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Introduction

This article contains some of the more frequently asked questions and the considered responses from FeedRight events held throughout New Zealand in 2014-2015. These events form part of the DairyNZ FeedRight initiative that is running from 2014 to 2017. An objective of the FeedRight programme is to provide farmers with knowledge and resources that enable them to make profitable and sustainable feed management decisions in pasture-based dairy systems.

Rumen

What differences exist in the rumens of cows fed pasture compared with a total mixed ration?

There are three main differences in rumens of pasture-based cows compared with rumens of cows fed a total mixed ration (TMR): water intake, rumen size, and rumen content.

Water intake

If cows have a high intake of good-quality pasture, they consume a greater volume of water (due to the high water content of pasture) compared with cows fed a total mixed ration. A cow eating 18 kg DM/day of a high quality pasture can consume about 100 to 120 litres of water a day.

In a pasture-based diet, loose faeces (as is often seen in spring) is typically associated with the high water content of the pasture and does not indicate health issues. The loose faeces are simply a consequence of the high water intake, rapid passage rate and fast rumen turnover.

Rumen size

Rumens from pasture-fed cows tend to be larger than from cows fed a TMR (approximately 20-25 % of liveweight for cows grazing pasture compared with 10% of liveweight for cows fed a TMR).

Rumen content

In the rumens of cows fed a TMR there are three distinct layers; however, these do not exist in the rumens of pasture-fed cows. In the rumen of a pasture-fed cow, there is no floating layer (i.e. no rumen mat) and everything is mixed together like lawn clippings.

Fibre

Do cows need hay/straw during spring in a pasture-based diet?

No. There is adequate fibre in spring pasture (also adequate "effective" fibre) for the rumen to function properly. The myth that "soft" pasture or the appearance of loose dung indicates a rumen upset or acidosis is associated with TMR or high-input systems and does not relate to cows eating a diet of at least 60% grazed grass. The DM percentage of the pasture is lower during spring, which means that extra water passes through the rumen. This water is not absorbed in the third stomach (omasum), and results in loose dung. Loose faeces is not a concern, unless the system is high input, in which case the amount of non-fibre carbohydrates, the fibre content (NDF) and the chop length of the diet should be checked (NDF should be at least 30% of diet).

Previous research investigating the role of fibre in maintaining an effective rumen environment was conducted with cows fed a TMR. From this work, some ideas have been introduced to New Zealand pasture-based systems. However, the rumen environment of a cow fed a TMR is very different to that of a pasture-based cow (see introduction). Cows that are fed a pasture-based diet have no floating "raft-layer" in the rumen. Therefore, the theory that straw will help form the raft layer and improve rumen function in pasture-based cows is not true.

Research data indicate that there is no benefit to rumen function or milk production when fibre (straw/hay) is added to a pasture-based diet. In fact, it can actually cause a drop in production, as a low quality (low ME) feed (e.g. straw) replaces high quality (high ME) feed (e.g. pasture). Additionally, the slower passage rate of straw can increase rumen fill and reduce DM intake.

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How important is fibre in TMR cows and how much fibre should be in a TMR?

If NDF content drops below 30% in a TMR, you will likely see undesirable changes in rumen volatile fatty acid patterns and rumen pH. However, this is also dependent on the amount of non-structural carbohydrates in the diet (the technical term for soluble sugars and starch). There are simplistic rules of thumbs for the amount of fibre needed in a TMR diet, for example, non-structural carbohydrates should not exceed 38% of the diet and NDF should not be lower than 30%. However, if feeding a TMR, then a qualified nutritionist should be used to balance the ration.

What can we tell from the faeces of the cow? Does it give us clues about whether dietary fibre is sufficient?

When cows are fed a TMR, the consistency of the faeces can be an indicator of rumen health. Loose, shiny faeces or the presence of bubbles in the faeces of a TMR-fed cow, indicates a rumen upset such as acidosis and the occurrence of hind-gut fermentation. Undigested feed (grain or fibre) passes into the large intestine where it is fermented and lactic acid is produced. The cow then brings in additional water from the bloodstream to offset the starch in the small intestine and the build-up of lactic acid. This creates watery faeces that are often pale in colour. The acid produced in the large intestine shows up as tiny bubbles in the manure. If enough lactic acid passes through the large intestine, it damages the lining and the cow produces mucus to offset this. When this passes out, the manure has a shiny appearance.

