Graze less, grow more? Leaf stage defoliation management of diverse and ryegrass-based pastures in Golden Bay, New Zealand

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Abstract

With climate change, and rising fertiliser costs, low-cost pasture growth strategies are needed for New Zealand farmers. This study compared functionally diverse pastures, (six grasses, four legumes, two herbs) with standard perennial ryegrass-white clover under high-rainfall, moderate fertility conditions in Golden Bay. Over three years, a 2×2 factorial study applied two defoliation intervals across two pasture types: cut when the standard pasture reached the 2.5-leaf stage (2.5LS) and when the diverse pastures reached the 3.0-leaf stage (3.0LS). In 2024, diverse pastures matched standard pasture in dry matter produced. Yield differences between treatments occurred seasonally in 2024, with standard pasture cut at the 2.5LS growing 12% more biomass than diverse pastures during autumn. In spring, both pasture types cut at the 3LS produced 20% more than pastures cut at 2.5LS. In summer 2024–25, defoliating at 3LS defoliation grew 9% more than the 2.5LS. Sown species declined from 85% (year 1) of total dry matter to 50% by year three. Seasonal rainfall was average, though late autumn sowing may have impacted subsequent persistence. These findings show that defoliation interval has a greater impact on increasing seasonal yield than the pasture mixtures compared. However, well-managed diverse pastures can match or in some seasons exceed ryegrass-white clover systems.

Keywords: *Festulolium*, functionally diverse pastures, grasses, leaf stage, legumes, perennial ryegrass, rotation length, white clover

Introduction

Changing climatic behavioural patterns (Sigid et al. 2026), rising costs of fertiliser and fuel, and increasingly stringent environmental regulations are providing increasing challenges for pastoral livestock systems. Improving pasture growth during difficult seasons is a low-cost strategy to mitigate some of these practical challenges. In some districts such as Golden Bay, pasture supply during summer can be affected by dry spells that increasingly limit pasture growth, while in winter and spring pasture growth is more often limited by anaerobic wet soil conditions, low temperatures, and nutrient loss due to leaching (Riley 1998).

Perennial ryegrass (*Lolium perenne* L.*)* and white clover (*Trifolium repens* L.*)* based pastures, which are present in many dairying parts of New Zealand, can be susceptible to soil moisture stress, heat stress, and to a lesser extent, anaerobic soil conditions (Goh & Bruce 2005). Owing in part to root system traits, perennial ryegrass is less effective at acquiring immobile soil nutrients compared to cocksfoot (*Dactylis glomerata* L.), and browntop (*Agrostis capillaris* L.) (Crush 1973; Fort et al. 2013), and shows greater susceptibility to drought than Festulolium or tall fescue (*Festuca arundinacea* Schreb.) (Fariaszewska et al. 2017). Yet in humid continental environments, perennial ryegrass and festulolium appear to persist similarly (Ivanova et al. 2020). Traits such as increased root extraction capacity, aerenchyma formation, greater root mass and root length density may confer greater resilience under the climatic and soil conditions in Golden Bay. Therefore, pastures incorporating functionally diverse species may enhance overall system resilience due to greater niche exploitation, relative to conventional perennial ryegrass-white clover swards (Descalzi et al. 2020).

A key research objective was to evaluate an optimal defoliation interval for diverse pastures in this area. The timing of defoliation is a critical management variable for maximising pasture productivity (Donaghy et al. 2008; Lee et al. 2008). Optimal defoliation intervals can be determined using leaf regrowth stage (LS) as an indicator of sufficient water-soluble carbohydrate reserves in leaves, roots and crown, ensuring grazing and subsequent recovery is as quick as possible. For perennial ryegrass, several authors (Fulkerson and Donaghy 2001; Lee et al. 2008; Chapman et al. 2012) found that the 2.5LS was optimal, and for tall fescue the 3.5LS was optimal (Donaghy et al. 2008; Turner et al. 2012). Once the optimal LS for defoliation is established, rotation length or the defoliation interval

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can be predicted using thermal time (Moot et al. 2021, Ordóñez et al. 2021).

There is limited research on the establishment and defoliation management of diverse pastures in wet regions of New Zealand such as Golden Bay (2060 mm annual rainfall).

