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IN BRIEF

Buying supplements

Making the right call in a feed shortage when income is low

DairyNZ

BENEFITS OF BETTER FEED ALLOCATION | RECIPE FOR REPRODUCTION

Contents

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To feed or not to feed – the science behind the DairyNZ Supplementary Feed Calculator

The Supplementary Feed Calculator is designed to help farmers make tactical decisions about purchasing feed during a feed shortage. DairyNZ principal scientist John Roche explains the science behind it.

Background

The profitability of supplement use depends on both the revenue generated from the purchased feed and how much it costs to buy and provide it.

DairyNZ has produced the Supplementary Feed Calculator to help farmers make tactical decisions about purchasing feeds during a short term feed shortage.

The Supplementary Feed Calculator (dairynz.co.nz/supplementaryfeed) uses international and New Zealand research results to estimate the milk production response of providing supplements to milking cows under different feed deficit situations and at different stages of lactation. It estimates the likely profitability of doing this under different milk price scenarios and compares the value proposition of different feeds.

John Roche, DairyNZ

Total milk production response to supplement

In the Supplementary Feed Calculator, the milk production response to feed offered is the sum of the milk produced when cows are receiving the supplement **(immediate response)** and milk produced later as a result of pasture spared and cow body condition score (BCS) gained from the supplement **(deferred response)**. Multiple experiments have been undertaken evaluating the milk production response to supplements under different levels of feed deficit. ▶

Although both the immediate and the deferred responses decline with increasing pasture dry matter intake (DMI), the deferred response is especially sensitive to feeding level (See Figure 1). For example:

- in severe pasture deficit situations (e.g., unsupplemented post-grazing residual of 1200kg DM/ha for a milking cow), as much milk is produced after the period of supplementation as during the feed deficit when the supplements are offered;
- when cows are relatively well fed (e.g., unsupplemented post-grazing residual of 1600kg DM/ha), the deferred milk production is only approximately 10 percent of the immediate response[1].

The total milk production response to supplement (immediate plus deferred response) is determined by many biological and management factors[2] that have been taken into account in the Supplementary Feed Calculator. They include the following:

- **Stage of lactation**
  The use of a cow's own body reserves for energy in early lactation and the amount of energy consumed that is partitioned towards gaining BCS in mid and late lactation can influence the immediate response to supplements. This is important, as any BCS gained through supplementation will be subsequently used for milk production (i.e., deferred milk production response) and it is therefore important to account for it.
- **Amount of purchased supplement that is wasted**
  The Supplementary Feed Calculator's estimate of feed wastage is:
  - 5% for in shed feeding;
  - 10% for feed offered on a feed pad;
  - 15% for feed fed in trailers in the paddock;
  - 20% for feed offered in the paddock during dry conditions;
  - 40% for feed offered in the paddock during wet conditions.

In addition, for silage, some energy is assumed to be lost in the fermentation process.

- **The amount of pasture refused – ie, substitution of supplement for pasture**
  When grazing cows are fed supplements, pasture DMI declines[2,3]; therefore, increases in supplement offered do not result in equal increases in total DMI, even in feed-restricted cows. The substitution rate is lower and the milk production response greater during autumn than during spring[4]. In the Supplementary Feed Calculator, substitution rate (i.e., pasture spared) is used to calculate the change in post-grazing residual following supplementation.
- **Amount of supplement offered:**
  As the amount of supplement offered increases, the total response to supplement declines[4]. This is because the cow becomes less hungry with every extra kg of supplement consumed and there is more substitution.
- **Type of feed and the processing of that feed:**
  The type of supplement offered affects the composition of the milksolids produced[4,5,6]. Feeds high in starch and sugar (e.g., barley, maize, tapioca; also called non-structural carbohydrate or NSC), on average, increase the production of milk protein more than milk fat, while feeds high in fibre and/or fat (e.g., palm kernel, soyhulls, broll) increase the production of milk fat more than milk protein[4,5].(see Figure 2). This is important because milk protein is generally worth substantially more than milk fat. However, this effect of feed type only occurs over the period while supplements are being consumed (ie, there is no deferred response).

