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Grazing management

The root to success

DairyNZ

PASTURE GROWTH PRINCIPLES | RYEGRASS AS A FEED | PROFITABLE SYSTEMS

Contents

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Grazing management – the root to success

This issue of the *Technical Series* highlights the fundamentals of good grazing management. In New Zealand pastoral-based dairy systems, grazing management is directly linked to profitability.

The focus on grazing management is becoming more critical with increased use of supplements, new environmental objectives and a need to retain our competitive advantage.

The dairy industry has a strategic target to increase profit from productivity by $65/ha per year. Improved grazing management is fundamental in achieving this, by increasing the amount of high quality pasture grown on each hectare of land and converting this efficiently to milksolids.

In New Zealand pasture-based systems, each herd typically has two grazing periods each day. With almost 12,000 herds in New Zealand, every day farmers are responsible for managing close to 24,000 grazing periods, with a successful outcome imperative to increasing on-farm productivity and profitability.

Successful grazing management is a skill, with results dependent on the plant, the grazing animal and the farmer.

Articles in this issue address all these components: the principles of pasture growth, the value and limitations of ryegrass as a feed for the dairy cow and the operational decisions made by the farmer.

The final article (pg 13-16) pulls all these together to define grazing management targets and processes which will improve profitability on-farm.

Feedback wanted

DairyNZ has initiated a Focus on Pasture programme aimed at improving grazing management on-farm and ultimately increasing pasture eaten per hectare.

We'd like to hear what you think can be done to improve grazing management and practices on-farm.

Email **sean.mccarthy@dairynz.co.nz** with ideas and suggestions.

Maximising leaf availability using pasture growth principles

Ongoing challenges to farm businesses, through the environment and milk price volatility, bring a need to sharpen the focus on pasture growth and utilisation. However, debate continues about how to best manage grazing of dairy pastures.

David Chapman, DairyNZ
Sean McCarthy, Cathal Wims, DairyNZ

Key findings

- Sunlight provides the basic food for plants, in the form of energy.
- Graze between the 2½-3 leaf stages to maximise energy capture, the efficiency of grass growth and long-term yield.
- Allowing growth to continue beyond this point means pastures will reach a ceiling yield after which no further dry matter will accumulate, and pasture quality will decline.
- Achieve an even and consistent grazing residual – between 3.5-4.5 cm on a rising plate meter so pastures quickly re-establish leaf area to capture light energy.
- Principles of pasture growth should be balanced with overall farm system considerations.

To help steer the debate, it is useful to consider the underlying principles of pasture growth and the effects of grazing on growth and pasture accumulation.

Energy from sunlight: the primary plant food

The starting point for understanding plant growth and pasture yield is light capture. Light energy is used by leaves for photosynthesis, providing energy for plant growth. In this sense, we can view light as the basic food stuff of plants.

Pasture yield accumulation was first related to light capture in the 1950s[1,2].

UK researchers took this a step further by working out how dry matter flows through plants and the canopy as pastures regrow from a post-grazing residual up to the ceiling yield[3,4]. What this uncovered is fundamental to the way pastures are now managed. ▸

Pasture regrowth after grazing

Grazing or harvesting pasture removes leaves and deprives plants of their primary food source – light energy.

Generally, the first leaf after grazing is relatively small because the plant has little energy for growing this leaf and, therefore, leaf size is restricted.

However, once grown, the first leaf adds more energy to the plant, so there is more energy for the next leaf (so it will be a bit bigger) and this pattern continues until the plant has regained its full energy status.

Leaves have a limited lifespan. Ryegrass is often termed a 'three leaf' plant because it generally sustains a maximum of three live leaves on a tiller at any point[5]. So, once the third new leaf has been produced (termed the three leaf stage, see figure 1), the first leaf produced immediately after grazing will start to die.

Ultimately, the pasture will reach 'ceiling yield' (shown by x in figure 2), while plants are still producing new leaves but the amount produced is cancelled by the rate of leaf death. At this point, the rate of loss through the old leaf dying is on a par with new leaf production.

Therefore, dead material will continue to accumulate at the base but no additional leaf material for grazing is accumulated.

Optimum time to graze

The commonly seen 's-shaped' regrowth curve is shown in blue in figure 3.

This charts the build-up in total pasture cover from the previous grazing. Cover builds up quite slowly to begin with, accelerates and then levels off towards ceiling yield.

Figure 3 also depicts two growth rate curves calculated from the s-shaped regrowth curve, which can help determine the optimum time to graze to maximise leaf accumulation.

Instantaneous growth rate is the daily rate of net pasture growth that contributes to net pasture accumulation. Instantaneous growth increases initially as new leaves are formed and no leaf death is occurring, and then declines as leaves start to die and cancel out the rate of new leaf production.

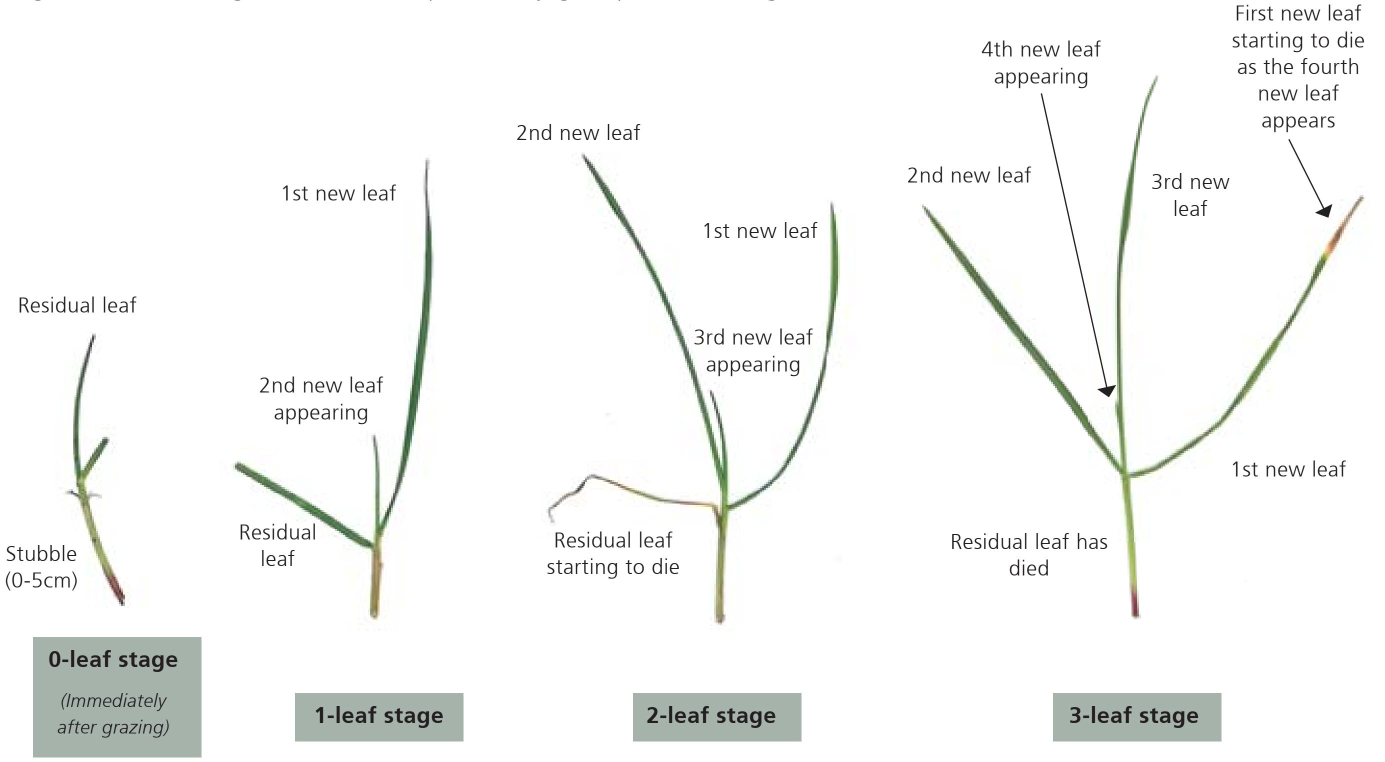
Average growth rate is the amount of pasture grown since the last grazing (current yield, less residual at last grazing), divided by the number of days.

