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Performance of tall fescue, cocksfoot and phalaris based pastures compared with perennial ryegrass, in on-farm trials

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Abstract

Ryegrass monocultures and mixtures containing at least one or two other grass species were compared on three sites over 3-6 years. At Atiamuri, under intensive dairying, a tall fescue-cocksfoot pasture yielded 3.7 t/ha/yr, and 14 kg/ha/day in spring and 17 kg in summer, more than the monoculture. Under dairying at Opiki, a phalaris-ryegrass mixture yielded 1.8 t/ha/yr, and 5 kg/ha/day in winter and 7 kg in autumn, more than the monoculture.

At Castlepoint Station, a cocksfoot-tall fescue pasture yielded 1.4 t/ha/yr, and 11 kg/ha/day in summer, more than the monoculture. These pastures would more closely meet (or exceed) animal feed demands, so increasing gross farm income through increased animal performance and carrying capacity.

Keywords Grasslands Kara cocksfoot, Grasslands Maru phalaris, Grasslands Puna chicory, Grasslands Roa tall fescue, ryegrass monoculture, dry matter yield, animal demand

Introduction

Perennial ryegrass-white clover pastures have been the cornerstone of New Zealand pastoral for more than 60 years: surveys of seed use (e.g., Belgrave *et al.* 1990) show that most farmers still prefer them.

Ryegrass (and clover) monoculture pastures are typically vigorous in establishment and easy to manage. However, in the last decade pasture stresses have increased in many regions, e.g., the Central Plateau and the East Coast. Drought, pests and disease, less fertiliser, grazing management (stocking rate, winter treading damage and summer overgrazing) and animal disorders (ryegrass staggers and facial eczema) have combined to

Table 1 Trial site descriptions

	Atiamuri	Opiki	Castlepoint
Location	60 km NW of Taupo	50 km SE of Palmerston North	70 km NE of Masterton
Soil Type	YBP - Taupo sandy silt	Humic clay - Makerua peat loam	YGE - Mangaweka silt loam
Climate	Summer-moist, winter-cold	Late summer-dry	Very summer-dry, mild winters
Rainfall (mm)	1250	900	900
Animal Enterprise	Dairying	Dairying	Sheep and beef
Sampling Duration	1987-1990 (sown 1986)	1987-1990 [sown 1986)	1983-1989 (Sown 1981)
Sown species and rates kg/ha	1.[1] Ellett[20] Huia[3] 2. Roa[20] Kara[6] Puna[1] Pitau[3]	1. Nui[25] Pitau[3] 2. Maru[9] Nui[10] Pitau[3]	1. Ruanui[20] Huia[3] 2. Wana[9] Roa[22] Puna[3] Huia[3]
Paddock description	Flat, high fertility, well drained	Flat, moderate fertility and drainage	Flat, moderate fertility and drainage
Stocking rate	3.4 cows/ha	3.2 cows/ha	10.7 SU/ha
Grazing management	Rotational	Rotational	Rotational
Fertiliser applied (kg/ha per year)	N P K S 60 56 120 64	N P K S 50360 45	N P K S - 20 - 15

[1] Name of mixture referred to in text.
YGE = yellow grey earth, YBP = yellow brown pumice

reduce production, persistence, and acceptability of ryegrass monocultures.

One response has been the introduction of alternative pasture species. Several of these grasses, legumes and herbs have been bred and released since the mid 1970s. Today, farmers can choose from up to 30 species and over 50 cultivars.

This paper presents results from 3 species comparisons of ryegrass monocultures with mixtures comprising more than one grass, and/or clover species, selected according to site and farming system.

Materials and methods

The main measurements at each site were total dry matter yield and percentage contribution of each species to total yield based on a full herbage dissection. Four 0.5 m^2 herbage enclosure frames were cut (8-9 cuts/yr) to a height of 2 cm, with a new frame site used after each cut. Limited replication at each site was achieved with subsamples (frames) and time (between 3 and 6 years' complete measurements). Statistical analysis, to compare the means of the different pasture treatments, used a standard ANOVA model.

