6

Feeding management of the milking herd

This chapter summarises the key feeding practices for SHD farmers and some adverse effects of poor feeding management.

The main points in this chapter

- There are many influences on milk responses to feeding supplements.
- Cows produce less and less extra milk for each extra level of supplement fed and this is called the decreasing marginal milk response.
- Some of supplement goes immediately into milk and some goes to body fat, which produces more milk later on.
- The Asian 'rule of thumb' to feed 1 kg concentrate per 2 kg milk produced provides a safety margin to feeding management, but can increase overall feed costs.
- There are several key metabolic diseases brought about through poor feeding management, the most important being lactic acidosis or grain poisoning.
- There are many simple observations to highlight these metabolic diseases.
- Farms should not be overstocked beyond their capacity to provide sufficient home-grown quality forages.

This second nutrition chapter, on feeding management, discusses milk responses to supplements, problems with feeding unbalanced diets and optimum stocking capacity on small holder farms. A four-page advisory leaflet, originally developed for Indonesian SHD farmers, on guidelines for feeding and herd management is presented in Appendix 4.

Because tropical forages can only support low levels of milk production (only 6–8 kg/cow/day), they must be supplemented with high energy concentrates to achieve target milk yields. If dietary protein is in short supply, high protein supplements should also be fed.

Supplements are fed to improve or maintain milk production, cow condition or reduce intakes of basal forages when in short supply. Basal forages are the major forages fed by SHD farmers, while supplements include all the additional feeds offered to

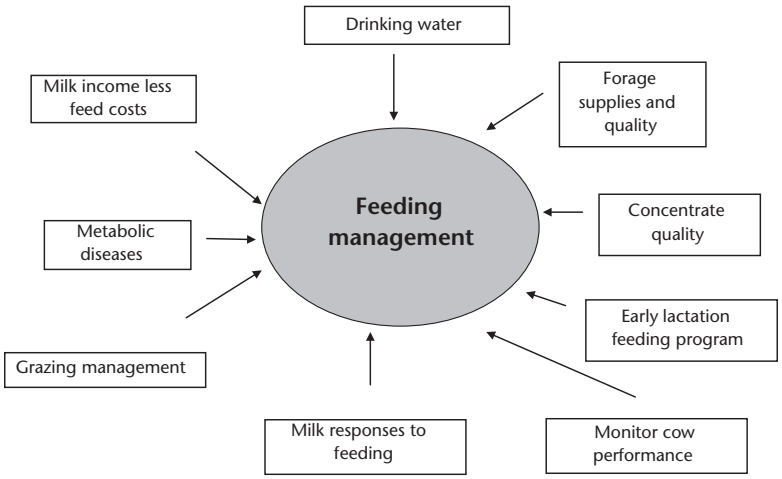

Figure 6.1. The key factors to consider when planning the milking herd's feeding management

improve cow performance. Where milking cows can graze for much of the day, the basal forage would be pasture.

Most SHD feeding systems are then based on hand feeding a single or combination of forages together with supplements. Farmers usually feed a set level of forage and increasing quantities of supplements depending on target milk yields.

The impact of supplementary feeding is difficult to assess because the results may not appear immediately as milk. In the short term, the response to a particular supplement may be small. But if that supplement is used to 'save' on other feeds – for example, until the basal forages become more readily available or until a lower-priced supplement (such as a crop residue) can be used – then it may be important and ultimately profitable.

The factors affecting responses to supplementary feeding are numerous (see Figure 6.2) and their interactions are complex.

6.1 How cows respond to supplements

6.1.1 Deceasing marginal responses

As the intake of energy increases, the amount of extra milk produced from each extra unit of energy decreases. In other words, the marginal, or additional, milk response decreases as the level of supplement intake increases.

The major reason for this decreasing marginal milk response is that, with successive increments of feed energy, the cow increasingly partitions nutrients from milk production towards body tissue deposition as milk production approaches the cow's genetic potential. In addition, the stage of lactation has an influence on how much of the supplement's nutrients 'go into the bucket' and how much 'go on the back'. Modern day milking cows in early lactation tend to lose weight to divert additional nutrients towards milk, while those in late lactation tend to repartition nutrients to replace previously lost body reserves.

This is how much fresh grass a milking cow can eat in one day.

