55 cm above the feeding strip, to protect the feed from the effluent. Feed barrier walls wider than 15 cm can restrict how far stock can reach into troughs or onto feed strips.

13.2.3 Feed storage

Feeds should be stored in secure and vermin-proof locations with easy access for the stock. They should be located well away from waterways. Most feeds are sourced in bags, although larger farms may handle feeds, such as by-products, in bulk. In these cases, good road access for trucks is essential, with the feed bunkers under cover. Such bunkers should have concrete floors and brick, concrete block or prefabricated or reinforced cement walls. For storing by-products with very low dry matter contents, soil ramps adjacent to these bunkers will aid discharge from trucks.

Forages can be conserved dry as hay or straw, or moist as silage. Hay or straw must be stored in weatherproof buildings and should not be stored in confined places if it is likely to be moist, where it can catch on fire. Silage must be continually covered with plastic sheets to exclude any air prior to feeding out. Silages can be stored above ground in bunkers or below ground in pits. In-ground pits are best for long-term storage but above-ground storage is preferred in areas with high rainfall. Buns or stacks are silage units without structural support, but with their high surface area-to-volume ratios, plastic costs per tonne silage and wastage rates can be high. Bunkers or clamp silos are the most common storage systems, while individually covered bales or stretchable bags are often used in regions well serviced by silage making contractors. The dimensions,

particularly their width, should be determined prior to their construction, based on the predicted daily rate of removal from the silage stack.

Silages can produce a lot of liquid, called leachates, during storage, which is very corrosive and lethal to aquatic life if it escapes into rivers or streams. The production of leachates can be reduced by incorporating dry material, such as rice straw or rice bran, at the base of the silage bunker.

13.2.4 Preparing concentrate mixtures

It is rare for milking cows to be offered only one type of concentrate, because of their high nutritive demands and the poor nutritive value of tropical forages. Concentrate mixtures usually contain a variety of energy and protein supplements together with minerals, usually macrominerals and, for high-yielding cows, maybe even microminerals.

One very simple method of hand mixing a complex concentrate mix for storage or immediate feeding is to spread each ingredient on top of each other in layers (even the mineral pre-mixes) then collect the mixture into bags or buckets by shovelling it perpendicular to the floor. This method is ideally suited for dry concentrate ingredients, although it could be used each day for offering mixtures containing wet by-products, such as cassava or soybean waste.

Molasses blocks are a good supplement and can be used as carriers of non-protein N or minerals. The blocks are solid, and fairly easy to make, transport and store. Molasses intakes should not exceed 20% of the total intake, because at higher levels it will depress digestibility.

If the basic ingredients of concentrate mixtures are stored, a space must be allocated to blend them into a formulation. Hand mixing may be practical with small herds of stock, but a mechanical mixer is preferred to ensure complete blending of mixes for larger groups of animals. These formulations are either placed on top of forages or fed out following removal of residual forages from the feeding troughs. With very large herds, however, a mixer wagon is a good investment to ensure consistency of ration formulations. Such mixtures are called total mixed rations, or partial mixed rations if stock also have access to grazed pasture.

The tradition of mixing water with the concentrate portion of the ration is widespread throughout Asia. Farmers wrongly believe that cows will better use concentrate slurries compared with dry mixes. This may be one way of providing additional water, in housing systems where there is limited free access and stock are only provided with restricted times to drink. However, given free access to water, there is no need to feed slurries of concentrates. Cows can be fed their roughage portion on a flat area of concrete with no sides. It is also easier to clean such a flat feeding area. Therefore feed troughs could become superfluous.

13.3 Additional features of dairy shed design

13.3.1 Additional health facilities

To ensure good health care, sufficient health facilities are needed. Sheds should include additional stalls for such purposes. These are as follows:

- A treatment area for confining animals in heat, artificial insemination, routine health checks, pregnancy diagnosis and examining sick cows. Because animals are usually separated when they leave the milking parlour, the treatment area should be located close by. The width should be at least 0.7 m per cow and the length 3 m. It is convenient to have a separate movable veterinary drug and equipment box for treating hoof problems, for trimming hoofs, taking blood samples, and so on. There should be one treatment stall per 20 stalls with a minimum of two.
- A separation area to treat sick cows properly and prevent the spread of disease. It should be located close to the milking parlour. The cows can be housed in this area in 1.2 m stalls, which could be changed into pens. Drinking water should be available, with concrete floor and gutters to allow for frequent cleaning and sanitising. There should be one treatment stall per 30 stalls with a minimum of two. With tie stalls, there is little need for a special separation area.
- A 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.
- Foot baths should be available; they should be at least 2 m long and 0.15 m deep. The width should be the same as the passage to prevent cows from bypassing the bath without using it.

