NOVEL GRAZING MANAGEMENT: MAKING BETTER USE OF WHITE CLOVER

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Introduction

The novel method of forage presentation being evaluated is based on growing grass and legume separately rather than together as a conventional mixture and allowing cows to choose which species to eat and in what proportion. Why might this be worth considering?

Recent studies on the grazing behaviour of animals provide a basis on which to propose this novel approach for presenting pastures to animals.

In this paper we will describe the basis for this novel management proposition and some experimental results which indicate the potential for quite large increases in milk production. Furthermore, we will describe how this might be applied on-farm, and outline some of the factors that need to be considered in translating experimental data to practice.

The nutritional value of white clover

White clover has a higher nutritive value than ryegrass (Ulyatt 1981). Many studies clearly demonstrate that animals grow faster and produce more meat and milk when they eat diets containing a high proportion of legume. Furthermore, those studies show that sheep (Gibb and Treacher 1984; Cosgrove *et al*., 2003) or cattle (Nuthall *et al*., 2000; Marotti *et al*., 2001) do not need to eat an entirely clover diet to produce at high levels. Often, 60-70% clover in the diet (the balance being grass) is sufficient to reach maximum production. More on that later.

Grass-legume mixtures

Pastures for dairy cows are typically sown with mixtures of grasses and legumes. Ryegrass and white clover dominate most seed mixes. These species are complementary to each other in many attributes and growing them together in a mixture should be an effective way to use them. White clover fixes atmospheric N and supplies N to the grass. Ryegrass and clover have complementary patterns of seasonal growth with grasses being more productive during autumn, winter and spring, and clover is potentially (given adequate water) more productive during summer.

They are also complementary in nutritional attributes (Beever *et al*., 1986). For example, clover has a high concentration of protein, which is rapidly degraded in the rumen. Grass by comparison has a higher concentration of fibre. Theoretically at least, a combination of the two species should match the nutritional requirements of the cow more closely than either species alone.

In practice, grass-clover mixtures do not consistently perform to their theoretical potential. The proportion of clover in perennial pastures is typically between 10-20% (Hoglund *et al*., 1979) and this

is too low to add substantially to the cows' nutritional intake. The proportion also varies seasonally, and is highly variable from year to year. In nutrient composition, a grass-clover mixture is not a consistent feed throughout all seasons of the year.

Constraints to intake

A major constraint to feed intake and production is insufficient feed, and obviously this is the first limiting factor that should be addressed in any management system. However, even with apparently abundant feed, cows may be 'restricted' in ingesting sufficient nutrients to support the level of production that they are genetically capable of. Constraints such as the capacity to harvest (time available for grazing each day, bite mass, requirement for chewing etc.) and digest (rumination, clearance from the rumen) forages may limit their intake. Cows can eat white clover faster than they can eat ryegrass, and it breaks down faster in the rumen and requires less rumination for particle breakdown and passage through the digestive tract. In short, cows can satisfy high nutrient demands from white clover more easily than from ryegrass.

Behavioural basis to these responses

Several studies demonstrate that cows like to eat a high proportion of clover when they are given opportunity to freely choose (Parsons *et al*., 1994). Most of these studies show that cows freely choose approximately 70-80% clover and 20-30% ryegrass. The high proportion of clover that cows like to eat is in marked contrast to the proportion offered to them in mixed pastures.

To make better use of the high nutritional value of clover, we need to grow more of it. One way to do that is to grow clover separately from grass. This removes the competitive suppression of white clover by the grass. It also makes it simple for the cow to eat as much clover as she likes.

Benefits to milk production

Studies in progress in the Manawatu demonstrate that cows offered grass and clover growing separately, side-by-side and able to choose freely from both of them produce up to 30% more milk ($P<0.05$) than cows given only ryegrass or a mixed ryegrass-clover pasture with typically low proportions of clover (see Figure 1). In this work to date milk composition has not been affected, and the response for milksolids is similar to that for milk volume.