When the maximum average growth rate is reached (see arrow in figure 3), this indicates the optimum balance between the amount of new leaf produced and the amount of old leaf dying. Beyond this point, the efficiency of further increases in pasture cover is declining, therefore it is the optimal point to graze.

So how can farmers identify this point? The curves in figure 3 are all determined by the sequence of leaf production and leaf death (figure 1). Therefore, leaf stage can be used to indicate the optimal grazing point[7].

Generally, maximum average growth rate occurs at approximately the three-leaf stage after grazing[8] (figure 1), so monitoring leaf stage is a practical way to track what is happening.

Figure 1. The leaf stages of well-utilised perennial ryegrass pasture as it regrows.



Grazing residual impact

The previous analysis of pasture dynamics and identifying the optimum grazing point is based on pasture regrowth following grazing residuals of 3.5-4.5 cm compressed height (7-9 clicks on rising plate meter).

The residual from which pastures regrow impacts on pasture dynamics, subsequent growth rates and the optimum timing of grazing. Figure 4 (pg 4) demonstrates the impact of different post-grazing residuals (low, medium and high) on average growth rate during the next regrowth cycle.

This highlights that:

- Time taken to reach maximum average growth rate (shown by the arrows) is very short with a high residual (a: blue line) and very long with a low residual (c: black line).
- The actual growth rate reached at the maximum average growth rate is lower for the high residual (y) and the low residual (z) compared with the medium residual (x).

Hence, the amount of pasture left behind after each grazing impacts on the optimum time to graze again and the maximum average growth rate achieved. Therefore, this affects the amount of pasture available at the next grazing. In other words, residuals play a key role in overall pasture growth.

Ensuring post-grazing residuals are consistently managed within a tight range (3.5-4.5 cm compressed height) will enable plants to capture as much sunlight energy as possible, and convert this into feed for cows by:

- Minimising the amount of old leaf material left behind after grazing. This will lead to the best possible growth rates allowing tiller size and density to adapt to a consistent light regime after each grazing. This minimises the 'lag' in the accumulation of new green leaf. When consistent residuals are achieved, approximately 25, 35 and 40% of total final yield comes from the first, second and third leaves produced[9].
- Allowing light to reach deep into the sward to stimulate the production of new tillers. This keeps tiller density high, allowing the pasture canopy to quickly regain full light interception after grazing. ▶

Figure 2. Changes in the rate of new leaf production and the rate at which old leaves die following grazing. Based on Bircham and Hodgson (1983)[3].

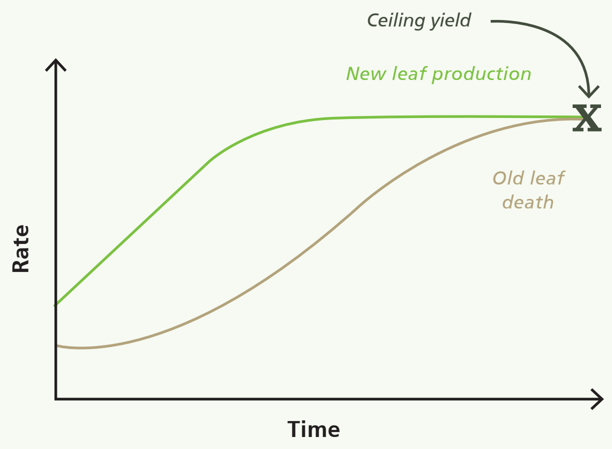
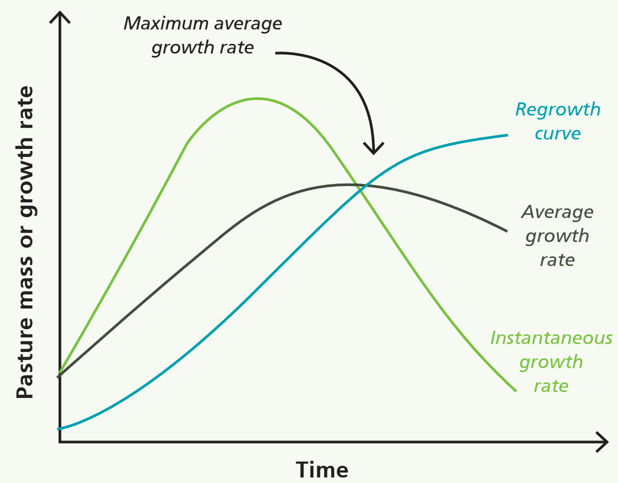


Figure 3. The regrowth curve and changes in average and instantaneous growth rates during a regrowth cycle. Based on Parsons *et al*. (1988)[4] .



Instantaneous growth rate: the daily rate of net pasture growth (leaf production – leaf death).

Average growth rate: the amount of pasture grown since last grazing divided by number of days.

Regrowth curve: the build-up of total pasture cover from the previous grazing.

Farm system considerations

On farm, implementation of the pasture growth principles is complicated by the need to balance animal requirements and feed supply throughout the year.

There are times when farmers need to bend 'the rules' of pasture growth to improve overall farm system outcomes. Consideration of such deviations allows improved decision-making.

Transfer of autumn/winter grown pasture to feed the milking herd in early spring

A common objective of grazing management during late autumn/winter is to transfer autumn/winter grown pasture into early spring, to achieve target pasture covers at calving and meet the pasture requirements of the milking herd.

This is achieved by lengthening the rotation in autumn and winter, beyond the time taken to grow three new leaves. Although this will result in some leaf death, feed can be transferred from a period of relatively low feed demand to a period of high feed demand.

Late spring – managing pasture surpluses and quality

During late spring, pasture growth rates often exceed herd demand, resulting in periods of temporary pasture surplus and, if not well managed, will result in reduced pasture quality and subsequently reduced animal performance.

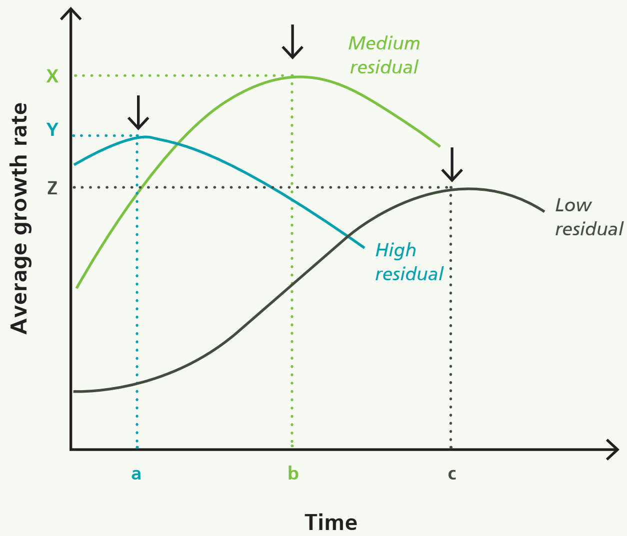
Removal of pasture surpluses (i.e. taking paddocks out of the round for silage) can reduce grazing intervals, resulting in grazing some pastures before the 2½-3 leaf stage. Where harvesting surpluses is not desirable, short grazing intervals may reduce pasture growth.

