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# Central Canterbury Organic Growers' Technology Transfer Project

## Mixed Pastures For Organic Livestock and Cropping Systems

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Ryegrass and white clover based pastures are used almost universally on New Zealand farms for their quick establishment, cheap seed, and ease of management and reasonable productivity. What is not generally recognised is that such pastures have a number of inherent limitations that can affect the whole farming system.

In this article I will focus on some of the shortcomings of ryegrass based pastures. This article also discusses the attributes of other species that can be used in pasture mixes to create more productive and persistent pastures and some establishment suggestions.

### My Background

I grew up on the 140 ha mixed cropping farm I now own at Woodbury, near Geraldine. I spent 6 years at Lincoln University doing a Masters degree in Agronomy and went on to spend 14 years working for MAF Research as a scientist in the South Island High Country and the East Coast Hill Country. Right through this time most of my work was focussed on the potential for deeper rooting and more drought tolerant pasture species than the traditional ryegrass/white clover pastures.

I then became a plant breeder for Dalgety AgResearch in Timaru, which held the marketing rights for some of the key species I had previously been trialling. This gave me the opportunity to get some of these species out onto farms and to develop mixtures that worked in practice to give improved productivity and animal health. About this time I started farming my own property using organic techniques and consulting for other farmers, so during the last 15 years I have been able to refine the concepts even further. The following comments are my reasons for always using mixed pastures on my own farm and in my recommendations to the clients I consult for.

### Ryegrass Based Pastures?

Most scientific reviews on the subject of pasture mixes find there is no consistent pattern of increased dry matter production from using mixed pastures of other species. I am not aware of any farmlet studies comparing animal performance on ryegrass versus mixed pastures, so the lack of a dry matter response is usually taken to mean that the correct decision for farmers is to continue using ryegrass-based pastures. There seems to be a lack of awareness that ryegrass, as a species, has a number of shortcomings which affect the whole farming system, which are not shared by all grasses.

### Productivity

Comparisons of productivity of ryegrass/white clover pastures and more complex mixtures based on ryegrass do not generally show any increase in productivity by the mixtures. However in recent years along the East Coast of NZ there have been programs aimed at increasing the use of non ryegrass, more drought tolerant species to improve productivity. Unfortunately these have generally been simple one-grass/ one-legume mixtures. My experience has been that this type of pasture does not confer the same benefits as more complex mixtures.

Where complex mixes based on deeper rooting species have been trialed; data has shown that even under irrigation such mixes are capable of producing more dry matter than ryegrass-based pastures.

Data on animal productivity on mixed pastures is very scarce. However a trial in the Manawatu was able to show increases in beef meat output of about 14% by use of a newly released red clover cultivar. This is particularly significant in organic systems reliant on clovers to build soil nitrogen levels, as there is a strong correlation between nitrogen fixation and productivity of clovers.

To a large extent the productivity of a mixed pasture depends on the suitability for the environment, management regime and the compatibility of the species sown.

### **Animal Health**

The alkaloid produced by the ryegrass endophyte fungus (which protects ryegrass from damage by Argentine stem weevil) also acts as an antifeeding agent for livestock. Thus it is very difficult to get young sheep to grow any faster than 120-150 grams per day during their first autumn no matter how lush the high endophyte ryegrass pasture.

On species such as timothy, tall fescue, prairie grass or low endophyte ryegrass growth rates of 200-240 grams per day are possible and on chicory, lucerne or clovers growth rates in excess of 300 grams per day are possible. 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. My own experience on my farm has been that the need for synthetic anthelmintics is substantially less when young stock are grazed on mixed pastures free from ryegrass.

Species such as deer and Alpacas are extremely susceptible to ryegrass staggers, so it is vital 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.

Having a range of species in a pasture is an accepted way to balance the mineral status of the diet. 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 (which is very high in zinc, potassium and calcium) or plantain (which is high in magnesium and calcium) in the pasture, is a particularly effective way increasing the mineral content of the pasture, which can improve stock health significantly.

Investigations in progress suggest that some plants, such as lucerne and chicory, have substantially lower levels of infective larvae of internal parasites in the zone harvested by grazing animals, which has potential to reduce the need for anthelmintics. There is also some evidence for a degree of direct anthelmintic effect from including plantain in the pasture.

