5

Observing cow signals

This chapter discusses the signals that cattle continually give out regarding their health and wellbeing, through their behaviour, posture and physical traits.

The main points of this chapter

- There are three questions to ask when using cow signals to aid farm management decisions, namely, *What do I see?*; *How did this come about?* and *What does it mean?*
- Don't just look, observe and focus these observations by asking: *Is everything as it should be or is there a potential risk in this situation?* Develop an observation routine and use records to aid and interpret any observation and follow-up actions.
- The three main reasons behind any behaviour are – that it satisfies a need; it is a reaction to a stimulus; or it may be due to a physical urge.
- To a large extent farming is about risk management and we can identify two types of risk, known and unknown. Known risks can be controlled by good management but minimising unknown risks requires alertness and good observations. To minimise any damage, farmers need to be able to respond quickly.
- This chapter assesses cow observations in different farm locations: while grazing; in the shed; at the feed barrier and in the milking parlour.
- Astute farmers know the signs of a healthy cow in that she is alert and active, has a glossy and smooth coat, has a good appetite and drinks well and walks and stands without discomfort.

- The early signs of sickness are often subtle, requiring skill and experience to recognise them – such cows may simply 'look different'. Shallow rumens, sweet-smelling breath, high temperatures and evidence of pain or discomfort are clear indicators and sick cows may often withdraw from the group and lie in a stall.
- The cowshed is a system where various factors interact: the layout (feed barriers, calving pen, ventilation); dimensions (width of laneways, roof height); materials (concrete or rubber floors, straw yards); management (hygiene, feeding, stocking density) and the animal, to mention just a few.
- The physical condition of feet and legs (such as bruises and abrasions) and lying behaviour are good indicators of cow stall dimensions and overall comfort. Lameness is a major problem in sheds with poorly constructed laneways and a poorly designed shed layout.
- Cows must have ample space at the feed barrier to minimise aggression and dominance behaviour. Rumen fill, dung consistency, hoof health, feeding behaviour, feed wastage and rumination are all signs of feeding management. Milk yield and composition are good indicators of nutrient intakes.
- The milking parlour provides an ideal place to assess udder and teat health, hocks and feet integrity and coat cleanliness. How a cow behaves tells us a lot about her emotional state and this state influences milk letdown and is also a good indicator of the mechanics of the milking process.
- Much can be learnt about the wellbeing of calves and the state of the calf shed from a competent calf rearer's sight, hearing, smell, taste and touch.
- Even though the dry period is like an annual 8 week holiday for adult cows, their feeding management is very critical during this period.
- It is important to be able to quantify the degree of heat stress endured by milking cows from both the environmental conditions and the animals' reaction.

5.1 Introduction

Cattle continually give out signals about their wellbeing and health. They do this through their behaviour, posture and physical traits. They also do it via their physiological measures such as breathing (respiration) rate, heart rate and concentrations of many metabolites in their blood. Apart from their respiration rate and possibly body temperature, all other physiological measures require expertise and equipment not normally found on dairy farms. With experience, cow

behaviour and signals can become important indicators of their performance and welfare.

As Hulsen (2011, 2013) states in his practical manuals on cow signals, the steps in using cow behaviour in farm management decision-making are:

- *What do I see?* This involves careful observations that should be described objectively and precisely.
- *How has this come about?* Why is this happening? What are the causes?
- *What does this mean?* What should I do? What are the practical solutions to any obvious problems?
- In essence, it is look, think, then do.

The major goals of dairy farming include the prevention of diseases and the improvement of cow comfort and wellbeing, resulting in optimal production. Note this does not mean maximise production because economic logic tells us that the returns from any extra production arising from changes in farm management practices must be greater than their costs. This introduces the concept of marginal costs and returns (in contrast to average costs and returns) and this is fully explained in the book *Business management for tropical dairy farmers* (Moran 2009a).

Many years ago, a wise service provider once told the senior author that 'a good calf rearer knows which calves are going to be sick tomorrow or next week'. This statement can be extended to cover all stock on the dairy farm in that 'a good farmer knows which of his dairy stock are likely to be sick tomorrow or next week'. Knowing this, the farmer can take earlier evasive action to save on veterinary bills and improve the cow's comfort. This early intervention can reduce the impact of the health problem through fewer days sick and fewer days until full recovery, if possible, or culling from the herd, if that is the best business and welfare decision. In addition to animal health issues, astute observations can anticipate other potential farm problems such as overstressed stock or changes in the quality of the feeds on offer. So the challenge is to pick up as many signals as possible before the real problems occur. This is the 'take home' message from this chapter. As a wise farmer told Hulsen (2011), 'not knowing something is forgivable, but not seeing something is stupid'. That might be a bit extreme, but it highlights the importance of developing the skills to become an effective observer.

Another reason for looking at cow signals more purposefully is to overcome the danger of 'farm blindness', that is thinking that what you see every day around the farm is normal. One should always ask what is normal on my farm, and is it the same for all farms? It is essential then to make it a point of including specific observations in your daily routine and discussing such matters with your farming colleagues and service providers. It is also worth visiting other farms to note how their specific observations may differ from your farm.

5.2 Don't just look, observe

Astute observers should take into account:

- Not just looking, but looking and observing. You must notice all the signals that stock give out because they can all provide important information on cow wellbeing and comfort.
- Focused observations. You must look for things to evaluate. Ask the question: *Is everything as it should be or might this situation pose a potential risk?*
- Open-minded observations. Look at things as if for the very first time and forget any excuses and preconceived ideas.
- Comparing your current observations with some form of standard that indicates whether additional action needs to be taken – you will then need to develop some standards for your particular situation.
- Observing from large to small, from many to few and from far to near. For example:
  - ➤ Is the herd uniform in size, coat condition, cleanliness, body condition, abdominal fill? If not, why not? Is any non-uniformity important?
  - ➤ How are the animals distributed within the building (particular cubicles, throughout the laneways, on the periphery of the buildings) and if it is non-uniform, why? Is it important?
  - ➤ How many cows are lying down in the cubicles? While resting, is it close to 85%?
  - ➤ How many cows show abnormal posture while walking? Is it sufficient to cause concern about lameness?
  - ➤ After looking at the big picture, zero in on certain areas of the shed or on specific cows worthy of additional observation.
- Ensuring there is an observation routine in which every animal receives some attention, with cows (milking dry and transition) observed three times daily and heifers and bulls twice daily.
- If possible, take into account cause and effect. For example, if there is a physical deformity, what might have caused it, such as swollen feet and access to concrete floors only?
- In addition to your eyes, nose and hands, 'paper information', namely, records, can greatly add to the usefulness of observations. This highlights the value of good record keeping that can be easily accessed to supplement the physical signals emitted by the cow.
- Designing the shed layout for easy observation, such as having gaps in feed barriers and perimeter fences and a centrally located cattle crush for ease of closer individual animal observation if necessary.

- Recording the key observations and any follow-up actions. Writing things down is recommended as it forces you to describe more clearly what you see. It also facilitates information exchange with farm staff and, if necessary, veterinarians or other professionals.

5.2.1 Differences between animals

Assess whether the herd is uniform or if there are marked differences between animals. Pay attention to:

- Animal development: are heifers much smaller than the cows? If so, focus more attention on heifer rearing.
- Body condition: when more than 10% of the cows are too fat or too thin. This indicates a long-term imbalance between feed intake and utilisation. Focus on trough space, availability of feed during the day, hoof health, the way cows select their feed and dietary fibre content.
- Hair colour, coat shine and cleanliness: a glossy coat is a sign of a healthy animal. A dirty coat is always a bad sign, and can identify such things as the need to change the bedding, scouring from illness or poor ration formation.
- Abdominal and rumen fill: these indicate feed intake over the last 24–48 h. Why did the cows eat less? Are we dealing with a risk group (see below)? High yielding cows and those close to calving must reach their optimal feed intake as soon as possible.
- Other signs: are there common abnormalities in the herd? For example, a consistently located lump on many cows' shoulders could indicate improperly constructed or installed feed yoke, or the cows have to reach too far into the feeding place to get their feed. Ulcers from lying indicate a need to improve or change bedding.

5.2.2 Logic of cow signals

There are generally three reasons for specific cow behaviour, namely:

- It satisfies a **need** and the cow wants something, for example she wants to eat her food, wants to lie down or is just plain curious.
- It is a reaction to a **stimulus**, for example she tries to avoid being physically hurt so she moves away from people or dominant cows or even jumps after touching an electric fence.
- It is due to a **physical urge** caused by pain, disease, hormones or she may be due to calve down.