Gliricidea is a high-quality tree legume suitable for milking cows (Sri Lanka).

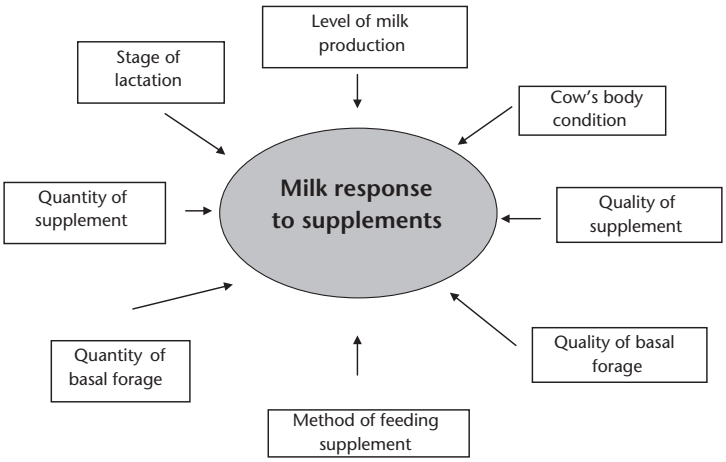

Figure 6.2. The key factors influencing milk responses to supplements

A second reason for declining marginal responses is that utilisation of one feed type can change with increasing intake of a second feed type, which is known as an associative effect. Efficient digestion of forages, particularly low-quality forages, requires an adequate population of fibre-digesting microbes in the rumen. By feeding increasing amounts of high-starch concentrates, the proportion of these microbes will decrease as more starch digesting microbes propagate as a result of the higher starch intake. Consequently, the digestion of the forage can decrease with increasing intakes of such concentrates. Additional starch excretion may also occur, further reducing feed utilisation. This can be particularly important when feeding high levels of supplements rich in fermentable carbohydrates, because rumen pH can decrease, dramatically reducing fibre digestion.

Supplementary feeding usually results in higher total feed intakes. Increasing intakes are the result of decreased times that consumed feed spends in the rumen where it is exposed to microbial breakdown. If less of that feed is digested and the nutrients are absorbed into the blood stream or pass down the digestive tract, less dietary energy becomes available for use by the animal. The cow partly compensates for this through decreased losses of energy via methane and urine with increasing feed intake. Although this may not be important unless total feed intakes dramatically increase through supplementation, it can contribute to declining marginal milk responses to supplements.

Another factor decreasing milk responses is the often incorrect assumption that all of the supplement is actually consumed. Rarely is there nil wastage, particularly if the supplement is roughage. Fortunately, stall feeding minimises such wastage, compared with feeding cows while outdoors.

The major difficulty when predicting milk responses to supplementation, even if substitution rates are known, is the lack of information on the relative importance of the above factors. Without such knowledge, dairy advisers can only, and probably incorrectly, assume additive effects when feeding a mixture of various feed types, which would tend to overestimate such milk responses particularly when there are marked

differences between basal roughages and supplement type or large amounts (say 5 kg DM/cow/day or more) of supplement are fed.

6.1.2 Immediate and delayed milk responses

Responses to supplementary feeding have both immediate and delayed components. Some of the supplement goes immediately to milk production and some goes to body fat, which contributes to milk production at a later stage when this condition is mobilised.

To manage the feeding of supplements effectively, it is important to know how cows respond to them. The response is variable and depends on the circumstances in which the supplement is fed.

The response in milk yield is generally due to the extra energy in the supplement. Unless the supplement improves the use of nutrients already in the diet or stimulates intake of the basal forage, farmers will not get any more milk than that produced from the energy the supplement contains.

In practice, forage substitution almost always occurs, resulting in the response being less than that predicted from the amount of energy in the supplement. The response will reduce at least by the equivalent of the energy in the forage no longer eaten. Also, some of the energy in the supplement goes to condition score rather than directly into milk, so the immediate milk response will be even smaller. Most experiments have only measured the immediate response to supplements. Because they are short term (usually only several weeks), they cannot measure the delayed milk response from body condition, hence the total milk response.

