Working with dairy farmers to improve their pasture management skills through better understanding the principles of ryegrass growth

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Highlights

The relationships between leaf regrowth stage, pre- and post-grazing pasture covers, and grazing rotation length are complex. Despite the existence of well-documented grazing guidelines for managing these relationships, implementation on-farm is highly variable indicating that skill levels are often inadequate and/or farmers are not convinced of the benefits. Twenty dairy farm managers and assistant managers from the Hopkins Farming Group in the lower North Island engaged in structured observation and discussion with experts to test the potential of the 3-leaf grazing technique for increasing pasture production and reducing imported supplement use from mid-spring to mid-autumn. The farmer members of the study group initially had little knowledge of the principles of ryegrass growth at the plant level, and how their management influences pasture production and persistence. Grazing management skills developed by group members during the process included: identification of pasture species within the sward, including perennial ryegrass; identification of leaf morphology, tillers, tiller buds and daughter tillers; pasture health checks to understand when new tillers appeared and their grazing and nutrient needs; and the importance of grazing residuals for future pasture quality. Pasture productivity, as measured by the amount of silage conserved, increased by approximately 0.45 t DM/ha during the 6 months of study through the application of this grazing management technique. Managing grazing using the 3-leaf technique requires a greater depth of knowledge than previous, simple, rotation length-based systems. Many farmers are concerned about the lack of persistence of new ryegrass cultivars, whereas it may be their management practices that have a greater influence.

Keywords: case study approach, co-learning, daughter tillers, leaf emergence interval, leaf regrowth stage

Background

One of New Zealand's noted agricultural advantages is the relative ease of both growing and utilising our temperate pastures. Pasture and crop harvested per hectare is one of the main drivers of profitability of grazing dairy systems (Dillon et al. 2005; Ramsbottom et al. 2015; Beca 2020). In New Zealand, DairyBase (https://www.dairynz.co.nz/business/dairybase/benchmarking/) data clearly show that the amount of pasture and crop grown and harvested per hectare is one of the main drivers of profitability; hence, any management programme that enhances pasture grown, and thus the potential to harvest more, will enhance profitability.

Grazing management on dairy farms has been researched and debated for decades. There is a wealth of fundamental and applied research that outlines the morphology and growth of a ryegrass plant, the interaction with the grazing animal and the responses of the pasture to grazing over time (Macdonald & Penno 1998; Fulkerson & Donaghy 2001; Chapman 2016). This information has been translated into appropriate and readily available formats for farmers. This includes the DairyNZ website (https://www.dairynz.co.nz/feed/) and publications (DairyNZ 2014; McCarthy et al. 2015), South Island Dairy Event publications (Chapman et al. 2014; Donaghy & Clarke 2016), and at many other dairy events.

However, the translation of this knowledge into effective on-farm practice continues to be a challenge. For example, McCarthy et al. (2014) found that, relative to targets embedded in best practice grazing management recommendations, 49% of ~ 380 grazing events on seven lower North Island dairy farms between August and May occurred too early in the regrowth cycle according to the leaf stage indicator. In addition, 62% and 48% of events missed the recommended pre- and post-graze pasture mass grazing targets, respectively. One factor that could be contributing to these results is a lack of understanding among farmers of the principles of ryegrass growth at the plant level, the impact of this on pasture, and the influence of their management on pasture production and persistence.

In this study, experts engaged with dairy farm managers from a large dairy/livestock business using the 3-leaf grazing technique as an example of a grazing management practice that focusses on maximising pasture growth and maintaining pasture persistence.

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The objective was to apply the 3-leaf grazing technique throughout spring, the main growing season, to explore farmer understanding of the principles that underlie the technique, the practicalities of implementing it, and farmer perceptions of the results.

On-farm case study

The approach used was a combination of many years of farm consulting experience working with a range of dairy farmers, and hands-on field work plus on-farm demonstration areas. The objective was to understand the level of farmer knowledge of dairy pasture systems overall and to test the efficacy of the current practice of morphological assessment of the grass for grazing management. This type of on-farm extension has proven effective for New Zealand farming systems in previous work (McIvor & Aspin 2001; Cocks et al. 2002; Lissaman et al. 2013).

We worked with the Hopkins Farming Group (HFG) to explore the pasture management undertaken by their farm managers, with the aim of improving pasture management through engaging in a series of on-farm measurements in the spring-summer of 2015/2016. The HFG is a Manawatu-based company with interests in both farming and agricultural machinery and owns ten dairy farms along with four dry-stock farms, covering a total area of around 4200 ha. The individual farms are run by farm managers under a farm overseer, with the lead author employed as a consultant to review all the farms.