Managing pasture covers

Pre-grazing yield must be managed to optimise pasture utilisation and animal performance, while allowing target residuals to be achieved. The recommended range is 2600-3200 kg DM/ha for lactating dairy cows.

During periods of rapid growth and on nitrogen-boosted pastures, grazing may need to occur between the 2-2½ leaf stages[9] in order to meet pre-grazing cover targets.

Figure 4. Impact of post-grazing residual on average growth rate during the subsequent regrowth cycle: high: > 6.5 cm; medium: 3.5-4.5 cm; low: < 2 cm compressed height. Based on Parsons *et al.* (1988)[4].



Fast facts

- Leaving a high residual (> 5 cm) can lead to fast rotations, which means the extra growth available from the third leaf is lost.
- Ensuring post-grazing residuals are consistently managed within a tight range (3.5-4.5 cm) will enable plants to capture as much sunlight energy as possible.
- When consistent residuals are achieved, approximately 25, 35 and 40% of total final yield comes from the first, second and third leaves produced[9].

Regrowth (green leaf) after 24 hours from a low and medium residual.

Ryegrass as a feed for the dairy cow

Optimum performance in pasture-based systems requires skilled grazing management. Here, we focus on the nutrient value of high quality ryegrass-dominant pastures, and the impact of adhering to good grazing management on animal performance.

Key findings

- High quality ryegrass pastures can meet the nutritional requirements of the dairy cow.
- Ryegrass plants contain leaf, stem and dead material. The leaf is nutritious and easily digested, whereas stem can reduce intake and dead matter has few nutrients.
- To achieve high levels of pasture utilisation and animal performance, focus on leaf availability for the cow.
- Microbial by-products and the microbes themselves are digested to provide energy and nutrients for the cow.

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Dairy cows are ruminants, with four stomach compartments (rumen, reticulum, omasum and abomasum) and have evolved to thrive on forages.

The anatomical configuration of the digestive system, combined with the process of rumination (chewing the cud), makes the ruminant very efficient at extracting energy from forages. In fact, ruminants are able to retrieve more nutrients from forages than any other herbivore of a similar size.

To achieve this, ruminants have formed ‘partnerships’ with microorganisms in the rumen. The microorganisms are mainly bacteria, but also include protozoa, fungi and archaea. Together they digest the forage eaten by the cow. ▶

A cow's rumen holds about 100 kg forage and there are about 10,000,000,000 bacteria in each millilitre of rumen fluid. Microbial by-products (volatile fatty acids) and the microbes themselves are digested to provide energy and nutrients for the cow. Thus, when feeding the dairy cow, it is the rumen microorganisms that are being fed more so than the cow herself.

Chemical composition of feeds

Before considering the value of pastures as a feed for the dairy cow, it is important to understand the chemical composition of feeds.

All feeds contain water, organic matter and a little inorganic matter. Plant organic matter is primarily made up of carbohydrates (sugars, starch and fibre) and nitrogen-containing compounds (crude protein). Organic matter also contains small amounts of lipid (a molecule which stores energy and is a structural component of cell membranes) and vitamins, while inorganic nutrients are the macro and trace minerals.

Carbohydrates can be split into two groups.

1. Non-structural carbohydrates or soluble sugars and starches contained within the cells.
2. Structural carbohydrates which are made up of hemicellulose and cellulose. Together with lignin, they make up the cell wall of the plant and are often referred to as neutral detergent fibre.

Crude protein is a measure of the total amount of nitrogen in a feed and includes true protein and non-protein nitrogen compounds.

Lipids typically account for 3-5% of ryegrass dry matter (DM) and comprise mainly fatty acids and waxes.

Pasture as a feed for dairy cows

Many of the nutritional recommendations widely provided are based on data derived from cows fed a total mixed ration (TMR) but these are not always applicable to grazing dairy cows. This is because pasture and pasture-fed cows have unique characteristics, some of which are listed below.

Carbohydrates

In theory, milk production is maximised when soluble sugars and starches are 35-40% of the diet. Although spring pasture contains 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 soluble sugars and starches.

This is because the building blocks of all carbohydrates (soluble sugars and starches, and fibre) are essentially the same (a simple sugar e.g. glucose) with the only chemical difference being the type of bond that joins the sugar molecules.

Rumen microorganisms are able to break all these bonds and supplying pasture-fed cows with sugars or starch does not improve the energy generated from microbial fermentation, unless it increases the total amount of energy supplied[1].

Additionally, TMR recommendations suggest that neutral detergent fibre should make up 27-33% DM with effective fibre, the fibre most effective at stimulating rumination and salivation, making up 20% DM.

Although high quality spring pasture contains more neutral detergent fibre than required (35-45% DM), this fibre is readily digested and does not limit intake.

Furthermore, although the 'effective' fibre in pasture is estimated to be relatively low (17-20% DM) compared with a TMR, and can result in lower than recommended rumen pH, there are no adverse effects on digestion or microbial growth[2,3]. This is because a decrease in pH in pasture-fed cows is usually caused by an increase in acetic acid (such as in vinegar) and does not result in rumen upset.

In comparison, a drop in rumen pH in a TMR-fed cow is usually associated with increased lactic acid which can have detrimental effects (rumen acidosis, lameness)[2,3].

In addition, providing additional 'effective' fibre (i.e. straw) to pasture-based diets does not improve rumen function or milk production. In fact, when straw was added to a pasture-based diet (pasture + 4 kg grain) milk production and the marginal response to grain were reduced[4].

Protein

Recommended protein levels for TMR-fed cows is a diet containing about 18% crude protein, of which 65% is degradable, while 35% is not digested in the rumen.

At most times, good quality pasture contains more protein than the cow requires. Even though the protein in pasture is highly degradable (70-90%), the fast rumen passage rate means there is still sufficient protein not digested in the rumen.

When protein is degraded in the rumen, ammonia is produced and either used by the rumen microorganisms or transported in blood to the liver, where it is converted to urea. Most urea is excreted in urine, but some is recycled into the rumen and a small amount appears in the milk (milk urea).

This process is not energetically expensive to the dairy cow and high dietary intakes of crude protein are not detrimental to health or reproduction in pasture-based cows. As a result, high quality pasture meets the protein requirements of the dairy cow.

Lipids

These can provide an energy source for the cow but are not utilised by the rumen microorganisms for growth. A dairy cow has a low requirement for dietary lipid (3-6% DM). In fact, too much lipid in the diet can reduce fibre digestion and decrease milk production. Pasture provides an adequate source.

Vitamins

Supplementation of vitamins is rarely necessary on pasture-based diets, although supplementing the cow with vitamin A, D and E should be considered when more than 50% of the diet is something other than fresh pasture.

Minerals

These are essential for both the rumen microorganisms and the cow. Pasture-fed dairy cows often require magnesium prior to calving and during spring. Requirements for mineral supplements are affected by region, soil type, stage of lactation and diet. See DairyNZ Farmfacts (dairynz.co.nz/farmfacts) for specific mineral requirements.