In contrast when a cow is primarily fed pasture, loose faeces and bubbles are not an indication of rumen upset. Especially in spring, the loose faeces is primarily due to the low DM content (or high water content) of pasture. As mentioned in the Introduction, the extra water is not absorbed and is excreted in the faeces.

In addition, carbohydrates can pass through the rumen into the large intestine of the cow due to the fast rumen passage rates of pasture-fed cows in spring. Active fermentation occurs and acids (not lactic acid) are produced, which can appear as gas bubbles in the faeces. Adding fibre (e.g. straw/hay) to pasture-based diets will not benefit rumen function; it will merely reduce the water intake and can slow passage rate.

Starch

Does feeding starch after calving/before mating improve fertility?

If cows are eating sufficient good quality pasture (i.e. residuals of 1500 to 1600kg DM/ha, with good pasture utilisation), supplementing with a starch-based concentrate will not improve reproduction.

Recently, on-farm trials were conducted to investigate the effect on reproduction of feeding a high starch supplement compared with a high fibre supplement. These trials involved 950 cows and three dairy herds and it was concluded from the results that increasing the amount of starch (non-structural carbohydrates) in the diet did not improve reproductive performance.

The theory behind using starch-based concentrates (e.g. maize grain or barley) or sugar-based feeds (e.g. molasses) to improve reproduction is based on increased concentrations of circulating hormones such as insulin and IGF-I, which, in theory, can lead to earlier cycling. However, the effect of increasing IGF-I on cycling is inconsistent and research in New Zealand indicates that 97% of the variation in time to first oestrus in New Zealand cows is related to things other than IGF-I levels. Additionally, increased IGF-I levels post-mating can lead to embryo death.

Reproductive performance above industry targets can be achieved when cows are fed solely on good quality pastures. If intake is restricted during the mating period either due to a pasture deficit (i.e. residuals are less than 1500 to 1600kg DM/ha) or prolonged adverse weather, then reproductive performance can be reduced. However, the effect is relatively small. In an experiment where cows were fed 55% of requirements for two weeks at the start of mating, the 6-week in-calf rate dropped by 7% and there was no difference in final pregnancy rate.

If there is a pasture deficit during mating, the focus should be on increasing the energy (MJ ME) available to the cow. The type of supplement used to achieve this is secondary and, therefore, supplement purchase decisions should still be based on cents/MJ ME.

Protein

Does a high protein pasture diet need supplementary carbohydrate to improve protein utilisation?

No. Good-quality high-protein pasture is highly digestible by rumen microbes. You cannot significantly improve the efficiency of protein, or more specifically, nitrogen use in the rumen by increasing the carbohydrate load. You can improve nitrogen-use efficiency by feeding low nitrogen feeds to your cows, but this is not due to improved utilisation of nitrogen. It is due

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to the removal of surplus nitrogen from the diet. So reduced nitrogen excretion when feeding more carbohydrates (e.g. maize with pasture) has very little to do with the carbohydrates, but with the reduced amount of nitrogen eaten by the cow.

What is the formula or equation to use to know if it is worth adding protein to the diet and how much should I pay?

There is no one equation to calculate if it is worth adding protein to the diet. The milk production response to additional protein will differ depending on the type of protein available (rumen degradable or undegradable) and the amino acid composition of the feeds.

Even if crude protein is limiting milk production, protein supplements are typically very expensive and if the system is not set up to feed protein supplements (i.e. in-shed feeding and appropriate storage), then wastage of this expensive supplement will be high. As with feeding any supplement, any potential increase in milk revenue needs to be greater than the cost of adding the extra protein to the diet.

For example in a research experiment, cows were fed a diet containing 50% summer pasture and 50% maize silage (crude protein = 11%). When approximately 1.3kg DM of the maize silage was replaced with 1.0kg DM soyabean meal (so that energy intake remained the same), the crude protein content of the diet increased to 16% and milksolids increased by 80g MS/kg DM soyabean meal.