Site descriptions

All three sites (Table 1) were located on successful, commercial properties, with problems of pasture quality, supply and/or persistence. White clover cultivars ('Grasslands Huia' or 'Grasslands Pitau') were sown with all pasture mixtures. At Opiki and Castlepoint the pastures compared were in the same paddock; at Atiamuri they were in adjacent paddocks. Grazing management in general was the same at each sites (Table 1).

Results and discussion

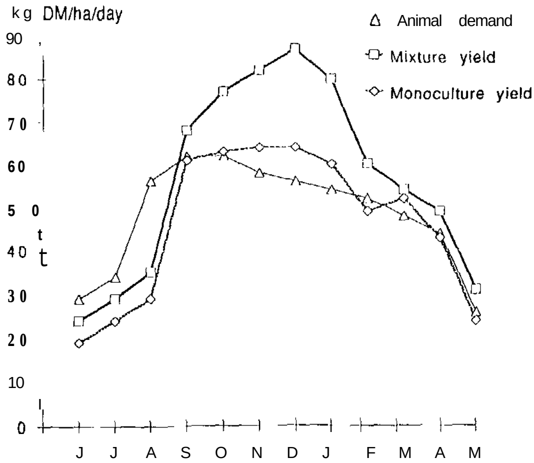

Figure 1 Mean monthly total DM yields and predicted animal feed requirement - Atiamuri.(based on daily DM feeding requirements of a herd stocked at 3.5 cows/ha, with an 85% pasture utilisation rate)

Table 2 The mean, annual and seasonal composition (% of total yield) of the sown components of the pastures.

Site	Mixture	Sown species	Autumn	Winter	Spring	Summer	Annual
Atiamuri	MIX 1	Ellett	73	79	57	57	63
		Pitau	12	5	13	13	12
	Mix 2	Roa	39	42	34	36	37
		Kara	30	36	38	30	33
		Puna	3	1	4	6	4
		Pitau	11	5	11	12	10
Opiki	MIX 1	Nui	68	79	74	56	68
		Pitau	16	10	14	29	19
	MIX 2	Nui	42	52	67	45	52
		Maru	32	30	10	20	21
		Pitau	14	8	12	21	14
Castlepoint	MIX 1	Ruanui	87	75	62	47	62
		Huia	9	6	9	19	11
	MIX 2	Wana	60	72	57	51	58
		Roa	17	10	12	11	12
		Puna	1	1	3	6	3
		Huia	7	4	10	13	9

Note:

Mean annual composition % are derived from yield data and not % data, other components included dead matter. other grasses and other species/weeds.

Atiamuri

Pasture yield

The 'Grasslands Roa' tall fescue mixture yielded 3.7 t DM/ha/yr more than the high endophyte (HE) 'Ellett' perennial ryegrass pasture (20 545 vs 16 790 kg DM/ha, $P<0.001$). The seasonal yield advantage of the Roa mixture was greatest during summer +17 kg ($P<0.001$) and spring +14 kg DM/ha/day ($P<0.05$).

Pasture composition

Species composition changed with season (Table 2). In the Ellett pasture perennial ryegrass contributed most to total yield in autumn and winter and least in spring and summer (dead matter and other grasses made up the balance). In the Roa mixture, tall fescue contributed most in winter and least in spring (Table 2). Tall fescue contributed more than cocksfoot in all seasons except spring. 'Grasslands Kara' cocksfoot contributed most over spring (38%) and winter (36%). 'Grasslands Puna' chicory yielded most over summer-autumn and was dormant over winter. Puna yield declined rapidly after an 8-day late-spring summer rotation in the third year. A similar result was reported by Lancashire & Brock (1983). suggesting that for best performance (and persistence), Puna chicory needs a minimum rotation length of approximately 20 days over this period.