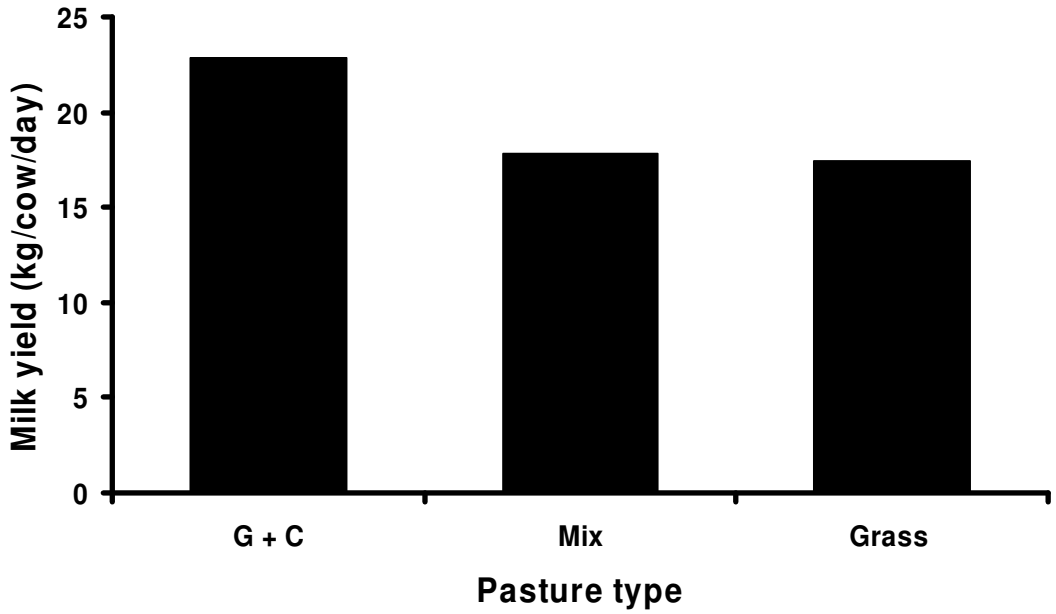

Figure 1: Milk yield of cows offered contrasting pasture types: continuous free choice of ryegrass and white clover growing separately, side-by-side (G+C), a mixed ryegrass-white clover pasture (Mix) or ryegrass only (Grass)

The milk yields for each pasture type shown in Figure 1 are the means for measurements made in mid-lactation during November and early December, and in late lactation during April. The higher milk yield by cows given grass and clover growing separately is consistent with studies conducted in UK (Nuthall *et al.*, 2000) and Australia (Marotti *et al*., 2001). Most of the additional production can be explained by the high proportion of clover eaten by cows having continuous free-access to both species. This form of presentation makes it possible to sustain that high proportion of clover in both the pasture and in the cows' diet. Mixed pastures cannot achieve, let alone sustain, that high proportion of clover.

Challenges to implementation

There are a number of factors that need to be considered in translating these experimental results into a simple, practical management system on the farm. Our work in progress is addressing some of these.

Does higher yield per cow translate to higher yield per ha?

Increasing the yield per cow may itself be valuable e.g. for realising the genetic potential of cows. However, most industry measures of profitability focus on yield per ha, and it is important to consider how changing the way in which pastures are presented to cows might affect yield per ha.

The DM yield of grass relative to that of clover is important in determining the total DM yield per ha. Growing grass and legume separately should not markedly alter the total dry matter yield compared with growing the same two species as a mixture (Harris and Hoglund 1977), if the proportions of each species were the same in each case. However, increasing the proportion of clover relative to grass (as growing them separately is intended to do) may change the total DM yield.

Figure 2 describes the relationship between the total dry matter production, the yield of milksolids per cow and the yield of milk solids per ha, for proportions of clover ranging from zero (all grass) to 100% (all clover). The milk yield per cow (dotted line in Figure 2) is determined primarily by the digestion and metabolism of nutrients and the physiology of milk production in the cow. It is difficult to influence. Cows produce extra milk in response to an increasing proportion of clover, up to approximately 60-70% (Harris *et al*., 1997; Marotti *et al*., 2001), beyond which there is diminishing return.