The Supplementary Feed Calculator uses this effect of dietary NSC and fibre to estimate the increase in milk protein and milk fat and uses the milk company's Value Component Ratio (VCR; the value of fat relative to protein) to allow a more accurate prediction of milk revenue.

Figure 1. Immediate and deferred milk production responses to supplement (g MS/MJ ME) with increasing post-grazing residual. The response to supplement decreases with increasing post-grazing residual; in particular, the amount of milk produced post-supplementation (i.e., the deferred response) declines quickly.

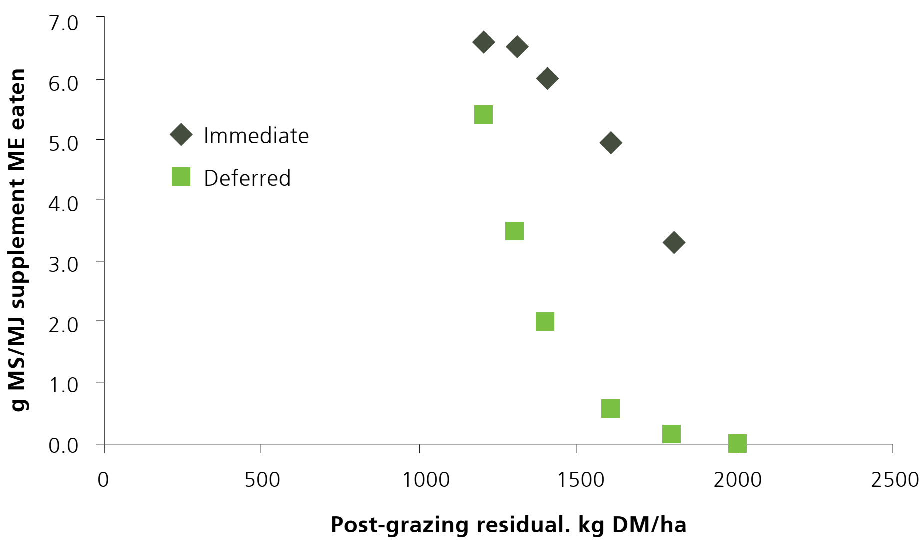
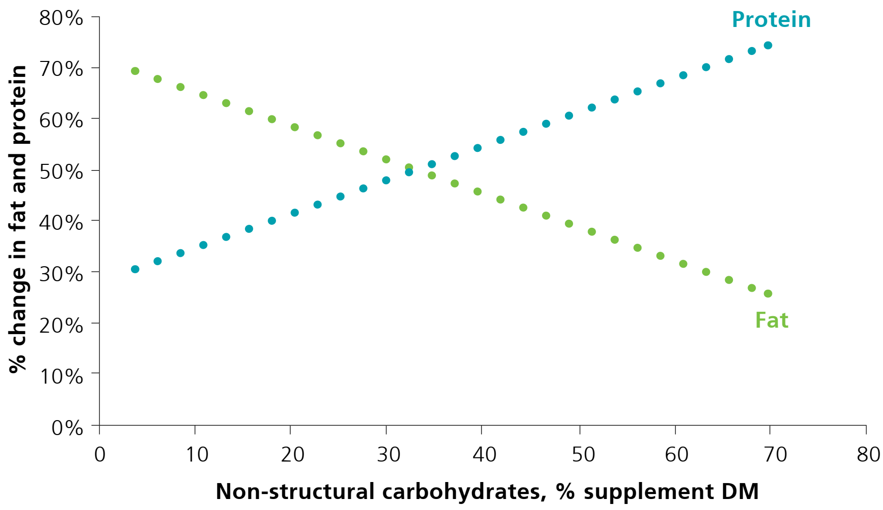


Figure 2. The change in milk composition with changing non-structural carbohydrate (NSC) content of the supplement offered. The more NSC offered, the higher the level of milk protein and the lower the milk fat level in each kg of MS.



Revenue and Costs

The Supplementary Feed Calculator accounts for all of the above factors, which allows a more accurate estimation of total revenue.