What is not clear is the effectiveness of different cutting intervals for the chosen functionally diverse pasture type in the climate and soil context of the northwest region of the South Island. There is some understanding of optimal leaf growth stages for grazing perennial ryegrass–pasture brome (*Bromus valdivianus* Phil.) pastures from a recent study conducted in Manawatu (Oliveira et al. 2023). It reported that diverse mixtures containing pasture brome, cocksfoot, perennial ryegrass and white clover exhibited a two-week extension in growth during a dry summer producing 14% more than when compared to perennial ryegrass-white clover pastures. This continued growth under low precipitation was attributed to the superior water extraction capacity of cocksfoot (Fort et al. 2013) and deep roots of pasture brome (García-Favre et al. 2021; García-Favre 2023). Oliveira's thesis (2024) showed higher proportions of pasture brome and cocksfoot persisted after two years when pastures were grazed at 2.5LS of perennial ryegrass in spring and 3.5LS of pasture brome in summer and autumn, compared with pastures grazed only at 2.5LS of perennial ryegrass. These findings suggest the potential for deeper-rooted grass species to enhance the persistence and productivity of mixtures by supporting species with less robust root systems.

This study addressed the questions of whether functionally diverse pastures confer a growth advantage, due to niche differentiation, functional complementarity and root mass, during the driest months (February – March) and under anaerobic conditions at a dairy farm in Golden Bay on moderate fertility Pakihi soils. The hypothesis was that functional diversity, and optimal defoliation regimes can match or improve upon the production of perennial ryegrass-white clover pastures under 2.5LS defoliation management and confer a yield advantage under conditions of stress.

Materials and Methods

Experimental design

The field study comprised 16 plots (4.2 × 7.5 m) in a 2 by 2 factorial design, arranged in a Latin Square. The experiment was located near Takaka (-36.809761, 175.436973) on an improved Pakihi podzol soil of Olsen P 17and pH 5.7. Four treatments were applied, made up of two pasture types (standard and functionally diverse) with two defoliation intervals. There were four replicates for each treatment. Eight plots were sown in a standard pasture mix of perennial ryegrass AR37 (*Lolium perenne*) and white clover (*Trifolium repens*), while the remaining eight plots contained a 12-species mixture including 6 grasses, 4 legumes, and 2 herbs (Table 1). Endophyte infection in perennial ryegrass AR37, tall fescue Max P and meadow fescue Max R (*Festuca pratensis* Huds.) was above industry standard (>70%).

Buffer strips Sixteen-metre-in width of perennial ryegrass-white clover were sown between plots to minimise edge effects and allow access. The surrounding paddock was sown in the same perennial ryegrass–white clover mixture as the standard treatment to maintain uniformity. After sowing, all treatments received 15 kg/ha P in the form of superphosphate 125 kg/ha K in the form of potassium chloride, 30 kg/ha elemental sulphur, and 26 kg/ha superphosphate. This application was repeated twice annually in spring and autumn.

Site:

Experiment location and climate conditions

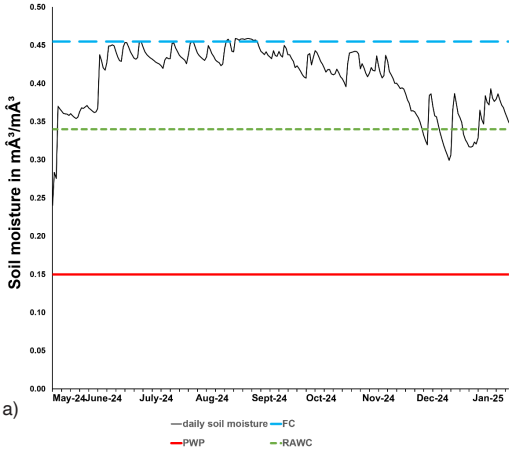
A weather station was located on the research site in May 2024 during the second year of the study, 1 year after pastures were sown. The weather station recorded the daily soil and air temperature (Figure 1a), and soil moisture (Figure 1b), at 5-minute intervals. Prior to the weather station, weather data was retrieved from NIWA (2026). Over the course of the study, it was evident that soil moisture was not limiting at any point measured, despite expecting this to be the case in late summer. Average monthly air temperatures and rainfall did not differ from the seasonal long-term average (NIWA 2026). During the winter following sowing of pastures (2 months later than planned), rainfall remained above average, and the site showed ponded surface water across low-lying areas throughout June and July.