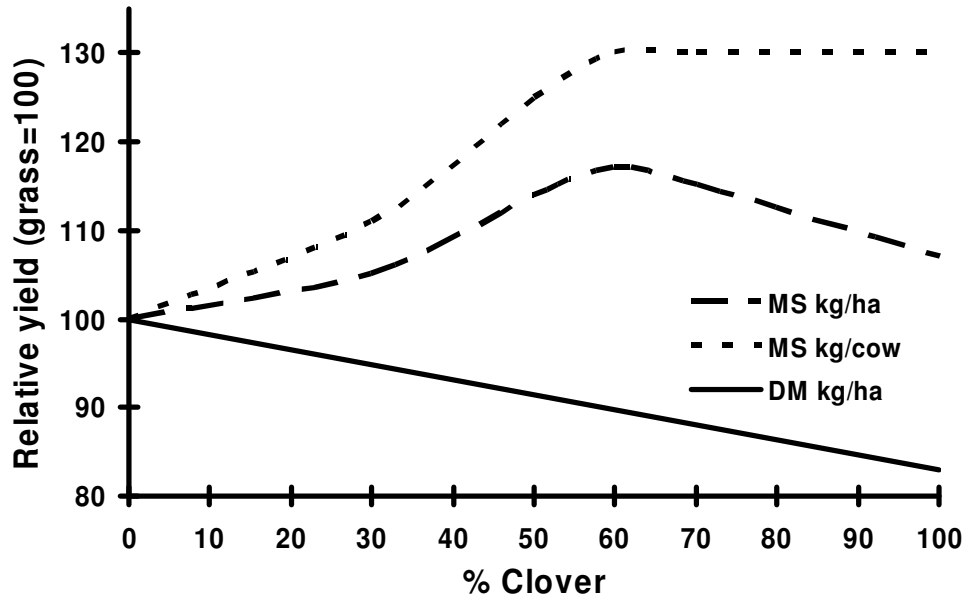

Figure 2: The relative yields (grass=100) of dry matter (DM) per hectare, milksolids (MS) per cow and milk solids per hectare as the proportion of clover offered to cows increases from 0 (i.e. all grass) to 100% (i.e. all clover)

The total annual DM yield of white clover is approximately 20% less than the yield of ryegrass. This estimate was derived from the DM yields of ryegrass and white clover measured at a range of sites from Waikato to Southland (Harris and Hoglund 1977; Widdup and Turner 1983; Black *et al*., 2003). For grass and clover growing separately, side-by-side, the total yield of DM per ha of grass plus clover (solid line in Figure 2) decreases as the proportion of each hectare occupied by clover increases.

As the proportion of clover increases, the increase in milk yield per cow, initially, more than offsets the decrease in total dry matter yield, and milk yield per hectare increases (dashed line in Figure 2). However, at high proportions of clover, beyond the proportion necessary to achieve maximum yield per cow, milk yield per hectare begins to decrease.

The relative yield of grass and legume is not always as shown in Figure 2. If the slope of the solid line reduced to zero (horizontal; i.e. the legume and grass are equal in annual dry matter production) or increased above horizontal (legume produces more dry matter than grass), the milk yield per hectare would increase. In practice, this would be the case at times of the year when white clover grows faster than ryegrass (e.g. summer) or when using legumes that are more productive than white clover.

Thus, while it may be possible to influence the relative yields of dry matter, the proportion of legume at which milk yield per hectare is maximised is comparatively consistent, around 60-70%. This proportion is similar to the proportion that cows freely chose to eat, and also similar to the proportion required for cows (and other ruminants) to produce at high levels.

When is the best stage of lactation to feed legumes?

One important question to consider is whether cows are likely to respond more at some stages of lactation rather than at others? If so, then it would be most effective to apply this management at the times of year when cows are most responsive. Early indications from our experimental work using spring-calving cows are that the additional yield of milk obtained from cows in late lactation is similar to that from cows in mid-lactation i.e. approximately 30% higher yield from cows given continuous free choice of grass and clover growing separately. However, when expressed in terms of extra kg of milk per cow the additional 30% yield per cow is greater in mid lactation (+6 kg) than in late lactation (+4 kg) because of the natural decrease in production as the lactation advances.

Which species of legume?

The answer to the question posed above on the optimum stage of lactation affects the choice of the most appropriate legume(s). We have evaluated this alternative method for presenting grass and legume using ryegrass and white clover, the most frequently used pasture legume in NZ. White clover grows most vigorously from late spring through until early autumn. There are many other

legumes that might also be suitable. Lucerne and red clover have similar seasonal patterns of growth to white clover but generally they are more productive, particularly in environments where the summer growth of white clover may be comprised by low or unreliable rainfall (Brown *et al*., 2003; Brock *et al*., 2003; and see paper by Dr Grant Edwards, this conference). Other legumes with better cool season growth may be more suitable if using this method of pasture management outside of the main growing season for white clover. Legumes such as *Lotus corniculatus* (birdsfoot trefoil) may also be suitable, especially for areas where white clover does not thrive. Birdsfoot trefoil has the added advantage in that it contains condensed tannins and does not cause bloat.

Species switching

There may be times of the year when legume-rich pastures are not required or not appropriate e.g. winter. Switching species from clover to grass (in autumn) or from grass to clover (in early summer) would potentially maximise the total annual forage production from each hectare of land. Furthermore, switching from legume to grass in autumn to enhance winter forage production would also allow the grass to benefit from the soil nitrogen fixed by the clover during summer. The herbicide and seed drilling technologies to enable this switching from one species to another is well developed. However, the practicalities of doing so have not yet been studied.

Summary

White clover is nutritionally better than ryegrass, and cows produce up to 30% more milksolids when clover is readily available.

Capturing that potential in higher milksolids production requires that we grow more clover.

Growing grass and clover separately overcomes some of the difficulties of mixtures and makes it possible to sustain the high proportion that cows like and produce well on.

Acknowledgements

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