The above highlights the high nutritional value of ryegrass as a feed for dairy cows and research has shown no production advantage in replacing it with an alternative feed source.

When energy from high-quality perennial ryegrass-dominant pastures was replaced with an equivalent amount of energy from maize grain, there was a small increase in milk protein yield, but milk fat yield decreased by almost twice the increase in milk protein. This resulted in no change to total milksolids produced and an insignificant increase in milk revenue[5].

Thus, in nearly all situations, with the exception of a drought (when protein may limit production[6]), energy intake is the first limiting component in grazing dairy systems. This was supported when milk production from cows fed a TMR was compared with cows grazing pasture.

Approximately 90% of the difference could be explained by system-related differences, such as increased feed availability, higher DM intake with greater DM feeds and reduced activity in a TMR system.

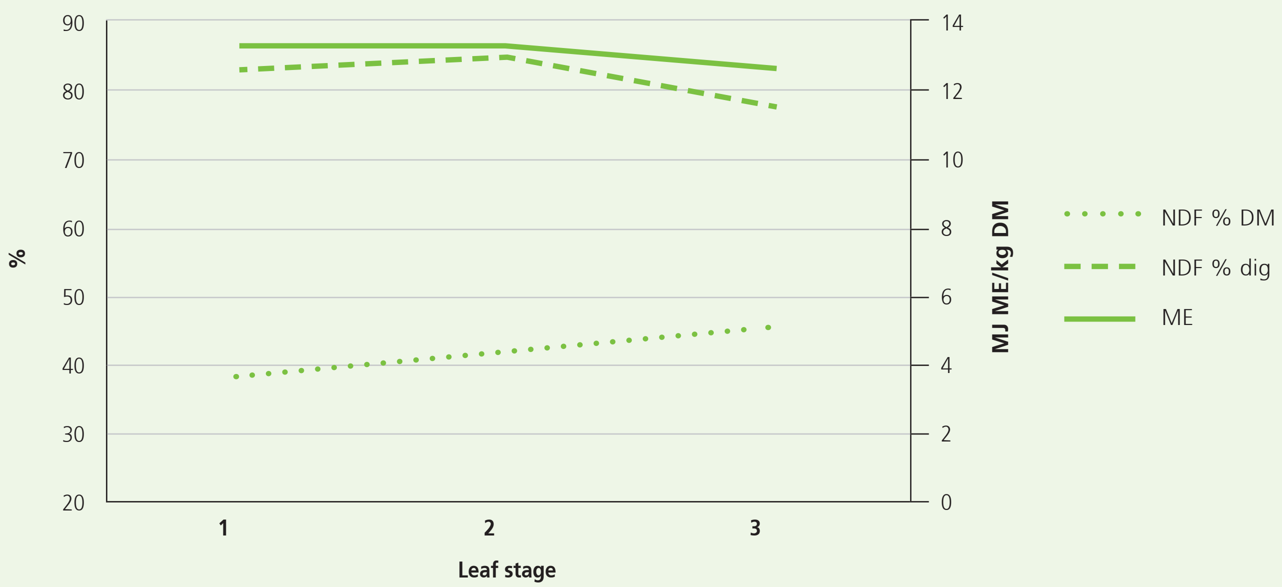
Ryegrass to milksolids

The nutritional value of ryegrass-based pastures as a feed for dairy cows has been well-established. Components of grazing management can also influence animal performance by altering the nutritional composition of pasture.

An earlier article (pg1-4) suggests that it is best management to graze ryegrass at the 2½-3 leaf stage.

Figure 1 outlines the composition of ryegrass at different leaf stages and highlights that at the 2½-3 leaf stage, this will also provide good quality (high energy) digestible pasture for the dairy cow. ▶

Figure 1. Composition of ryegrass at different leaf stages.



KEY: NDF = neutral detergent fibre; NDF-dig = digestibility of NDF; ME = metabolisable energy.

The effect of grazing management on animal behaviour and performance is well publicised. The dairy cow grazes pasture in successive layers from the top to the bottom of the sward.

Stem and dead material act as a barrier to grazing, reducing bite size, biting rate, eating time and daily intake[7].

Table 1 outlines the effect that ryegrass composition (leaf, stem and dead material) has on digestibility and energy (MJ ME/kg DM) of the pasture.

Table 1. Typical digestibility[8] and ME of plant components

Component	Green leaf	Soft stem	Hard mature stem	Dead material
Digestibility	70-85%	65-75%	40-50%	40-50%
Energy MJ ME/kg DM	10.5-12.5	10-11	6.5	6.5

Therefore, grazing at the 2½-3 leaf stage, targeting consistent grazing residuals and maximising leaf material in the grazing horizon will provide large quantities of good quality pasture for the dairy cow, delivering good performance throughout the whole season[9].

Conclusions

Good quality ryegrass-based pastures are a very well-balanced feed for dairy cows, supplying energy, protein, lipids, vitamins and minerals.

To grow and utilise as much energy as possible from pasture, grazing management should focus on leaf availability and achieving consistent grazing residuals. This will enable efficient use of this valuable feed source and maintain good pasture quality and high milksolids production throughout the season.

Fast facts

- There is a need to maximise leaf availability in the grazing horizon.
- The structural carbohydrate (fibre) in leafy pasture is highly digestible.
- Stem and dead material can act as a barrier to grazing and reduce energy intake.

An insight into operational grazing management

Grazing management involves controlling the interaction between pasture and grazing animals[1]. There is an abundance of scientific information on the pasture and cow components of dairy farm operations, yet the important role of the farmer and their decision-making process is often over-looked.

Key findings

- Effective operational grazing management is critical in optimising pasture eaten per hectare and animal performance.
- Operational grazing management comprises three main components that occur in a cyclical manner:
  - planning the grazing event (i.e. paddock recruitment)
  - using control steps to monitor, then adjust the plan if necessary (i.e. shuffling paddocks)
  - implementing and managing each individual grazing event.
- To enable effective planning and control mechanisms, targets for grazing management indicators such as pre-grazing yield and grazing residuals need to be clearly defined.

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It is important to understand this complex process and identify key decision-making criteria, as the daily grazing management processes used by farmers at the paddock level have a significant influence on farm productivity and profitability.

Operational decision-making

Management comprises three functions: planning, implementation and control which occur in a cyclical manner. Farmers typically develop a plan for a specific time period and use control decisions to manage any uncertainty while it is implemented.

For example, a farmer might develop a plan for the week ahead and monitor pre-grazing yield because of rapidly changing grass growth rates. If pre-grazing yield moves outside the target range, the farmer may consider contingency plans and select a control mechanism, such as making baleage, therefore negating the impact of the uncertainty or changing growth rates.

The planning phase can be divided into three levels: strategic (i.e. feed budgeting), tactical (i.e. weekly farm walks) and operational[3], with strategic and tactical planning receiving most research attention[5,6]. Operational plans, or daily paddock grazing plans, consider factors such as pre-grazing yields and grazing residuals, daily feed intake and soil conditions[4].

Farm case study data indicates almost half of grazing events are poorly managed, with pre-grazing yields and grazing residuals falling outside optimum ranges (see pg 13-16).

With approximately 12,000 dairy herds in New Zealand each with two grazing events each day, there is a need to understand the decision-making process better to improve grazing management and increase productivity and profitability on-farm.

