Transition cow nutrition – priming the herd to perform or just another way to spend money?

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Summary points – Effective management of the transition cow

- Nutrition and management during the transition period are important, but success is set several months earlier!
- Mature cows should be BCS 5 and younger cows BCS 5.5 one month before calving.
- The range in BCS within the herd is as important as the herd average.
  - Preferentially manage thin and fat cows from late lactation to minimise the range.
- Assess the herd twice weekly from one month pre-calving and draft cows showing signs of springing.
- Manage feed intake of springing cows
  - Feed springing cows 80-90% of their requirements for metabolisable energy if BCS 5 or greater.
  - If less than BCS 5, feed springing cows 100% of their metabolisable energy requirements.
  - **<u>Do not over-feed springing cows</u>**!
- Supplement springing cows with 20 g magnesium/cow/day.
- Supplement colostrum cows with 100 g calcium/cow/day.

Background – what is the transition period?

The six- to eight-week period around calving that encompasses late pregnancy and early lactation is often referred to as the ***Transition Period***, as the cow transitions from a state of pregnancy and positive energy balance to a lactating state in negative energy balance.

There can be little doubt about the importance of this period for the dairy cow; failure to transition successfully can result in reduced dry matter intake, milk production, poorer reproduction, an increased incidence of metabolic and infectious diseases, many of which are inter-related, and an earlier culling. In fact, an analysis of culling data in the United States indicated that 25% of cows culled, left the herd in the first two months post-calving[1]. Preliminary data from New Zealand concur, with the risk of death 3 to 6-fold greater in the month immediately post-calving than later in lactation (Chris Compton, unpublished data); this is especially true for older cows.

There are many recommendations about how best to manage and feed the cow through this period. Some of these recommendations conflict with each other and many mean a change to the farming system that has made New Zealand farmers so successful. So, what is correct? The main points of contention are discussed in this following article.

History - Steaming Up, DCAD, and Lead Feeding – what is the basis for the current confusion?

The importance of nutrition and management of the cow during the pre-calving and early lactation periods has been debated for almost a century. At the World Dairy Congress in 1928, Robert Boutflour from the UK suggested that there were four factors undermining the productivity of the dairy cow, one of which was "*the* *neglect of the preparation of the cow for her next lactation period*" [2]. At this event, Boutflour introduced a new term, encouraging farmers to "*steam up*" their cows during the month before calving. Subsequent research in New Zealand in the 1970s supported this recommendation in pasture systems, reporting that cows fed approximately 25% more than requirements during the month before calving produced 15-20% more milk fat than cows fed 25% less than their requirements[3]. When this was combined with study results from the United States in the 1990s, which indicated that cows that lose body condition score (BCS) before calving are more prone to metabolic and infectious diseases[4] and at an increased risk of excessive fat accumulation in the liver after calving[5], it became accepted by most people that the 'springing' cow must not be underfed in the two weeks before calving.

In addition to experiments evaluating the effect of dry matter (DM) and, more importantly, energy intake pre-calving, the role of the pre-calving diet on the incidence of milk fever has been a topic of considerable research effort since the mid-1960s[6]. At first, it was believed that high pre-calving dietary calcium was the culprit and, indeed, there is a sound physiological basis for this. Adult animals absorb as much calcium as they need; therefore, if fed more than requirements, they absorb a smaller proportion[6]. When they calve and need a large amount of calcium for milk production, they are unable to absorb enough from their diet and they get milk fever. However, in practice, it is not practical to reduce pre-calving dietary calcium to the levels required to prevent milk fever[7]. In the 1980s and 1990s, Block[8] and Goff and Horst[7] pioneered a new dietary prevention method, by manipulating the dietary concentration of what are loosely referred to as metabolically 'strong ions' (sodium, potassium, chlorine, sulphur); this became known as the *Dietary Cation-Anion Difference* (**DCAD**) and could be used to significantly reduce the incidence of milk fever in housing systems based on total mixed rations (**TMR**).

These 'facts' about the importance of pre-calving energy balance and dietary mineral concentrations led to the development of pre-calving or '*lead feed*' rations, wherein a cow is provided with a source of supplementary energy, protein, minerals, and vitamins during the two weeks before calving, in addition to her base ration, to prepare her for the upcoming challenge of calving and lactation and to reduce the risk of metabolic diseases. However,

1. the majority of the research was undertaken in North America and Europe, where the dairy production systems, milk production expectations, and the genetics of the cow are very different from those in New Zealand
2. many of the recommendations have originated from epidemiological studies, wherein cause and effect were not determined
3. there have been a large number of experiments over the last 15-20 years that provide considerable evidence to refute the recommendations for 'best practice' transition cow nutrition that were derived from the epidemiological studies and, more importantly, on the appropriateness of the advice provided for pasture-based farming systems.

