Assessment of the performance of non-ryegrass pasture mixtures

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Abstract
Drawing on practical farming experience and on-farm observations, plus a range of trials from both published and unpublished sources, the authors have compared the relative benefits of mixed species pastures (MSP), also known as mixed herb leys, with traditional ryegrass white clover pastures. This collection of data, demonstrates production advantages using MSP, with lower weed and pest problems, leading to economic benefits and therefore contributing to more sustainable pastoral systems.
Keywords: animal production, endophyte, *Festuca arundinacea,* financial return, grassgrub, internal parasites, *Lolium perenne,* thistles

Introduction
Ryegrass and white clover based pastures are used very widely on New Zealand farms for their quick establishment, cheap seed, and ease of management and reasonable productivity. There seems to be a lack of awareness that ryegrass and to a lesser extent white clover, as species, have a number of shortcomings that affect the whole farming system. These shortcomings include poor tolerance of drought and grassgrub attack, weed invasion (i.e. thistles) and problems related to endophyte, yet such shortcomings are not shared by some alternative species.

In this paper we review the attributes of other species that can be used in pasture mixes to create more productive and persistent pastures, present some grazing trial data and examine the economics of sowing different pastures.

Pasture productivity
In recent years there have been an increasing number of reports demonstrating the increased productivity that can be achieved by the use of non-ryegrass pastures or multi-species pastures (MSP) e.g. Judd *et al.* (1990), Ruz-Jerez *et al.* (1991), Johnson *et al.* (1994), Daly *et al.* (1996), Rollo *et al.* (1998). Generally these comparisons have shown increased spring and summer production compared to ryegrass, little difference over autumn and in some situations increased winter growth.

Animal productivity
Just including Pawera red clover in the pasture mix gave an increase in beef meat output of about 10% in a grazing trial in the Manawatu (Cosgrove & Brougham 1988), an increase in milk production of 24% on a Bay of Plenty farm (Keogh & Thomson 1996) and a 24% increase in weaned lamb growth rate in the Manawatu (Keogh & Thomson 1996). These results are particularly significant in organic systems reliant on clovers to build soil nitrogen levels, as there is a strong relationship between nitrogen fixation and productivity of clovers (Sinclair 1973)

A grazing comparison of tall fescue and ryegrass pastures in Hawkes Bay (Wright *et al.* 1985) showed that for lambs fed the same pasture allowance in early summer, carcass weight gains were not different between the pasture types and taking a previous silage cut made a significant impact on ryegrass liveweight gain, but had little effect on lamb liveweight gain on tall fescue pastures. However for ewes grazed on the same pastures from January to March the higher live weight at mating on the tall fescue based pastures, which resulted from better autumn growth rates (about 100g/hd/day difference during the trial period) gave an extra 11% and 20% lambs born/ewes mated on the tall fescue pastures in the two years of the trial.

Similar results have come from comparisons with more complex mixtures with deer in Otago (Table 1).

Other studies have looked at the advantages from MSP on milk production, where on-farm studies in the Waikato have shown increases of around 16 – 23 % (Thom *et al.* 1998, 2002). Several of these reports attribute much of the increased production to the higher legume content of the pastures which do not contain high endophyte ryegrass, although freedom from ryegrass staggers and facial eczema are also mentioned (Thom *et al.* 1997).

Animal health
Endophyte
The effects of the alkaloids produced by the various ryegrass endophyte fungi that protect ryegrass from damage by Argentine stem weevil have been extensively documented (e.g. Woodfield & Matthew 1999).

Fletcher *et al.* (1999), reported a list of known health and production problems in sheep associated with grazing perennial ryegrass with endophyte. These included reduced weight gains, increased dags and flystrike, heat stress and staggers.

It is very difficult to get young sheep to grow any faster than 120-150 g/day during their first autumn no matter how lush the high endophyte ryegrass pasture, whereas on species such as timothy, tall fescue, Prairie grass or low endophyte ryegrass and lucerne, growth rates of 200-240 g/day are possible (Scales *et al.* 1995; Fraser & Rowarth 1996), and on chicory, growth rates in excess of 300 g/day are possible (Scales *et al.* 1995)

This suggests that young stock grazing high endophyte ryegrass are under considerable dietary stress. Such stress is likely to make them more susceptible to internal parasites. The authors' on-farm experience have been that the need for synthetic anthelmintics is substantially less when young stock are grazed on mixed pastures free from high endophyte ryegrass.

