MALAYSIAN FARM MANAGEMENT NOTE 7

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FEEDING MANAGEMENT OF THE MILKING HERD

The essence of good farm management is to supply sufficient farm inputs for a desired level of production of farm outputs. For the farmers this means setting milk production targets, each day, each month or each year and determining the necessary farm requirements to achieve these targets. The major requirements for sustainable milk production are healthy productive and fertile dairy cows and their necessary feed nutrients supplied in forages and concentrates. The forages are either grown on farm or purchased. The concentrates are usually purchased, either already formulated or as their ingredients, the latter usually as agro-industrial by products.

Feeding management includes both the supply of feeds and their presentation to the milking cow. Dairy cows are herbivores and have digestive systems well adapted to forage-based diets. Belonging to a group of mammals called ruminants, they have a multi purpose digestive system. As well as the stomach that breaks feeds down into their basic nutrients, they have a rumen which is like a large "fermentation vat" where micro-organisms pre-digest these feeds. The rumen of a mature dairy cow is up to 200 L in volume where the feeds can spend 12 to 24 hours before moving onto the "true" stomach.

Nutrients supplied by feeds

When cows consume their smorgasbord of feeds, the major nutrients they extract from them are water, energy, protein, fibre, vitamins, minerals and vitamins. The four nutrients that have the major influence on cow performance are water, energy, protein and fibre.

1. Water. The body of a dairy cow is composed of 70 to 75% water. Milk is about 87% water. Water is not a feed as such because it does not provide specific feed nutrients. However it is essential in body processes and to regulate body temperature. Water is involved in digestion, nutrient transfer, metabolism and waste removal. Water has structural and functional roles in all cells and all body fluids. An abundant, continuous, and clean source of drinking water is vital for dairy cows.

2. Energy. Dairy cows use energy to function (walk, graze, breathe, grow and put on body condition, lactate, and maintain a pregnancy). Energy is the key requirement of dairy cows for milk production. It determines milk yield and milk composition.

3. Protein is the material that builds and repairs the body's enzymes, hormones, and is a constituent of all tissues (muscle, skin, organs, foetus). Protein is needed for the body's basic metabolic processes, growth and pregnancy. Protein is also vital for milk production.

Proteins are made up of nitrogen which is bound into various amino acid molecules. Amino acids are the building blocks for the production of protein for milk, tissue growth and the development of the foetus during pregnancy.

4. Fibre. For efficient digestion, the rumen contents must be course with an open structure and this is best met by the fibre in the diet. Fibre contains most of the indigestible part of the diet. Cows require a certain amount of fibre for rumen function. It ensures that the cow chews its cud (ruminates) enough and therefore salivates. Saliva buffers the rumen against sudden changes in acidity.