White clover content was similar in both pastures - highest in spring and summer at 13% and lowest in winter. Deadmatter content in the Roa mixture was half of that in the Ellett mixture (12% of yield), the main differences occurring in spring and summer.

Over time, themos t significant change in composition was between Kara and Roa. In the first year Kara contributed 48% of yield and Roa 13%, but by the last (4th) year, Roa had reached a high of 54% and Kara 21% of yield.

Discussion

In the Roa mixture, tall fescue and cocksfoot were well balanced by the 2nd and 3rd year. Tall fescue, a summer- and autumn-active species (Anderson *et al.* 1982), became the primary grass species and Kara (spring-, summer- and winter-active) the secondary species. This reversal was most likely due to: superior Kara seedling vigour, an increase in pasture utilisation, and increasing use of nitrogen, which would favour Roa tall fescue in this environment (Moloney *et al.* 1992). In a high producing dairy pasture, cocksfoot should contribute a maximum of 35% of total yield; higher levels may reduce animal production.

The yield from the Roa mixture provided more feed at calving than the ryegrass pasture, although both mixtures failed to meet the sudden animal demand in late winter (Figure 1). From September to April, the Roa mixture clearly exceeds both the animal demand and the yield of the Ellett pasture. This feed surplus should enable an increase in stocking rate, improved cow feeding and the option of feed conservation. By contrast the Ellett pasture would not enable either option. The higher dead matter content of the ryegrass monoculture (twice that of the tall fescue pasture) over spring and summer may reduce the quality of this pasture.

The large spring and summer yield response of the Roa mixture reflects not only the growth rhythms of the sown grasses but also the good summer rainfall and high fertiliser applications (Table 1). Addition of a cool-season grass such as 'Grasslands Maru' phalaris might have further improved the seasonal yield of the Roa mixture, particularly over late winter. This mixture, known as a 'tall fescue triple grass mix', has performed very well elsewhere (Moloney, unpublished).

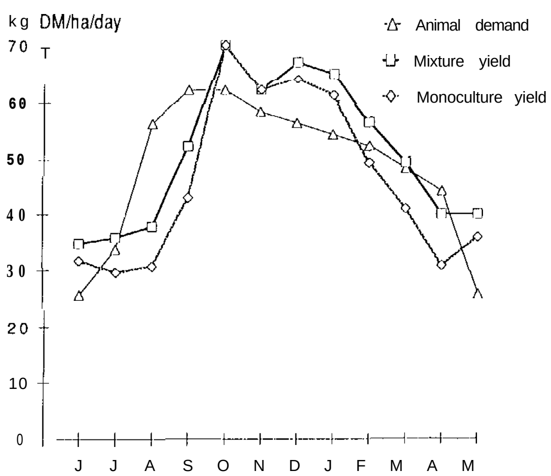

Figure 2 Mean monthly total DM yields and predicted animal feed requirement - Opiki. (based on daily DM feeding requirements of a herd stocked at 3.5 cows/ha, with an 85% pasture utilisation rate)

Opiki

Pasture yield

The Maruphalaris and highendophyte 'Grasslands Nui' mixture yielded 1.8 t DM/ha/yr more than the HE Nui ryegrass monoculture (18 234 vs 16 431 kg DM/ha pa, $P<0.05$). This yield advantage came in autumn (7 kg DM/day extra) and winter (5 kg).

Pasture composition

HE Nui was the primary grass species in all seasons (Table 2), being highest in spring and lowest in summer and autumn. Maruphalaris, the secondary grass species, was highest in autumn and winter (mean 31%) and lowest in spring (10%). Whitecloveryieldedonaverage 2% more in the HENui ryegrass pasture than in the Maru mixture in all seasons except summer (8% more). Annual dead matter was similar for both swards, but in spring and autumn the Maru mixture had less than half the dead matter (6% vs 14%) of the ryegrass monoculture.