These help answer the question: *Why is the cow behaving in a certain way?* If you do not know whether such behaviour is normal, compare the cow in question

with other cows on your own farm and then those on another farm to assess the possible reasons in a completely different situation. Further details on normal and abnormal behaviours are given in Chapter 4 of this book.

As genuine cow signals are repeated, for example kicking off a milk cluster only once may mean a single cow is overreacting, but does she do it at every milking and if so, why? If it is repeated many times, then there must be a common cause such as over milking, the vacuum level is too high, there are teat injuries or even severe fly irritation.

If a cow looks as if she intends to do something, makes an attempt to do it but then stops, there must be a reason why she did not follow through her intention. What were the circumstances or stimulus or stimuli that made her change her mind? Learning to recognise normal behaviour and then the things that might inhibit this provides valuable information about the underlying relations in a herd, housing or health of a cow.

An observation that defies logic can be an extremely valuable cow signal. Hulsen (2011) calls these unclassified notable observations (or UNO, 'you know'). At first glance these findings may appear to be insignificant, but on reflection and further consideration, the observation can become important. If it can be a potentially harmful UNO, it justifies an explanation. For example, if a particular cow drinks water from dirty puddles, she must be thirsty, so providing additional or more accessible fresh drinking water would solve this problem. When evaluating UNOs, use the same three steps listed above, namely:

- Describe exactly what you see.
- Ask yourself, or someone else, what the cause is.
- Determine what influence the signal has on comfort, health and production, and decide whether or not to take action.

5.2.3 Indicator animals and locations

Indicator animals are those that belong to certain groups of stock on the farm that are at greater risk than others. They are often the first to send out signals indicating something is wrong. Observing abnormal behaviour from members of these high-risk groups can provide advance notice of a problem. For example, high yielding milkers will be the first to show up a problem in the formulation of the ration, through unexpected drops in milk yield.

Indicator animals can also be used to monitor the likelihood of a potential problem occurring on the farm, such as a shortage of forage might first become apparent with the changes in milk yields in heifers in the milking herd. Poor handling may first become apparent when previously bolder cows are slower to enter the dairy.

Risk locations on the farm can identify where stock are more likely to be injured, such as a long rough track where small stones can injure hooves, or the calf shed where sudden changes in weather can upset calf wellbeing.

There are times of greater risk for different stock groups on the farm. These can be related to:

- the season, such as the middle of the dry season when soil moisture levels are at their lowest
- a particular date, such as the first extremely hot day in summer
- stock age, such as at weaning time in milk-fed calves
- stage of lactation, such as when the first insemination is usually due.

Additional observations (and actions if necessary) and routine preventative measures can reduce stress during these times to limit any likely problems (Figures 5.1 and 5.2). Responding rapidly to such problems can prevent serious consequences. So it is important to plan ahead to assess whether everything is as it should be and potential problems can be quickly detected and acted upon.

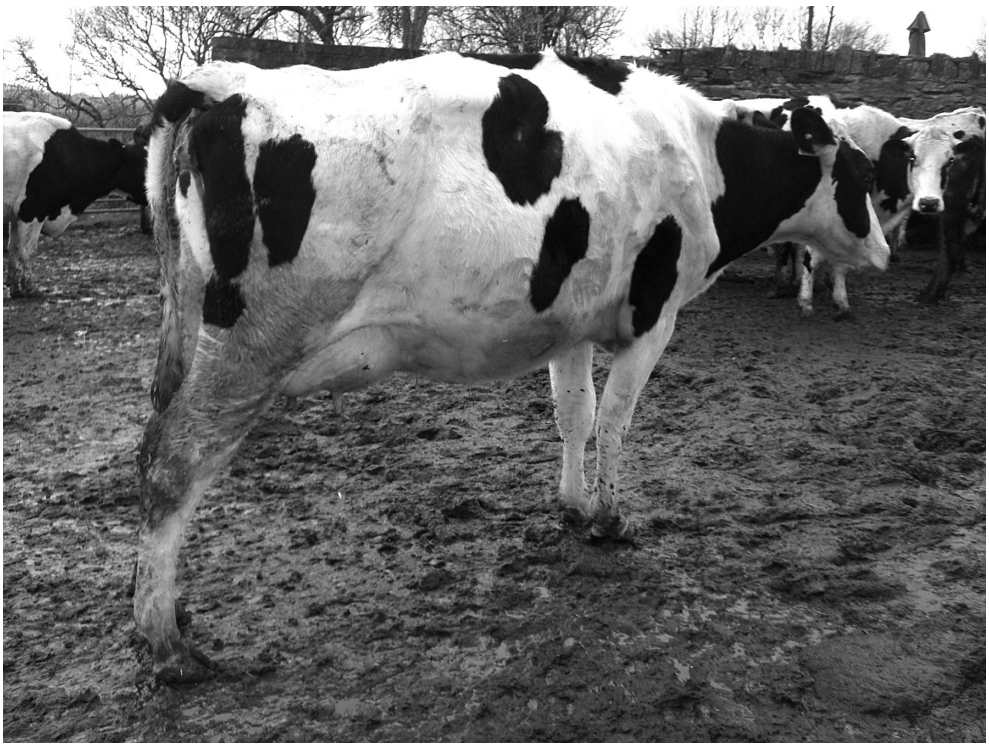

Figure 5.1: Lameness is a major problem on many tropical small holder dairy farms.

Figure 5.2: These dairy heifers are in appalling body condition and shed conditions.

5.2.4 Risk management

To a large extent, risk can be controlled and we can distinguish two types of risk, known and unknown. Known risks can be controlled by good management strategy. To minimise unknown risks requires alertness and good observations and to minimise any damage, quick response.

Risk management can be broken down to two steps, prevention and damage control. Prevention is reducing the likelihood of a risk occurring, such as:

- Guarantee success, for example, by providing quality forages and feeds.
- Incorporate risk-reducing strategies into daily routines, for example, by calving cows down in a clean, safe and accessible area or maintaining a closed herd by not buying cows in.
- High quality housing and equipment, for example, a well functioning, self-locking feed yoke, or an accessible and well-maintained foot trimming crush with sharp hoof knives at hand.
- Ongoing skill development and effective management, for example, updating technical skills, be willing to change, try and prevent 'farm blindness'.

Damage control is ensuring any damage from the risk is minimised by:

- Identifying the risk through thorough checks
- Acting quickly with strict farm discipline
- Acting effectively through using the necessary knowledge, skills and equipment.

5.2.5 Success factors

Avoiding risks and working out what went wrong are both important steps in improving farm management. But even without doing this, farm management can evolve. A successful farm is not determined by the absence of mistakes but by the proper development of prerequisites for success. Successful entrepreneurs identify and focus on key factors that will lead to success.

These factors depend on the objectives of the business. A high yielding farm with healthy stock and one that produces the bulk of its own forages requires:

- cows with good health, especially feet and legs
- cows with high genetic potential for conformation and production
- cows with capacity to consume and utilise lots of feed
- optimal availability of food with high quality, palatable dietary components in the right proportions
- good housing and outstanding stock care
- minimising heat stress
- high quality risk management.

These success factors need to be routinely monitored to determine whether everything is as it should be (all farm activities, stock health status) and whether this is likely to continue (risk management). The farm can develop into a first rate operation by:

- eliminating management mistakes, that is, remedying shortcomings
- controlling risks and paying closer attention to those areas needing improvement
- concentrating efforts to finetune the success factors in the entire farming business.

Hulsen's (2011) book has many 'take home messages' and the key ones have been summarised as 'one liners' in Box 5.1.

5.3 Cow signals while grazing

Observing grazing stock gives a good insight into their normal behaviour and needs. The way a cow walks; her rumen fill; if she's standing alone – all are signals that could indicate a need to keep a closer eye on individuals or groups of animals.