To achieve this, case studies were undertaken with two New Zealand dairy farmers during autumn 2013. Each farmer was interviewed at six grazing events for insight into operational grazing management decision-making and to ascertain their decision-making pathway.

Farmers were interviewed on-farm when the cows were being moved and asked questions about their actions, targets and decision-making criteria[7].

Management practices at the farm level

For most farmers, planning at the operational level is structured, as these decisions are made every three to seven days throughout the year and, as a result, become subconscious actions.

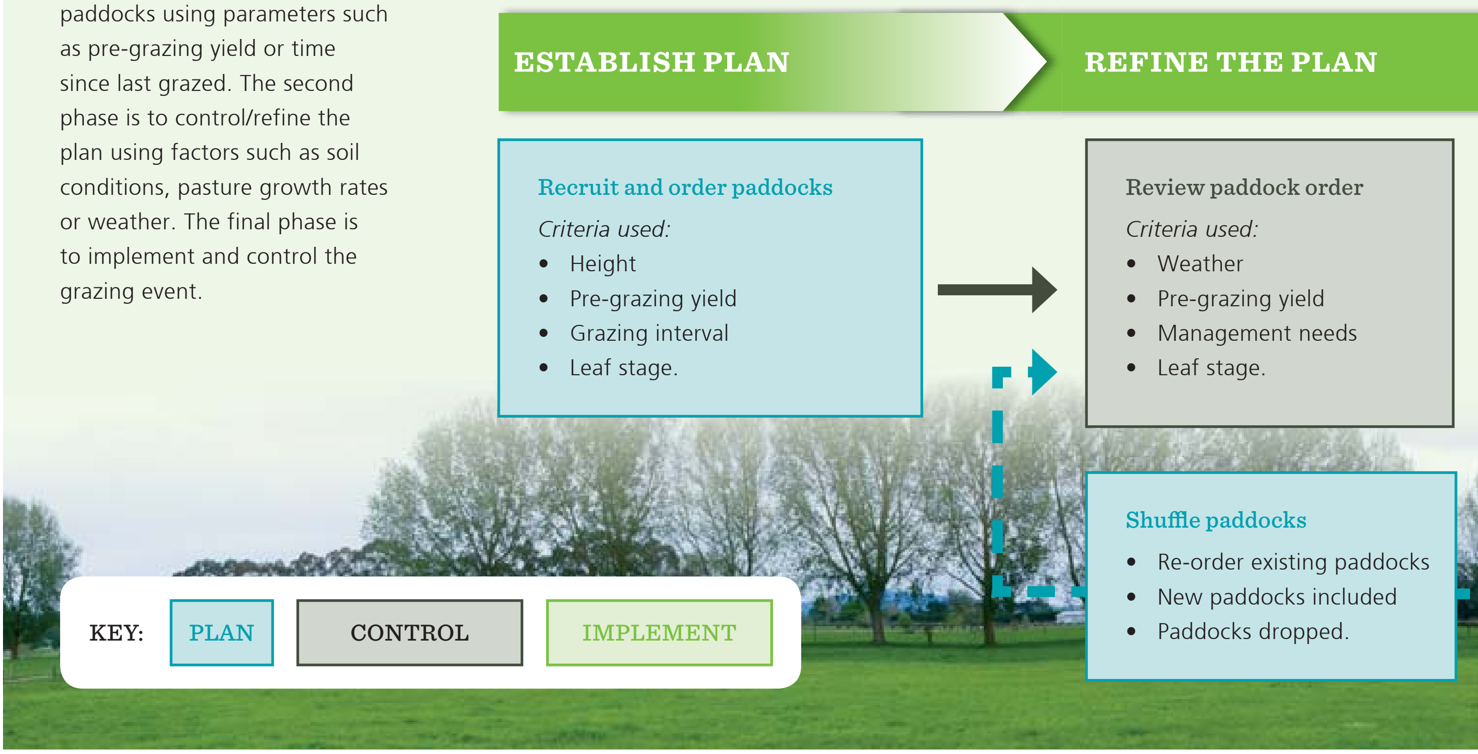
Goals for the planning period are normally pre-determined based on experience, but may change under extreme conditions (e.g. drought). Farmers determine the timeframe for the grazing plan and adjust the length over the year in response to the level of uncertainty, such as varying pasture growth rates. For example, the timeframe will be longer when growth rates are slow and shorter when growth rates are fast.

Information from the case studies indicated that Farmer A assessed his farm's pasture to identify and select paddocks with the highest yields for grazing over for the next seven days.

This is labelled the 'paddock recruitment process' because paddocks are recruited into the grazing plan for the upcoming period, in this case seven days. Once recruited, paddocks were ranked to develop the grazing sequence, with the longest grass paddocks grazed first (see figure 1).

Grazing management process

Figure 1. This outlines grazing management steps, based on the case study farmers. The initial phase is to recruit paddocks using parameters such as pre-grazing yield or time since last grazed. The second phase is to control/refine the plan using factors such as soil conditions, pasture growth rates or weather. The final phase is to implement and control the grazing event.



Other factors considered in the grazing sequence include paddock size, evenness of pre-grazing cover and paddock characteristics, such as location.

In contrast, Farmer B based his paddock recruitment process on the grazing interval. The paddocks grazed first had not been grazed for the longest period of time and pre-grazing cover had less influence on the selection decisions made.

Another step in the management process was the specification of standards or targets for control purposes, which developed with experience.

These included indicators that the grazing sequence should be changed or new paddocks brought in, i.e. shuffling of paddocks; the pasture allocated or amount of supplements for a grazing should be changed; grazing duration should change; or if action should be taken with the paddock after grazing.

Control of grazing events

The control of individual grazing events occurred before, during and after grazing. On the day of grazing, both farmers assessed the paddock's pre-grazing yield and, based on this, could change the grazing area or amount of supplement to ensure target post-grazing residuals were met.

This is a form of preventative control because they minimised the problem's impact before it occured[8]. Once the herd was grazing a paddock, both farmers monitored cow behaviour and developing grazing residual.