The objective for the HFG is to grow, consume and conserve as much high-quality pasture as possible on all their farms, while reducing the reliance on purchased supplement. The farms used maize silage and palm kernel expeller (PKE) to fill feed deficits in dry summer/autumn and cold winter periods. Although as a group the HFG had a single objective, the attendees (approximately 20) had a range of experience and understanding of grazing management principles, similar to the wider dairy farming community.

Fortnightly meetings between the two senior authors and HFG farm managers, assistant farm managers and any other key staff were held over the spring-summer of 2015/2016. The aim was to focus on understanding the key principles of grazing management, and to ensure that all the staff were able to identify and incorporate the plant-related indicators (e.g., leaf regrowth stage, tillering) into their management.

The successive visits allowed the group to evaluate the effect of any management decisions made based on these principles. Much of the activity of the group took place on-farm and in the paddock, looking closely at these plants that drive our grazing systems.

Farmers were encouraged to trial different management practices within 'paired paddocks' or 'part paddocks'. For example, the impact of leaving a longer residual (around 2100 kg dry matter (DM)/ha) was demonstrated by leaving an approximately 10-m-wide strip of longer pasture along the front of a paddock, and the remainder of the paddock topped to around 1600 kg DM/ha. The group was then able to return to this area twice in the following 3 months to observe aerial tillering and then tiller death and a stalkier and less-dense pasture compared with the remainder of the paddock.

Case-study outcomes

All of the HFG staff said that they had heard about grazing ryegrass at the '3-leaf stage' but they questioned whether the information being presented was correct, or practical, or would translate into their systems. The first meeting with the HFG farm managers identified gaps in their knowledge with respect to their own pastures. Therefore, significant time was spent upskilling the group about the ryegrass plant. This developed into the steps and outcomes described below.

The first step was the identification of ryegrass in the pasture. Most did not know the composition of their pastures, assuming that they were still comprised of the species sown in previous years, therefore what was actually in the pastures was often unknown. The first outcome was the farm managers acknowledging that they could not readily identify ryegrass and that many of their 'ryegrass' pastures were in fact dominated by other grass species. It is common for pastures sown with ryegrass to deteriorate over time, with ryegrass disappearing and being replaced with other less-productive grasses and weeds. Because this often happens slowly over time, farmers do not always recognise the deterioration until the pasture is obviously no longer performing. Consequently, farmers frequently comment that ryegrass is not lasting, replaced with other grasses, weeds, and bare areas. They regularly perceive that newer ryegrass varieties are not as persistent as older ones.

The second step was the identification of ryegrass tillers, daughter tillers and tiller buds in the field. For the farmers, realising that tillers survive for no more than a year (Jewiss 1966), with two main periods of tillering, in autumn and spring, was an important point. This enabled a discussion of the impact of the farm managers' grazing management, through ryegrass morphology, on pasture productivity. Consequently, the second outcome was a recognition by the farmers that their pastures were a population of 'tillers' aged less than 1 year, even if that paddock had been sown 8-10 years previously. Perennial pastures were therefore considered a 'repeating annual crop' and there was discussion regarding the impact of current management on the future performance of those pastures. As the tillering periods in autumn and spring are critical for increasing or decreasing pasture density, the impact of cows grazing at this time is a key factor.

The third step was the introduction of a pasture 'health check' that the managers could undertake. This was where mature 'parent' tillers could be assessed in these key tillering periods of spring or autumn, for the presence of emerging 'daughter' tillers, or, at least healthy tiller buds at their base (defined as tiller buds that were yellowy green or white and did not break off when gently rubbed). It was made clear that each time a leaf was produced, a tiller bud was also produced, but that tillering was dependent on environmental conditions being optimal (Jewiss 1966), so tiller buds can accumulate at the base of the parent tiller.

However, if the parent tiller is stressed, then these young tiller buds would be aborted. In spring, with adequate water, sunshine and nutrients (the paddocks used by HFG were confirmed to be within agronomic optima for soil fertility), the only remaining major factor preventing tillering would be whether the parent tillers had adequate reserves of energy (water-soluble carbohydrates). This is a direct reflection of grazing management, especially grazing rotation (Fulkerson & Donaghy 2001). The third outcome, therefore, was that the farm managers could identify the impact on their plants of overgrazing at the paddock scale.