Box 5.1: 'One Liners' about how cows and humans communicate with each other

- Don't just look … observe.
- Like cows, use all your senses when observing; ears and nose as well as eyes.
- What do I see, why has this happened, and what does it mean?
- Observe from large to small, from many to few, from far to near – then do this in reverse.
- If cow signals are genuine, they will be repeated.
- Why is a cow doing this? Does it satisfy a need, is it a reaction to a stimulus, is it due to a physical urge?
- Cows are herd animals, so tend to do things simultaneously, but they also form smaller groups within herds, generally based on social order.
- Cows use subtle signals to indicate their social 'class' or ranking (dominance or submissiveness).
- Conflicts often occur between cows of similar rankings.
- Cows tend to moo when they are on heat or are hungry.
- Each cow has a personal space and this varies in size between breeds and their feelings of security and trust.
- Cows feel secure when they know they have plenty of feed, they have escape routes and they know the person handling them.
- Cows feel insecure on slippery floors, when they are very lame and when in the presence of unpredictable personnel.
- The presence of cobwebs in the cowshed is indicative of low air movement, hence poor ventilation.
- If more than 10% of the resting cows are standing, stall comfort needs to be improved.
- When cows lie down, up to 30% more blood circulates through the udder.
- Ration formulations rarely correspond to what cows actually consume – they act only as a starting point and need to be verified and modified on the farm.
- The body language of the cow is the best management adviser – if you can read the cow, you know what to do.
- Cows will tell you what they want.

Although pasture is the most natural environment for cattle, it is still necessary to consider the cow's comfort. Certain aspects are beyond the farmer's control such as excess sun, wind and rain and dampness. For these constraints, cows should be provided with shelter. At the very minimum, they must always have a dry area where they can lie down.

When cows lie down at pasture their behaviour provides a lot of information about their wellbeing. Lame and stiff cows lie in less upright positions and they have a much greater tendency to lie on their side compared to healthy cows. They also hold their head lower.

5.3.1 Leg and hoof health

Pasture provides the best environment for cow hooves as the ground is soft and provides a good grip. But long distances to walk and hard tracks with rough surfaces can still lead to hoof and feet problems. When walking over rough surfaces, hooves are worn down and injuries can occur, especially during wet periods when hooves are softer. The social order, particularly when cows are walking in a line, can disrupt movement when dominant cows push and even bring the line to a standstill. Driving cows in an impatient way leads to fighting and sudden movements and may even frighten cows. If the cows don't have time to see where they are putting their feet, this can cause physical damage. Uneven wear also leads to lameness problems when the outer claw grows faster than the inner claw, resulting in greater weight being placed on the outer claw.

Lameness can be evident when the cow is standing, due to pain in the leg bones and joints. Moving is not painful but bearing weight is and the cow swings the foot forward smoothly but then tries to avoid putting weight on it. Lameness can also only be evident when the cow is moving and this is caused by pain in the tendons or muscles. The animal tries to move the leg as little as possible but does not have difficulty bearing weight. There can be combinations of these two types of lameness.

The degree of lameness can be quantified using a five point lameness/locomotion score, which is described in Chapter 6. Lameness scores in individual cows can be used to select cows for hoof examination before they become clinically lame. Lameness scores for groups of cows or the entire herd are related to cow performance. The higher the lameness score, the greater the reduction in feed intake and milk yield and the poorer the body condition.

5.3.2 Signals of good and poor health

When assessing cow health, proceed from large to small. It is best to observe with an open mind rather than make judgements or excuses. Having someone else come and look with you can help you see more and draw better conclusions.

Signals of good cow heath include:

- The cow is alert and active, she does what she wants to do and is aware of her surroundings. Her eyes and ears are attentive and she is curious about noise and other stimuli.
- She has a glossy, smooth, clean coat without any blemishes. Cows that do not feel well soon lose the shine from their coat and the hairs of their coat may stand on end.
- She has a good appetite and drinks well. Food intake is evident from the rumen and abdominal fill. If food intake is poor for a long time, the cow will lose weight and eventually lose body condition. When she is not drinking enough

or is losing excessive fluids, the eyes become sunken and the skin becomes tight.
- She walks and stands without any signs of pain or discomfort. When in pain or lame, a cow arches her back. Irritation in the pelvic area causes the cow to hold up her tail. If having difficulty walking, the cow first makes movements indicating she is about to walk, followed by obvious head movements when she starts walking.
- The cow is well cared for, with good housing. Cow signals such as overgrown hooves, mange and lice are indicators of poor care and should have been attended to much earlier. Unclipped udders and backs, and dung caked on the cow's skin all suggest a lack of care.

There are eight scoring systems mentioned in this chapter that quantify cow wellbeing and health. These are locomotion/lameness, hooves, legs, cleanliness, rumen fill, dung, body condition and teats. Full details of all these systems are described in the next chapter. Appendix 3 provides a summary of good cow health and welfare while Appendix 4 provides a summary of poor cow health and welfare.

Farmers often notice sick animals because they look slightly different from other stock in the group. The earliest signs are subtle, requiring skill and experience as well as effort to recognise them. It is important to look specifically at animals in risk groups and at risk times.

Cows in negative energy balance have elevated levels of acetone in their blood, milk, urine and on their breath. Some people can smell acetone, even when several metres from the cow.

A high body temperature is an early and clear sign of disease and is part of the immune response and inflammatory process. A cow that is sick but not running a temperature may have a digestive disorder or could be in shock, which occurs when blood circulation is failing. In that case, the cow is cold to the touch especially her ears, lower limbs and udder. Taking her temperature should be the first step in any diagnosis.

When in pain, stock try to reduce the pressure on the sore part, take shallow and rapid breaths and are less aware of their environment. They also eat and drink less, showing signs of dehydration. They will often withdraw from the group and if they are in the shed, they will lie in a stall. Lame cows are more easily startled because they are less able to get away and this becomes very obvious on slippery floors.

5.4 Cow signals in the cowshed

The cowshed is a system where various factors interact: the layout (feed barriers, calving pen, ventilation), dimensions (width of laneways, roof height), materials

(concrete or rubber floors, straw yards), management (hygiene, feeding, stocking density) and the animal, to mention just a few. Lame cows place a higher demand on the floor area and the stalls than do healthy cows, and need more space to move. The availability of forages and concentrates influences the social order in the herd and therefore the need for space.

So what standards should a good facility try to achieve? Ultimately, there is one constant factor that determines this standard, namely, the cow. People translate these cow requirements into specifications on the building plan. As cows, their diets and people change, the norm needs to be modified continually. The best solutions are found by weighing up the pros and cons and making a compromise between too much or too little. These decisions are often reached with the aid of specialists, together with good farm sense.

5.4.1 Space and social order

There should not be anything to prevent the cow having easy access to her food, the drinking water or her bed. Every animal needs a certain amount of space in order to feel comfortable. For example, cows need to have enough room to pass each other without touching and they should be able to escape and find a safe haven. Cows with horns increase the need for space and escape routes.

Every herd has a complex social order. There are small groups with bosses and their subordinates and leaders and followers. Bosses are those animals that are allowed to eat first, while leaders initiate activities. A dominant cow forms a serious obstacle to a low ranking animal, which will only pass the more dominant cow if she feels safe to do so. She needs to be able to escape and in order to do that, must have enough space, healthy feet and legs and sufficient grip on the floor. Cows that are lying down do not participate in the competition for social order.

The most common cause of fighting is competition for feed; this occurs when palatable feed is not available throughout the day. In the struggle to get to the tastiest feed, the lower ranked animals will always end up eating second. First-calf heifers have a low social rank and don't know all the cows in the herd. Due to their timidity, they lose out when competing for feed.

Along with visually observing social interactions, things like rumen fill, milk yield, and long bouts of standing, rather than eating or resting, all provide good information about the comfort within the herd.

5.4.2 Shed design and construction

Every shed has its own risks and risk locations. By observing every location in the shed thoroughly, with and without the cows, you can prevent many problems. Risks are found not only in certain areas but also in certain circumstances. These

include changes in the weather, hot weather with high humidity, when mixing groups (such as heifers and dry cows), general unrest in the shed, cows on heat, a relief milker, drying cows off and changing ration formulations.

Cows like to drink water without being interrupted so water troughs should not be located too close to feeding areas. If so, low ranking cows would hesitate to drink when thirsty. Locating troughs sufficiently high so cows cannot defecate into the water is not such a good idea because cows like to drink on the level and the steps up to the trough put extra pressure on the hooves.

Cows are sensitive to the amount of light in the shed. They have a reflective layer at the back of their eyes which enables them to see better in dim light. However, they need a lot more light to stimulate their biorhythm than for ordinary sight. Being daytime creatures with a temperate seasonal rhythm, the winter (16 h dark and 8 h of light) is the natural time for them to be dry while the summer (14 to 16 h of light and 6 h of uninterrupted darkness) is optimum for lactation. These conditions stimulate milk production, the animals feel well and are more likely to show signs of heat. Such wide variations in daylength do not occur in the tropics and so diurnal rhythms play little part in their physiological responses to the tropical climate.