Management

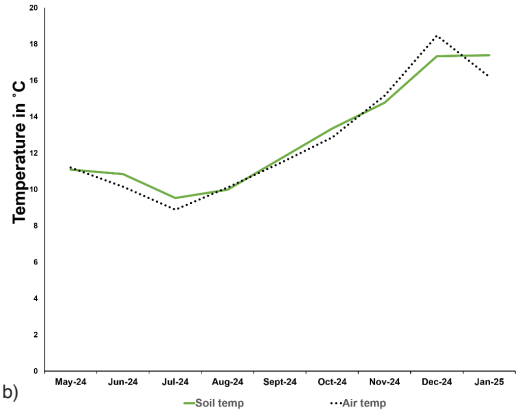
Before sowing, existing perennial ryegrass pasture was removed with two applications of WeedMaster 360 glyphosate (3.2 L/ha) in April 2023, and plots were direct-drilled on May 10th during autumn 2023. During establishment, pasture composition was monitored by point analysis using 90 square gridded quadrat. Manual oversowing was undertaken where seedling establishment was poor. The two defoliation treatments were applied once pastures reached establishment, determined by the pluck method, with cutting intervals determined by LS based on regular visual observations. The defoliation timing treatments applied across both pasture types were triggered (1) when perennial ryegrass reached 2.5LS and (2) when the Festulolium treatment reached 3.0LS. After two 30 ×30 cm quadrats were taken with hand clippers, each plot was cut to just above the basal nodes, which was 3-4 cm above ground level. All plots were cut with an NZ made tow and mow ^{tm} twin 1000 topping mower (https://www.towandmow.co.nz).

Table 1 Pasture species, cultivars and sowing rates for the two pasture types used – (1) standard pasture seed mix and (2) functionally diverse pasture seed mix.

Species	Common name	Cultivar (Endophyte)	Sowing Rate (kg/ha)
Standard pasture seed mix			
Lolium perenne L.	Perennial Ryegrass	Rely (AR37)	23
Trifolium repens L.	White Clover	Attribute	3
Species of the functionally diverse pasture seed mix			
Dactylis glomerata L.	Cocksfoot	Savy	1.5
Festuca arundinacea Schreb.	Tall Fescue Continental	Hummer (MaxP)	9.5
Festuca pratensis Huds.	Meadow Fescue	Oakden (MaxR)	9.5
Bromus stamineus E Desv.	Pasture Brome	Gala	19
Bromus catharticus Vahl.	Prairie Grass	Atom	9.5
Festuca pratensis × *Lolium multiflorum* Lam.	Festulolium	Primefest	4
Cichorium intybus L.	Chicory	Choice	1.5
Plantago lanceolata L.	Plantain	Agritonic	1.5
Lotus Pedunculatus Cav.	Lotus	Maku	3
Trifolium pratense L.	Red clover	Relish	5.5
Trifolium repens	White clover	Tribute	0.5
Trifolium ambiguum × *Trifolium repens*	White clover Caucasian clover hybrid	Aberlast	4



a)



b)

Figure 1a Soil moisture, -field content (FC), permanent wilting point (PWP) and - readily available water holding capacity (RAWC); (b) Average monthly soil and air temperatures on site.

Figure 1b Captures soil moisture data using the onsite weather station and permanent wilting point was estimated based on Pakihi soil analysis by McDonald (1955). Readily available water content was estimated based on 80 percent of the total water holding capacity and similar values for other types of Pakihi can be found in the work of (McDonald 1955).

Measurements

During sampling, herbage and root samples were collected from the central two-thirds of each plot to avoid edge effects. Before defoliation, on the same day, the herbage in two 30 × 30 cm quadrats per plot were cut to a standard height of 2 cm, weighed fresh and weighed after 48 hours of drying at 70˚C to estimate dry matter yield. During seasonal sampling trips, pasture growth was measured by taking three 66 cm × 30 cm quadrat cuts per plot, botanical composition was measured both by using a 90 grid square quadrat (1 cm^2) for point analysis and taking a 20 g subsample

of each quadrat cut, sorting this into individual species and measuring the dry weight as above. The remaining fresh pasture samples were sorted into leaf, stem, flower heads, dead material and weeds, and each component dried and weighed as above to give an estimate of the proportions of vegetative and reproductive material in herbage.