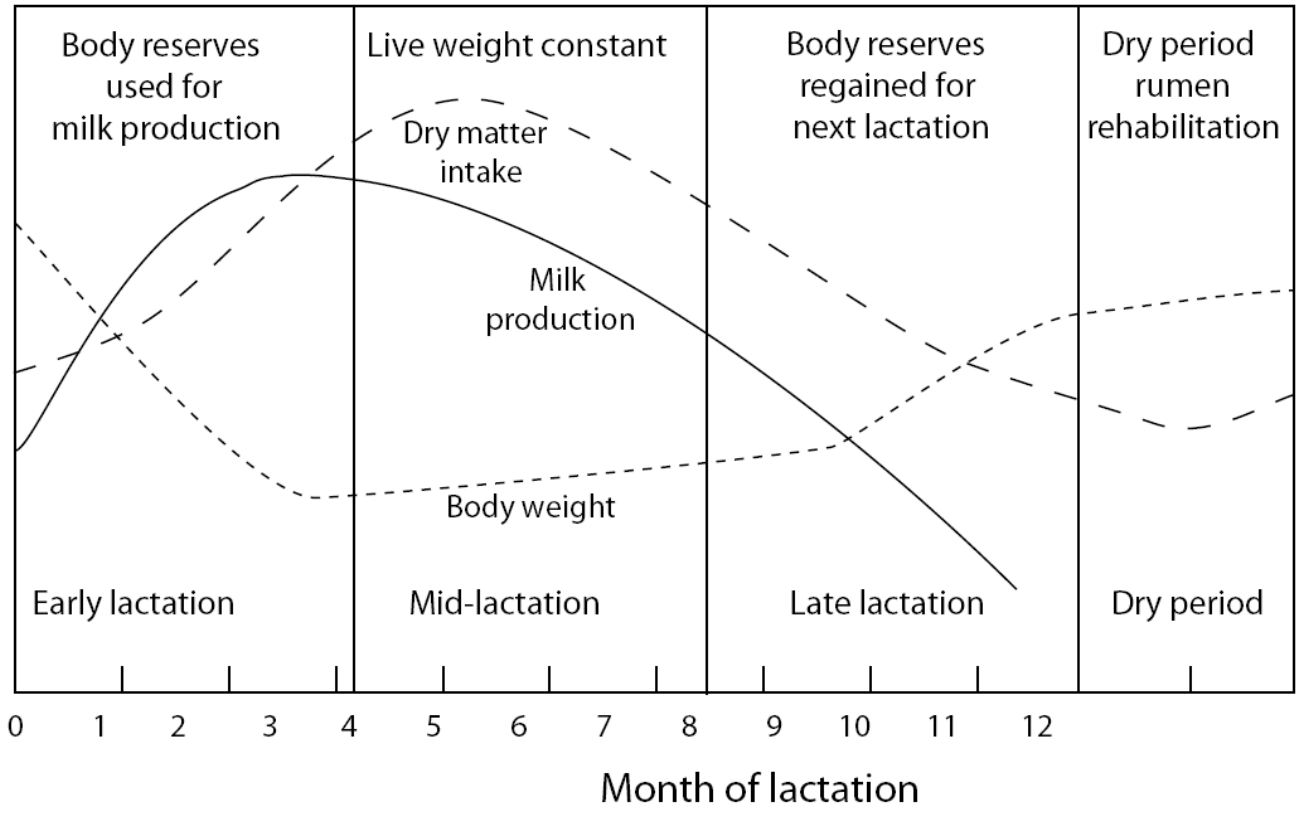
5. Vitamins are organic compounds that all animals require in very small amounts. At least 15 vitamins are essential for animals. Vitamins are needed for many metabolic processes in the body; eg. for production of enzymes, bone formation, milk production, reproduction and disease resistance.

6. Minerals are inorganic elements. They are needed for teeth and bone formation, enzyme, nerve, cartilage and muscle function or formation, milk production, blood coagulation and efficient utilisation of energy and protein.

The lactation cycle

Cows must calve to produce milk and the lactation cycle is the period between one calving and the next. The cycle is split into four phases, the early, mid and late lactation (each of about 120 d) and the dry period (which should last as long as 65 d). In an ideal world, cows calve every 12 months.

A number of changes occur in cows as they progress through different stages of lactation. As well as variations in milk production, there are changes in feed intake and body condition, and stage of pregnancy. The following figure presents the interrelationships between feed intake, milk yield and live weight for a Friesian cow with a 14 month inter calving interval, hence a 360 d lactation.



Dry matter intake, milk yield and live weight changes in a cow during her lactation cycle

Following calving, a cow may start producing 10 kg/d of milk, rise to a peak of 20 kg/d by about 7 weeks into lactation then gradually fall to 5 kg/d by the end of lactation. Although her maintenance requirements will not vary, she will need more dietary energy and protein as milk production increases then less when production declines. However to regain body condition in late lactation, she will require additional energy.

If a cow does not conceive, she has no need for additional energy or protein during pregnancy. Once she becomes pregnant she will need some extra energy and protein. However, the calf does not increase its size rapidly until the sixth month, at which time the nutrient requirement becomes

significant. The calf doubles its size in the ninth month, so at that stage a considerable amount of feed is needed to sustain its growth.

Cows usually use their own body condition for about 12 weeks after calving, to provide energy in addition to that consumed. The energy released is used to produce milk, allowing them to achieve higher peak production than would be possible from their diet alone. To do this, cows must have sufficient body condition available to lose, and therefore they must have put it on late in the previous lactation or during the dry period.