Cows perform best within a predetermined temperature range. Below –5°C cows use energy to maintain body temperature while above 20°C they use energy to remain cool, and above 25°C feed intake begins to decrease. When showing signs of severe heat stress, cows with high respiration rates prefer to stand, sometimes with their front end higher than their rear end. This is so the intestines put less pressure on the diaphragm and the cow can breathe more easily. Ventilation is important, particularly around the head, to facilitate air exchange from the lungs. Heat stress is one of the major constraints to small holder dairy (SHD) systems in the tropics with inadequate ventilation restricting heat dissipation in many of the sheds. Roof heights are frequently too low and lack of open sides restricts air movement in sheds. Fans are only occasionally incorporated into ventilation systems while sprinkler systems are rarely installed.

On tropical SHD farms, floors are mainly concrete and all too often they are not roughened or grooved. The majority of effluent disposal is by hand using shovels and scrapers. Despite the fact that there is adequate water in areas with high rainfall, it is rarely used to wash down floors. Consequently floors are often slippery, thus reducing a cow's self-assurance and confidence when moving around the shed. Cattle may well have difficulty performing their natural behaviours such as self-grooming and mounting when a cow joins a sexually active group of cows. Hoof health also suffers as burdens of infection are high and hooves are kept moist on the faeces-contaminated floors. The lack of rubber mats or other soft bedding restricts the use of free stalls for lying down and even in tie stalls cows will not rest for sufficiently long periods.

Slippery floors lead to many signals of discomfort in cows, such as slipping when being rounded up or when taking evasive action and can lead to poor expression of heat. Cows look for less slippery areas in laneways, walking carefully with legs placed apart and heads low and taking small steps and negotiating corners with care. Cows are generally more apprehensive, while low-ranking cows and heifers look for safe havens such as in dead-end laneways.

Obviously the state of the hooves and legs are also prime determinators of how stock cope with floor surfaces in sheds. Scoring systems for hooves and legs are described in the next chapter.

5.4.3 Stalls or cubicles

Cows like to lie down for up to 14 h per day. Lying down is important because the cows can rest, their feet can rest and can dry off and there is more space available for other cows in the laneways. It also increases blood flow through the udder (by up to 30%) thereby increasing the flow on precursors to produce milk.

The lying periods fit in between the periods of feeding and standing. A lying period typically lasts 30 min to 3 h, so the cow stands up and lies down many times each day. During the long lying period in the middle of the day or during the night, she rises, stretches and lies down again immediately, usually on her other side. Cattle spend half their time lying down and they lie down and get up around 16 times every day. When a cow lies down, she puts two-thirds of her weight on her front knees, and they drop freely from a height of 20 to 30 cm. It is therefore very important to have good quality bedding so she can painlessly lie down whenever she wants to. If she takes longer than 5 min on average, you should check the stall and bedding for reasons why she does not lie down immediately.

If stall comfort is not optimum, cows will not lie down unless they are very tired. They are then more likely to lie down for longer than normal and will eat and drink less. In addition, certain problems will soon start to appear – such as swollen hocks. If more than 10% of resting cows are standing, stall comfort needs to be improved.

Stalls are the compromise between space and hygiene. When a cow needs to defecate, she passes dung regardless of where she is. For good hygiene, which will help to prevent udder infections, it is essential that cows do not defecate in stalls and that they are cleaned out several times each day. Small heifers will always defecate in their stalls. Poor stall design can make standing up or lying down difficult. If this is the case, the cows will lie down for abnormally long periods and could have injuries to their knees and hocks. Difficulties when getting up can lead to damaged teats. The stall floor is also important – it should be soft with sufficient grip. Sand or a layer of sawdust (more than 10 cm deep) is the most comfortable.

A brisket locator prevents the cow from lying too far forward in the stall. It should be rounded, with a little give and not too high (say 10 cm). Head rails

should not hinder the cow when she stretches her head. Therefore, they should be positioned at less than 20 cm or higher than 90 cm. The dividers should encourage the cow to lie straight, without risk of bruising.

Injuries that indicate that stall design needs improving include:

- **Bruises**: These result from forces at right angles to the hock and occur when the cow lands heavily on the stall floor and from the pressure on the hock when lying down and getting up. The stall surface is too hard or there is insufficient bedding.
- **Abrasions**: These result from forces parallel to the skin over the hock and may indicate that the stall surface is too rough or too slippery, the bedding is too coarse or the stalls were badly built.

Factors that make stall comfort worse:

- **Wet stalls** that soak the skin and lead to hair loss. In addition, skin infections will develop more easily.
- **Acidosis and related problems** cause laminitis due to toxins in the blood damaging small blood vessels particularly in the hooves and joints. This results in pain and a stiff gait and cows have difficulty lying down and standing which leads to bruised hocks.
- **Lameness and leg weaknesses** cause greater difficulty in lying down and standing so cows will have to use their head as a counterbalance even more than normal. Cows are then likely to end up falling forward. They also land heavily and develop abrasions from the stall floor.
- **Large and heavy cows** need a lot of strength and space to stand up and lie down.

Further details of the physical facilities involved in cow comfort are presented in Chapter 7.

5.5 Cow signals at the feed trough

Cow nutrition focuses on achieving maximum dry matter intake and a healthy rumen. There are many factors contributing to rumen health. Nutritionists tend to focus on issues such as ratio of energy to protein and ensuring the ration has sufficient fibre and minerals. However, astute farmers should consider all the factors that can influence a cow's eating behaviour.

Calculated rations rarely correspond exactly to what the cow actually consumes, because of natural variation and the need to make assumptions. Therefore, the ration calculation only acts as a starting point, which needs to be verified and possibly modified in the shed.

When evaluating nutrition, health and production, you need to look to the past as well as the present with the aim of achieving even better results in the future. Information from the past helps you to learn and to understand the current situation. It can be used as the basis for setting new goals such as 'next year I want to produce 50 L more milk per cow and also halve the feet problems'. The cow signals you notice can be used to evaluate the current situation.

Overcrowding at the feed bunk results in increased aggression between cows. This leads to hoof damage and lameness as less dominant cows try to avoid dominant animals by turning away from them, causing them to twist their rear feet on an abrasive surface (concrete). Increased aggressive interactions can lead to even more severe claw damage. The potential for laminitis also increases as cows may consume fewer, but larger, meals or even have reduced feed intakes and spend more time on concrete rather than lying in the stalls. Headlocks reduce this aggression and improve access to feed by socially subordinate cows during peak feeding periods, by offering some physical separation between adjacent cows.

5.5.1 What signals to look for

A high yielding cow giving 30 L/day of milk has a rumen volume of 150 to 200 L and each day, consumes about 22 kg of dry matter and passes about 35 kg dung.

When looking back, important cow signals include:

- changes in body condition scores
- annual and monthly production figures and milk records
- number of metabolic diseases, such as displaced abomasum, milk fever and ketosis
- total number of illnesses
- number of cows culled with the reason for culling
- fertility records.

When assessing the situation and making changes, the important cow signals (and what they indicate) are:

- rumen fill (feed intake and rate of passage)
- milk production today and yesterday (feed intake and energy to protein ratio)
- dung consistency (feed intake and digestion)
- selective feeding (well mixed ration and palatability of ingredients)
- daily feed residues (should be 5 to 10% of feed offered)
- feed wastage (feed intake and selective feeding)
- chewing the cud or rumination (fibre)
- hoof health (locomotion score)
- heat stress.

Close investigation of the cow's body condition around the abdomen can provide a guide as to how much a cow has eaten today, this week and this month (Hulsen 2013).

- A cow that has eaten well has a good rumen fill, belly fill and body condition.
- A cow that has not eaten enough **today** has a reduced rumen fill. This is apparent from the depressed left flank, located at the back of the ribs under the rear lumbar vertebrae, just in front of the cow's hip and is more fully described in Chapter 6.
- A cow that has not eaten well this **week** has a reduced belly fill. This is apparent from the depressed abdomen, located midway down the abdomen under the ribs.
- A cow that has not eaten well this **month** has a reduced body condition score, described more fully in Chapter 6.

Milk production data provide valuable information about individual cows as well as groups. The standard values are affected by the genetic potential of the herd as well as the ration. Table 5.1 presents some examples.

