

13

Problems with unbalanced diets

This chapter:

Explains why some diets lead to reduced milk yields and metabolic problems.

The main points in this chapter:

- diets should be properly balanced for energy, protein, fibre and certain minerals to ensure optimum cow performance
- examples of metabolic disorders due to dietary problems include milk fever, grass tetany, ketosis and lactic acidosis
- a code of Good Manufacturing Practice (GMP) is presented to minimise potential problems with contamination of prepared animal feeds
- feed buffers stabilise rumen pH and help overcome acidosis
- certain feed additives may be more suited to intensive production rather than small holder dairy systems
- manure consistency is a useful guide when trouble shooting feeding problems
- the on-farm feed safety section of the FAO (2004) guide to good dairy farming practices is presented.

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

13.1 Some indicators of unbalanced diets

The most important indicators of unbalanced diets can be used to identify dietary problems, while others are listed in Section 13.5.

13.1.1 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.

13.1.2 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 (see Table 13.2 for a summary of a manure consistency scoring system to assist with balancing diets).

13.1.3 Low milk fat test

A drop in milk fat test tends to occur when the herd is placed on a low fibre diet (eg a diet high in cereal grain and very immature forage).

When the rumen microbes ferment fibre, the resulting end product, acetate, is used to produce milk fat. If the level of fibre in the diet is low, milk fat production decreases.

The easiest way to increase the fibre content of the diet is to feed hay or straw. Take care though when feeding out poor quality forages. A drop in dietary energy intake could cause milk and protein yield to fall.

13.1.4 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, cows' major protein source, is reduced.

Under most circumstances, providing a higher energy diet will lift protein or the solids-not-fat test. Cow will respond to protein supplementation with a lift in protein or the solids-not-fat test only if they are truly deficient in dietary protein. This is because they are unable to utilise energy properly when there is a protein shortfall.

When protein is lacking, microbial growth is depressed. As a result, microbial fermentation is reduced and less energy becomes available. Cows then lose weight to compensate for the lack of dietary energy. When fat is mobilised, values for the milk fat test tends to increase.

13.1.5 Reduced feed intake

Many of the causes are discussed later in this chapter.

13.2 Metabolic disorders and unbalanced diets

Metabolic disorders can be clinical, when there are obvious symptoms, or subclinical, when there are not. Even at the subclinical level, metabolic disorders 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.

Nutritional management at this time also has a major role in minimising milk fever and grass tetany.

13.2.1 Milk fever

Milk fever is caused by a sudden and severe decrease in blood calcium levels at the onset of lactation, due to large increases in demand for calcium for milk production. The incidence of milk fever increases with age and the number of previous lactations.

Cows have mechanisms for adapting to these increased demands for calcium. The mechanisms are:

- increasing the absorption of calcium from the intestine
- mobilising calcium reserves held in bones.

These mechanisms are activated in response to low concentrations of blood calcium. But they take some time to start working following calving. When this process does not happen quickly enough, calcium replenishment into the bloodstream cannot keep pace with the output of calcium in milk. Once calcium levels fall, muscular tremors and paralysis occur, followed by cow collapse and eventually death.

The key to reducing the incidence of milk fever is to stimulate cows' mechanisms for mobilising calcium from the skeleton and increasing absorption from the intestine prior to calving, so that they are 'primed' to meet the increased calcium demands after calving. The following management strategies can be implemented:

- feed diets low in calcium during the dry period – this means restricting fresh pasture (particularly legumes) and providing grass-based hay instead
- alter the cow's Dietary Cation–Anion Balance (DCAB).

Dietary cation–anion balance

The dietary cation–anion balance refers to the balance between positive ions (sodium, potassium) and negative ions (chloride, sulfate). Ideally, negatives should outweigh positives, but this is difficult to achieve in a forage-based system.

Feeding higher levels of negatively charged ions produces a condition called metabolic acidosis. Cows can remove calcium from bone more rapidly when they are affected by metabolic acidosis. Calcium mobilisation is encouraged, thus preparing cows for the increased requirements around calving. To do this, the diet must be higher in anions than cations. This means feeding lower levels of potassium and sodium.

How can the dietary cation–anion balance be managed?