Soil moisture was measured with a Campbell Scientific HydroSense 2 e 30cm TDR probe, and canopy temperature was measured with an infrared sensor.

Root mass was measured by taking three 7.5 cm wide by 15 cm deep soil cores were taken inside each pasture quadrat to form one replicate of each plot. These cores were later washed; any remaining aboveground herbage was removed and roots dried and weighed. The root dry weight was measured nine months into the study and at the end of the study period in January 2025.

Data analysis

A factorial ANOVA was used in R-studio 2026.01.0 build 392 to assess the main interaction effects of sowing treatment, defoliation management and season on pasture yield. Sowing treatment, defoliation management and season, were fixed variables, while plot was included as a blocking factor to account for the unavoidable soil differences seen across the paddock. Model assumptions were assessed with post hoc tests for the homogeneity of variance, which included QQ plots, residuals versus fitted plots, and fixed vs leverage. Normality was formally tested using the Shapiro-Wilk test. Where significant main or interaction effects were detected, post hoc pairwise comparisons were performed using estimated marginal means with Tukey adjustment, implemented via the "emmeans" package. Seasonal variation in yield was assessed within the same modelling framework.

A linear mixed model was used to assess the relationship between sowing treatment, cutting treatment, sampling date and root mass. In this model, plot was included as a random effect due to soil spatial variation, and date was a fixed effect. This was done in R-studio using the "LmerTest" function. Otherwise, residuals were analysed following the same procedures as for pasture yield. Due to the presence of multiple sown and volunteer species within each treatment, species were analysed individually using analysis of variance (ANOVA) in R-studio to test for differences between sowing treatments and defoliation management. Temporal variation was not explicitly modelled in these analyses, and sampling time points were therefore treated independently. Model assumptions were assessed using residual diagnostics and the Shapiro–Wilk test. Where significant effects were detected, pairwise comparisons were conducted using estimated marginal means with Tukey adjustment via the "emmeans" package. Botanical composition data at selected sampling points were analysed using an equivalent model structure. All analyses were conducted using a significance threshold of $\alpha = 0.05$.

Results

Annual pasture production

Using defoliation interval to determine cutting resulted in nine cuts per year for the 2.5LS treatment based on perennial ryegrass LS, and eight cuts per year for the 3.0LS treatment, based on festulolium LS. Overall, 2024 showed no significant differences in annual pasture production when comparing functionally diverse pastures and perennial ryegrass- white clover pastures ($F_{358} = 0.87$, $p = 0.461$) under any of the defoliation treatments. On average, functionally diverse pastures cut to 3.0LS of festulolium produced 17.1 t DM ha/y, while standard perennial ryegrass pastures managed to the 2.5LS of perennial ryegrass produced 16.6 t DM ha/y.

Seasonal pasture herbage accumulation

Pasture production was significantly different between seasons ($P<0.001$) and between pasture treatments in autumn 2024, spring 2024, and summer 2024-25. Extending leaf regrowth based on the 3.0LS defoliation criteria significantly increased herbage accumulation in spring 2024 and summer 2024 ($P< 0.001$).

Autumn was the only season to show significant seasonal interactions between pasture mixture and defoliation interval ($F_{1,58} = 4.83$, $p = 0.032$). During autumn 2024, perennial ryegrass-white clover pasture under the 2.5LS defoliation interval grew 14% more dry matter (574 kg DM/ha) compared to perennial ryegrass-white clover pasture defoliated to the 3.0LS ($t_{58} = 3.21$, $p = 0.002$) (Figure 2).