5.5.2 Considerations when preparing the ration

Mature cows eat between 7 and 12 meals per day and each meal lasts about 45 min, giving a total eating time of 6 to 8 h per day. Heifers eat more frequently and consume less at each meal. These should always be sufficient fibre in the rumen to correct acidosis caused by rapidly fermenting feeds. Cows should produce a lot of saliva (from rumination) and the rumen wall should quickly absorb the end products of digestion. To maintain a healthy rumen, cows need to eat sufficient fibre, so ideally they should eat forages and concentrates at about the same time. If the ration does not contain sufficient fibre, cows may actively seek out high fibre feeds such as straw or hay. Low fibre rations increase the risk of a very low rumen pH developing which can lead to toxins killing off some of the bacterial microbes.

Table 5.1. Examples of herd problems as indicated by milk production and composition data.

Problem	Check point
Severe negative energy balance or ketosis	Difference between milk fat and milk protein %: • > 1.0% indicates negative energy balance • > 1 25% indicates ketosis
Acidosis	Low fat %
High incidence of social conflicts	Heifer production below expectation
Low disease resistance in the herd	Disappointing production from older cows Low milk protein in older cows (< 3.2%) Too many sick cows

For fibre to be effective, the particles should be longer than 0.6 cm, so aim to work with forage 4 cm long.

The rumination time provides valuable information on the ration's fibre content and cows should ruminate for 8 to 10 h per day, making a total of 16 h chewing. High yielding cows produce about 300 L/day of saliva when cud chewing is optimal. At any one time, more than 50% of the cows lying down should be ruminating and this should increase to 90% 2 h after feeding. Cows commence rumination about 45 min after eating and will lie down for about three-quarters of their time spent ruminating. Cud chewing sessions last 30 min or more during which time cows chew each regurgitated cud 50 to 70 times before swallowing it. If chewed less than 50 times, this indicates insufficient fibre.

Cows select their feed on the basis of taste and smell, not nutritional value. This is easy to do with dry mixes and when fed particles are long (> 7 cm). Selective feeding can be assessed by eating behaviour (for example, if cows are burrowing into the feed), variations in dung from cows offered the same ration and of course, by comparing the ration on offer with the residues. Cows often use their tongue to pick out long fibres with the shorter pieces dropping out and later, eaten off the ground. This is characterised by cows burrowing holes and then shaking out the feed.

Cows must be able to approach the feed barrier or trough safely and every animal should have enough space to eat in a relaxed manner. A space for every cow in the herd is an ideal, however, being herd animals, cows all like to eat at the same time. The competition at the feed barrier means that cows will be in a hurry to eat and may not consume enough at any one meal. Separating out first-calf heifers from older cows will reduce this competition and lead to lower risk of acidosis and higher milk production, as they will be more relaxed when eating, thus will eat smaller meals more often.

Unlimited access to drinking water is just as important as providing sufficient fresh feed. Cows like to drink fast, up to 20 L/minute. If they cannot, their water intake will decline and their feed intake and milk production will suffer. Every 1 kg feed dry matter utilises 5 L water and a 40% decrease in water intake can cut milk yield by 25%.

Cows prefer to drink from a large water trough at a low level and like to be able to stand quietly and safely while drinking. They will always choose the freshest and cleanest water. Cows commonly drink when they get up from resting, after eating and again after milking. Water troughs should then be placed in many positions throughout the shed and close to the feed barriers. As a rule of thumb, one large trough should be provided for every 20 cows or one smaller one per 10 cows.

5.5.3 Risk groups

On every farm there are groups of animals that are susceptible to shortcomings in the ration. These groups then require closer monitoring than others. They can also

be used as a means of monitoring risks, as indicator animals. Separating risk groups from the rest of the herd reduces the risks. For example, freshly calved cows and heifers should be separated from the rest of the milking herd.

The four main groups of risk animals are:

- **Heifers:** Risks include inadequate feed intake, acidosis and hoof problems. The connective tissue in heifers becomes weak at the time of calving. Rations too high in energy or protein result in udder oedema and soft hooves. If the mineral ratio is wrong, this may also contribute to oedema. In addition, these animals may not eat enough forage compared to concentrate, a particular problem with insufficient space at the feed barrier. This can lead to laminitis. The combination of weakened connective tissue and laminitis increases the probability of hoof problems.
- **Freshly calved cows:** Risks include milk fever, ketosis and fatty liver, metritis and mastitis. If these cows do not eat enough soon after calving, they need extra care and attention. Calving down in a dirty pen can lead to udder and uterine infections.
- **Cows in first two months of lactation:** Risks include inadequate energy intake, acidosis and displaced abomasum. During the first 6 to 8 weeks of lactation, low forage intake can lead to acidosis. The acidic rumen is poorly filled, does not contract and the contents are mushy. The dung shows the signs of poor feed digestion, smells acidic and alternates between thick and thin. Cows do not ruminate properly or for long enough, so often discarded cud is seen in the pen.
- **Cows at end of lactation**: Risks include getting over fat and reducing concentrate intakes too quickly. Condition score, milk fat and protein levels should be monitored. Getting too fat is due to too much energy and not enough dietary protein or a ration that is too rich for the level of milk production.

5.6 Cow signals in the milking parlour

The cows enter the milking parlour one by one and stand for at least 5 min during which time you get a good look at their udders, bellies and legs. Before you put the milk cluster on, you feel the udder and teats and assess the foremilk (strippings). Then you can record how much milk she gave. As a daily routine, milking then provides many opportunities to watch out for cow signals. The better you see the cows, the more information you can gather. If it is difficult to see the cows clearly in the parlour, then you will need to do more monitoring in other places.

For many farmers, milking is the best part of the day as they enjoy the peace and quiet as well as the close contact with their cows. Peace and quiet are good signs in the milking parlour because the cows are also relaxed and it's easier to

notice whether they are healthy or showing signs of illness. Restlessness occurs when there is fear or pain or irritation.

Milkers who are relaxed and 'animal focused' enhance the calmness of the cows. Often they have a good feel for the cows and know almost everything about every animal. However, not all farmers have this skill and have to work hard to remember the information. If several people milk the cows, the important information has to be recorded, such as which cows are currently being treated with antibiotics. Hanging a clipboard where it is clearly visible is a simple effective method. It takes time to teach yourself to become aware of things to observe in the milking parlour and you need to develop a good routine. For example, always check the foremilk (strippings), rumen fill, hocks and hooves.

A relaxed milker positively affects the milking process. This has been covered in detail in Chapter 4. The parlour should provide good lighting, particularly at the bottom of the udder, be warm in winter and cool in summer, and be free from draughts to provide a pleasant working environment. A fan provides fresh air, discourages flies and helps to keep any fumes from the footbath out of the parlour.

5.6.1 Cow behaviour during milking

The cows should not be nervous at milking time. Pay close attention to their behaviour, such as how keen are they to come in? If they are nervous, what is the cause? Is milking painful? Do they have unpleasant experiences in the milking parlour? Is the floor slippery? Cows often enter the parlour in the same order, this reflects their social order in the herd. So if a cow does not enter in her normal position, something unusual is probably going on.

Rough handling while rounding the cows up leads to conflict and some cows having to move abruptly. The cows can injure themselves and have hoof problems. They will also become more anxious. Restlessness, fear and pain increase levels of adrenalin and other stress hormones in the blood which will inhibit the release of oxytocin, the hormone that makes cows let down their milk. As well as causing milk letdown and uterine contractions, oxytocin creates a thirst which explains why cows like to drink during and after milking and also at calving.

Cows are creatures of habit so will milk out better if a simple routine is followed when preparing the udder and putting on the cluster, rather than working in a haphazard way. The cow should stand still so that the cluster can be attached quickly without any air being sucked in. The cluster should be attached between 60 and 90 s after pre-treatment of the udder, then the milk should start flowing almost immediately and keep on flowing. Putting on the cluster, milking itself and cluster removal should all take place quietly. If the milker is calm, the cow barely notices the milking process.

If the cow is unsettled and jumpy, there could be a variety of causes, such as pain, fear and demanding concentrates. It could also be due to malfunctioning of

the milking machines, the milker being rough, not enough space for the cows to stand, teat injuries, fly irritation or stray voltage on the cluster or other equipment. Defecating and urinating during milking are signs of anxiety. Another signal is how the cow responds to the sucking noise of the cluster. She should not jump. A fearful response might be due to being previously punished for kicking off the cluster.