As well as accounting for direct costs of supplements, it also includes associated costs (e.g., tractor running costs, depreciation, and repairs and maintenance).

The Supplementary Feed Calculator makes no allowance for capital costs (i.e., it is assumed that the equipment for feeding is already available) or variable costs that aren't associated with feeding.

Limitations of the Supplementary Feed Calculator

Although a useful resource to help estimate the value proposition from different feeds in a unique situation, the following limitations should be kept in mind:

a) the Supplementary Feed Calculator is a resource to help with tactical purchases of feed and should not be used to make strategic decisions around feeding that lead to a change in the farming system and extra costs. These are not accounted for in the Supplementary Feed Calculator.

b) The Supplementary Feed Calculator is not a ration balancing model. The resource assumes that energy is the dietary factor that is limiting production. This will be true in the vast majority of situations. However, in an extremely dry summer or in a system already feeding more than 30 percent of the diet as energy supplements, there is a risk that other nutrients (e.g., protein or specific amino acids) become limiting and the response to different supplements could be more or less than proposed.

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The financial benefits of better feed allocation

The more a farmer knows about each paddock's pasture mass, the better grazing the result and the greater the farm operating profit. Modelling was performed by DairyNZ staff Sean McCarthy, Cathal Wims and Alvaro Romera, led by senior scientist Pierre Beukes.

Key findings

- On-farm knowledge of individual paddock pasture yield varies widely.
- A farm-scale simulation estimated the effect of three levels of grazing management on farm profitability.
- At a $3.65/kg MS milk price optimal feed management could add $333/ha to operating profit.
- This occurred through:
  - better post-grazing residuals which maximised pasture growth
  - more accurate feed allocation and higher milk production.

Pierre Beukes, Sean McCarthy, Cathal Wims Alvaro Romera, DairyNZ

A focus on grazing management is becoming more critical with increased use of supplements, new environmental objectives and the need to remain competitive. Pasture allocation is a key component of grazing management. Rotation or round length is normally part of this process and determines the proportion of the farm grazed each day. For each grazing, the size of the selected paddock and its pasture cover determines pasture allowance per cow. This has important consequences for pasture dry matter intake, pasture utilisation, and post-grazing residual. The post-grazing residual, in turn, impacts on pasture regrowth, quality of subsequent available pasture, and supplement feeding decisions[1].

Obtaining good estimates of individual paddock pasture mass (kg DM/ha) is time consuming. Tactics used on farms vary from best practice weekly farm walks through to very simplistic decision making that uses little to no knowledge of pasture mass. The impact of these differing approaches was evaluated using the DairyNZ Whole Farm Model (WFM)[2] in a modelling exercise which replicated as closely as possible a commercial farm operation.

Scenarios for grazing modelling

The WFM was set up with three different feed management approaches.

Optimal feed management assumed that pastures were assessed accurately and the longest paddock always grazed first. Feed allocation was extremely well managed, with supplements used only to meet cow requirements when grazing below target residuals. Surplus was taken when residuals were consistently greater than 1700kg DM/ha, with paddocks greater than 3500kg DM/ha harvested.

Good feed management assumed that pastures were assessed with 85 percent accuracy, therefore some error in paddock selection and pasture and supplement allocation occurred. Surplus was taken when residuals were consistently greater than 1700kg DM/ha, with paddocks greater than 4000kg DM/ha harvested.

Poor feed management assumed little assessment of pre-grazing and hence poor feed allocation. Surplus was taken when residuals were consistently greater than 2000kg DM/ha, with paddocks greater than 4000kg DM/ha harvested.

Variation in pasture growth between paddocks was modelled using data from 26 paddocks on DairyNZ's Scott Farm, Hamilton, for the period 1 June 2011 to 31 May 2012, where growth rate differences of up to 30 percent were observed between the highest and lowest producing paddocks.