In spring 2024, the largest difference in defoliation treatment was observed ($P<0.001$). Both perennial ryegrass and diverse pastures cut to the 3.0LS produced 19.7% more on average than pastures cut at the 2.5LS (Figure 2), a 758 kg DM/ha increase ($t_{357} = 4.54$, $P< 0.001$). This was also the only season in which, by waiting for the festulolium to reach the 3.0 leaf stage, one whole cut less was taken compared with when defoliated at the 2.5 leaf stage. This growth increase was associated with an 11-day (114 growing degree days with a 4 degree base temperature) longer recovery before spring defoliation (77 days for 3.0LS versus 66 days for 2.5LS). In summer 2024-25, both pasture types with the longer defoliation interval had 9.3% higher dry matter yield than those pastures cut to the 2.5LS of perennial ryegrass ($t_{357}= 2.55$, $P= 0.011$), on average 388 kg DM/ha more. Defoliation intervals ranged from a maximum of 98 days in winter to a minimum of 28

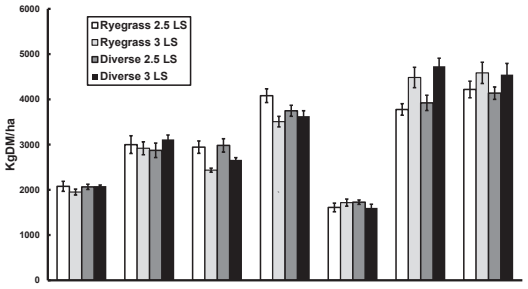


Figure 2 Seasonal pasture production (kg DM/ha) The vertical bars indicate (±) S.E.M. Different letters within a season delineate statistical differences using Tukey's test ($p < 0.05$). (2.5LS) denoting pastures cut at the 2.5 leaf regrowth stage of perennial ryegrass, (3.0LS) denoting pastures cut when Festulolium reached the 3.0 leaf regrowth stage.

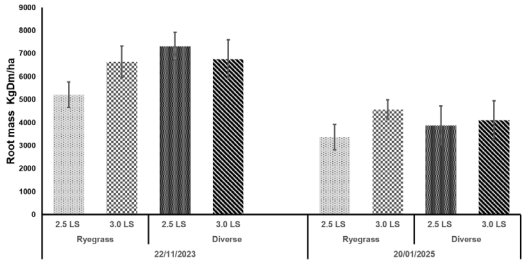


Figure 3 Botanical composition over sampling periods (% of herbage dry matter contributed by each botanical group). (2.5LS) denoting pastures cut at the 2.5 leaf stage of perennial ryegrass, (3.0LS) denoting pastures cut when Festulolium reached the 3.0 leaf stage.

days in summer for 3.0LS, and a maximum of 95 days in winter to a minimum of 21 days in summer for the 2.5LS.

Botanical composition

The botanical composition of all four treatments changed over time (Figure 3). Though botanical composition was expected to change seasonally, overall, there was a weak downward trend in the percentage of sown species, comprising 85% of pasture dry matter in July 2023, which fell to 50% by 2025 (t_{140} = 1.69, P= 0.09). Weed species were predominantly comprised hairy buttercup (*Ranunculus sardous* Crantz), broad-leaved dock (*Rumex obtusifolius L.*), and volunteer grasses were predominantly Yorkshire fog (*Holcus lanatus* L.) and browntop (*Agrostis capillaris)*. Defoliation interval weakly affected total legume content (F_{140} = 2.41, P= 0.10). Defoliation at the 3.0LS of festulolium resulted in lower legume percentages over spring and higher percentages over summer when compared to the 2.5 LS defoliation interval. Interestingly, in a pairwise comparison, white clover was the only legume that weakly responded to the effect of defoliation management (F_{140} = 3.46, P= 0.06), showing an increased percentage growth overall when managed under the 3.0LS when compared to 2.5LS defoliation interval (Figure 3).

An analysis of vegetative and reproductive material in bulk samples from summer 2023-24 suggests differences in pasture quality between perennial ryegrass grazed at the 2.5LS and all other treatments. Defoliation at the 2.5LS resulted in a greater percentage of leaf material and lower percentage of dead material compared with defoliation at the 3.0LS (F_{140} = 4.39, P< 0.05).