Livestock such as deer and Alpacas are extremely susceptible to ryegrass staggers, so it is more important to have endophyte free pastures available for such animals. Alpacas are so susceptible to ryegrass staggers that once exposed to endophyte poisoning, the staggers will reoccur whenever the animals are stressed (Anne Rogers pers. comm.).

Mineral levels

Having a range of species in a pasture is an accepted way to balance the mineral status of the diet i.e. tall fescue tends to have low sodium content, which can be a problem in simple mixtures, but is not in complex mixtures. Including herbs, such as chicory or plantain in the pasture, is a particularly effective way of increasing the mineral content of the pasture (Crush & Evans 1990; Stewart 1996) which can give a useful improvement in animal performance (Scales *et al.* 1995).

Scales *et al.* (1995) and Knight *et al.* (1996) have shown that lambs feeding on lucerne and chicory can have lower levels of internal parasites, which may have the potential to reduce the need for anthelmintics.

Thus it is important for optimum livestock health and performance that mixed pastures are used – it is not sufficient to plant novel endophyte ryegrass based pastures.

Weed infestation

Ryegrass pastures are quite prone to invasion by weeds such as thistles, particularly after a dry autumn or grassgrub/Porina damage. A grazing trial at Geraldine was established in 1987 to investigate compatibility of grasses and legumes with Puna chicory. The trial was laid out with three replicates with 10 m^2 plots and dense, even swards were formed across the whole trial. The trial was separately fenced and periodically grazed with large numbers of sheep during the first three years, after which the fence was removed and grazed as a typical rotationally grazed sheep pasture. In the second year, following a very dry autumn, counts of nodding thistle were made and after progressive invasion by Californian thistle, further counts were taken in Year 7.

Thistle numbers recorded illustrate the potential for other pasture species to reduce weed invasion compared to ryegrass (Table 2). The general pattern was that those species that best form a complete sward, with good cover of the sown species, such as tall fescue and cocksfoot, were best at preventing the invasion of both Nodding and Californian thistles.

A further noteworthy observation was that the numbers of chicory plants were very low by the time the Californian thistle counts were taken in Year 7. Yet wherever chicory had been included in the original mixture, the number of Californian thistle plants was very low. There were clear, straight lines across the trial, dense Californian thistle on one side and nothing on the other side where the chicory had been grown. Since most Californian thistle rhizome growth commonly occurs in the compacted zone just below the cultivation zone, it seems likely that the deep taproot of chicory may be breaking up compacted layers down the soil profile, and making conditions unfavourable for Californian thistle growth.

Insect damage

The numbers of grassgrub larvae in the soil are controlled into a cyclical pattern by natural pathogens and predators. Unfortunately the level at which grassgrub numbers usually start to crash is higher than the level at which substantial damage starts to happen to ryegrass-based pastures. Two trials that measured the effects of a high population of grassgrub larvae on grass pasture productivity, showed that of all the commonly used grasses, ryegrass was by far the most sensitive (Tables 3 and 4)

A more recent study with phalaris mixtures (Fraser 1994) confirmed that pasture and animal productivity of species such as tall fescue, phalaris and cocksfoot are little affected by grass grub while ryegrass productivity is substantially reduced. An observation by David Musgrave (Author), on his own farm at Woodbury near Geraldine, is that, since using MSP for 15 years, the visual appearance of grassgrub has been negligible. However on sampling the soil on one occasion, he found that the population of grubs was 600 /m^2 – an unusually high population, which would have eliminated a ryegrass based pasture, but in this case still supported a productive MSP.

Business case

Assumptions

The financial data are taken from Profit Plan Gross Margins provided by an Ashburton based farm management consultant (Rae 2003). The returns, as presented assume a conservative 10% increase in animal

Table 1 Spring/summer productivity of deer grazing various pasture types at Invermay.

Pasture types	Grazing days (stag equivalents) (over spr/sum)	Deer live-weight gain (kg/ha/day)	Total spr/sum liveweight gain * (kg/ha)	Relative productivity *
High endophyte Nui ryegrass	1089	6.05	11.4	100
Low endophyte Nui ryegrass	1769	5.52	9.9	86
Roa tall fescue	2326	6.40	14.9	130
Roa tall fescue/Pawera red clover and Puna chicory	2470	7.17	17.7	155
LSD	460			

After Stevens *et. al.* 1992 (total liveweight gain calculated from the data).