There are several components to a successful transition across calving, but pre-calving body condition score (**BCS**), the way in which the cow's BCS is achieved in autumn, the pre-calving dietary mineral concentration, and the amount to feed the cow in the weeks before calving are the factors most debated in New Zealand. These will be considered in more detail.

Body condition score

The optimum calving BCS, the effect of being thinner or fatter than optimum, and whether BCS is gained fast or slow have all been debated. Here are the facts.

Target BCS: *The range in BCS within the herd is as important as the average BCS of the herd. Thin and fat cows should be preferentially managed during late lactation and during the non-lactating period.*

There have been a considerable number of experiments undertaken globally to determine the optimum calving BCS and these were recently summarised in an award winning scientific review[9]. In short, mature cows should calve at a BCS of 5.0, while first and second calvers benefit in reproduction and health from being BCS 5.5. These scores refer to the official body condition scoring system of New Zealand (*Body Condition Scoring Made Easy*: http://www.dairynz.co.nz/animal/herd-management/body-condition-scoring/how-to-bcs/). Although other people may have their own version of condition scoring, all of the published recommendations relate to this official body condition scoring system and farmers should use accredited BCS assessors to help in scoring their herd (http://www.dairynz.co.nz/animal/herd-management/body-condition-scoring/certified-assessors/).

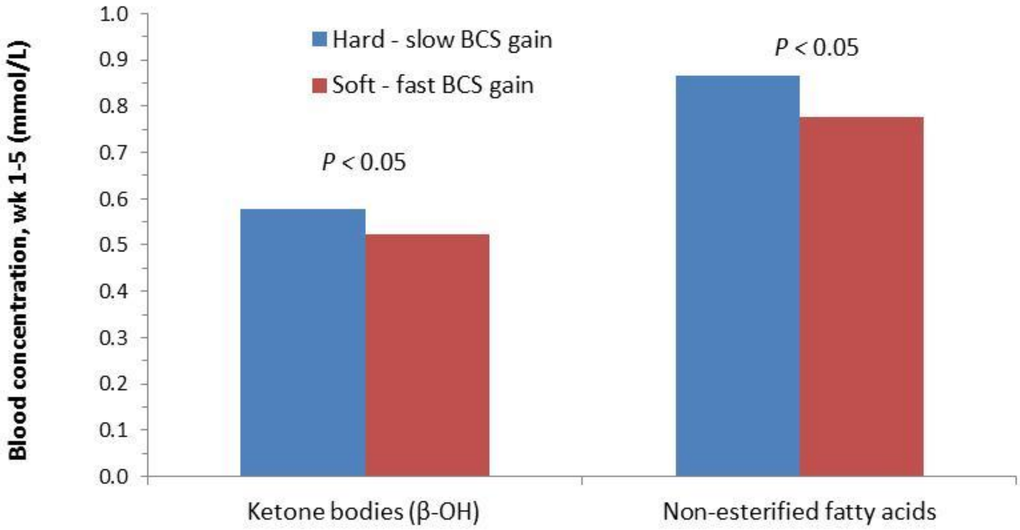
Mature cows that are thinner than BCS 4.5 or fatter than BCS 5.0 at calving are at an increased risk of metabolic and infectious diseases after calving. Therefore, not only is the average BCS of the herd important, the range is equally important. This means managing the herd from March onwards to identify thinner and fatter cows for preferential treatment.

- Low BCS cows at calving (mature cows BCS < 4.5 and younger cows < 5) are at an increased risk of infectious diseases, like mastitis and metritis. These cows need an extended dry period as well as additional feed to give them sufficient time and energy to gain enough BCS.
  It is unusual for non-lactating cows to gain more than 0.5 BCS units in a month, even when preferentially fed, and cows gain virtually no BCS in the month before calving or in the two weeks following the end of lactation. These six weeks must be deducted from the time available for BCS gain. This means that cows will generally require 70 days dry to gain 0.5 BCS units, 100 days dry to gain 1.0 BCS unit, or 130 days dry to gain 1.5 BCS units.
  In addition to the health risks associated with low calving BCS, thinner cows at calving tend to be thinner at peak milk and there is a greater risk of them contravening the minimum BCS targets as defined in the Animal Welfare Code.
- High BCS cows at calving (mature cows BCS >5 and younger cows BCS >5.5) are at an increased risk of both metabolic and infectious diseases, like ketosis, milk fever, and mastitis. For example, in a New Zealand experiment, 40% of cows calving at BCS 5.5 had excessive ketone bodies in blood. In comparison, 0% of cows calving at BCS 4.5 or 5.0 had high circulating concentrations of ketone bodies. This is consistent with Scandinavian data that indicate a doubling of the risk of ketosis as calving condition increases from 5.5 to 6.0[10].
  High BCS can, sometimes, be more difficult to manage. These cows should be milked for as long as is practical and should be 'limit fed' during the dry period (i.e., fed no more than maintenance) to ensure that they don't get too fat.