Based on the spatial grid square botanical analysis (data not shown) both pasture types contained volunteer Yorkshire fog (*Holcus lanatus)*, browntop (*Agrostis capillaris)*, plantain (*Plantago lanceolata* L.), white clover and *Lotus pedunculatus* Cav plants. Diverse pastures also had *Lotus pedunculatus*, red clover (*Trifolium pratense* L.) and plantain as sown species. Differentiating what was sown from what grew as a volunteer in the functionally diverse pastures was impossible; therefore, these species are quantified in each treatment. Differences in sown composition continue to be seen, with diverse pastures containing more tall fescue and festulolium (F_{140} = 56.8, P< 0.001) whereas perennial ryegrass pastures retained more of that species (F_{140} = 78.4, P< 0.001). Diverse pastures also contained greater amounts of red clover (F_{140} = 3.2, P= 0.07), though these findings were marginal. After two years, proportions of total volunteer species across all pasture types did not differ significantly, though Yorkshire fog content was marginally greater in the 2.5LS functionally diverse pastures when compared to the standard perennial ryegrass pastures under the 2.5LS defoliation (F_{140} = 3.1, P= 0.08). Due to these treatment differences overall, Yorkshire fog was present in greater frequency in diverse pastures when compared to perennial ryegrass, though only marginally (t_{140} = 1.78, P= 0.053).

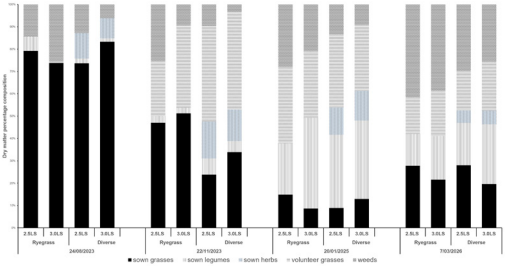


Figure 4 Root mass by cutting treatment and pasture type, The vertical bars indicate (±) S.E.M. (2.5LS) denoting pastures cut at the 2.5 leaf regrowth stage of perennial ryegrass, (3.0LS) denoting pastures cut when Festulolium reached the 3.0 leaf regrowth stage.

Root mass

Root dry weight was 38% lower at the end of the study when sampled in summer 2025 compared with the spring of 2023 (F_{44} =20.6, P< 0.001) (Figure 4), representing substantial seasonal and temporal variation, as would be expected. Pasture treatment had a significant effect on root dry weight in spring 2023 ($F_{33.5}$ = 6.97, P= 0.012), with functionally diverse treatments producing 11.5% greater root biomass than the standard perennial ryegrass-white clover treatments. There was weak evidence of a trend between defoliation interval and pasture mixtures ($F_{33.5}$=3.13, P=0.08), suggesting a moderating effect in which defoliation at the 3.0LS may be linked to increased root mass in both pasture treatments.

Discussion

Defoliation criterion (leaf regrowth stage) influenced pasture growth more than pasture type in this study. In spring 2024, pastures managed with defoliation at the 3.0 leaf stage of festulolium produced greater biomass on average compared to those grazed at the 2.5LS of perennial ryegrass irrespective of pasture type. The 3.0LS defoliation treatment provided pasture plants with an additional 114 growing degree days (°C days) for the accumulation of water-soluble carbohydrate and root reserves before defoliation. Ordóñez et al. (2021) demonstrated in pasture grasses, including perennial ryegrass and pasture brome, that the fastest leaf regrowth and greatest accumulation of water-soluble carbohydrates in basal leaf tissue occurred in spring at the 3.0LS for perennial ryegrass and the 4.0LS for pasture brome. In that study, extending the defoliation interval increased the leaf elongation rate, resulting in more rapid post-defoliation regrowth (Ordóñez et al., 2021). The observed difference in growing degree days between the 3.0 LS and 4.0 LS in their study (100–150 °C days) was comparable to the differences documented in the present study between the 2.5LS and 3.0LS defoliation intervals of perennial ryegrass and festulolium (114 °C days).