We know most about the immediate response to supplements from studies in temperate countries. Whether these will be similar to responses in tropical countries requires further research. The major differences between temperate and tropical climate zones is the poorer quality of tropical forages and the fact that many supplements are based on by-products, which vary greatly in nutritive value in tropical countries. Another difference may be the poorer quality control in feed mills, hence the greater variation in energy and protein contents of formulated concentrates in tropical countries. Therefore, it is highly likely that milk responses in Asia will be lower than those in temperate countries.

6.1.3 Guidelines for temperate grazing dairy systems

In early lactation, the average immediate response to feeding concentrates containing 12 MJ/kg DM of ME is 0.6 kg of milk per kg of supplement DM, ranging from 0.2 to 1.0 kg.

In mid-lactation to late lactation, the average immediate response is 0.5 kg of milk per kg of supplement DM, ranging from 0.3 to 0.8 kg.

One generalisation sometimes made is that ‘you get half the response now and the other half later, when the condition score energy is converted back to milk’.

6.2 Milk:concentrate ratios in production rations

Many Asian dairy advisers use a general ‘rule of thumb’ that for every 2 kg of milk produced above that supplied from forages, farmers should feed 1 kg concentrate. This is

a safety measure because of lack of knowledge on the nutritive value of the feeds, particularly the forages. It also provides supplemental energy to cows when fed only limited amounts of forage. In any dairy system, whether in temperate grazing systems or Asian SHD systems, the principles for feeding milking cows should be:

1. feed sufficient quality forages first, then
2. supplement with concentrates, which are
3. formulated to overcoming specific nutrient deficiencies
4. to achieve target milk yields.

With knowledge of the feeding value of the forages and concentrates, and their costs, more objective, hence better, decisions can be made on how much concentrates should be fed to achieve target milk yields. Granted this requires more knowledge and greater effort than following the 'feed 1 kg concentrate per 2 kg milk' rule, but such decisions can greatly reduce feed costs, hence improve profitability, when expressed as milk income less feed costs.

Table 6.1 presents a series of milk:concentrate ratios to achieve target milk yields. When cows are fed better quality forages, more milk is produced per kg concentrate fed. The 2:1 (1 kg concentrate/2 kg milk) rule is only applicable with very low-quality forages, namely those with ME contents of 7–8 MJ/kg DM.

Milk production is very responsive to nutrient intake. Among livestock producers, dairy farmers are very fortunate in that their cows' milk yield today is directly affected by their feeding management yesterday. No other type of livestock provides such a rapid feedback to herd management. Once farmers set their target milk yields, as long as they are realistic about their farming system, they can monitor their success or failure in achieving these by gradually changing one of the feeds in the cows' ration. If the additional milk produced, as feeding levels are improved, returns more than the additional feed inputs, then that was a profitable management decision.

Farmers should change their feeding program, but only one feed at a time, say once each week, then note the milk response. They should also note changes in other feed inputs. For example, if they increase concentrates and find cows eat less forage, and know the cost of energy or protein in the various feeds, they can then decide on the most profitable combination of these feeds.

Table 6.1. Milk:concentrate ratios (kg milk produced/kg concentrate fed) to achieve target milk yield in cows fed forages of varying quality

Milk yield (kg/day)	Forage quality (MJ of ME/kg DM)			
	7.3	8.2	9.0	9.9
6	1.8	8.6	–	–
10	2.0	4.0	12.5	–
14	2.1	2.9	12.7	46.7
18	2.2	3.0	6.0	25.7
22	2.2	2.9	4.1	12.9

6.3 Problems with unbalanced diets

Diets should be properly balanced for energy, protein, fibre and certain minerals to ensure optimum cow performance. This section discusses some of the indicators of unbalanced diets and also the major metabolic disorders that can be traced back to nutrient deficiencies.

6.3.1 Some indicators of unbalanced diets

The most important indicators of unbalanced diets can be used to identify dietary problems, these being:

- **Lack of rumination.** After an initial period of eating forages, animals normally start to ruminate or chew their cud. If this is not occurring in much of the herd (say 50%), then there may be a lack of fibre in the diet. This may be confirmed by looking for changes in milk composition as described below.
- **Loose manure.** If faecal material is very loose and watery, it may indicate a lack of fibre in the diet. Assessing any changes in milk composition can also check this.
- **Low milk fat test.** A drop in the milk fat test tends to occur when the herd is placed on a low-fibre diet (such as a diet high in cereal grain and very immature forage). The easiest way to increase the fibre content of the diet is to feed hay or straw. Care needs to be taken though when feeding out poor-quality forages. A drop in dietary energy intake could cause milk and protein yield to fall.
- **Low milk protein (or solids-not-fat) test.** Low milk protein or solids-not-fat (SNF) content is common in early lactation when cows are in negative energy balance. In other words, their energy needs are greater than their intakes, causing them to lose body condition. Shortages of energy reduce protein utilisation by rumen microbes. As a result, the supply of microbial protein – the cows' major protein source – is reduced. Under most circumstances, providing a higher energy diet will lift protein or SNF. Cows will only respond to protein supplementation with a lift in protein or SNF if they are truly deficient in dietary protein. This is because they are unable to use energy properly when there is a protein shortfall.
- **Reduced feed intake.** Many of the causes are discussed in the following section.

6.3.2 Metabolic disorders and unbalanced diets

Metabolic disorders can be clinical, when there are obvious symptoms, or sub-clinical, when there are not. Even at the sub-clinical level, they can depress feed intake and cause production losses.

Metabolic disorders such as ketosis and acidosis are usually linked to low intakes around calving or abrupt changes in diet.

Managing nutrition well during the dry period and in early lactation is the key to preventing or minimising the occurrence of metabolic disorders. The aim is to:

- maximise nutrient intake around calving and in early lactation by providing enough high-quality feed
- avoid decreases in intake caused by sudden changes in diet when cows calve and join the milking herd.

Table 6.2. Metabolic disorders arising from unbalanced diets

	Cause	Symptoms	Treatment
Milk fever	Sudden decrease in blood calcium levels	Decreased intake and milk yield. Calving paralyses, death.	Feeding management prior to calving to stimulate cow's ability to mobilise body calcium
Grass tetany	Low blood magnesium levels	Decreased intake and milk yield. Muscular staggers, death.	Feed magnesium supplements
Ketosis or acetonaemia	Cows rely on fat reserves for energy during early lactation	Decreased intake and milk yield, characteristic smell of breath	Feed well-balanced diet during early lactation
Lactic acidosis (grain poisoning) and laminitis	Rumen pH becomes very low due to high starch intake	Decreased intake and milk yield. See below.	Include rumen buffers in diet and sufficient roughage
Bloat	Build up of foam in rumen, which stops gas from escaping	Left side of cow is swollen. Cow stands up and lies down frequently.	Put hose down oesophagus, administer oil, stab left flank to release gas
Urea toxicity	Ammonia poisoning	Rumen stops moving, death	
Feed toxicities	Anti-nutritional factors in diet. See below.	Sickness and death	Identify cause and remove from diet

The most important metabolic disorders are summarised in Table 6.2, while one of the most prevalent disorder, lactic acidosis, is discussed in more detail below.

6.3.3 Lactic acidosis

Acidosis can be clinical (with cows obviously sick) when the rumen pH falls below 5.0 or sub-clinical when the rumen pH falls below 5.5. Symptoms of sub-clinical acidosis include:

- low milk fat, below 3.0–3.3%
- low milk protein
- reduced milk yield
- reduced feed efficiency
- sore feet due to laminitis or overgrown claws
- manure in cows on same diet varying from firm to very liquid
- manure foamy, containing gas bubbles
- manure containing larger than normal lengths of undigested fibre, more than 1.2 cm long
- manure containing undigested yet ground grain, less than 3.5 cm in size
- limited rumination, less than 50% of the cows cud chewing while resting
- cyclical feed intake.

To avoid acidosis, high-starch feeds should be introduced gradually (i.e. 0.5 kg grain/cow/day) so that the population of rumen microbes can adjust according to the type of

fermentation that is required (more starch-fermenting microbes may be needed). Different cows respond differently to grain feeding. Some cows can handle 6 kg grain/day, while others will get sick on 3 kg/day; there is always a cow that will eat more than her fair share. The key to success is to make it a gradual daily increase and to watch the cows and check for symptoms of acidosis or grain poisoning.

Acidosis can be overcome by feeding more fibrous roughages, but that can lead to reduced feed intake, hence milk yields. Buffers can be included in the diet to stabilise rumen pH so that the rumen environment allows a healthy population of rumen microbes.