- 1 **Choose forages carefully.** They can affect the acid–base balance. Some forages are high in potassium (often due to potassium fertilisers). Hays grown on soils with poor fertiliser histories generally contain less potassium.
- 2 **Feed anionic salts (also called acid salts).** These salts include magnesium sulfate (Epsom salts), ammonium sulfate and ammonium chloride. Some of these salts are quite unpalatable. There are various methods of feeding them, including commercially prepared pelleted supplements. Mixing these salts into molasses to improve palatability is not a good idea, as molasses contains potassium, which, being positively charged, tends to cancel out the effect of feeding the extra negatively charged ions. Anionic salt mixtures should be discontinued after calving.

13.2.2 Grass tetany

Grass tetany or grass staggers often occurs in lactating cows within the first few months after calving. It appears as muscular spasms and convulsions and can eventually cause death. Grass tetany is associated with low magnesium levels in the blood. Since magnesium is not stored in the body, the cow relies on a daily intake of magnesium to meet her needs.

Conditions that reduce magnesium intake or blood magnesium levels and increase the likelihood of grass tetany include:

- feeding grass-dominant rations – these may not supply the magnesium necessary to meet the needs of a cow in early lactation
- topdressing grasses with potash (potassium) or nitrogenous fertilisers, as these can reduce the availability of magnesium to the animal (as potassium and ammonia restrict the absorption of magnesium)
- short periods of fasting which can occur during yarding, transport or exposure to cold, wet, windy weather.

Grass tetany can be prevented by including a magnesium supplement in the diet to provide each cow with 10 to 15 g/d of magnesium. Supplementation should begin one week prior to calving.

Common sources of magnesium are:

- insoluble magnesium oxide (known as causmag) dusted on to hay or added to concentrates at a rate of 50 g/cow per day or dusted on to pasture at a rate of 50 to 75 g/cow per day
- magnesium incorporated into licks
- soluble magnesium sulfate (Epsom salts) at a rate of 50 g/L per cow per day in drinking water or at a rate of 60 g/cow per day in a drench
- soluble magnesium chloride at a rate of 5 g/L per cow/day in drinking water or at a rate of 100 g/cow per day in a drench.

High levels (over 30 g/cow per day) of granulated magnesium oxide have been identified as a common factor in herds which are affected by severe outbreaks of

Salmonella. This needs to be weighed up against the risk of grass tetany. Some veterinarians suggest lowering granulated causmag levels if a *Salmonella* case occurs.

13.2.3 Ketosis or acetonaemia

Ketosis, or acetonaemia, occurs when cows rely heavily on fat reserves for energy during early lactation. It is most common in cows fed low energy diets during early lactation. When there is insufficient energy in the diet, cows draw on body condition to make up the deficit.

Fat reserves contain ketones, a source of energy. Ketones are often used by cows to supplement dietary energy, particularly during early lactation – hence the expression ‘milking off her back’. To prevent ketosis, feed a well-balanced diet with enough energy to minimise the reliance on body fat reserves in early lactation. Supplying starchy feeds rich in rapidly fermentable carbohydrates or feeding molasses can reduce the incidence of ketosis.

Ketosis highlights the need to avoid abrupt changes in the diet which may decrease intake in early lactation, and also underlines the importance of maximising nutrient intake with high quality feed during this period.

13.2.4 Lactic acidosis

Under extreme conditions, such as feeding very high levels of starchy supplements, large amounts of lactic acid are formed in the rumen. Acid may be produced faster than it can be absorbed or buffered. When lactic acid continues to build up, the rumen pH decreases (becomes more acidic) and microbial activity slows down. When the microbes stop working, fibre digestion is reduced and voluntary food intake is depressed.

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

- low milk fat test, below 3.0% to 3.3%
- low milk protein test
- reduced milk yield
- reduced feed efficiency
- sore feet due to laminitis or overgrown claws (see Chapter 19)
- manure in cows on same diet varying from firm to very liquid (see Table 13.2)
- 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 intakes.

To avoid acidosis, cereal grain should be introduced gradually (ie 0.5 kg grain/cow each day) so that the population of rumen microbes can adjust according to the type of fermentation 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 (grain poisoning).

Acidosis can be overcome by feeding more fibrous roughages, but that can lead to reduced feed intakes, 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 (see Table 13.1).