A typical Waikato farm was simulated using NIWA weather data for three climate years – 2004/05 representing a "good" pasture yield of around 20 t DM/ha; 2013/14 representing a "normal" pasture yield of around 17.5 t DM/ha; 2012/13 for a "poor" pasture yield of around 16 t DM/ha. 2012/13 prices were used; $290/t DM for purchased silage, $270/t DM for PKE, $140/t DM for silage made from the milking platform, and a cost of $40/t DM for feeding supplements. The results come from modelling on a milk price of $3.65/kg MS. Modelling was also undertaken at a $5/kg MS milk price.

Annual pasture yield

The results showed increasing annual pasture yields from poor feed management to optimal feed management scenarios (See Table 1). The higher pasture yield in the optimal scenario came from better control of average farm covers and post-grazing residuals in November to February, compared with the good feed management and poor feed management scenarios (See Table 1).

Lower pasture covers in June-July and lower residuals in September resulted in approximately 0.5 t DM/ha more pasture yield in the good feed management scenario, compared with poor. This is explained by the fact that more pasture is grown by keeping average pasture cover in the rapidly growing phase of the grass growth curve. It is achieved by having good post-grazing residuals, around 1500 to 1700kg DM/ha, and not allowing covers at the top end of the pasture wedge to get too high[3].

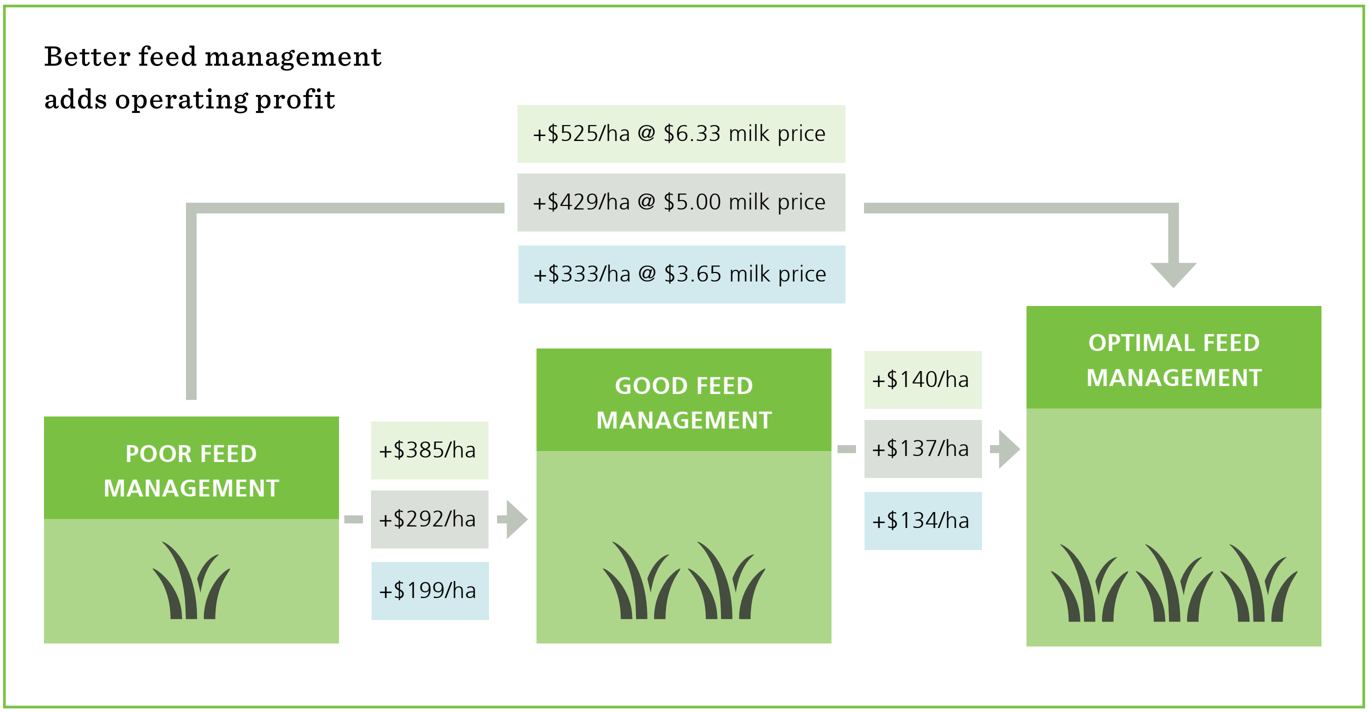

Figure 1. With each level of feed management, more operating profit per hectare is achieved.