The fourth step was identification of ryegrass leaf regrowth stage, and how this can be used as a generic tool in the field to identify an optimum window for grazing rotation (being between the 2- and 3-leaf stages; Fulkerson & Donaghy 2001). This was the principle of 'use it or lose it', i.e., that ryegrass only maintains three live leaves and this '3-leaf stage' signals the onset of significant leaf senescence.

There is a process to determining leaf regrowth stage in the field which can become straightforward with experience. There are several issues that in practice farmers find confusing, including whether to count the remnant leaf, and how to deal with reproductive tillers, which can maintain between 0 and 5 or 6 live leaves. The fourth outcome was that the farm managers became proficient at quickly estimating the leaf stage of their pastures.

The fifth and final step was a discussion of post-grazing residuals and the importance of target post-grazing residuals to maintaining high-quality pasture in the subsequent grazing rotations and maintaining future growth rates and pasture density (Lee et al. 2008). The impact of canopy closure, through a combination of high post-grazing residuals and high pre-grazing pasture yields, on reducing pasture quality and density (Roche et al. 2017), was also discussed. Shaded areas within paddocks, e.g., long grass around dung patches, were used to show the impact of shading at the tiller level. It was clarified for the farm managers that the aerial tillers subsequently produced were normally not viable as their roots were burned by the sunlight before they could reach the ground and establish (McKenzie 1998). The final outcome was that the managers had a good understanding of the importance of maintaining consistent post-grazing residuals targeting 1500-1700 kg DM/ha.

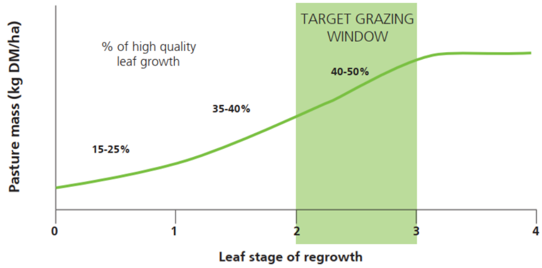

Figure 1 The regrowth of a pasture follows a sigmoid or S-shaped pattern, starting slowly and then increasing over time before slowing down again when a canopy is formed. The 'target grazing window' is between the 2-leaf and 3-leaf stages (Source: McCarthy et al. 2015, page 7).

Discussion and practical implications

The estimation of leaf regrowth stage was a critical part of the exercise. The central thesis was that through targeting a rotation close to the 3-leaf stage throughout spring, the main growing season, the pastures would be growing quickly, while quality would be retained.

It was discussed with the farm managers how quickly pastures on a longer rotation can 'get out of control' and lose quality through shading and seed head development; this is why most farmers, in peak spring growth, would be on a rotation closer to the 2-leaf stage or even shorter. Grazing the plant closer to 3 leaves per tiller, compared to earlier in regrowth, increases the pasture DM produced through grazing pasture at a time of potentially faster growth, i.e., towards the top of the sigmoid regrowth curve (Figure 1). The approach discussed was to align their grazing rotation as close to the 3-leaf stage as possible, deliberately creating a surplus of pasture and being prepared to be aggressive with making silage (e.g., early identification of surplus and then timely silage-making to avoid a decline in quality and a reduction in future pasture density through shading). It was also to maintain a post-grazing residual of 1500-1700 kg DM/ha and limit increases above this.

During the regular farm visits through early spring to early summer, the leaf emergence interval was assessed to help plan rotation lengths. Leaf emergence was established both from examining the leaf regrowth stage of paddocks about to be grazed (i.e., "what leaf stage are you grazing at?"), and by examining the leaf regrowth of paddocks 13 days after grazing (i.e., "what is the current leaf regrowth stage?").

In this way, leaf stage was used in two ways by the group; in the reactive sense, i.e., confirming (or not) that the management to date had resulted in paddocks being grazed 'in the zone' to maintain optimal production and quality, and in the proactive sense, i.e., whether it was necessary to make adjustments in the coming weeks so that paddocks continue to be grazed in that same zone.