However, the increased milk revenue (i.e. $0.40 at a milk price of $5.00) and the savings from spared maize silage (approximately $0.39), did not offset the cost of the soyabean meal ($0.99kg DM). See examples in table below.

Milk price	**$5.00**	**$6.50**	**$8.00**
Revenue from MS response	0.40	0.52	0.64
Savings from maize not fed	0.39	0.39	0.39
Revenue + savings	**0.79**	**0.91**	**1.00**
Cost of soya bean meal (incl. 10% wastage)	0.99	0.99	0.99
Revenue over feed costs	**-0.20**	**-0.09**	**0.01**

Therefore, when it comes to supplementing with protein, profitability depends on:

- the base diet being fed
- the protein supplement used
- the total cost of feeding the supplement
- any increase in milk revenue and savings from unused supplement.

Protein:fat ratio

Is protein:fat (P:F) ratio a measure of adequacy of feeding?

Yes and No. Yes, the P:F ratio can indicate the energy status of the cow but it can also be influenced by the dietary composition and is therefore not a sensitive measure of cow nutritional status.

If a cow's intake is restricted, the P:F ratio will generally decrease and when extra energy is added to the diet, the P:F ratio will increase. However, the type of carbohydrate fed to the cow can also affect both milk protein and fat production, irrespective of energy balance. A much better measure of whether cows have adequate feed is to look at post-grazing residuals and milksolids yield in conjunction with the P:F ratio. This will help determine if cows are underfed and whether it would be profitable to give them additional feed.

Are milksolids worth more when the P:F ratio is greater?

Yes. Protein is worth more than fat in most milk payment systems; therefore, the value of each kg of milksolids increases as the P:F ratio increases. However, the increase in milk revenue when the P:F ratio is increased is not large. For example, if protein is worth twice the value of fat, increasing the P:F ratio from 0.75 to 0.80 increases the milksolids revenue from $5.93 to $5.99 at a payout of $6/kg MS and from $7.90 to $7.99 at a payout of $8/kg MS. As the milksolids price declines, so does the price advantage of a high P:F ratio.

Milk urea

When should I change a diet based on milk urea (MU)?

Never, based solely on MU concentrations. Milk urea (MU) is not an accurate indicator of dietary protein content and is very variable. "Up and down like a toilet seat" is an analogy that has been used to describe the variation.

The only time that MU concentrations can be useful is when supplements make up a large proportion of the diet. In this instance, a high MU concentration (greater than approximately 30

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mg/dL) may indicate the cow is being fed more protein than required. A re-evaluation of the dietary protein relative to cow requirements may allow expensive protein supplements to be removed from the diet.

What is milk urea (MU)?

MU is a by-product of the breakdown of dietary protein in the rumen, and although MU concentration is associated with the protein content of the diet, it is not an accurate indicator of dietary protein adequacy. The digestion of protein in the rumen releases ammonia. Excess ammonia is absorbed through the rumen wall into the blood stream and converted to urea in the liver. Most of the urea is excreted in the cow's urine although some passes into the milk.

How is MU expressed in New Zealand?

Be aware of what values you are looking at: milk companies, New Zealand labs, and universities may use different units for MU or MU nitrogen (MUN). Information from other countries is often expressed differently to what is on the milk docket here.

MUN is 47% of MU. The conversion equations are:

MU (mg/dL)	=	MUN (mg/dL)	x	2.14
MUN (mg/dL)	=	MU (mg/dL)	x	0.47
(mg/dL	=	miligrams per decilitre)		

What do high MU levels mean?

Due to the crude protein content of high quality pastures, MU concentrations are typically higher in cows grazing pasture compared with cows fed a total mixed ration or high levels of supplementary feeds and can reach levels of 50 mg/dL or more.

High MU concentrations are not detrimental to milk production, cow health or reproduction and the process of converting ammonia to urea is not energetically expensive.

What do low MU levels mean?

If MU concentrations are low (approximately less than 20 mg /dL) this may indicate there is not enough protein in the diet. As there are other factors that alter MU concentrations, laboratory analysis of feed ingredients and/or an assessment of the complete diet for protein (and amino acid availability) should be undertaken, before any nutritional changes are made.

Even, where dietary protein levels are lower than recommended, the total cost of feeding the additional protein must be considered and compared with the predicted milksolids response before protein supplements are purchased and fed.