While she is being milked, the cow will often seem to be in a daze while she may also chew her cud. Feeding concentrates can encourage cows to come into the parlour and will stimulate milk letdown. Be consistent and precise when providing concentrates because cows learn to demand more by behaving restlessly and kicking off their cluster. This behaviour develops because the cow is rewarded with extra concentrate. Some clever cows are even able to operate the concentrate lever themselves.

The rear quarters contain the most milk and at the end of the milking process, all quarters should be milked out. Take off the clusters when the rear quarters are empty; this does not mean that the front quarters have been over milked.

Cows should be able to leave the milking parlour quietly and in a relaxed manner. Jumpy cows and sudden movements are the first signs that they are unsettled. Cows should not have to worry about slipping or being chased when entering or exiting the milking parlour. Sharp bends and slippery floors are risk locations for the cows and make them nervous. Cows also dislike steps, so a slope is a better option, with the milking area at the highest point. Sharp protrusions, electric wires and a traffic jam at the exit all act as obstacles. So avoid risks and remove obstacles.

5.6.2 Cleanliness, hygiene and cow health

Cows have to be clean because good hygiene prevents disease. Dirt is also a negative signal indicating the cow has been or is ill (diarrhoea) or that something untoward has recently happened, such as she fell or was jumped on. If the cows are always dirty, then it is difficult to spot any changes in the degree of cleanliness.

Dirty **udders** and **teats** increase the likelihood of mastitis, which is caused by two types of bacteria. These are first, the contagious bacteria that live on the cow's skin and are transferred from cow to cow in the parlour. The other bacteria are environmental bacteria that live in the shed, stalls and straw yards contaminating the udder there. Dirty udders are hard to clean properly and they contaminate milk with dirt and bacteria. Clipping the hairs off the udder improves the hygiene, ease of working and access to the teats for cleaning.

Dirty hooves indicate either there is a lot of dung on the floors or that it is very loose hence the hooves are wet for a large part of the day. Dirty wet hooves are more susceptible to disease (soft hooves and skin, pathogens in the faeces), will make the footbath ineffective and can be transferred to the teats. Ideally dirty

hooves should not be hosed in the milking parlour as this will distribute dirt and manure further in the area via the fine water droplets.

In many milking parlours, the **hocks** are at eye level during milking, making it easy to monitor their health by assessing the number and type of hock injuries. The normal healthy hock is free from skin lesions and swelling. Ideally, the hair coat in that area is smooth and continuous with the rest of the leg. Bald patches are acceptable but bruising and infections cause pain and discomfort, therefore, they are serious signals. The cause is likely to be the stall floors, stall design and/or lameness. In deep sand stalls that are well maintained, it is rare to find any hock showing bald areas or swelling. This, as well as comfort to the cow as seen by lying behaviour, are two of the reasons why deep sand stalls are the most production and welfare friendly bedding.

The bony part of the hock can also become swollen through severe bruising when a fluid-filled cushion forms. This is a sign that the stalls are uncomfortable. Traumatic abrasions from dirty, wet stall floors can cause the skin to become infected and this can extend subcutaneously (under the skin). In severe cases, the joint also becomes infected and very swollen and makes the cow permanently very lame. She must then be culled. Hulsen (2011) sets the herd targets for stall injuries to the hock at 30% for bald patches, 10% for bruises and 10% for skin infections.

What applies to hocks also applies to **hooves**. The top side of hooves can be easily examined in the milking parlour, although the underside is more easily examined in the shed. First assess the overall health, hygiene and cow stance. Look for any signs of pain, swelling around the coronary band (at the top of the hoof tissue) and laminitis. Cows with sore hooves regularly lift their legs and spraying cold water on a hoof with an open wound, often digital dermatitis, causes an immediate pain reaction. For this reason, affected cows will try to avoid footbaths.

Hoof conformation should also be assessed because abnormalities occur through irregular growth or uneven wear. This can be affected by foul-in-the-foot (see Chapter 6), laminitis and genetics. Poor foot trimming can also be the reason for many cows not standing properly. With laminitis, the attachment of the hoof wall to the underlying bone weakens and the hoof tip turns upwards. This is visible as a cleft at the front of the hoof and divergent growth lines up the hoof.

Hoof problems can be minimised by ensuring:

- Low infection rates: keep the floors and hooves clean and dry, treat infections promptly and use preventive footbaths. Also try and maintain a closed herd so as not to import potential hoof problems.
- Good feeding strategy: provide sufficient fibre in the diet to prevent laminitis and ensure the rapidly and slowly degradable ration components are eaten simultaneously.

- Optimum immunity: ensure optimal feeding management, particularly of the transition cows and the integration of first-calving heifers into the milking herd.
- Avoid injury: provide level floors with sufficient grip, with some give (so not too hard) and no loose stones. Ensure good routine foot trimming and aim for peace and quietness in the cowshed.

Ongoing problems with soft, wet hooves require closer attention to make the surroundings cleaner and drier. Aggressive hoof infections require focusing on the sources of infection and on optimum hoof and cow immunity. If there are problems with excessively dry hooves, the best approach is to ensure even load distribution and optimal hoof shape (by trimming). It is generally not advisable to make the surroundings damper because this can increase the infection pressure. Hoof disorders can occur due to constant exposure to adverse conditions such as a continuously wet floor, but short-term factors can also be a cause, such as a heavily contaminated area of the shed. Faecal material and moisture are risk locations for hoof infections.

Rumen fill can also be assessed during milking as it provides a good opportunity to assess the volume of the rumen contents, which is a guide to the content and thickness of the fibre layer. Cows standing with their left side towards the handler will provide an excellent view of the rumen, but with practice, a view of the right side will also prove useful. Depending on the length of milking, the last cows' rumens will not be as full as the first cows'. Stage of lactation is also going to vary the rumen fill. Maximum dry matter intake should be reached by 10 weeks post-calving. The rumen scoring system is fully described in Chapter 6.

Milk quality: It is important to routinely evaluate the integrity of the milk before putting on the milk cluster. To closely examine milk, first extract some by hand milking as foremilk, discard the first few strips as they just flush away the bacteria in and around the teat opening. If there is something wrong with the milk, small clots of milk protein are easily seen. In severe cases, these may also contain blood proteins that have leaked into the milk through blood vessel walls in the mammary tissue. Mastitic milk (even subclinical) has a higher salt content than normal milk, hence it has a higher electrical conductivity when tested. If clinical mastitis occurs due to late diagnosis, other cows are more likely to become infected. Blood clots and red colouration caused by burst blood vessels are more common in heifers because the udder is still growing rapidly and there is udder oedema. Sometimes the symptoms occur through the cow slipping and falling over. This bleeding generally stops on its own accord.

For the **teats**, milking is an intensive process. Healthy teats and a well-functioning machine are the prerequisites for success together with correct teat

shape, proper teat placement and appropriate milking speed. The teat end together with the teat canal form a crucial barrier against invading bacteria. Forces on the teat end during milking cause calluses to develop and if the skin around these calluses becomes roughened rather than remains smooth, udder infections and mastitis are more likely to occur. Such infections can be caused by:

- vacuum level being too high
- pulsation rate is not properly adjusted
- cows are milking for too long
- continued milking when the quarter is empty (over milking)
- rubber liners don't fit, due to abnormal teat shape or wrong liners
- rubber in the liners is damaged and the liners feel roughened due to delay in replacing them.

After milking, good teats are flexible and naturally coloured. The teats should be dry when the cluster is removed. If they are wet, the milk is not being removed quickly enough from the cluster and it is shooting back and into the teat. This creates the risk of the udder becoming infected with bacteria from the teat skin or from a previous cow.

If the liner fits properly, the vacuum is much lower at the top of the cup than at the teat end. With small teats, such as in heifers, and liners that are too large or wet from preparing the cow for milking, the vacuum can be excessive at the teat end. This can cause small haemorrhages in the skin and the cows become unsettled due to painful teat ends.

The 'pinch line' where the rubber liners come up to on the teat, is the result of the teat being stuck on the liner. This is caused by a liner that is worn out, stiff or too wide, or a pulsator that has an excessive rest phase. The teat score provides some degree of objectivity when describing teat health and is described in Chapter 6.

5.7 Signals given out by calves and heifers

Dry cows and heifers are high risk animals as they go through many risk times and may not receive enough care when the farmer is busy. This is unwise given that future herd performance depends on these cows. Times of risk include birth, the first few days of life, disease outbreak in calves, moving, weaning, ration changes, mixing groups, certain types of weather and climatic changes, a different handler and transportation. Other more farm-specific risks become apparent on closer inspection and when planning future management strategies.