Milk production

Good feed management was predicted to increase milksolids production by around 70kg MS/ha (See Table 1). Both good and poor feed management scenarios had periods of under- and over-feeding, resulting in fluctuating intakes and milk production.

However, periods of under-feeding were more frequent and more severe in poor feed managment, indicating that paddock selection and, therefore, pasture allowance was wrong more often. The occasional over-feeding in both good and poor scenarios, and the consequent increase in milk production during these periods, came from inaccurate supplement feeding, which resulted in increased dry matter intake, but also wastage of pasture through substitution[4]. In essence, both under-feeding and over-feeding stemmed from poor paddock selection and supplement feeding based on unknown or incorrectly estimated pasture allowance.

Operating profit

Milksolids production and cost of supplements were the main factors that influenced the differences in operating profit predicted for the three scenarios. Profit was approximately $134/ha higher in optimal, compared with good feed managment (see Figure 1), mainly driven by higher cost of supplements in good because of less pasture grown, less silage made, and more PKE purchased (see Table 1). The higher profit of approximately $199/ha in good, compared with poor feed management scenarios was primarily due to lower milk production in the poor scenario, the consequence of more frequent and more severe under-feeding of lactating cows. The operating profit of $199/ha was sensitive to milk price and changed to $292/ha at $5.

The potential benefit of $199/ha for good feed management should be moderated by approximately $23/ha/year to account for costs of weekly pasture assessments and pasture data evaluation to improve grazing management decisions[5]. This adjustment results in a total increased operating profit of $176/ha at a $3.65/kg MS milk price. A similar adjustment for costs took the $5 milk price operating profit to $269/ha.

Table 1. Modelling results of the three feed management approaches on a typical Waikato farm.

	Optimal	Good	Poor
Annual pasture yield (t DM/ha)	18.7	17.8	17.3
Milksolids production (kg/ha)	1283	1281	1210
Cost of supplements ($/ha)	1402	1491	1471

Conclusion

The results suggest that good feed management of pasture, when compared with poor, can increase operating profit by $176/ha at a milk price of $3.65. In reality, most operators will fall between these two categories – good and poor management – and pasture monitoring activities will invariably be influenced by seasonal workload. Also, the quality of pasture mass estimates will vary depending on how these are conducted and/or the skill of the assessor. However, this study does indicate that the costs associated with time and effort required for grazing management are small in comparison with potential gains in operating profit.

For more information visit **dairynz.co.nz/grazing-management**.

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Reproductive failure – do cows need more feed to get in calf

Nutrition is important for getting cows in calf. However, this doesn't mean that feeding supplements will improve herd reproduction. DairyNZ principal scientist John Roche and senior scientist Chris Burke explain.

Key points

- Fertility has declined significantly over the last two decades for many reasons.
- Genetics plays a role in reproductive success.
- Cow nutrition is important for getting cows in calf. This does not mean you will get more cows in calf by feeding supplements.
- Achieving body condition score (BCS) targets at calving is probably the most important nutritional influence for getting cows in calf.

John Roche, Chris Burke, DairyNZ

Getting lactating cows in calf has never been easy. It has become even harder over the last 25 years.

- **USA:** inter-calving interval increased by one month and services per conception increased 33 percent[1]
- **Ireland:** services per conception increased by 14 percent[2]
- **UK:** calving rate to first insemination declined from 56 percent to 40 percent[3]
- **New Zealand:** 6-week re-calving rate declined from 70 percent to 50 percent[4]. ▶

These studies indicate a reduction in conception rate and an increase in embryo mortality over the last 25 years, while longer post-calving anoestrous intervals and reduced expression of heat have also contributed to the decline[1,5].