Ryegrass tiller populations in the Nui pasture changed little between August 1988 (4396) and April 1990 (4786/m²). However, in the Marumixture, tiller density of ryegrass andphalaris increased from 473 1 to 6282/m² and from 504 to 1060/m², respectively.

Discussion

Inclusion of Maru increased ryegrass tiller population by 33%, probably due to reduced ryegrass pulling, a common problem on this soil type. However, the tiller density of HE Nui ryegrass in the Nui-only pasture varied more over time, increasing only 9% between August 1988 and April 1990. 'Grasslands Kopu', a larger-leaved, erect cultivar with more cool-season growth than Pitau (Moloney *et* al. 1987). might have improved white clover contribution in the Maru mixture over both winter and summer.

These results demonstrate that simply adding a single grass species such as Maru phalaris to a ryegrass monoculture can significantly increase seasonal yields. The Maru and HENui mixture showed good compatibility, Maru offering extra autumn and winter growth without affecting performance of Nui.

This cool-season advantage is consistent with the growth rhythms of Maru phalaris (Rumba11 1980).

The Maru mixture yielded 16% more than ryegrass monoculture in winter and 19% in autumn (Figure 2). In winter, improved cow nutrition will increase milkfat production per cow and improve cow condition as mating approaches (a period of peak animal stress, Brookes 1986). Feeding the herd above animal demand over autumn will also improve animal production but more importantly allow the cow to be dried-off in a state of increasing cow condition which will in turn improve cow performance in the coming lactation. Including Maruphalaris in a HE ryegrass mixture has the potential to achieve both these objectives.

The animal performance on these species was compared with that on ryegrass in South Taranaki under intensivedairying(3.7 and 4.3 cows/ha) over 4 lactations. Pastures of Roa tall fescue and Maru phalaris produced at least the same amount of milkfat (MF) as perennial ryegrass (ryegrass 690, tall fescue/phalaris 698 kg MF/ha respectively) (Thomsonet *al.* 1988; Thomson 1988). However, in 2 of the 4 lactations (a wet winter, cool spring and a dry summer-autumn), they yielded 50 kg/ha more MF than the ryegrass pastures. Cows on the alternative species also had consistently higher body weights.

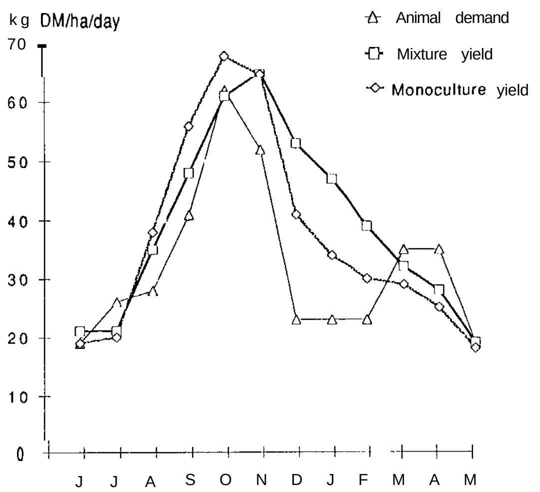

Figure 3 Mean monthly total DM yields and predicted animal feed requirement - Castlepoint. (derived from a 5.5 kg ewe rearing 1 lamb, stocked at 18SU/ha),

Castlepoint

Pasture yield

Over the 6-year trial, the Wana cocksfoot mixture yielded on average 1.4 t DM/ha/yr more than the 'Grasslands Ruanui' perennial ryegrass monoculture (13 956 vs 12 615 kg DM/ha) ($P<0.01$). The seasonal advantages of the Wana mixture over Ruanui were in summer (11 kg DM/day) and autumn (4 kg).

Pasture composition

The Wana mixture was dominated by Wana in all seasons (Table 2). Wana content was highest during winter and lowest in summer (51%). Roa tall fescue contributed most to yield in autumn and least in winter, while Puna chicory peaked in summer at 6%.