Slow or fast – which is best? *The speed at which a cow gains BCS during the non-lactating period does not affect the rate of BCS loss, the health or the production of the cow during the following lactation.*

In recent years, a number of farm advisers have suggested that cows that gain BCS quickly (soft fat) lose it quickly post-calving when compared with cows that gain BCS slowly through late lactation and into the dry period. This recommendation is based on one experiment in the United States[11]. However, an analysis of data available from previous experiments in New Zealand did not support this view. In fact, in an experiment undertaken in spring 2014, cows that gained BCS more quickly during the dry period had lower concentrations of fat in blood (i.e., non-esterified fatty acids or NEFA) than cows that gained BCS slowly (Figure 1). Although there was no difference in milk production between these treatments, the blood measurements indicate that the cows that gained BCS quickly may have been metabolically healthier than those that gained BCS slowly. However, the effect was biologically small and, arguably, not very important. What is important is that rapid BCS gain during the dry period did not negatively affect the cow.

Figure 1. Effect of speed of BCS gain in autumn on blood concentrations of ketone bodies (β-hydroxy butyrate) and non-esterified fatty acids during the first 5 weeks after calving. ***Note:*** The cows that gained BCS immediately after drying off were metabolically healthier than cows that gained the BCS slowly during the late lactation and dry periods.



How much do I need to feed 'springing cows'? *Cows should not be overfed in the month before calving. As long as BCS targets have been achieved, cows should consume 80-90% of their requirements in the weeks before calving. If less than BCS 5 one month before calving, cows should be fed to their requirements.* ***Springing cows should not be fed more than requirements****!*

As stated previously, for almost 100 years, the accepted advice has been to feed springing cows as much as they'll eat. This is based heavily on observational studies, which reported that cows losing BCS before calving were at a greater risk of metabolic and infectious diseases after calving[4], and experiments, wherein cows that were 'force fed' pre-calving had lower concentrations of fat in their liver at calving[5]. However, more recent experiments indicate that these conclusions were wrong. It is more likely that the relationship between BCS change pre-calving and post-calving disease is associative and not causative because:

1. In the experiment in which cows were 'force-fed' before calving[5], the cows' metabolic profile two weeks post-calving was inferior to cows that were not 'force-fed': blood NEFA concentrations were 50% greater in 'force-fed' cows and blood ketone body concentrations were 100% greater.
2. Results from experiments profiling the behaviour of transition dairy cows indicate that cows that get sick post-calving had reduced DM intake before calving[12]. In other words, these cows were already sick before calving, but the sickness did not become clinical until the pressure of calving and lactation. It was the malaise that caused the increase in NEFA and not the other way around.
3. Experiments that were established to restrict cows before calving did not result in increased disease post-calving. In fact, the majority of studies show an improvement in metabolic health[13, 14, 15, 16, 17].

The lack of a negative effect from restricting cows before calving has been proven in experiments in the US, Europe, and New Zealand and, in fact, these studies indicate a positive effect of the slight restriction on energy balance and liver health. One factor to consider, however, is the BCS of the cow. Recent research results in New Zealand indicate that if a cow is less than BCS 5 at calving, she should be fed to requirements (Table 1). In comparison, if she is a BCS 5 or greater, she will probably benefit from being fed 80-90% of her requirements. Irrespective of her pre-calving BCS, ***dairy cows should not be fed more than requirements in the two weeks before calving***.

Table 1. Recommended daily metabolisable energy (ME) intake for cows during the last two weeks before calving. ***Note:*** recommendations are dependent on their pre-calving BCS[17].

Mid-lactation Lwt	Pre-calving Lwt	Recommended ME intake if BCS <5	Recommended intake of ME if BCS 5 or greater
350	400	95	80
400	460	105	90
450	520	115	100
500	580	125	105
550	630	130	110
600	690	140	120

Dietary Cation-Anion Difference (DCAD) and milk fever prevention

Milk fever is a multifactorial disease, making it difficult to isolate a specific cause. Magnesium supplementation pre-calving reduces the incidence of milk fever significantly. Similarly, restricting the energy intake of springer cows increases blood calcium on the day of calving.