The first few days of life are a challenging time for all newborn calves. They must get sufficient colostrum (5 L on the first day with at least half of this during

the first 12 hours). This, together with clean, comfortable housing, are the keys to success during the first month of life. The best signals of quality calf care are:

- number of cases of diarrhoea
- mortality rate (also record the age)
- number of navel infections
- growth and feed intake.

The senior author has written a book specifically on young stock management on tropical dairy farms (Moran 2012b). This book contains considerable

Table 5.2. Using your senses to monitor the wellbeing of calves and conditions in the calf shed.

Senses	Indicators of wellbeing
Eyesight	Bright and alert eyes Droopy or upright ears Soft and shiny skin and coat Panting and rapid respiration rates Abnormal discharges from eyes, mouth or body Whether navels and joints are swollen State of faeces residues on calves' back legs (colour and consistency) State of faeces on floor (runny, too clumpy) Any excess feed residues Willingness of calves to eat and drink Any abnormal calf behaviour Proportion of calves resting, standing or moving around If calves stretch when they get up General state of calf shed (drainage, ventilation) General tidiness and cleanliness of calf shed
Hearing	Grinding of teeth Bellowing Laboured breathing Coughing Unsettled calves moving around pens Dripping taps or water troughs
Smell	Abnormal odour of calf's breath Odour of faeces Any other abnormal calf odours (infected hooves) Odour of whole milk or CMR powder Odour of bedding Odour from mouldy feeds Odour of air, hence state of ventilation Odour coming from poor drainage
Taste	Taste of whole milk or calf milk replacer solution Taste of concentrates and forages
Touch	Whether noses are dry Whether ears are warm, hot or cold General level of heat or cold stress for calves Any abnormal draughts Whether air is too damp, indicating poor ventilation Temperature of milk or calf milk replacer solution

information about many aspects of calf and heifer rearing, with one chapter (Chapter 12) specifically on calf and heifer signals called 'Communicating with the calf'. It contains Table 5.2, which provides some insight into how humans can use their six senses to assess how well the calves are coping with their shed environment.

5.8 Signals given out by dry cows

For the milking cow, the dry period is like an 8 week annual holiday. The first few days are stressful because of the changes in management, specifically the previous twice daily milking. This is followed by a period of rest and contentment. But at the end of this dry period, the cow must be completely ready for the recommencement of her duties in the milking herd but in addition, she must give birth to her calf and then immediately return to milk production. The cow's body condition should hardly change during the dry period yet she must eat sufficiently to maintain it. Ideally there should be daily evaluations of rumen fill, feed residues and dung and weekly assessments of body condition.

The period around calving time represents the time of greatest risk in the cow's life. Adequate preparation and outstanding care are key factors if this transition period is to take place with minimum problems. Usually the cow will pass through two groups during their dry period. First, she will be classed as a 'far-off cow', from drying off to 3 weeks before calving. Then she will become a 'close-up cow' for these last 3 weeks. This is part of the transition period, from 3 weeks before until 3 weeks after calving.

5.8.1 Transition period

Targets at the beginning are:

- body condition score of 3.5 points out of 5, or 5 points out of 8
- maximum feed intake; check rumen fill and weigh feed
- proper mineral balance; undertake blood and urine analyses
- healthy feet and legs; use leg, hoof and locomotion scores
- good overall health; cow is alert.

During the transition period, aim for:

- optimum ration; check ration formulation, dung score, disease status
- continuous availability of palatable feed and water; check rumen fill, water troughs, feed intake
- outstanding hygiene; check cleanliness scores and shed
- comfortable stalls, spacious and well-ventilated housing; check lying behaviour, space and climate control

- minimal stress; check gradual changes in management and also behaviour
- good quality care and control of conditions; evaluate care and risk management.

5.8.2 Far-off group

Dry the cow off in one go and hygienically insert a tube of 'dry cow' antibiotic cream as part of the mastitis prevention program. Move her to the resting group where she will be fed a very basic ration but with plenty of drinking water. The feed intake will slowly decrease because the growing foetus is occupying more space in the abdomen.

During the dry period, the teat canal is closed by a keratin plug, which develops over several weeks. However, in about 10% of the cows, the closure is incomplete, bringing a continuous risk of mastitis during the dry period, particularly immediately after drying off and just before calving.

5.8.3 Close-up group

It takes 4 to 6 weeks for the rumen to completely adjust to a new ration, hence the milking cow ration should commence 3 weeks before calving. During the transition period, all types of unrest, discomfort and stress, such as radical changes in housing and feeding and large changes in groupings, are undesirable. Introducing new cows to the close-up group will invariably lead to some conflicts, but after one or two days a new order will be established and peace and quiet will return. Avoid group changes on the day of calving, unless the cow has been isolated to remove any competition.

Just before calving, the udder fills, often with oedema present. The vulva swells and loosens and once the ligaments (running from the spine to the pins beside the tail) are completely slack, the cow usually calves within 24 h. The body temperature also falls by between 0.5 and 1.0°C.

5.8.4 Calving

Check every animal thoroughly at least three times each day and if necessary, intervene quickly and effectively. On the day of calving, use established routines, setting goals and checking whether they have been achieved. If they have not, then improve appropriate management. Such goals include:

- 95% of cows calve in the calving pen
- < 5% have retained placenta at 8 h or more post calving
- < 10% develop metritis
- < 5% develop hypocalcaemia (milk fever)
- < 5% calf mortality within the first 24 h
- < 5% have displaced abomasum.

5.8.5 Post calving

On the day she calves, the cow does not eat much because of the calving process and the associated stress, which is due to social conflicts, deficiencies in the housing and dietary changes. Severe stress can lead to several days of underfeeding. The feed intake on the day of calving is a good indicator of the quality of the dry cow management. The more she eats, the better start she will get to her lactation.

5.9 Cow signals of heat stress

5.9.1 Symptoms of heat stress

There are many symptoms of heat stress, with ones more relevant to shedded cows shown in italics below (Moran 2005). The initial signs are behavioural while the last five signs are the more severe physiological ones due to a failure to cope and therefore requiring immediate attention to reduce their adverse effects on cow performance. In order of increasing severity, they are:

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

As well as behavioural symptoms, heat stressed cows will produce milk containing less milk protein or solids not fat. In addition, milk fat levels may decrease if cows markedly reduce their forage intakes.

The severity of heat stress depends on many factors. These include:

- actual temperature and humidity
- length of the heat stress period
- degree of night cooling that occurs
- ventilation and air flow

- cow breed and size
- level of milk production and dry matter intake before heat stress
- housing type, overcrowding, aspect
- water availability
- coat colour, if exposed to sun
- hair coat depth.

Milking cows are maintained in a variety of environmental conditions. Without access to shade, the heat load on cattle grazing at pasture is generally lower than for cattle in dirt yards, because the dirt surface absorbs less heat then grass, thus radiate more heat onto the stock. For example, the surface of a dirt yard can reach 60 to 80°C (on a day with high solar radiation and ambient temperatures of 40 to 45°C), but it will cool down rapidly once the sun sets. Clearly, access to shade, whether at pasture or in yards is highly desirable in regions with high radiation heat loads.

5.9.2 Temperature Humidity Index

The best single descriptor of heat stress is the Temperature Humidity Index (THI), as this combines temperature and relative humidity into a single comfort index. The relationship between temperature, humidity and THI is presented graphically in Figure 5.3 and also in Appendix 1. The higher the index, the greater the discomfort, and from Figure 5.3, this occurs at lower temperatures for higher humidities. Its effect on cow performance is summarised in Table 5.3.

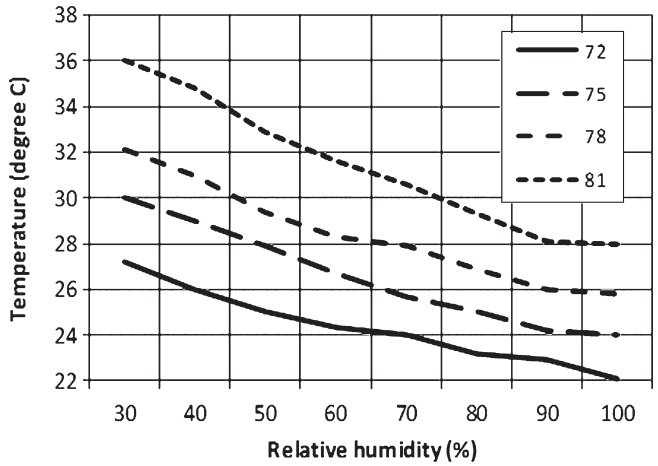

Figure 5.3: The effect of increasing relative humidity on the temperature to produce the same Temperature Humidity Index (72, 75, 78 or 81).