Feeding management can also influence the incidence of subclinical acidosis in that when cows do not have access to feed when they are hungry, they overeat when they do, 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 (see Chapters 5 and 14). It is then important that all cows should be able to eat when they want to.

Another symptom of acidosis is sore feet. Farms where cows are less able to lie down, hence 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 eight hours 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.

13.2.5 Feed toxicities

Not all animal health problems arise from unbalanced diets. Some feeds contain anti-nutritional factors (Devendra 1992) 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, sal seed meal
- trypsin inhibitor in soybean products.

Mouldy silage can contain bacteria such as *Listeria*, which can cause abortions in dairy cows; it 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, *Fusarium* and *Aspergillus* which produce mycotoxins and aflatoxins 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 as well as other industrial or environmental contaminants, such as

heavy metals. Many of these compounds can accumulate in animal tissues and be excreted in milk.

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

Code of Good Manufacturing Practice

The Food and Agriculture Organization of the United Nations (FAO 1997) has developed a code of Good Manufacturing Practice for the preparation of formulated animal feeds based on the following recommendations:

- Buildings and equipment, including processing machinery, should be constructed in a manner which permits ease of operation, maintenance and cleaning.
- Records should be maintained concerning source of ingredients, formulation including details and source of all additives, date of manufacture, processing conditions and any date of dispatch, details of transport and destination.
- Water used in feed manufacture should be of potable (drinkable) quality.
- Machinery coming into contact with feed should be dried following any wet cleaning process.
- Condensation should be minimised.
- Sewage, waste and rain water should be disposed of in a manner that ensures that equipment, ingredients and feed are not contaminated.
- Feed processing plants, storage facilities and their immediate surroundings should be kept clean and free of pests.
- Raw materials of animal and plant origin and mineral supplements, veterinary drugs and other additives should be obtained from reputable sources, preferably with a supplier warranty.
- Equipment should be flushed with clean feed material between batches of different formulations to control cross-contamination.
- Pathogen control procedures, such as pasteurisation or the addition of an organic acid to inhibit mould growth, should be used where appropriate and results monitored.
- Apart from feeds fed moist, such as silage and wet by-products, feed should be kept dry to limit fungal and bacterial growth, which may necessitate ventilation and temperature control.
- Packaging material should be newly manufactured unless known to be free of hazards that might become feedborne.
- Feeds should be delivered and used as soon as possible after manufacture.
- All plant staff should be adequately trained and should work on these standards.

13.3 Buffers

Buffers stabilise rumen pH and help prevent reductions in pH caused by acids produced in the rumen.

Saliva contains sodium bicarbonate and sodium biphosphate, which are both naturally occurring buffers. They neutralise rumen pH, keeping it stable at around pH 6 to 7.

When cows chew their cud (especially in response to fibrous forages) they produce large quantities of saliva (100–150 L of saliva/cow per day). With enough fibre in the diet, saliva production alone can generally maintain rumen pH.

When cows are fed high levels of cereal grains, starch is fermented quickly in the rumen to produce Volatile Fatty Acids (VFAs). The production of volatile fatty acids, especially lactic acid, may be greater than the rate at which they are absorbed or buffered. The resulting decrease in the pH of the rumen (increased acidity) stops other bacteria from digesting fibre. This in turn slows digestion and causes a loss of appetite.

Acidosis can be prevented in diets high in grain and low in roughage or fibre by supplying mineral buffers. Table 13.1 outlines some common buffers and additives used in high grain diets. However, these are not a substitute for fibre, and the fibre content of the diet should be maintained.

Table 13.1 Buffers and additives used in high grain diets

Additive/buffer	Diet DM%	Feeding rate (kg/t grain)	Function
Sodium bicarbonate (NaHCO ₃)	1.5–2	15–20	Neutralises rumen acids to help prevent digestive upsets. Can be bitter and become unpalatable to stock if more than 4% fed. Tends to absorb moisture and form clumps which should be sieved out before feeding.
Causmag	Up to 1	10	Neutralises rumen acids. Source of magnesium to prevent grass tetany.
Sodium bentonite	Up to 4	Up to 40	Effectiveness as a buffer uncertain. Moderates the digestion of grains in the rumen and prevents cows from eating too much grain.
Crushed limestone	1.5	15	Effectiveness as a buffer uncertain. Useful in high grain diets as a source of calcium and magnesium

13.4 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 dry matter intake, a more stable rumen pH and/or improved fibre digestion. 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 which 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, be important in preventing lactic acidosis.