Although a negative DCAD increases calcium absorption, lowering the DCAD alone is impractical in systems where springer cows consume a large proportion (≥50%) of fresh forage in the diet.

Milk fever was first reported in the 18th century. Although only 1-2% of cows are diagnosed with milk fever each year nationally, it can be a very frustrating metabolic disease on individual farms. In addition, for every 2% milk fever, approximately 5% of cows have clinically low blood calcium, and more than 30% of cows are subclinically affected[18]. Even the subclinical condition is likely to reduce DM intake and increase the risk of other diseases, like ketosis or mastitis[19].

Milk fever is caused by insufficient blood calcium to meet the requirements for colostrum production and still maintain smooth muscle function in the cow. It is, particularly, a disease of older cows (i.e., 5 years and older), but is affected by

- cow breed[20]: Jerseys are 5 times more prone to milk fever than Holstein-Friesians
- BCS[20]: milk fever risk is greater when cows are <BCS4 and >BCS 6
- the weather[20]: milk fever increases during frosty weather and during heavy rain, and
- the cow's diet before calving[7,20,21].

As mentioned previously, although dietary calcium concentration affects the ability of the cow to absorb calcium, it is not possible to create a diet low enough in calcium before calving to prevent milk fever. However, it is still important to keep dietary calcium low. Recently, four dietary strategies have been proposed to prevent milk fever.

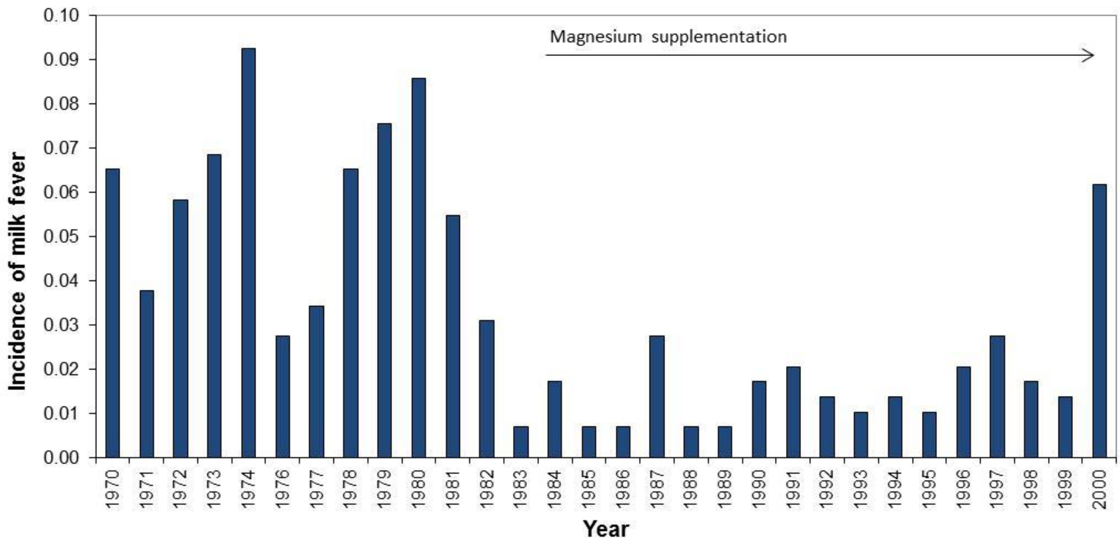
1. *Magnesium supplementation*: magnesium is probably the most important dietary component in milk fever prevention[20,21]. Research undertaken in New Zealand highlighted a dramatic reduction in the

incidence of milk fever with pre-calving magnesium supplementation; average incidence of milk fever dropped from 6.1% to 1.3% (Figure 2[20]).

Cows should be supplemented with approximately 20 g magnesium/day during the two weeks before calving. This is approximately 40 g magnesium oxide (e.g. CausMag). Source of magnesium oxide is important – so, cheapest is probably not best. Some sources of magnesium oxide have been prepared badly, making the magnesium much less available. This cannot be easily determined by examining the product: Australian-sourced magnesium oxide is probably best.

Although magnesium sulphate and magnesium chloride have been reported to prevent milk fever more effectively than magnesium oxide[22], it is difficult to feed sufficient amounts of these compounds (150 or 200 g/d of magnesium chloride and sulphate, respectively). However, it could be beneficial to provide 50-60g/cow/day of either magnesium sulphate or chloride in the water trough in addition to the magnesium oxide supplementation. If dusting on pasture, apply 60-80 g magnesium oxide/cow/day.