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

### **Weed Infestation**

Ryegrass pastures are quite susceptible to weed invasion, particular after a dry autumn or grass grub/Porina damage. I established a fully randomised grazing trial on my farm at Geraldine in 1987 to investigate grass mixtures with Puna chicory. In the second year, after a very dry autumn, counts of nodding thistle were made and after progressive invasion by Californian thistle further counts were taken in year seven. Thistle numbers recorded below illustrate the potential for other pasture species to reduce weed invasion.

**TABLE 1: Levels of thistle infestation of various pasture species**

Cultivar	Nodding Thistle Plants per m <sup>3</sup>	Californian Thistle Stems per m <sup>3</sup>
Perennial Ryegrass	1	30
Chicory	0.1	2
Tall Fescue - Au Triumph	0.2	1
- Roa	0.8	6
Cocksfoot	0.1	4
Prairie Grass	1.7	33
Sheeps Burnett	0.9	31
Italian Ryegrass	3	27

Generally the pattern was that those that form a complete sward with good cover of the sown species, such as tall fescue, were best at preventing the invasion of both Nodding and Californian thistle.

A really interesting result was that the numbers of chicory plants were very low by the time the Californian thistle counts were taken. Yet wherever chicory had been included in the original mixture the number of Californian thistle plants were very low. There were clear, straight lines across the paddock, thick Californian thistle on one side and nothing on the other side, where the chicory had been. This and other observations suggest that the deep taproot of chicory is breaking up compacted layers down the soil profile and making conditions unfavourable for Californian thistle growth. If one digs a hole down to the subsoil, one usually finds the Californian thistle rhizomes in the compacted zone just below the cultivation zone.

### **Insect Damage**

The numbers of grass grub larvae in the soil are controlled into a cyclical pattern by natural pathogens and predators. Unfortunately the level at which grass grub 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 grass grub larvae on grass productivity showed that of all the commonly used grasses, ryegrass was by far the most sensitive. Species such as tall fescue and cocksfoot were scarcely affected, while ryegrass production was dropped by 50-60%.

Since I started using mixed pastures on my own property, I have only once noticed faint signs of grass grub damage - when I sampled the affected area I found over 600 grubs per square metre – an unusually high population which would have completely disappeared a ryegrass based pasture.

### **Choice of Species**

**Tall fescue** - has many desirable attributes for use in mixed pastures. It is a deep rooting species that makes it one of the most drought tolerant of the common temperate species. Some cultivars have excellent spring growth - up to 25% more than ryegrass in the early spring, and because they do not rehead after flowering, they have excellent yields of green leaf over the summer.

A feature of tall fescue-based pastures is the excellent legume content - my experience has been that the right cultivars of tall fescue form an excellent base for very productive mixed pastures based on both lucerne and clovers. I have many testimonials from very satisfied farmer clients who have sown such pastures.

**Prairie grass** - has only been used in NZ pastures for about 25 years, but in that time has gained a reputation for high productivity, particularly over the autumn and winter. Unfortunately, it is almost universally recommended to be sown only with clover as a special purpose pasture. Yet a long term grazing trial in the Manawatu has shown that in more complex mixtures, Matua has thrived under both cattle and sheep type managements for ten years. My experience has been that in mixtures with tall fescue, both Matua and Gala grazing brome contribute significantly to cool season growth and will persist as long as the pastures are not set stocked for too long.

**Cocksfoot** - tends to be the most widely used of the other grasses. Cocksfoot has many attributes in common with tall fescue – drought and insect tolerance, and excellent summer autumn production. Unfortunately, a high level of cocksfoot in a mixed pasture severely reduces both lucerne and clover production compared to other grasses and cocksfoot is not particularly palatable to livestock. Both problems are particularly significant in organic systems, which reduces the usefulness of cocksfoot and I generally recommend only small quantities of cocksfoot in a mix.

**Phalaris** - is unique in its ability to thrive in high nitrogen, heavily grazed areas such as stock camps. Being a very hardy perennial, it competes well with the barley grass, which also thrives in such areas and can greatly reduce the barley grass problem. Phalaris is also totally resistant to grass grub.

Phalaris can be toxic to animals, but when used as a very minor component of a mixture this has never been a problem and it is one of the few species to persist in stock camps and under high levels of grass grub.

**Red Clover** - as I have already mentioned, red clover based pastures have the potential to increase legume yield and hence fertility build up in the soil. Although they are relatively short lived, they can still contribute significantly to the productivity of an organic cropping system.