13.5 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 13.2)
- cows eat all the concentrates on offer
- rumination – ideally 50% of the herd should be ruminating when resting
- hair coat – appearance and cleanliness
- cow's 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 using the locomotion index (see Chapter 19)
- body condition at different stages of lactation, using the scoring system (see Chapter 18)
- 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-non-fat) contents
- metabolic problems (see Section 13.2)
- physical conditions in shed such as cleanliness and ventilation.

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. Take action when a quick check remains abnormal for several consecutive days or several quick checks become abnormal at the same time.

If whole cereal grains are purchased for processing while formulating the concentrate mix, manure should also be checked for whole grains. Only take note of intact grains, those with starch in the grain, and disregard grain husks. Excessive amounts of intact whole grains in manure indicate inadequate digestion. The likely causes are:

- the grain has not been processed or crushed adequately
- the diet may be deficient in fibre.

Seek nutritional advice to determine the cause of the abnormal manure.

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 13.2.

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 be made only on faecal pats on clean floors (ie without any urine contamination that will change pat consistency over time).

Table 13.2 Evaluating manure consistency

Score	Manure description	Action required
1	Very liquid manure with consistency of pea soup. May leave cows 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 loose 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

13.6 FAO guide to good dairy farming practice

The FAO, in collaboration with the International Dairy Federation, published a 30-page manual for dairy farmers to support the marketing of safe, quality assured milk and dairy



This 100-day-old Napier grass is very low in nutritive value, even when managed well (Central Java, Indonesia).

products (Food and Agriculture Organization 2004). The focus of the manual is to relate consumer safety and best practice at the farm level to prevent problems occurring rather than solving them once they occur.

There are recommended or Good Agricultural Practices (GAP) for five areas of farm activity:

- 1 animal health
- 2 milking hygiene
- 3 animal feeding and water
- 4 animal welfare
- 5 environment.



Oil palm frons are a very poor forage source, even when finely chopped (Malacca, Malaysia).

Table 13.3 summarises those practices specifically related to feeding management in GAP 3 and 4.

Table 13.3 Good practices in farm management related to animal feeding, watering and welfare
(Source: FAO 2004)

Good agricultural practice (GAP)	Examples of suggested measures to achieve GAP	Objectives and control measures
GAP 3. Animals need to be fed and watered with products of suitable quality and safety		
3.1 Ensure animal feed and water are of adequate quality	3.1.1. Ensure the nutritional needs of the animals are met 3.1.2. Ensure good quality water supplies are provided, regularly checked and maintained 3.1.3. Use different equipment for handling chemicals and feed stuffs 3.1.4. Ensure chemicals are used appropriately on pastures and forage crops 3.1.5. Only use approved chemicals for treatment of animal feeds or components of animal feeds and observe withholding periods	– Keeping animals healthy with good quality feed – Preserve water supplies and animal feed materials from chemical contamination – Avoid chemical contamination due to farming practices
3.2 Control storage conditions of feed	3.2.1. Separate feeds intended for different species 3.2.2. Ensure appropriate storage conditions to avoid feed contamination 3.2.3. Reject mouldy feed	– No microbial or toxin contamination or unintended use of prohibited feed ingredients or veterinary preparations – Keeping animals healthy with good quality feed
3.3 Ensure the traceability of feedstuffs bought onto the farm	3.3.1. All suppliers of animal feeds should have an approved quality assurance program in place 3.3.2. Maintain records of all feeds or feed ingredients received on the farm (specified bills or delivery notes on order)	– Quality assurance program of feed supplier
GAP 4. Animals should be kept according to acceptable principles of animal welfare		
4.1 Ensure animals are free from thirst, hunger and malnutrition	4.1.1. Provide sufficient feed (forage and/or fodder) and water every day 4.1.2. Adjust stocking rates and/or supplementary feeding to ensure adequate water, feed and fodder supply 4.1.3. Protect animals from toxic plants and other harmful substances 4.1.4. Provide water supplies of good quality that are regularly checked and maintained	– Healthy, productive animals – Appropriate feeding and watering of animals