13.3.2 Housing for young stock

The area needed to house young stock depends on:

- their number
- the type of housing
- the calving pattern of milking herd
- the replacement percentages of the milking herd
- the division of the herd into age groups.

A good management practice is to divide young stock into the following four age groups:

1. 0- to 1-month-old milk-fed calves
2. 1- to 5-month-old milk-fed and weaned calves
3. 5- to 22-month-old weaned heifers and yearlings
4. 22 months and older pregnant heifers.

Group 1 should be housed in clean and disinfected individual pens (0.6×1.3 m), separated from the cows. The pen partitions should be solid and smooth, 1.5 m in height. The floor should consist of wooden slats 20 mm apart.

Group 2 can be housed in tie stalls (0.7×1.5 m) or group pens. Group 3 can be housed in tie stalls (0.8–1.0 m wide $\times$ 1.7–2.1 m long, depending on live weight), group pens or free stalls. Group 4 can be housed with dry cows, although they will have different feed requirements.

It is easier to observe calves, and there is less risk of disease transfer, when they are individually penned. Ideally, the pens should be moveable and be enclosed with three draught-proof walls. Each pen should have 1–2 m² of floor space with a well-drained floor and, if desired, clean bedding each day. An individual pen 1.5 m × 0.8 m is the minimum required up to 4 weeks of age while a pen 1.8 m × 1.0 m will suffice for an 8-week-old calf.

13.3.3 Calf cages

Containing each calf in a raised metal cage provides the best housing because they are isolated from each other, live in a well-ventilated and clean pen, are easier to feed and water (because the rearer does not have to bend down to feed them) and, of most importance, allows for much easier individual surveillance. Calves should live in cages up to 3 weeks of age, after which they can be moved to individual pens.

Each cage should be 110 cm long, 75 cm wide and 105 cm high (including the legs). The rear of the cage is a removable gate to put the calf into or remove it from the cage. The floor can be made from wood or plastic, with the floor lattice perpendicular to the length of the cage. The space between floor boards should be 1.5–2 cm. The cage should stand on legs and be 30 cm above floor level. To avoid injuries, there should be no sharp edges inside the cage. The metal bars should be about 15 cm apart: any narrower can lead to injuries if calves get their legs stuck between the metal bars.

13.3.4 Outdoor area for night-time

Once the sun sets, outdoor areas are cooler than inside any shed. Saudi Arabian dairy feedlots have them, as do many Australian dairy feedlots. They are much less common in Asia because of the high rainfall and problems with mud. Where cows are commonly housed out of doors, they should be an integral part of any shed design. Whether the floor needs to be concrete or brick or just plain dirt is another issue.

Cows will eat more during the cooler part of the day, so provision must be made for adequate feeding space. It is better to provide the bulk of the forage in the evening, particularly during summer, so feeding space is important. Free access to adequate watering space is essential. Also, because it is easier to observe oestrus when cows are loose in a yard at night, permanent lighting is important.

A lounging area for the milking herd should:

- be located in a well-ventilated area
- be well drained
- have a dirt or gravel surface
- provide at least 5–10 m²/cow
- incorporate water troughs
- incorporate troughs for feeding forages.

13.3.5 Stock-handling facilities

It is important that stock can be handled safely when individually separated from the herd. The farm should have a set of cattle yards that includes a race for AI, a crush for

close veterinary attention and treatment and, if desired, a set of scales to weigh stock routinely.

13.3.6 Storage of veterinary drugs and other dairy equipment

Veterinary drugs should be stored in a dark cupboard or, if required, inside a refrigerator. For security purposes, the cupboard should be lockable. Other dairy equipment, such as detergents and sanitisers for cleaning milking machines and equipment for trimming feet or dehorning calves, should also be stored in a specific location. Milk-harvesting equipment, such as buckets, sieves and milk cans should be stored off the ground and hanging upside down to aid drying.

13.3.7 Bull pen and mating yard

Although many farmers use AI to mate their cows, herd bulls are often kept to mate heifers or cows that have been unsuccessfully inseminated several times. Bulls should be kept separate from the adult cow herd except when used for mating. A mating yard will allow for cows on heat to be separated from other stock for better control of the bull's activities.