Pasture

What controls intake in a pasture-based system?

Intake control involves complex processes. There are several factors that control a cow's intake.

- Chemical feedback mechanisms: hunger or satiety hormones are produced in response to products of digestion and signal the brain whether the cow should continue grazing or stop
- Feedback from post-rumen processing (e.g. passage rate)
- Grazing time: a cow is often limited by the number of hours in the day for grazing. Time spent ruminating, walking, milking, lying will determine how many hours the cow has available to graze pasture
- Physical rumen fill: although there are distension/stretch receptors in the rumen, when cows are fed high quality forages, these have little impact on intake. If the quality of feed drops (NDF greater than 50%) then these physical factors play a bigger role.

Are supplements needed to balance a pasture diet?

No, supplements should only be used to fill true feed deficits in a grazing system and not to try and balance the diet. Good quality pasture provides a well-balanced feed for dairy cows, supplying energy, protein, lipids, vitamins and minerals. It is true that cows fed a TMR will produce more milk than cows grazing pastures; however, the majority of the difference in milk production is due to the increased DM intake and reduced activity in a TMR system, and not the composition of the diet. Therefore in a pasture based system if supplements are required they should be purchased on a cents/MJ ME basis.

In dairy systems, where supplements make up a high proportion of the diet and cows are producing high levels of milksolids (e.g. in excess of 2.5kg MS/d), factors other than energy may be limiting milk production. In these scenarios, the specific diet requirements should be considered and the type of supplement that is purchased should be determined by the nutrient that is limiting milk production (e.g. amino acids, starches) and the cost/benefit of feeding that supplement.

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For more information on pasture as a feed for the dairy cow, check out the DairyNZ Technical series (Aug 2014).

Is there enough sugar in pasture?

Yes. Even though, in theory, milk production is maximised when soluble sugars and starches are 35-40% of the diet and spring pastures contain less than this, the structural carbohydrates (fibre) in good quality, leafy pastures are highly digestible (70-85%) and degraded relatively quickly, thus supplying similar energy to sugar.

This is because the building blocks of carbohydrates (soluble sugars, starches and fibre) are essentially the same; simple sugars, and it is the bond that joins these sugar molecules together that is different. The different carbohydrates can be compared with lego blocks. Sugar such as is found in molasses is like having a pile of lego blocks, pulled apart and all ready to go. Then starch, which is found in cereal grains and vegetable wastes, is like lego blocks that have been loosely joined together, you have to pull them apart before you can use them. Finally, fibre as is in pasture, is like having an object constructed from the lego blocks that takes time to pull apart before they can be used.

Thankfully, the bugs in the rumen are capable of breaking all of these bonds so the sugar molecules can be used for energy. Thus replacing pasture with feeds that are high in sugar or starch does not improve the energy generated from the rumen bugs, unless it increases the total amount of energy supplied.

Is grazed pasture more expensive than supplements?

No. You need to consider this in the context of can you eat more pasture, grow more pasture or do you need to buy more. There are only minor costs associated with eating more pasture include upskilling and allocated time for pasture management. The next cheapest option is to grow more pasture. Additional costs here include regrassing, weed control and fertiliser, and this is still typically cheaper than purchasing supplements. When no more pasture can be grown or eaten on farm, then the next option is to buy more land. The correct decision in this situation will depend on the cost/ return of the land compared with the cost of buying and feeding supplements.

For information on the cost of pasture, check out Inside Dairy (May 2015, page 24)

Supplements

Is PKE a quality feed?

PKE is a by-product and the quality can therefore vary with each batch. As it is an unusual feed, (high in short and medium chain saturated fatty acids) there is no equation

developed to determine ME accurately. Using other similar feedstuffs, ME is estimated to be between 10 and 11.5 MJ ME/kg DM.

There are two forms of PKE, solvent extracted and physical/mechanical extracted. Although the fat content of solvent extracted PKE is much lower, there does not appear to be a large difference in milksolids response to these two products. Why this is the case is not known, but may be due to the chemicals used during the solvent extraction improving the digestibility of fibre.

PKE is relatively high in phosphorous, therefore in herds prone to milk fever, it should be limited (approximately 3 kg DM) to springing cows.