In the Ruanui pasture, ryegrass contribution to yield was highest in winter, similar in autumn and spring and lowest in summer. In this pasture, other summer components were white clover, dead matter (both at 19%) and resident cocksfoot (10%). The line of Ruanui ryegrass sown had a 10% endophyte level; by year four this had increased to 90%+, clearly showing the significant effect Argentine stem weevil damage.

Contribution of Huia white clover was similar for both pastures in all seasons except in summer, when it contributed 19% of yield in the Ruanui pasture and 13% in the Wana. Subterranean clover occurred naturally in both pastures, but in the Wana pasture its annual yield was much less than in the Ruanui (5 1 vs 604 kg DM/ha). The Ruanui pasture contained 27% more dead matter (mean for 6 years) than the Wana, mostly during summer and autumn. Despite the predominance of Wana in the Wana mixture, nutritive quality appeared unaffected. Samples of the sown grasses only, Ruanui and Wana, taken in June and September, showed little difference in either digestible organic matter (% DOM) or crude protein levels.

Discussion

In the 6th year, winter treading damage reduced Wana cocksfoot, and increased in Roa tall fescue from 7 to 25% of yield. The significantly lower summer yield of white clover in the Wana mixture can be attributed to both the summer activity of Wana and to its dense, prostrate and aggressive habit. These same characteristics appear to have restricted the successful reseeding of subterranean clover, which significantly lowered its yield compared with that in Ruanui pasture. Had Grasslands Karacocksfoot, a more erect type withlower tiller density (Rumba11 1982). been commercially available at sowing, the balance of cocksfoot, tall fescue and clover might have been better. However, in years when winged thistle infestations were bad, Wana's aggressivehabitvirtuallyprecludedthistleestablishment, while the Ruanui pasture had up to 50-65% of ground cover in thistle.

There was aprogressive ingress ofresidentcocksfoot in the Ruanui pasture (10% of yield), and of resident ryegrass in the Wana pasture (8% of yield). This demonstrates the natural process of mixtures occurring by default in any given environment, regardless of what has been sown (Campbell 1990). However, by waiting for this process to occur naturally, one has forfeited the chance to utilise the genetic improvements made through modem plant breeding programmes (Rumba11 1983).

Although the Ruanui pasture showed a higher white clover yield than the Wana during summer (Figure 3) (because of Ruanui's low 47% of yield), the Ruanui pasture was poorly utilised by grazing animals in late-spring andsummer. At this time,proportionofflowering stem was very high, while the Wana mixture remained leafy. Also, proportion of dead matter (19%) was high in the Ruanui pasture during summer, and therefore under common grazing, stock preferred the Wana mixture over late-spring summer.

The key problems in this difficult environment (Table 1) are poor summer pasture growth and quality, and ryegrass staggers. The Wana mixture helped to alleviate both by yielding 34% more summer DM than the monoculture, and providing staggers-free forage (i.e. these species do not contain endophyte). The large seasonal summer advantage of the Wana mixture is clear. By exceeding animal demand at this time, finishing options become a reality in a system that has traditionally sold store stock. In addition, the building of breeding stock liveweight over late summer and early autumn should improve lambing percentage and ovulationrates.

Conclusions

The mixtures were compiled by careful selection of compatible species to address the key pasture problems and requirements at each site (Charlton 1991).

The grass mixtures demonstrated both annual and seasonal yield advantages over the grass monocultures, fitting more closely the animal feed demands of the respective systems, and so providing the potential for improving gross farm income through increased animal performance and carrying capacity.

Cocksfoot, tall fescue and phalaris all coped well with stresses. By contrast, the ryegrass monocultures yielded less annually and seasonally, particularly in summer and winter.

These results demonstrate the advantages of using simple grass mixtures in place of monocultures (e.g. ryegrass). Chosen with care andcorrectly established, a mixture of 2-3 complimentary grasses and clover species can profitably increase pasture performance.

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