During the farm visits, a single leaf emergence was frequently around 11 or 12 days per leaf and down to 9 days for very short periods. It was observed that the second grazing round, in September, was at best around the 2-leaf stage and frequently less than the 2-leaf stage, similar to results found in an on-farm study by McCarthy et al. (2014). In an average spring, experience has found that with leaf regrowth, the rotation lengths on many farms are around the 2-leaf to 2.5-leaf stage (20 to 25 days) for a short period of time and then move closer to the 2-leaf stage or less, especially going into early summer. These shorter rotations would be expected to result in a smaller root system and fewer tillers, and less overall yield, compared with a rotation around the 2.5- to 3-leaf stage (Donaghy & Fulkerson 1998).

The assumed leaf emergence in Manawatu is around 9 days per leaf in spring. While this was true in the monitoring period reported here during peak growth for a few weeks, many farmers assume that this leaf appearance holds throughout the spring and early summer, and never take the time to do their own monitoring. Observations with the HFG, and other clients throughout Manawatu, suggest that many ryegrass-based pastures are being grazed at fewer leaves/tiller than farmers assume.

From the perspective of tiller survival and root growth, which are both critical processes that govern plant survival and pasture persistence, there is no issue with grazing at the 2-leaf stage as this is regarded as the minimal rotation interval for ryegrass (Fulkerson & Donaghy 2001). However, as mentioned previously, yield would be expected to be lower than grazing on a longer rotation such as at the 2.5- or 3-leaf stage. Grazing repeatedly before the 2-leaf stage would be expected to reduce plant performance and survival (Fulkerson & Slack 1994, 1995).

In support of this, anecdotal feedback from farmers on rotation lengths of less than 20 days for a significant period over the spring and early summer, is that their pastures were not persisting and had 'thinned' out after 3 or 4 years. The implications of this decline in productivity and persistence are significant, with greater costs in re-grassing, and more supplement purchased.

The observation, once the HFG managers began to implement longer rotations while maintaining post-grazing residuals, all the while monitoring tillering, was that it was initially lots more work! This higher workload was due to the hands-on monitoring of pastures in the rotation to assess leaf stage. This is at a time of significant workload on farms (just finished calving, coming into mating, dealing with peak pasture growth rates). For the same reason, there was initially some reluctance to set up demonstration areas to visit at future meetings. After about the third visit (1.5 months into the meetings), the group was starting to realise the value of the demonstration areas.

Once the farm managers implemented a grazing rotation targeting the 2.5- to 3-leaf stage, which was on average 6 days longer than their previous rotation, they made a number of observations. One observation was that they needed to be more proactive with monitoring and decision making as the pace or speed of change was significantly faster. Simple calculations indicated 10% to 15% more grass was grown when the grazing rotation was extended to be continually closer to the 2.5- to 3-leaf stage. These higher pasture growth rates, with no change in stock numbers, resulted in ~150 t DM more pasture silage harvested as supplementary feed on the 330 ha case study farm, compared with the average amount of silage harvested in the previous 2 years. This extra pasture silage helped reduce the quantity of supplement (maize silage and PKE) used/purchased and demonstrated the growth potential of the longer rotation.

The HFG farm managers also observed that there were more daughter tillers associated with the longer rotations than in paired (demonstration) areas on shorter rotations (data not collected). This was reflected in comments about the pastures being stronger and more vigorous in a subsequent dry summer. Several of the case study farmers commented that they believed the newer ryegrass varieties were not as persistent as older ones. However, it is not clear how much of their concern regarding poor persistence may relate to issues inherent in newer cultivars, and how much may relate to their on-farm pasture management. In the current case study, more tillering was observed under a longer spring rotation, suggesting that pasture persistence may be improved by this technique.

Conclusions

Work with the HFG, and other farmers in the Manawatu region, highlighted that there was significant loss of potential pasture production, with an associated impact on persistence when not grazing pastures in the optimal range. Optimising pasture management by targeting a rotation length of ≥2.5-leaf stage, allowed the farm managers greater flexibility to manage pasture availability.

This case study with both the HFG farm managers and other farmers, highlights the value of monitoring leaf stage and understanding the full implications of the consequent management decisions on pasture productivity and persistence. Farmers in the case study realised that they could exercise some control over the persistence of their pastures through modifying their grazing management practices whereas before this they were often more likely to assume it was a 'new cultivar' issue.

Compared with infrastructure and farm inputs, management practices can be faster and less costly to change. However, they require a greater depth of knowledge and understanding of the interactions between pasture management principles, climate/season and farm system. The benefits of improving pasture management in dairy systems would be significant. This case study showed the benefits of a co-learning approach when working with farmers and the need for further education within the pastoral industries and stronger connections between theory and practice.

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