**Lucerne** - as a single species is an open invitation to weed invasion, with high levels of soil nitrogen and bare ground during the cool season. While most research fails to find any yield increase from including single grass species in mixes with lucerne, I have experimented with various lucerne based mixes on my own and clients farms and the results have been very positive. If the right combinations are used the stands remain weed-free and productive, with excellent animal health and they make very high quality hay or silage.

**Chicory** - is the most important herb widely available at present. It is a very important component of mixed pastures because its high productivity, high quality and high mineral content promotes healthy animals. Its ability to improve the soil structure and reduce weeds is also important.

**Plantain** - has recently received the attention of NZ plant breeders and data is accumulating to show a reliable reduction in animal scouring and some degree of vermifugal effect. It also has high mineral content and the cultivar Tonic has excellent winter growth, which helps to counter the generally lower levels of minerals in cool season herbage.

**Sheeps Burnett** - has been widely used in the past for its high mineral content and good cool season growth. While it grows well on poor soils, I have found it to quickly reduce to a very minor component on more fertile soils.

#### **Some suggestions for mixtures**

For most situations a clover based mixed pasture will be easier to manage and will give good performance even in a dry year. Clover based pastures should include chicory, timothy, tall fescue, grazing brome, phalaris, cocksfoot, red clover, white clover, plantain and yarrow.

However, on lighter soils or drier environments it is worth going to a lucerne-based pasture. For such mixtures it is really critical to match the grass cultivars to the lucerne cultivars, so that the growth rhythms are similar. If this is not done you are likely to have either grass or lucerne dominating. I have established a number of very successful examples of lucerne based mixed pastures – including one on my own farm (800 mm average rainfall) which stayed as a very productive, well balanced, weed free pasture for ten years. Such lucerne-based pastures should include lucerne, chicory, timothy, tall fescue, grazing brome, phalaris and cocksfoot.

### **Soil testing**

It is advisable to get a soil test before proceeding to resow new pastures to check for the following:

1. That calcium, magnesium, potassium and sodium levels are present at close to the optimum ratios, which is important for plant and animal health. It is the ratio that is important rather than the absolute level and to calculate the ratios you need to know the Cation Exchange Capacity of the soil.
2. That phosphate and sulphur levels are present in close to the optimum levels.
3. That trace elements such as boron, cobalt, copper, selenium and zinc are present in close to the optimum levels. Lack of any of these elements can be particularly important for stock health.

Not all soil-testing laboratories routinely test for all these parameters – I personally use R J Hill Laboratories. If you want to farm organically it is helpful to get your soil test done through an organic consultant so that you get a fertiliser recommendation suitable for your system.

### **How to establish**

To establish new pasture you need to kill the existing sward by either:

- Spraying with herbicides or steam weeding, followed by direct drilling. If there are lots of annual species such as barley grass or thistles it may be necessary to spray in the autumn and again in the spring before planting.
- Prepare a conventional seedbed to plant into by cultivation.

To ensure that you get the pasture balance you wanted (and sowed), it is important to sow in early autumn (no later than early March) or early spring. This is because some of the species used in mixed pastures vary in their ability to establish at low temperature or are winter dormant (e.g., chicory). Late planting will mean that such species are poorly represented in the pasture.

It is important to drill at 2–3 cm depth – deeper planting will mean that some of the small seeds cultivars will not emerge. In dry conditions this surface can very quickly become dried out and give patchy establishment. I have found that heavy rolling immediately after drilling restores the capillary action to the soil and helps to keep the surface moist – which greatly enhances establishment. In windy areas, such rolling can increase the risk of wind blow during the establishment phase.

### **Pasture management**

Planted at the right time, a mixed pasture will establish at about the same speed as a ryegrass-based pasture.

It is desirable to take the first grazing when the pasture reaches about 10–15 cm height, as this will remove any annual weed growth and encourage the pasture to thicken up.

All the mixtures I have suggested are designed for rotational grazing rather than set stocking. This does not mean a fresh paddock is needed every day, but it is desirable to have at least four paddocks your stock can be rotated around.

**Conclusions**

I have designed and trialled mixed pastures (or mixed herb leys) extensively on farms on the summer dry East Coast areas. These pastures are based around the species mentioned above, but can incorporate up to 10-12 species. By addressing many of the inherent limitations of ryegrass-based pastures, mixed pastures are able to have a considerable impact on the health and productivity of organic (and conventional) farming systems.