Figure 2. Proportion of cows that got milk fever at No 2 dairy, Ruakura between 1970 and 2000. ***Note:*** the reduction in milk fever when magnesium supplementation began[20].



2. _Calcium supplementation_: Supplementing cows with calcium (e.g., ground limestone) during the colostrum period increases blood calcium and reduces the risk of milk fever[22]. The majority of milk fever occurs in the 24-48 hours after calving. If cows can be supplemented with calcium during this period, the risk of classical milk fever decreases. There is little evidence that supplementing calcium beyond the colostrum period is of benefit in pasture-based systems. However, in individual herds, if cows get milk fever in established lactation, calcium supplementation is important. Calcium should not be supplemented in the weeks before calving, except as a final resort and under advice from a trained nutritionist.
3. _Lower dietary cation-anion difference_: The DCAD refers to a difference in the concentration of metabolically 'strong' minerals in the diet. Minerals like sodium, potassium, calcium, and magnesium have a positive charge when dissolved in a solution, when compared with minerals like chlorine, sulphur and phosphorus, which have a negative charge. In addition, minerals like sodium, potassium and chlorine dissociate completely in solution (strong ions), while minerals like calcium, magnesium and phosphorus do not (weak ions). Multiple DCAD equations have been tested; the most effective in predicting changes to acid-base balance is:

DCAD (mEq/kg DM) = ([Sodium] + [Potassium]) - ([Chlorine] + [Sulphur])

Calculating the DCAD is complicated by the need to account for the valence of the mineral element considered (i.e., the electrical charge of the ion).

Controlled research experiments have provided evidence that calcium absorption can be increased by lowering DCAD to less than 0 mEq/100g DM[23]. This threshold is important because it is when DCAD is reduced below 0 mEq/100g DM that urinary calcium concentration increases without a decline in blood calcium. This indicates that the homeostatic mechanisms regulating blood calcium have been primed for increased calcium absorption.

Although the biochemistry is the same, irrespective of diet or farming system, this threshold makes DCAD impractical in most grazing systems. Firstly, the DCAD is very high in fresh forages because of the high potassium content. This means that the cows would have to receive too much anionic salts (e.g. 1 kg Epsom salts/cow/day) to sufficiently lower blood pH and increase calcium absorption. In addition, as pasture composition varies throughout a paddock, the DCAD varies with each mouthful. It is, therefore, difficult to manage DCAD when a fresh forage is the main feed.

You can reduce the DCAD to less than zero by feeding most of the diet as maize silage and/or straw and providing anionic salts. If applying this strategy, care must be taken not to overfeed cows.

4. Restricting cows metabolisable energy intake to 80-90% of their requirements in the weeks before calving increases blood calcium on the day of calving and the day after calving, reducing the risk of milk fever. The mechanism by which this works is, as yet, unknown, but the effect is consistent across pasture-based and TMR-based diets.

Do I need to supplement with straw?

Straw provides little to no nutritional value, but can be used to reduce the energy content of the pre-calving diet or to placate hungry cows.

Straw provides little or no nutritional value to the transition cow. However, it can help reduce their intake of metabolisable energy in the weeks before calving. It can, therefore, help in the prevention of metabolic diseases. However, it is no more effective than fresh air in this regard[24]. It does not lead to improved rumen development or an increase in the intake capacity of the dairy cow post-calving.

Conclusions

There can be little doubt that transition cow nutrition and management is important. However, it is often over-complicated by inappropriate recommendations.

Most importantly, transition cow management begins several months before calving by ensuring that mature cows are BCS 5 at calving and younger cows are BCS 5.5. In achieving this, pre-calving nutrition becomes simpler. Remember, the range in BCS is as important as the herd average.

From one month before calving, cows should be checked for signs of springing twice weekly and separated into a springer mob. If BCS 5 or greater, cows should be fed to consume 80-90% of their requirements (i.e., allow for wastage). If less than BCS 5, cows should be fed to consume 100% of their requirements. Cows should not be fed in excess of their requirements.

Although the effect of DCAD is biochemically the same in grazing cows as in housed cows, the concept is impractical in animals harvesting a large proportion of their diet as high potassium fresh forage. To avoid milk fever, cows should be restricted to 80-90% of their metabolisable energy requirements, supplemented with 20 g magnesium/cow/day (allow for 50% wastage if dusting – 100% wastage in very wet weather) in the two weeks before calving, and supplemented with 100 g calcium/cow/day (i.e., 300 g limeflour) during the colostrum period after calving.

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