How much Palm Kernel Expeller (PKE) can I feed my cows? What percentage of the diet?

From a rumen health point of view, PKE is a safe feed as it contains very little starch and there is no risk of acidosis. It does have a relatively high fat content (8 to 10% DM), but due to the saturated form of these fats, there doesn't appear to be a negative effect on fibre digestion. Although PKE is high in fibre (70% NDF), it does not contain any effective fibre (the fibre that stimulates rumination and saliva production); so, from a health perspective, PKE should not make up more than approximately 60% of the diet.

From a milk production perspective, PKE contains approximately 18% crude protein, but is low in the amino acid lysine. This means that if it was fed at more than 50% of the diet to lactating cows, a lysine deficiency may limit milk production.

What is best – PKE or barley?

This depends on your motive for feeding supplements. If you want to increase milk protein percentage then barley (a starch-based feed) will be better than PKE (a fibre-based feed), which will increase milk fat percentage. If you want to make money, then all DairyNZ data indicate that your key driver for purchasing supplements should be cents/MJ ME. In this case, barley is rarely as good value as PKE.

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Use the online Supplement Price Calculator to determine which supplement will be the most profitable dairynz.co.nz/supplement-calc

How much maize silage is required per day to put on 1 BCS unit in three months?

Research from DairyNZ indicated that a non-lactating cow required about 160kg DM maize silage to gain 1 BCS unit. The required daily amount will depend on the length of the dry period and this needs to take into account that the cow will not gain BCS in the first 10-14 days dry and will gain very little in the last 25-30 days dry. This means that if a cow was dried off 90 days prior to calving, there would be about 50 days available for BCS gain. If the cow needed to gain 1BCS unit, then she would need to eat 3.2kg DM maize silage/day for 50 days, over and above the feed required to for maintenance, pregnancy and activity requirements.

For information on time required to gain BCS in dry cow, check out the DairyNZ Technical Series (April 2014).

What is the benefit of feeding molasses?

Benefits of molasses include improved shed flow, carrier for minerals, and increased palatability of other feeds. In terms of production, it is difficult to claim benefits, as research on molasses is very limited. Research conducted at DairyNZ indicated no increase in milk production or BCS gain from feeding liquid molasses to early lactating cows. This may be, because rumen passage rate of molasses is fast and the inlet and outlet of the rumen are very close to each other, thus the molasses may have passed through undigested. Alternatively, this may have been due to high levels of substitution. Because molasses is a sugar, the satiety signals sent to the brain would reduce pasture intake.

Substitution

What affects substitution?

Any system of feeding that increases total nutrient intake has the potential to increase production. This occurs when supplements are introduced into a pasture-based system; however, there will always be some level of substitution or reduction in pasture intake when supplement is eaten. Substitution can be negative (pasture wasted) or positive (pasture spared).

Predicting short term responses to supplement feeding depends on accurate estimates of substitution. On average, grazing time is reduced by 12 minutes for every kg of supplement that is added into the system. However, the rate of substitution can differ and is influenced by many factors:

- season (spring vs. summer vs. autumn)

- pasture residuals and supplement intake (type, quality and amount)
- type of pasture (grass-dominant vs. clover-dominant)
- animal factors (e.g. BCS, genetics).

Substitution means that:

- less pasture will be consumed and if management is not altered, post grazing residuals will increase
- total intake is less than expected
- the milk response is less than the theoretical maximum.

How do pasture and supplement intake affect substitution?

The more pasture that is offered the greater the potential level of substitution when supplements are introduced into the system. Similarly, with increasing amounts of concentrates offered, the level of substitution typically increases.

How does the time of year affect substitution?

Substitution is greatest in spring and lowest in autumn. Research indicates that for each kg DM of supplement eaten, substitution is 0.1kg DM greater in spring than in summer and 0.1kg DM greater in summer than in autumn. For example, if the substitution rate was 0.5 in spring, for every 1kg DM of supplement eaten, cows would reduce their pasture intake by 0.5kg DM. In summer, for every 1kg supplement fed pasture intake would be reduced by 0.4kg DM, and in autumn 0.3kg DM.