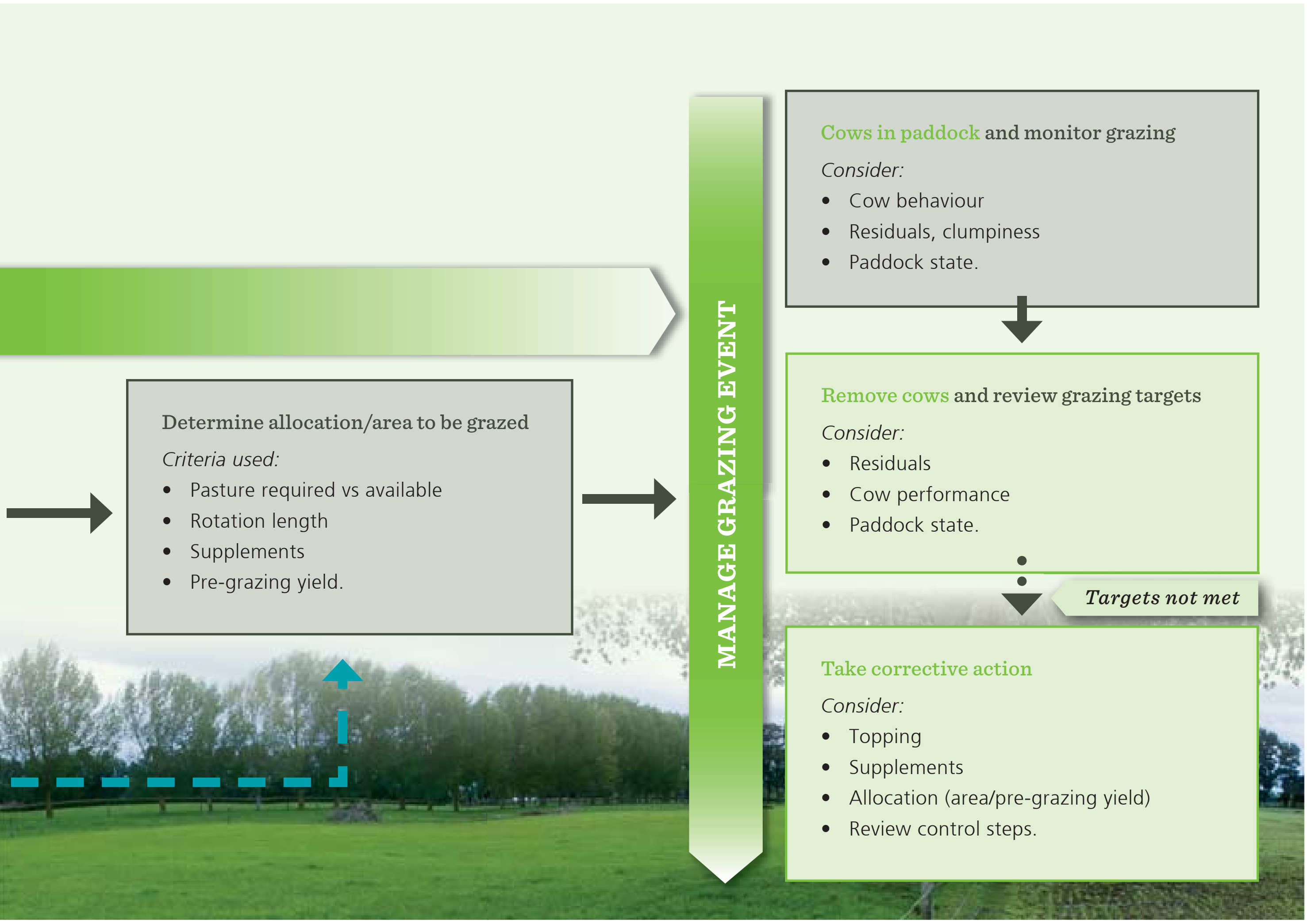
This is a form of concurrent control where the paddock is monitored in real time and contingency plans implemented if there is a significant deviation from target[8].

Once the herd was removed from the paddock, post-grazing residuals and clumpiness were assessed again.

This is a form of historical control where the deviation from the planned targets is corrected by implementing actions such as topping or during the next cycle of decision-making[8].

Although some specific details of the grazing events varied between the two case study farmers, some key themes were identified.

In both cases, the operational management consisted of making grazing plans and refining and implementing those plans using control steps, not only after the planned grazing events but also prior to and during their implementation.



Recruitment of paddocks into a grazing plan

The first step is a planning horizon of up to seven days, when a group of paddocks are selected to be grazed during that period. The decision to recruit the paddock for grazing is generally based on the length of time since it was last grazed (grazing interval) and/or the quantity of pasture in the paddock (pre-grazing yield or height).

'Shuffling' paddocks within the grazing plan

Soon after paddock recruitment and up until the grazing event, the paddocks may be rearranged to include additional paddocks not previously chosen or, more usually, to rearrange the order to be grazed.

This shuffling is largely determined by pasture growth rates, prevailing and expected rainfall and temperature, and paddock characteristics including size and location.

Management of individual grazing events

The last step is split into three time parts: immediately prior to grazing (just before cows enter the paddock), during the grazing event and after grazing.

Despite the complexity of operational grazing management, these case studies identified themes that ultimately render the management practice adaptable by farmers. The case studies highlighted two important concepts for successful grazing management.

1. A need for clearly defined targets for grazing management indicators, such as pre-grazing yield and grazing residuals.
2. Reflection on the existing grazing management process to identify if any additional planning and/or control steps need to be implemented.

Fast facts

- The planning phase can be divided into three levels: strategic (i.e. feed budgeting), tactical (i.e. weekly farm walks) and operational[3].
- Successful implementation of a grazing plan requires effective control decisions to manage uncertainty.

Grazing management – striking the right balance

The relationship between farm profitability and pasture consumption per hectare is well recognised for New Zealand pasture-based systems. International comparisons of total cost of production also indicate that as the proportion of pasture increases in the diet, the total cost of production decreases[1].

Key findings

- Profitable pasture-based dairy systems achieve high pasture dry matter (DM) eaten and high animal performance per hectare.
  - Key indicators of pasture growth, utilisation and cow performance per hectare are pre-grazing yields, leaf stage and post-grazing residuals.
- To optimise pasture eaten per hectare:
  - target pre-grazing leaf stage of 2½-3 or pre-grazing yields of 2600-3200 kg DM/ha.
  - target post-grazing residuals of 3.5 cm in spring/early summer, 3.5-4.0 cm in mid-season and 3.5 cm in late autumn/winter (compressed height).
- Case study data indicates that targets are not met for about 50% of grazing events.
- Implementing simple, consistent and reliable grazing management practices will help achieve these targets.

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Previous articles in this issue have highlighted the impact of leaf stage, pre-grazing yield and grazing residuals on perennial ryegrass growth, cow intake and performance, and the decision-making process for managing grazing. This article focuses on integrating these to maximise overall farm performance.

Success in a pasture-based system relies on growing as much pasture as possible, then ensuring cows utilise the majority of that pasture (high % pasture utilisation) to produce as much milk as possible.

Therefore, assuming pastures are managed to maximise growth (see pg 1-4), an optimum balance between pasture utilisation and individual animal performance must be determined.

Figure 1. Relationship between pasture allowance (> 3 cm), pasture dry matter intake (DMI) per cow and pasture utilisation adapted from Baudracco et al., (2010)[2]. As pasture allowance increases, the marginal increase in DMI decreases, therefore pasture utilisation is reduced.