13.3.8 Farm office

Maintaining good farm records is much easier in a farm office. An area at home or in the dairy shed should be dedicated to keeping records. It must have a desk and good lighting. It must be a quiet place to set up the office files (preferably in a filing cabinet), computer and office supplies. The how and when of keeping farm records depends on the person recording them. Computers are very convenient, but require money to purchase and skills to operate efficiently. Record keeping should be given as high a priority as other farming activities.

Suitable chairs and tables should be included for business meetings with service providers and other farm-related visitors.

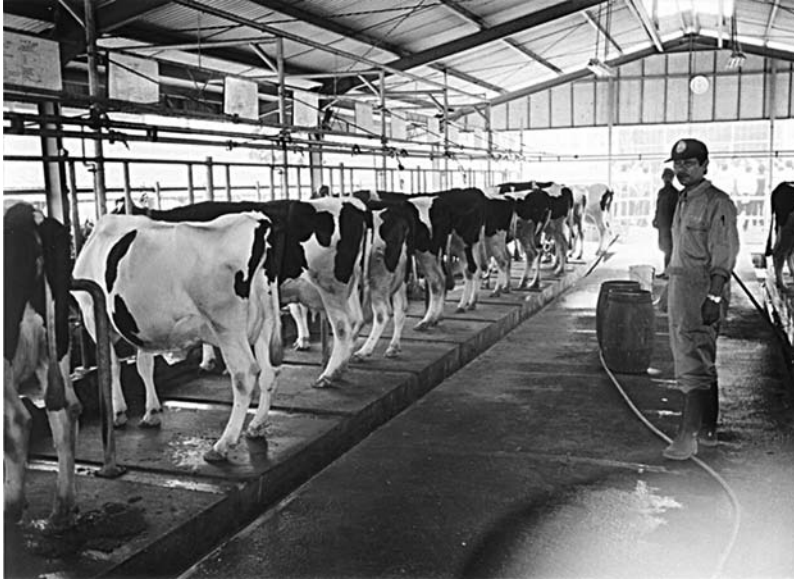
13.3.9 Staff quarters

Farm staff should be provided with space to eat and relax when off duty. This could include a shower and toilet, food preparation area and storage for their work clothes.

13.4 Milk harvesting

Once a decision is made that cows are allowed outside to cool down at night, it seems logical to plan their movements around milking times. A separate milking area has many advantages. It can be centrally located, requiring only one supply of hot water (for cleaning animals and equipment). Daily hosing down and weekly disinfecting will minimise environmental constraints to good milk quality. Furthermore, if farmers eventually decide to invest in machines for milking, one milking area minimises problems with low vacuum pressures in long air lines.

Milking hygiene is very poorly managed in many countries, particularly those where farmers are not rewarded for their milk quality. However, it will become important as



A well-managed and well-constructed dairy shed in Indonesia.

milk processors invest in the industry and when farmers consider value adding with other dairy products, such as cheese, that require high-quality raw milk.

Cows can be milked in a variety of ways. Hand milking is very common throughout Asia, while bucket milking is used for cows in tie stalls. Loose housed cows are usually milked in a separate milking area, which can be specifically designed for ease of cleaning and occasionally sterilising. Hot water is essential for thorough, twice-daily cleaning of all milk-harvesting equipment. Ideally, milk-cooling equipment should be installed, unless there is close access to a milk collection centre.

Bucket milking is the simplest and least expensive system to install, but the milk must be carried to the cooler. This type of system is usually used in small herds and where cows are milked on a level floor of the shed or milking area. A separate vacuum line can be built around the entire shed if the cows are to be milked in tie stalls. The labour of carrying milk to the cooler can be avoided by installing a transfer system, which consists of a small receiving tank (say 30 L), including a built-in filter, mounted on wheels so it can be moved around the shed. Pipeline milkers transport the milk directly from the cow's udder to the milk cooler and are usually installed in milking parlours where the milker stands below the level of the cows. Although they are expensive, they save backbreaking labour and are usually designed to be cleaned in place: a feature that not only saves labour but helps to ensure good sanitation. Details of maintaining the milking equipment are discussed in section 14.4.