During the same period, milk production/cow has increased and cows now tend to lose more BCS in early lactation. Because of this, many people have associated failure to get cows in calf with negative energy balance in early lactation. They assume that feeding cows more pasture or feeding particular supplements in early lactation will improve reproduction.

Reproductive failure – influence of genetics

Comparisons between New Zealand cows and those of North American ancestry offered the same diet has proven that genetics has a strong impact on reproductive failure. New Zealand cows have higher conception rates and supplementary feeds offered to cows well fed on pasture do not correct the poor reproductive performance of the North American cow. Detailed experiments at DairyNZ and internationally have discovered that there are important differences between these strains in the:

a. length of their reproductive cycle
b. concentration of important hormones circulating in blood
c. expression of key genes in the uterus that enable the embryo to grow and survive.

It is unlikely that these genetic effects can be overcome by nutrition.

Reproductive failure – influence of nutrition

Many nutritional factors have been suggested as contributing to the decline in fertility in New Zealand.

Body condition score: Body condition score at calving is arguably the most important nutritional factor associated with getting cows pregnant. Cows that are fatter at calving, cycle earlier and tend to be fatter at mating[7]. However, cows that are too fat lose excessive condition after calving and are less likely to conceive. For this reason, it is recommended that mature cows calve at BCS 5; this ensures they cycle early, lose on average no more than 1 BCS unit between calving and mating, and are greater than BCS 4 at mating[7]. Younger cows (heifers and second calvers) tend to be healthier and less prone to disease (mastitis and endometritis)[7,8] and they cycle earlier if they calve a little fatter than mature cows (BCS 5.5).

It is important to pay attention to nutrition during late lactation and during the dry period to ensure that cows reach recommended BCS targets. Failing to get cows to target condition at calving cannot be corrected by nutrition in early lactation.

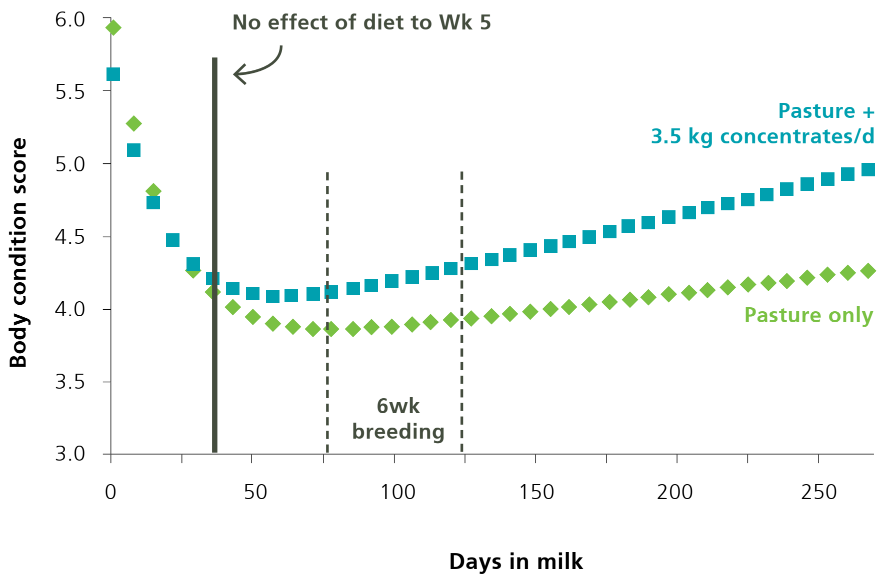
Transition period: Nutrition of the springing cow before calving influences liver health after calving. This may affect the incidence of metabolic diseases and uterine infections, which can affect reproductive performance. Management of the cow during the transition period was recently profiled in the June issue of *Technical Series* available at **dairynz.co.nz/techseriesjune15**.

Intake: Many believe that cows fed only pasture cannot eat enough to meet demand and that supplements will therefore improve energy balance[9]. It is true that cows cannot eat sufficient DM in early lactation to meet energy requirements for milk production; they will be in negative energy balance and will therefore lose BCS. This is primarily controlled by genetics, and feed amount or feed type have little effect on BCS loss in the first four to five weeks of lactation[6,7] (See Figure 1).