Table 5.3. Effects of Temperature Humidity Index (THI) on dairy cow performance.

Comfort zone	THI	Stress	Comments
A	< 72	None	–
B	72–78	Mild	Dairy cows adjust by seeking shade, increasing respiration rate and dilution of blood vessels. Cow performance is adversely affected with reproduction more so than milk yield.
C	78–89	Severe	Both saliva production and respiration rates increase. Feed intakes decrease while water intakes increase. Milk production and reproduction are both reduced.
D	89–98	Very severe	Cows will become uncomfortable due to panting, high saliva drooling and high body temperatures. Milk production and reproduction will markedly decrease.
E	> 98	Danger	Potential cow deaths can occur.

Comfort zone. A: No stress; B, Mild stress; C, Severe stress; D, Very severe stress; E, dead cows.

Heat Load Index

Meat and Livestock Australia (2006) has developed a Heat Load Index to assess environmental heat load on feedlot cattle. This is based on a combination of measures of heat load, namely:

- black globe thermometer, a measure of radiation heat load which takes into account both ambient temperature and solar radiation
- relative humidity
- wind speed.

The index includes several adjustment factors such as genotype, coat colour, access to shade, water temperature in drinking troughs and whether the animal is sick or healthy. Use of this index over time allows for the calculation of an accumulated heat load and the required heat loss during the night to maintain zero heat balance. However, developing such a Heat Load Index for Asian SHD cows, normally maintained in sheds, is unlikely to provide an additional useful management tool.

Adverse effects of heat stress

For Friesians producing 20 kg/d, a THI above 78 leads to a decline in milk yield. A THI of 78 occurs at 29°C with 50% humidity or at 27°C with 80% humidity. There is also a decline in milk composition (milk fat and milk protein contents) but this occurs at 1–2°C higher than corresponding break points for milk yield.

With regard to reproduction, this declines before milk yield, namely, at THI of 72, equivalent to 25°C plus 50% humidity or 23°C plus 80% humidity. Cows in

early pregnancy (up to 3 weeks) can abort while cows in mid-pregnancy can have reduced birth weights. Cows are also more likely to have shortened and/or silent heats (less than 8 h). Heat stress delays heat (hence submission rates) and, at the time of insemination or during the following 3 to 5 weeks, it can reduce conception rates and increase embryo mortality. By comparing conception rates between seasons (hot v cool or wet v dry), heat stress may be diagnosed as a problem if seasonal conception rates differ by more than 10–12%.

Cows are particularly vulnerable at temperatures above 30°C or, above 25°C with high humidity. Cows producing more than 15 kg/d of milk are more susceptible to heat stress due to their higher metabolic heat load. Zebu cows are less susceptible than Friesians because of their dense flat coat and higher density of sweat glands, however, exactly how less susceptible has not been documented. When planning strategies to minimise heat stress, it is then important to give priority to non-pregnant cows, usually in early lactation.

Adverse effects of heat stress are delayed by several days. The effect of mean THI two days earlier has the greatest influence on milk yield, while the effect of mean temperature two days earlier has the greatest influence on feed intake.

Another good 'rule of thumb' when assessing heat stress for dairy cattle is that air temperature (in °C) added to humidity (in %) should be below 90.

Improvements in milk yields of up to 3 to 5 kg/d are possible through effective cooling strategies.

5.9.3 Using respiration rates as a guide to heat stress

Clinical signs of heat stress

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

- Mild heat stress: Drooling, increased respiration to 70–100 breaths/min.
- Moderate heat stress: Drooling, respiration of 100–120 breaths/min and occasional open mouth panting.
- Severe heat stress: Drooling, respiration rate greater than 120 breaths/min and open mouth panting with tongue out. Cattle also have an agitated appearance, hunched stance and will often have their head down.
- Cattle can move from mild to severe heat stress very quickly, within 30 min to a few hours. Therefore extra vigilance is required once mild heat stress is detected.

Monitoring respiration rates

Observing the behaviour of cows is important in deciding when to modify management. If respiration rates reach 70 breaths/min, milk yield and reproduction may be compromised; this corresponds to 39°C body temperature, in

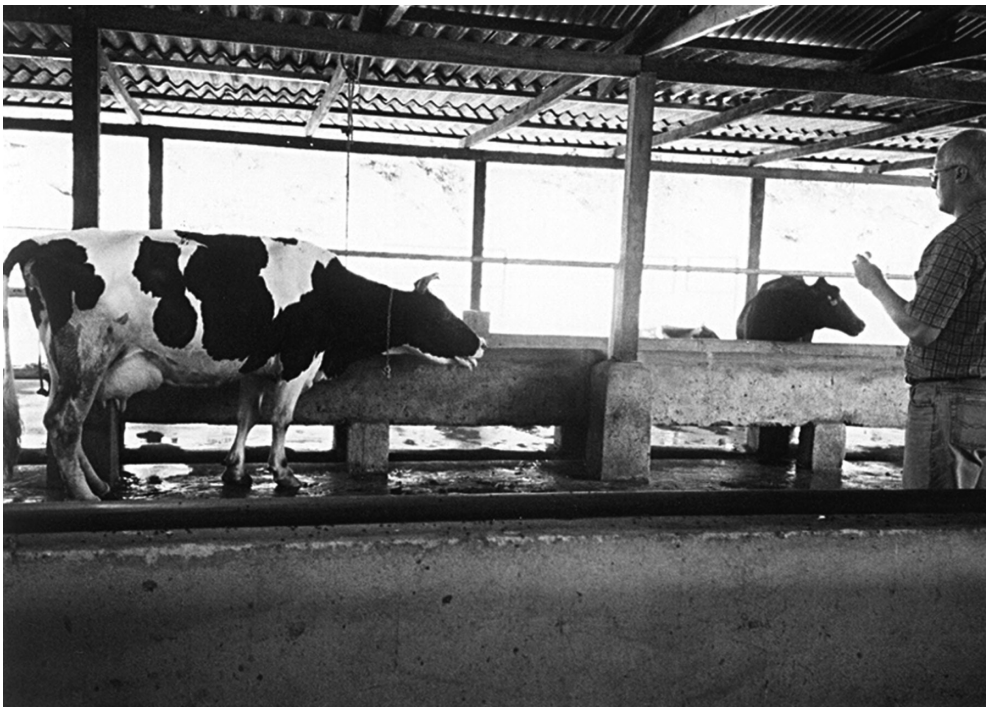

Figure 5.4: Counting respiration rates in a heat stressed cow.

contrast to a normal body temperature of 38.5°C. Higher yielding cows have faster respiration rates, because of the extra body heat production associated with higher feed intakes and milk yields. For such animals, if respiration rates exceed 80 breaths/min in 70% of the cows, it is indicative of heat stress. Certainly, when they exceed 100 breaths/min, cooling strategies should be introduced.

Respiration rates are easy for farmers to monitor. Ensure the cow is standing or lying in a relaxed state and preferably cannot see the farmer (see Figure 5.4). To improve accuracy, the farmer could move his hands in time with abdominal movements until they are at a steady rate. Using a watch, he should count the abdominal movements for 10 s, repeating the exercise to ensure the count is consistent. Multiplying this by six will give the respiration rate in breaths per minute.

Monitoring respiration rates at various times of the day is a useful tool in assessing the suitability of sheds for milking cows. If rates exceed say, 60 breaths/min in the morning, before the shed heats up, it is likely that the cows would benefit from simple modifications in their environmental management. It is unlikely that major modifications in shed design could be justified, such as increasing roof height or pitch or shed height at the side, although serious

consideration should be given to constructing roof vents. If minor improvements cannot be made in the shed's natural ventilation, such as removing obstructions to the prevailing breeze, fans and/or sprinklers should be installed.

One enterprising farmer in Vietnam constructed a small shelter away from the cowshed, which maximised natural ventilation through a high roof and its location, making best use of prevailing wind. Whenever he noted cows with high respiration rates, he hosed them down then moved them to the small shed to alleviate their heat stress.

A panting score has been developed for feedlot beef cattle and this is fully described in Chapter 6.