13.4.1 Designs of milking parlours

All parlours should have a high-quality concrete floor and metal rails for durability and ease of cleaning. Walls are not required, but, if included they should be at least plastered

masonry walls. The pit where the milker stands should have a floor level 90 cm below that of the cows for the most comfortable working position. The number of stands is determined by the allowable milking time of the herd or time taken by the cows to eat the concentrate rations usually fed. Parlours can be of the following types:

- **Abreast parlour.** The milker and the cows share the same floor space. Cows can enter and leave individually. The stands should be 1–1.1 m wide when a bucket milker is used or when the cows are hand milked, while 0.7–0.8 m is adequate when a pipeline-milking system is used. The width for the milker should be 0.6–0.8 m. The main drawback is the relatively long distance to walk between milking points, and the cows obstructing the milker.
- **Tandem parlour.** This allows for individual care of the cows, but has larger space requirements.
- **Walk through parlour.** Cows enter and leave in batches. The narrower width can be an advantage if fitted into an existing building.
- **Herringbone parlour.** This provides a compact working area and allows feeders to be fixed to the side walls. Three or four stands on each side should suffice for up to 80 milking cows. Its popularity is due to its simplicity and high capacity (measured as cows milked per man hour). However, the risk of cows kicking the milker is greater than in parlours where the milker stands beside the cow.
- **Rotary parlour.** Because these are expensive to install, they are better suited to much larger herds.

It is best to equip milking parlours with grain feeders that allow each cow to be fed in proportion to her milk production. Because cows expect to be fed while being milked, they will enter the parlour more readily, thus saving some labour. Each cow can be manually fed her ration using a measuring scoop.

An entrance to a milking parlour that is straight, with no turns, will ensure a smooth and convenient operation. Once trained, stock will walk readily into the parlour. A single 1 cm step will help keep manure from being carried into the parlour. An exit leading to an uncrowded area will facilitate the flow of cows. It should be narrow (70–80 cm depending on the size of the cows) to keep the cows from turning around.

13.4.2 Milk room and cooler

Sanitation is the primary consideration in handling milk, whether from a hand- or machine-milked cow. Adequate supplies of potable water are essential for cleaning the milking equipment immediately after use. Hot water (85°C) mixed with a chemical detergent are required for effective cleaning and cold water used for rinsing. Milk should be handled in a separate area that can easily be cleaned and is free of insects, birds, rodents and dust.

The milk room should be well ventilated, with a concrete floor sloped 20 mm/m to a drain and with masonry walls having a smooth, water-resistant surface that can be easily and thoroughly cleaned. On dairy farms of sufficient size, the milk is cooled by cold water circulated between an evaporative water cooler and a milk cooler (plate heat exchange), through which the milk is passed until it is adequately cooled. Where milk is transported in cans, cooling can be accomplished through a coil, which is immersed in

the can. The larger scale farmer, having a pipeline milking system, and milk collection by a tanker, will require a refrigerated cooler and holding tank.

With machine milking, the vacuum pump and engine that powers it, should be put in a separate engine room.

13.5 Sanitation and effluent management

Dairy farm effluent is both a liability and an asset to the small holder farmer. It is a liability so far as contaminating feeds, encouraging flies and animal health issues are concerned, whereas its role in fertilising forages is an asset. Unfortunately, its full potential is not realised unless all the nutrients contained in the urine are returned to the pastures. The nitrogen in urine is easily lost through volatilisation, unless it is stored and recycled to the pastures in liquid form.

Each day each cow produces 30–35 kg faeces and 12–16 kg urine plus shed effluent from washing down floors. Each day a 50 cow shed then produces 1.6–1.8 t faeces plus 700–1000 L urine, which is equivalent to 1.5–2 m³ volume, excluding rainfall run-off. Therefore it is important to:

- design floors for efficient effluent run-off
- ensure that there are suitable gutters and sufficient wash down water to keep floors clean
- ensure that the effluent pit and pond has sufficient capacity
- ensure that the base of the pond is 1 m above the water table
- provide equipment to handle solid effluent for recycling onto the forage area
- provide equipment to remove liquid effluent, such as a pump and pipes that lead directly to the forage area
- be aware that ‘social standards’ are always changing
- consider an area to dry manure for bricks or cooking fuel.

13.5.1 Effluent as a liability

The management of animal manure represents a major health hazard on small holder farms, with the problem increasing with herd size, unless specific facilities are constructed. The problem is associated with a number of issues, such as:

- the quantity and quality of faeces and urine produced
- the adequacy and frequency of removal
- storage in proximity to the shed
- labour availability
- the methods of storage and disposal
- the value and use of manure
- community concern about pollution (smell, as well as contamination of groundwater and water courses).

The human health hazards are becoming more serious than previously realised, due to inadequate supervisory and sanitary measures. For example, in Thailand, a survey noted waste water from SHD farms constituted a considerable risk to public health

because of its very high content of inorganic pollutants and the presence of coliform organisms (Chantalakhana *et al.* 1999). Furthermore, there was considerable contamination of groundwater supplies in nearby towns via waste water from local farms as well as via leaching from stored manure.