Table 2 Levels of thistle infestation of various pasture species.

Sown species	Cultivar	Nodding thistle (plants/m^2) Year 2	Californian thistle (stems/m^2) Year 7
Perennial ryegrass	Droughtmaster	1	30
Chicory	Puna	0.1	2
Tall fescue	Au Triumph	0.2	1
Tall fescue	Roa	0.8	6
Cocksfoot	Saborto	0.1	4
Prairie grass	Matua	1.7	33
Sheep's burnet		0.9	31
Italian ryegrass	Concord	3	27

Table 3 Autumn and winter pasture production in the presence or absence of grassgrub at Wairakei.

	Cultivar	Insecticide treated (kg/ha)	Untreated (kg/ha)	% loss
Perennial ryegrass	Ruanui	2480	520	79
Tall fescue	S170	3180	2870	10
Cocksfoot	Apanui	2130	1760	17
Prairie grass	Matua	2520	2040	19
White clover	Huia	1700	500	71

Adapted from East *et al.* (1980).

performance from mixed pastures (a difference exceeded in all the trials referred to in Animal performance), that only one topping in the second season is required to control thistle growth (our experience) and that mixed pastures do not need topping to remove seed head growth to maintain pasture quality as most ryegrass pastures do (our experience).

We have made an attempt to quantify the potential costs and returns from planting a mixed species pasture compared to a simple ryegrass-white clover pasture (Table 7). The costs and returns are based on an East Coast sheep/beef farm and Taranaki dairy farm, but it is a relatively simple exercise to apply a similar cost/ benefit analysis to an individual farm situation.

Net returns from 16-25% higher by using MSP

Table 4 Grassgrub numbers and autumn pasture production in the presence or absence of grassgrub in Central Hawkes Bay (averaged over 3 years).

	Autumn grass grub numbers (no./m^2)	Autumn dry matter production (% loss)
Ryegrass	180	33
Tall fescue	235	6
Phalaris	247	18
Prairie grass	206	14
Cocksfoot	106	10
Browntop	181	37

After Kain *et. al.* (1979)

Table 5 Costs and returns from various pasture types.

	Ryegrass(with AR1)/white clover	Clover-based mixed pasture (MSP)	Lucerne-based mixed pasture (MSP)
Sheep & beef (over 3yrs)			
Income(10 su /ha)	$660 x 3 = $1980	$726(660+10%)=$2178	$726(660+10%)=$2178
Seed costs	$240 ($210 – 280)	$250 ($240 – 265)	$230 ($220 – 250)
Variable costs –			
Thistle control	$60 (3l Tropotox)	$20 (1 topping)	$20 (1 topping)
Pasture topping	$60 (1 per annum)	Nil	Nil
Grassgrub control	$75 (BioSheild)	Nil	Nil
Total costs	$435	$270	$250
Net return	$1,545	$1908 (23% increase)	$1928 (24.8% increase)
Dairy (over 3yrs)			
Income (12 su /ha)	$610 x3 = $1830	$671(610+10%)=$2013	
Seed costs	$185 ($175 – 230)	$310 ($240 – 360)	
Variable costs –			
Thistle control	$60 (3l Tropotox)	$20 (1 topping)	
Pasture topping	$60 (1 per annum)	Nil	
Grassgrub control	$75 (BioSheild)	Nil	
Total costs	$380	$330	
Net return	$1,450	$1,683 (16% increase)	

After Rae (2003).

compared to ryegrass based pasture over a 3 year period are demonstrated (Table 5). It is widely assumed that the cost of sowing mixed species pastures is substantially greater than for a simple ryegrass-white clover pasture. The cost of using ryegrass seed containing the new novel endophytes means that this is currently not the case. Since the novel endophytes only partially address the limitations of ryegrass as a pasture species, this relatively simplistic look at the economic performance of various pasture mixtures highlights the need for farmers to re-evaluate their choice of pasture mix.

Conclusions

The authors have used mixed species pastures extensively on farms on the summer dry East Coast areas, with useful increases in productivity and profitability. Similar reports have been published from many areas of New Zealand. By addressing many of the inherent limitations of ryegrass-based pastures, non-ryegrass mixed species pastures are able to have a considerable impact on the health and productivity of a wide diversity farming systems throughout the country, thus contributing to the overall sustainability of these pastoral systems.

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