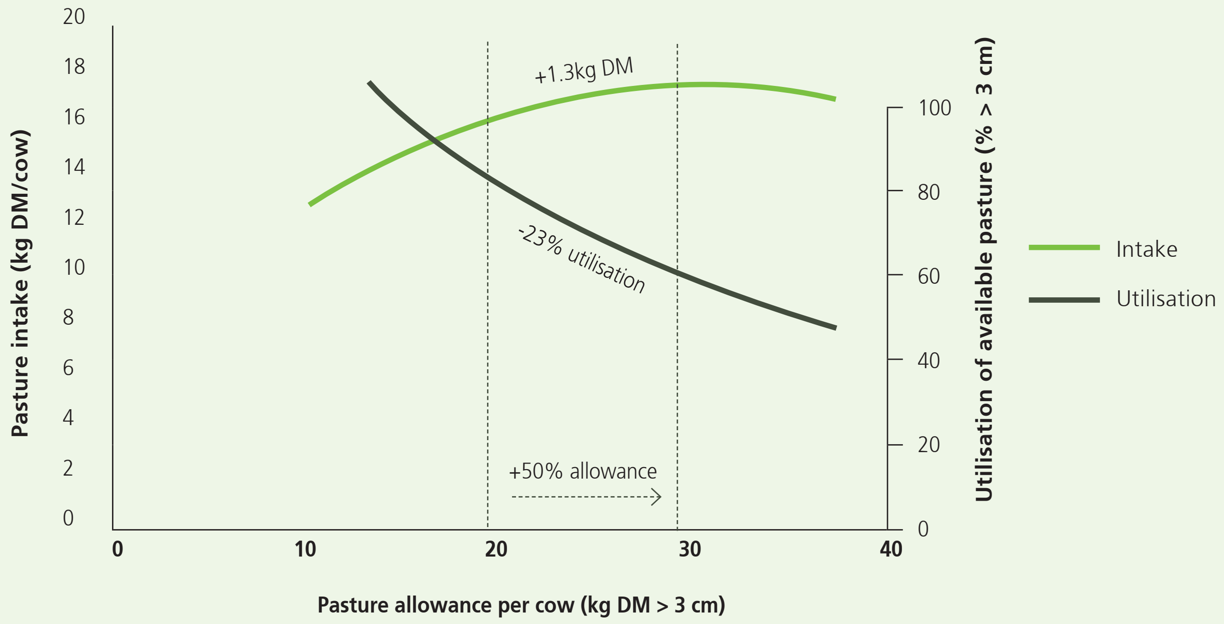


Figure 1 highlights the relationships between pasture allowance, pasture utilisation and intake per cow. For example, increasing pasture allowance from 20 to 30 kg DM (50%) is predicted to increase intake per cow by 1.3 kg DM but reduce utilisation by 23%.

This indicates that a compromise between pasture utilisation and individual cow dry matter intake (DMI) must be achieved.

The response to increasing pasture allowance is quite low at higher levels.

Other research reports that pasture intake increases by 0.45, 0.23 and 0.12 kg DM per kg DM allowance within the ranges of 10-15, 15-20 and 20-25 kg DM (respectively) above a 5 cm residual[3]. In other words, the marginal increase in DMI reduces as allowance increases.

Poor pasture utilisation (% utilised above 3.5 cm) which results in high post-grazing residuals will suppress pasture growth rates in the subsequent regrowth cycle (see pg 1-4). It will also reduce pasture digestibility at the next grazing (see pg 5-8), negatively impacting on animal performance.

To achieve high levels of utilisation and high energy intakes throughout the season, cows should be offered moderate allowances of high quality pasture.

Increasing stocking rate by one cow/ha has been reported to result in an 8% decrease in milk yield per cow but a 20% increase in milk output per hectare[4], again suggesting a trade-off on animal performance to achieve higher performance per hectare is required: lower DMI per cow but increased pasture utilisation per ha.

Peyraud and Delagarde[5] proposed that feeding grazing cows to 90% of their potential intake, i.e. well fed, achieves a good balance between performance per cow and per ha.

Grazing residuals

Grazing residuals are a key indicator of pasture utilisation following grazing. In late spring, perennial ryegrass tillers move from vegetative to reproductive growth, resulting in some important changes in pastures.

Reproductive development leads to stem elongation and increasing proportions of stem in the grazing horizon, the portion of the sward to be eaten, which may lead to slight increases in post-grazing residual height. Consequently, grazing residuals will increase slightly in summer and cows would have to be forced to eat low quality stem and dead leaf to negate this.

Achieving target grazing residuals in spring will subsequently reduce the ratio of reproductive to vegetative tillers, thereby minimising this increase in grazing residuals. Winter offers an opportunity to reset the residuals' level for the coming season and ensure leaf growth is promoted in the base of the sward.

Therefore, there is little room for deviation through the critical spring period, from a target residual of 3.5 cm with a slight increase in summer to 4.0 cm (8 clicks) and 3.5 cm again in late autumn/winter.

Figure 2 portrays the ideal range for grazing residuals throughout the season.

Although pasture is valuable and nutritious, supplementary feeds are often added to the system. Generally, supplements will increase total DMI, however when supplement is fed, some pasture will be left in the paddock.

This is known as substitution and is characterised by a decrease in grazing time of approximately 12 minutes/kg DM supplement and, consequently, a decrease in pasture utilisation[6]. Substitution can be negative (pasture wasted) or positive (pasture spared). The primary driver for substitution is cow hunger, most often reflected in how much pasture remains uneaten (post-grazing residual) when the cows leave the paddock.

Post-grazing residuals are the primary driver of milksolids response – as residuals increase, the milksolids response to supplements decreases[7].

Figure 3 outlines the potential impact of supplement feeding on grazing residuals after consecutive grazing events (rotations) in a paddock where residuals are not well-managed (see pg 9-12). Figure 3 also illustrates how this increase is small at each event but cumulative over consecutive grazing events with the grazing horizon rising and preventing the cow from achieving the target residual over time (see pg 5-8).

Therefore, monitoring grazing residuals and good operational decision-making is essential to ensure high milksolids response to supplements and high levels of subsequent pasture growth and quality.

Current on-farm scenario

Data from seven case study farms between August 2012 and May 2013 highlights a large range in the key indicators of grazing management, suggesting significant potential to increase on-farm productivity (figure 4).

Overall, 49% of measured paddocks were grazed before the two leaf stage, 62% were grazed outside the recommended pre-grazing yield and 48% of measured paddocks were grazed to < 3.5 cm or > 4.5 cm (< 7 or > 9 clicks).

Failure to meet grazing residual targets may be a consequence of poorly managed pre-grazing yields; poor allocation of feed; impact of paddock size and topography on pasture allocation; inability to determine the residual height correctly or failure to recognise the importance of grazing management decisions.

Figure 2. Schematic representation of target post-grazing residual height (cm; compressed height) throughout the season (cm x 2 = clicks).

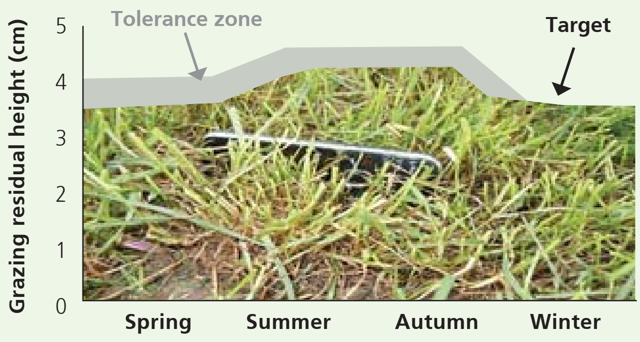


Figure 3. Potential impact of supplement feeding on grazing residuals in spring after consecutive grazing events (rotations) with poor decision-making (adapted from Stockdale 2000[8]).

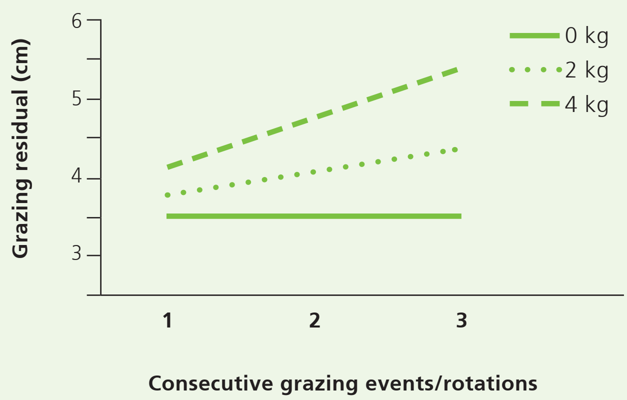
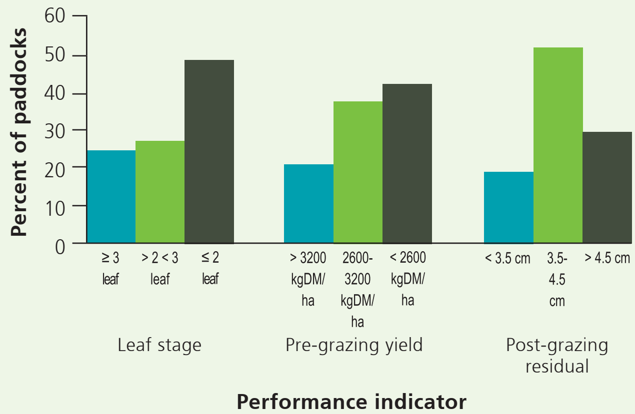


Figure 4. Proportion of paddocks with leaf stage, pre-grazing yield and post-grazing height, within different ranges, on seven case study farms between August 2012 and May 2013.