Not only is effluent management an environmental constraint to small holder dairying because of its potentially adverse influence on cow performance and cost of forage production, but, of equal importance, it can alter the livelihood of farmers themselves through community legislation limiting locations of farms. This can be particularly important for dairy farmers situated close to large towns and cities. In developed countries, there is now considerable effort to ensure farming activities are seen as ‘clean and green’ and this concept will no doubt extend into the humid tropics in years to come.

13.5.2 Effluent disposal systems

Floors should be made from concrete or easily washable material. They should be designed for efficient drainage with a good slope with wide channels for easy urine and faeces removal. A manure pit should be dug, large enough to hold the shed’s manure produced over 2 or 3 days. A channel should be dug leading from the walking area to the pit and lined with concrete. The pit should be covered with a plastic sheet or banana leaves to reduce the sunlight, because this volatilises the nitrogen in the manure, reducing its value as a fertiliser. A fence around the pit will minimise risks to children and wandering stock.

It is important to collect as much urine as possible from the shed. It is advisable to use minimum water to initially wash out the manure drains, then direct the main washings from the floor into another pit or directly out to the forage producing area. An alternative effluent system is to direct all manure and shed washings into the one pit equipped with a manure pump to direct the effluent to the forage producing area, along gutters between the rows of plants.

13.6 A checklist for planning dairy sheds

Physical aspects:

- aspect of shed with respect of wind and sun
- flooring (material, slope)
- rubber mats for floors
- wooden or metal uprights
- roof height
- roofing material (‘colourbond’ or tiles)
- maximum natural ventilation
- feed troughs (cement, wood or other material)
- water drinkers (automatic, trough plus float valve, trough plus hose)
- location near feed-growing areas (for effluent recycling)
- design shed to allow easy stock observation
- wide aisles for ease of carrying heavy loads.

Services:

- electricity (single or three phase)
- water (drinking, cooling, washing, sanitising)
- water heating (liquid petroleum gas or fire)
- water for washing down, taps and hose for floor flushing.

Environment:

- insulation for under roof
- sprinklers for cooling
- hose for washing down hot cows
- cooling fans (large overhead or small moveable)
- fans for all milk cow areas or just for high-yielding cows
- computerised system to initiate specific cooling cycles
- plant trees, grass around sheds.

Effluent disposal:

- suitable gutters to keep floors clean
- effluent pit (suitable capacity)
- one large pit for several sheds
- liquid effluent removal (pump and pipes)
- solid effluent removal
- location of fodder growing areas for recycling
- area to dry manure and make bricks/cooking fuel.

Feeding facilities:

- separate feed-storage areas
- bird, vermin and insect proof
- silage pits
- bunkers for urea-treated straws
- fresh or dry forage feeding
- hay shed for bulk storage of purchased hay/straw
- concentrate storage (bulk or bag)
- chopper for processing roughages
- feed mixer (horizontal or vertical) for concentrate formulations
- stationary mixer wagon to process total mixed rations
- farm utility for transporting feed, stock and milk
- farm tractor for handling bulk feed
- floor space for hand-mixing concentrates.

Milk harvesting:

- hand or machine milking
- separate milk-harvesting area
- mobile mini milkers or milking plant

- vacuum lines above cows
- engine room for milk plant
- specific buckets/milk cans for each shed
- bulk milk handling equipment (vat, milk can)
- refrigerated milk vat in each shed or for entire complex
- other milk processing equipment (pasteurising, packaging)
- specific equipment for cleaning/sanitising milk handling equipment.

Adult cows:

- tie stalls or free stalls
- adequate feeding space per cow
- access to drinking water
- level of milk production
- group cows by stage of lactation
- halter and rope or neck yoke
- separate large yard for heat detection and night cooling
- handling yards and crush for veterinary attention
- AI or natural mating yard
- mating yard for bulls.

Young stock:

- separate milk-rearing shed
- separate weaned young stock shed
- suitable capacity for 25–30% replacement rate in same shed
- design of calf-rearing pens (above ground or deep litter)
- location of milk-fed calves (away from adult stock)
- material for calf pens (bamboo, wood, metal)
- area for mixing milk replacers and calf concentrates
- hot water for cleaning equipment
- feed scales for weighing all feeds
- livestock scales for weighing stock
- hospital/isolation pen for infectious diseases.

Personnel:

- office and suitable furniture
- computer facilities
- 'smoko' or tea room
- living quarters (if overnight work is required)
- lockable storage of veterinary drugs and valuable equipment.