A further benefit of extending the spring defoliation interval is enhanced root development. Notably, García-Favre et al. (2023) reported that, under a 2.5-3.0LS cutting regime, pasture brome exhibited 42% less root mass below 10 cm than when cut at 3.5-4.0LS. Stuckey (1941) found that root growth rates in perennial ryegrass, Italian ryegrass (*Lolium multiflorum* Lam.), cocksfoot, and meadow fescue peak in early spring, subsequently declining once floral initiation occurs. During summer, as flowering commences, root systems in species such as perennial ryegrass and meadow fescue deteriorate, whereas the primary roots of cocksfoot remain intact (Stuckey, 1941). In the present study, longer 3.0LS defoliation intervals may have been weakly associated with increased root presence in perennial ryegrass pastures over summer, potentially due to greater accumulation of growing degree days between defoliations and, consequently, more opportunity for reserve deposition in root tissue. In contrast, diverse pastures, which included species with perennial-like root systems such as cocksfoot (Stuckey, 1941), likely exhibited less seasonal fluctuation in root mass due to the presence of multiple root system types (e.g., cocksfoot with perennial roots, red clover, and chicory with taproots). However, additional root measurements would be necessary to determine clear trends in seasonal root growth under different defoliation intervals.

The principles of grass growth and recovery after defoliation (Hopkins & Hüner 2004) also go some way in explaining why, in the summer of 2024, the 3.0LS defoliation interval grew significantly more. A greater potential source of root reserves and water-soluble carbohydrate going into summer may have allowed pastures greater resources to extend into growing more leaf area (Ordóñez et al. 2021), or more effective root systems to access nutrients and water (Hill et al. 2006). Although including species with functional diversity was intended to maximise soil water use, prevailing wet conditions allowed alternative selection pressures to be observed. Late sowing and prolonged wet winters (NIWA 2026) combined with a heavy soil type (McDonald 1955) probably promoted the growth of volunteer weed species. Yorkshire fog, hairy buttercup, and broad-leaved dock, all of which thrive in anaerobic and high-aluminium environments (López et al. 1997) became prominent.

Weed presence increased over the two years, and as sown pasture species % lessened, the differences between pasture mixtures in the field became less. This may have potentially negated some of the differences between pasture types that were expected due to differing traits between the functionally diverse and the standard pastures. In autumn 2024, perennial ryegrass cut to 2.5LS produced more dry matter than all other treatments. No botanical composition analysis exists for that autumn season; however, an analysis of vegetative and reproductive samples and botanical samples from summer 2023-24 provides some insight. Firstly, perennial ryegrass cut at the 2.5LS had less dead material and a greater leaf bulk than all other treatments. Secondly, because the diverse pasture was mainly made up of early-maturing grass cultivars including Primefest festulolium and Hummer tall fescue, a tendency towards seeding would likely have led to lower overall dry weight. Pastures going to seed tend to prioritise resources for reproduction over vegetative growth and tillering (Hopkins and Hüner 1995). Thus, it is plausible that the more frequent

cutting treatment at the 2.5LS defoliation treatment encouraged greater production of vegetative tillers and less reproductive material in perennial ryegrass, but the tendency of diverse pasture to go to seed earlier meant the same effect was not seen in the functionally diverse 2.5LS treatment.

Practical implications

- Introducing diverse species pastures in a Golden Bay environment resulted in no detrimental effect on pasture performance compared with re-sowing traditional perennial ryegrass and white clover.
- Farmers in regions with similar climates and soils such as Golden Bay might not see immediate yield gains from diversifying pasture species when compared to re-sowing ryegrass, when soil moisture is non-limiting. However, management practices (e.g., longer defoliation intervals) that promote deeper or more robust root systems in diverse species pastures could improve pasture resilience and productivity in the long term.
- Attention should be given to the incursion of volunteer weed species under wet conditions on heavy soils, as these can quickly outcompete sown pasture species of more palatable and beneficial qualities. The climate and soil environment exert the greatest selection pressure on pastures, and noxious weeds may require additional management strategies to maintain functional diversity.
- Extending defoliation intervals to 3.0LS based on festulolium, particularly during early spring and into summer, when compared with defoliating to the 2.5LS of perennial ryegrass, can be a practical tool to maximise yield and potentially improve root structure, thus supporting overall pasture system resilience.
- Using the 2.5LS of perennial ryegrass as a guide for defoliation interval over autumn may be an effective option for maintaining pasture growth leading into winter.

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AI declaration

During the preparation of this work, the authors used Grammarly proofreader and ChatGPT v3.5 to improve the readability of specific paragraphs. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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