Winter crops

What is the role of feeding straw with fodder beet to prevent acidosis?

In order to avoid rumen acidosis, cows must be transitioned properly onto a fodder beet diet. The first 14-21 days of transition are very important to the success of the winter feeding regime. The cows should be introduced to the crop slowly, starting with no more than 2kg DM fodder beet/cow/day and with the supplement (straw, hay, silage) fed before the cows are given

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access to the crop. The fodder beet should be increased by 1 kg DM every second day until targeted allowance is reached. When cows are fully transitioned, DairyNZ recommends that cows eat a diet of no more than two thirds fodder beet and one third supplement (straw, hay or silage).

Transition period

How do I transition my cows? Is it true that I should underfeed my cows before calving?

If cows are at or above their target BCS, (5 for mature cows and 5.5 for first and second calvers) prior to calving, then research suggests they should be fed about 80% to 90% of their energy requirements for one to two weeks pre-calving to reduce the risk of metabolic diseases after calving. If cows are below their BCS targets, they should be fed 100% of their energy requirements. For example, a 500kg cow at BCS 5.0 or above, needs to eat about 100 MJ ME for one to two weeks pre-calving.

For more information on feeding the transition cow, check out the DairyNZ Inside Dairy (June 2014) and DairyNZ Technical Series (June 2015)

What is dietary cation-anion difference (DCAD)?

DCAD refers to the difference in the concentration of specific minerals in the diet; for example, sodium and potassium (cations) and chlorine and sulphur (anions). These minerals regulate the alkalinity of the blood, which in turn regulates calcium absorption from the intestine and possibly calcium mobilisation from bone. When DCAD is reduced to negative values (less than -100 meq/kg DM) intestinal calcium absorption is increased.

Can we alter the dietary cation-anion difference (DCAD) in NZ pasture-based cows?

Yes we can; however, in pasture-based systems it is very hard to achieve a negative DCAD; therefore, the DCAD concept is virtually irrelevant. In systems where cows are offered large proportions of maize silage, brewers grain, molasses, or other low DCAD feed ingredients, a small amount of anionic salts (magnesium sulphate or magnesium chloride) may reduce the DCAD sufficiently to help prevent milk fever.

Health

Is rumensin ever worth adding to feed?

Rumensin can be an effective bloat control or prevention agent; however it cannot prevent acute/severe bloat. In terms of milk production, results are variable. The average milksolids response to 300 mg of rumensin is about 30g of extra milksolids. However, responses range from -80g to +80g of milksolids. To date, it is not known how and why rumensin causes negative or positive production responses and more experiments are necessary to gain a better understanding of the effects of rumensin in pasture-fed dairy cows and the interactions with fibre and starch. In terms of reproduction or BCS, rumensin has no benefits in the New Zealand pasture-based system.

For more information on Rumensin, check out the DairyNZ Technical series (Dec 2011).

If BOH or BHBA (β-hydroxybutyrate) levels are high, does this mean my cows have ketosis?

No, not always. Overseas data indicate that a cow has ketosis when blood BOH levels are greater than 2 mmol/L, and sub-clinical ketosis when BOH levels are greater than 1.2 mmol/L. However, BOH levels are also affected by the diet, and pasture-based cows have a greater basal concentration of BOH than those fed a high proportion of starch-based supplements or a TMR.

Therefore when the diet is predominantly pasture, ketosis cannot be diagnosed based on BOH concentrations alone. Additional indicators of energy balance, in particular free fatty acids (NEFA) and if possible, glucose should be measured in the blood. If NEFA levels are greater, and glucose levels are lower than recommended, then the risk of clinical and sub-clinical ketosis is increased. Other symptoms of ketosis include decreased DM intake and milk production and sometimes a sweet smell on the breath. There are three main causes of ketosis:

- Type 1 ketosis is a result of a sudden drop in energy intake. This can be due to underfeeding or adverse weather events (e.g. floods, snow storms).

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- Type 2 ketosis generally occurs post-calving when the cow is mobilising body fat to meet the demands of milk production. Cows that are too fat at calving (BCS > 5.0) are particularly at risk.
- Silage ketosis is due to cows ingesting poor quality silage. The silage undergoes a secondary fermentation and when ingested increases the risk of ketosis.