This is a revised version of the September 2011 Technical Series article '*Reproductive failure – do cows need more feed to get in calf?*' For the full article visit **dairynz.co.nz/techseries**.

Although a negative energy balance during mating will reduce the likelihood of a cow getting in calf, the effect on fertility is not as great as many think. DairyNZ data[10] indicates a reduction of 4 percent in 6-week in-calf rate if cows lose 2 BCS units during early lactation compared with cows that lose 1 unit. Furthermore,

Figure 1. Effect of supplementing cows with 3.5kg/d of a concentrate feed throughout lactation on BCS gain compared with cows grazing fresh pasture[6].



in a large study in which cows had a 40 to 50 percent restriction imposed for the first two weeks of mating, these cows had a 6-7 percent lower pregnancy rate to first service and 6-week in-calf rate[11]. Although such a decline in fertility is important, this was a very severe restriction.

> ***Results indicate that feeding level in early lactation is not the main reason for poor fertility and that supplementation, per se, will not improve in-calf rates.***

Supplementation can influence BCS from week six of lactation onwards (See Figure 1), but the effect is small[6]; results from New Zealand studies suggest that feeding cows 270kg of a maize grain-based concentrate (i.e. 13 MJ ME/kg DM) during early lactation increased cow BCS by 0.25 units[6] at the start of mating and cows gained more condition through mating (0.1 BCS units over 42 days[6]) than if they were offered pasture alone (Figure 1). This difference in BCS and in BCS change, however, would only be expected to increase the six-week in-calf rate by 1 percent[10].

Collectively, results suggest that low DM intake in early lactation is not the major cause of reproductive failure in New Zealand. If cows are grazing to residuals of 1,500-1,600kg DM/ha, offering supplements will not improve reproduction. If cows are grazing to residuals below 1,500kg DM, providing cows with energy supplements may improve reproduction; however, the effect of a small restriction (i.e., 1-2kg DM/d) on reproduction is probably small.

> ***If you can't economically justify supplementary feeds on the basis of increased milk production, they will not affect reproduction.***

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Science snapshots

DairyNZ levy funded or supported science

Management of chicory and plantain *(Lee et al)*[1]

- This experiment aimed to determine the optimal rotation length for maximising the yield and feed quality of chicory and plantain.
- Plots of pure chicory (cultivar 'Choice') and plantain (cultivar 'Tonic') were sown in spring 2010 and harvested at differing intervals determined by the herbage height (15 to 55cm) for 18 months.
- Spring-sown chicory and plantain produce reproductive stem in their second season. Mature stems reduce feed quality and utilisation so reducing stem growth is a management priority.

Chicory recommendations:

- For farmers wanting a short-term 'summer' crop, grazing chicory at 35cm height (21-28 day rotation) optimises yield.
- If farmers are taking the crop into a second season, a shorter grazing interval (25cm height, 16-25 day rotation) optimises leaf yield while restricting stem growth.

Plantain recommendations:

- Increasing the interval between grazing, increases leaf yield as well as stem yield.
- In addition to the negative impact of stem on quality, plantain leaves become more fibrous and less digestible as they age (i.e. under longer rotation lengths).
- Because of these two factors a compromise must be made when managing plantain, with some sacrifice in yield or quality.
- Grazing plantain at 25cm height (2-5 week rotation depending on growth/season) appears to provide a good balance between yield and quality. This requires further testing in a farm system.

Factors associated with the financial performance of spring-calving, pasture-based dairy farms *(Ramsbottom et al 2015)*[2]

- A database containing financial and physical information from 1,561 pasture-based dairy farms in Ireland was used to quantify the relationship between on-farm management practices, farm physical characteristics, and financial performance.
- On average, the primary factor associated with on-farm profitability was pasture harvested/ha, with milk production/ha, stocking rate, and the median calving date of the herd also contributing.
- As the proportion of purchased supplementary feed increased, milk yield and yield of milk components increased, but both pasture harvested/ha and farm profitability declined due to an increase in both variable and fixed costs that exceeded the revenue gained.

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