Achieving the targets

Managing leaf stage and pre-grazing yields requires increased focus at a tactical and operational level. An effective grazing management process (pg 9-12) will enable the correct decisions to be made to ensure targets are achieved.

This will enable the correct rotation length to be set, based on the assessment of leaf stage, and ensure the paddocks grazed are within the desired pre-grazing yield range.

Figure 5 highlights the importance of managing pre-grazing yield to achieve grazing residual targets and high DMI. To achieve 16-18 kg DMI while reaching 3.5 cm grazing residual, pre-grazing yield must be managed at between 2800-3200 kg DM/ha, with higher intakes necessitating lower pre-grazing yields for a similar target residual. This relates to the impact of sward canopy structure on intake dynamics (see pg 8). Achieving similar DMI with excessive pre-grazing yields requires high grazing residuals with a negative impact on subsequent pasture growth (pg 1-4) and quality. Pursuing higher DMI will need to be balanced with achieving the target leaf stage to maximise pasture growth (pg 1-4) and with optimising pasture utilisation (figure 1).

Where lower DMI is sufficient (14 kg DMI), such as in late lactation, pre-grazing yields up to 3800 kg DM/ha may be grazed to 3.5cm.

This requires good decision-making, aided by weekly farm walks, skipping paddocks when required and attention to post-grazing residuals.

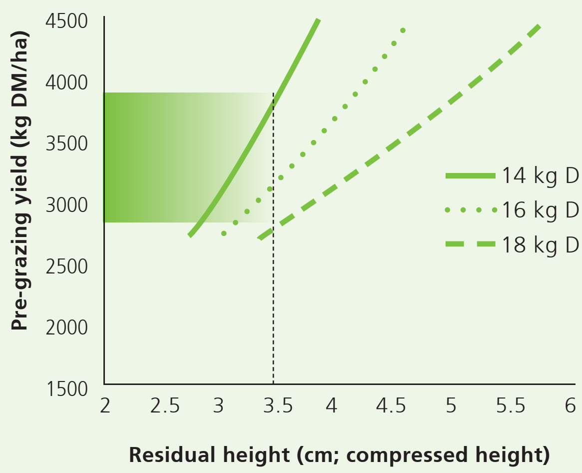
Managing by leaf stage also requires consideration of the relationship outlined in Figure 5. For instance, nitrogen fertiliser-boosted pasture will have high yields at lower leaf stages, requiring grazing before the 2½ leaf stage. It is also important to consider the farm's feed demand compared with the amount of pasture grown, with a more advanced leaf stage (longer grazing interval) more favourable for higher stocked farms. Approximate regional leaf appearance rates have been outlined previously[10].

To achieve even and consistent residuals across the whole paddock at every single grazing is challenging. It requires increased focus at the operational level (see pg 9-12) to capture opportunities before, during and after each grazing event. Changes to pre-grazing yield and adverse weather events add to this challenge.

During prolonged periods of high rainfall, target grazing residuals may not be attainable with longer patches or clumps of grass left behind, reducing subsequent growth (see pg 1-4). Hence, if target grazing residuals are not met and pastures become 'patchy', it makes good sense to correct these.

Measures such as grazing at a lower pre-grazing yield in the next rotation, removing the paddock for silage, grazing with dry cows or topping can be used.

Figure 5: Simulated effect of pre-grazing yield and grazing residual height on DMI, based on INRA (French National Institute for Agricultural Research) equation 2010[9].



Conclusion

A balance between pasture growth, utilisation and animal performance must be achieved over the season. Key indicators include reaching target residuals, leaf stage and pre-grazing yield.

Effective decision-making is essential and where targets are not met, actions are needed to mitigate any negative impacts. If targets are continually missed, a review of the grazing management process is required.

Fast facts

- The marginal increase in dry matter intake reduces as pasture allowance increases.
- To achieve 16-18 kg DMI while reaching 3.5 cm grazing residual, pre-grazing yield must be managed at between 2800-3200 kg DM/ha
- Increasing stocking rate by one cow/ha has been reported to result in an 8% decrease in daily milk yield per cow but a 20% increase in milk output per hectare[4].

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Science *snapshots*

DairyNZ levy funded or supported science

Nutrient deficiencies in transition cows

(Roche, J.[1])

- The 6-8 week transition period between late pregnancy and early lactation results in a several-fold increase in the cow's requirement for energy, protein and minerals.
- Achieving target body condition score (BCS) at calving is important to maximise the production, health and reproduction outcomes after calving.
- Having achieved BCS targets, there is increasing evidence that feeding cows 20% less energy than they require to maintain body condition during the two weeks before calving improves post-calving energy balance and lowers the risk of metabolic disease.
- Protein deficiencies postpartum are unlikely where 50% or more of the dry cow diet is from high protein forages, such as pasture and kale.
- 'Downer cow' as a result of dietary phosphorus deficiency is being increasingly reported, particularly in cows fed fodder beet. Supplementing cows with phosphorus (~20-30g/cow per day) during the dry period appears to overcome this.

Grazing behaviour changes when cows graze chicory and plantain *(Gregorini et al[2])*

- Cows consumed a perennial ryegrass-dominant sward (PRDS) or a PRDS including 20, 40 or 60% of the diet as chicory or plantain.
- When grazing chicory and plantain, cows took fewer but larger bites ('big bites') and spent more time chewing each bite than when cows consumed PRDS.
- Rumination time was reduced by up to 90 minutes and ruminative chewing by 20% when cows consumed chicory and plantain as 60% of their diet.
- Decreased rumination time and chews during rumination indicate faster breakdown of forage particles, thus faster rumen fermentation and turnover. However, intake was not affected. Cows fed chicory and plantain spent more time idling, likely due to cows reaching satiation.
- With similar chemical composition, chicory presented greater constraints to ingestion than plantain. Therefore, although chicory has been considered to have a greater nutritive value than plantain, its overall feeding value may be no greater than plantain.

Inter-annual variability in pasture accumulation

(Chapman et al.[3])

- Year-to-year variation in pasture accumulation rate is common in temperate regions, resulting in imbalances between feed demand and supply for grazing animals.
- Computer models that can prospectively and reliably simulate pasture growth for a month or more using long-term weather forecasting could greatly improve operational and tactical management decisions.
- Current models have reasonable predictive ability but more development is needed to prove their effectiveness and build in capability to use real-time farm data, such as pasture mass and soil water content.
- This technology may provide opportunities for pasture-based farmers to gain greater control over variability in feed supply and improve the efficiency of resource use, such as water for irrigation.