Feeding management can also influence the incidence of sub-clinical acidosis in that when cows cannot eat when they are hungry, they overeat (having a larger than normal feed) when they eventually get access to the feed trough. In this case, the acidosis is not caused by lactic acid, but by excess production of the volatile fatty acids from rumen digestion. It is important therefore that all cows should be able to eat when they want to.

Farms where cows are less able to lie down, hence they spend too long standing, particularly on hard surfaces, can have greater problems with sore feet due to both trauma and acidosis. Cows should be able to lie down for at least 8 hr each day. Other factors that can increase problems with sore feet include:

- heat stress (when some cows prefer to stand)
- cows spending too long waiting to be machine milked
- cows with 'perching' behaviour: namely standing with their front feet in the feed trough and their back feet on the floor.

6.3.4 Feed toxicities

Not all animal health problems arise from unbalanced diets. Some feeds contain anti-nutritional factors such as:

- prussic acid (cyanide) in some varieties of forage sorghums, when harvested or grazed as immature crops, or when drought stressed
- hydrocyanic acid in fresh cassava forage
- mimosine in some varieties of *Leucaena*
- gossypol in whole cottonseed and cottonseed meal
- tannins in banana stems and leaves, mango seed kernel or sal seed meal
- trypsin inhibitor in soybean products.

Mouldy silage can contain bacteria such as *Listeria*, which can cause abortions in dairy cows and can also pass through the milk and infect humans. Noxious fungi in silage can lead to pneumonia and abortions in cows. Many different coloured moulds can be found in poorly preserved silages, but unfortunately their colour is not a good guide to the type of mould or its toxicity.

The high humidity and temperature of tropical environments encourages the growth of many contaminating microbes. For example, mycotoxins and aflatoxins such as *Fusarium* and *Aspergillus* can grow on moist cereal grains and by-products. Feed ingredients, of both plant and animal origin, are frequently contaminated with *Salmonella,* which can cause disease and death, particularly in young calves.

In humid tropical countries, veterinary drugs may be administered in animal feeds, some of which have been banned in many Western countries. There can also be potential

hazards, to both animal and human health, from excessive levels of herbicides, pesticides and fungicides, or other industrial/environmental contaminants, such as heavy metals. Many of these can accumulate in animal tissues and be excreted in milk.

The recent human health issues arising from 'mad cow disease' (bovine spongiform encephalopathy) have led to bans in most countries in feeding products derived from ruminant animals back to ruminants.

6.3.5 Other feed additives

A feed additive can be described as a feed ingredient that produces a desirable animal response.

Feed additives have gained attention and use in recent years. Expected responses from feed additives include higher milk yields, increases in milk fat and protein contents, improved DM intake, a more stable rumen pH and improved fibre digestion. It must be stressed that these additives may be more suited to intensive production rather than small holder dairy systems.

The primary feed additives currently being used are ionophores and antibiotics. Monensin (sold as Rumensin®) and lasolocid (sold as Eskalin®) are two commonly used additives that produce their effects by modifying the rumen environment. They alter the microbial population of the rumen, which in turn changes the mix of end products from microbial fermentation.

Rumensin® reduces the population of microbes that produce methane gas (which cannot be used by the cow as an energy source). The proportion of microbes that ferment feed to other more useful sources of energy is increased, resulting in improved milk yields. Responses to this additive depend on the diet and the stage of lactation.

Eskalin® inhibits the microbes that produce lactic acid and can therefore play a role in preventing lactic acidosis.

6.3.6 Troubleshooting feeding problems

There are many simple observations farmers can use to highlight problems with feeding management. Such quick checks include:

- manure consistency, colour and content (see Table 6.3 below)
- cows are actually eating all the concentrates on offer
- rumination; ideally 50% of the herd should be ruminating when resting
- hair coat; appearance and cleanliness
- cow visual appearance; the diet should be reviewed if the cows are looking poor with dull sunken eyes, scruffy coat and hunched backs
- respiration rate, coughing and nasal discharges
- mobility of legs and feet
- body condition at different stages of lactation
- physical appearance and smell of forages
- physical appearance and smell of concentrates
- sudden changes in milk yield
- sudden changes in milk composition, namely fat and protein (or solids-not-fat) contents

- metabolic problems, as discussed above
- physical conditions in shed such as cleanliness and ventilation.