From calving to peak lactation

Milk yield at the peak of lactation sets up the potential milk production for the year; one extra kg per day at the peak can produce an extra 200 kg/cow over the entire lactation. The full lactation response to extra milk at peak yield varies greatly with feeding management during mid and late lactation. There are a number of obstacles to feeding the herd well in early lactation to maximise the peak. The foremost of these is voluntary food intake.

At calving, appetite is only about 50 to 70% of the maximum at peak intake. This is because during the dry period, the growing calf takes up space, reducing rumen volume and the density and size of rumen papillae is reduced. After calving, it takes time for the rumen to "stretch" and the papillae to regrow. It is not until Weeks 10 to12 that appetite reaches its full potential.

Peak lactation to peak intake

Following peak lactation, cows appetites gradually increase until they can consume all the nutrients required for production, provided the diet is of high quality. From Figure 1, cows tend to maintain weight during this stage of their lactation.

Mid and late lactation

Although energy required for milk production is less demanding during this period because milk production is declining, energy is still important because of pregnancy and the need to build up body condition as an energy reserve for the next lactation. It is generally more efficient to improve the condition of the herd in late lactation rather than in the dry period.

Dry period

Maintaining (or increasing) body condition during the dry period is the key to ensuring cows have adequate body reserves for early lactation. If cows calve with adequate body reserves, they can cycle within two or three months after calving. If cows calve in poor condition, milk production suffers in early lactation because body reserves are not available to contribute energy. In fact, dietary energy can be channelled towards weight gain rather being made available from the desired weight loss. For this reason, high feeding levels in early lactation cannot make up for poor body condition at calving.

Proportion of productive cows in the milking herd

One good measure of the performance of the milking herd is the proportion of cows actually producing milk. For herds with a 12 month calving interval, lactation length should be 300 d (for a 65 d dry period), so lactation length would be the calving interval less 65 d, meaning that 82% of the cows are milking at any one time with 100% calving rate. However in most year-round calving systems, only a maximum of 74% of the adult cows (including the first calf heifers) are likely to be milking. The longer the dry period, the less the number of cows milking at any one time. The number of cows milking at any one time is influenced by several factors, the most important ones being lactation length, intercalving interval and calving rate. Guidelines for tropical dairy farmers are:

- 74%; excellent

- 60-73%; acceptable
- 50-59%; below average
- 40- 49%; not good

How cows respond to supplements

Because tropical forages can only support low levels of milk production (only 6 to 8 kg/cow/d), 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 farmers, while supplements include all the additional feeds offered to improve cow performance. Where milking cows can graze for much of the day, the basal forage would be pasture.

Most dairy 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.

Deceasing marginal responses

The factors affecting responses to supplementary feeding are numerous and their interactions are complex. 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.

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, as 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 absorbed into 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 a roughage. Fortunately, stall feeding minimises such wastage, compared to 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, 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
- large amounts (say 5 kg DM/cow/d or more) of supplement are fed.

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. It 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.

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”.

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 feeding 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.

The following table 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 energy contents of 7 to 8 MJ/kg DM.

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

Milk yield (kg/d)	Forage quality (MJ of energy/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

Milk production is very responsive to nutrient intake. Amongst livestock producers, dairy farmers are very fortunate in that their cow's 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, so long as they are realistic to 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.

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.

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 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. Take care 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 solid-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 SNF test. Cow will only respond to protein supplementation with a lift in protein or SNF test if they are truly deficient in dietary protein. This is because they are unable to utilise energy properly when there is a protein shortfall.
- *Reduced feed intake.* Many of the causes are discussed in the following section.

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.

Lactic acidosis

Acidosis can be clinical (with cows obviously sick) when rumen pH falls below 5.0 or sub clinical when rumen pH falls below 5.5. Symptoms of sub clinical 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
- 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 starchy 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 your 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 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.

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 then important that all cows should be able to eat when they want to.

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 8 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

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 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 play a role in preventing lactic acidosis.

Trouble shooting 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
- Cows are actually eating all the concentrates on offer

- Rumination; ideally 50% of 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 action when a quick check remains abnormal for several consecutive days and/or several quick checks become abnormal at the same time.