Keep in mind that a sudden change in one of these quick checks may be due to a temporary fluctuation in nutrition. Provided that the check quickly returns to normal, cow performance may not be adversely affected. It is important to take immediate action when a quick check remains abnormal for several consecutive days and/or several quick checks become abnormal at the same time.

6.3.7 Monitoring manure consistency

Manure that is excessively loose or dry and firm for the diet fed may indicate a dietary imbalance that requires action. Manure pats can be easily evaluated using a 1 to 5 scoring system as described in Table 6.3.

When assessing the herd's average manure score, it is important to assess the range in consistency of faecal pats. If more than 20% are one score or greater (or less) than the average, this may indicate a nutritional imbalance or management problem. With cows living in sheds, the consistency of manure should only be made on faecal pats on clean floors, that is without any urine contamination that will change the consistency over time.

6.4 Optimum stocking capacity

Forages always provide a cheaper source of the key feed nutrients (energy and protein) than do concentrates. It is usually cheaper to grow these forages on the farm rather than purchase them. It is easier to control forage quality on farm, through fertiliser and harvest interval, than with purchased forages. When relying on off-farm forage supplies,

Table 6.3. Evaluating manure consistency

Score	Manure description	Action required
1	Very liquid manure with consistency of pea soup. May leave cow's rectum in a steady flow. Includes cows with diarrhoea.	Increase effective fibre intake and seek nutritional advice
2	Runny manure which does not form a distinct plie. Manure will splatter on impact and form lose piles less than 25 mm high.	Consider increasing effective fibre intake
3	Manure has porridge-like consistency. Forms a soft pile 40–50 mm high, which may have several concentric rings and a small depression in the middle. Make a plopping sound when it hits concrete floors and will stick to the toes of your shoes.	This is the desired consistency
4	Thick manure, sticks to shoes and readily forms piles more than 50 mm high	Consider reducing effective fibre intake and increasing concentrate intakes. Seek nutritional advice.
5	Manure appears as firm faecal balls	Consider reducing effective fibre intake and ensure adequate drinking water is available. Seek nutritional advice.

Table 6.4. Optimum stocking capacities for small holder dairy farms with different levels of forage management (Moran 2005)

Quality of forage management	Poor	Average	Good
Forage yield: t DM/ha/yr t fresh/ha/yr	 10 67	 20 130	 30 200
Milking units/ha forage	3.4	6.9	10.3
Adult cows/ha forage	4.0	8.1	12.1

One milking unit is one adult cow plus 20% of a replacement heifer.
Assumed forage intakes:
7.5 kg DM/day for 275 day/yr for milking cows
4.5 kg DM/day for 90 day/yr for dry cows
3.0 kg DM/day for 365 day/yr for 20% of a replacement heifer.

farmers depend on what is available, either from traders who harvest the roadsides, paddy fields, tree plantations or forests or from other farmers who sell their excess supplies, either as crop by-products (such as rice straw or corn stover) or forage crops specifically grown for sale.

In my earlier book (Moran 2005), I listed a series of assumptions and calculations of optimum stocking capacities for SHD farmers with different level of forage management. Calculations were made for farmers who run replacement heifers on the same farm as their milking herd and for farmers that have them reared off farm. The calculations also included three levels of forage management – namely poor, average and good – to produce 10, 20 and 30 T forage DM/ha/yr respectively. Table 6.4 presents the range of optimum stocking capacities.

For a farmer growing the maximum quantities of quality forages, to feed his milking cows well, he should have no more than 8–10 milking cows per ha of forage grown on his farm. However, most dairy small holders do not manage their forages well enough to produce the highest yields of forage. Therefore a more realistic recommendation would be 6–8 milking cows (plus the replacement heifers) per ha of forage grown on farm.

Unfortunately, most SHD farmers like to keep more cows than this recommendation, meaning they must either have to purchase forages off farm, underfeed their milking cows (and heifers) with less forage, or if they aim to produce high yields of milk (say more than 12–14 kg/day), feed excessive levels of concentrates to each milking cow. This is a more expensive way to produce milk, and frequently leads to digestive problems, such as sub-clinical acidosis. Not only will this reduce feed efficiency, it will increase the cost of production and reduce farm returns. Therefore, as all good business owners aim to, farmers should produce at the optimum level to maximise efficiencies and profits. Farmer shouldn't put too many cows onto their farms if they cannot feed and manage them properly.