Principles of a mixture

This tutorial outlines the principles and practices that are important for the successful management of a mixed pasture.

A mixture of clover with grazing herbs like plantain (*Plantago lanceolata*) and chicory (*Chicorium intybus*) gives a high quality pasture for lamb growth.

The dairy industry 'standard' pasture mix - ryegrass and white clover.

Why grow a mixture?

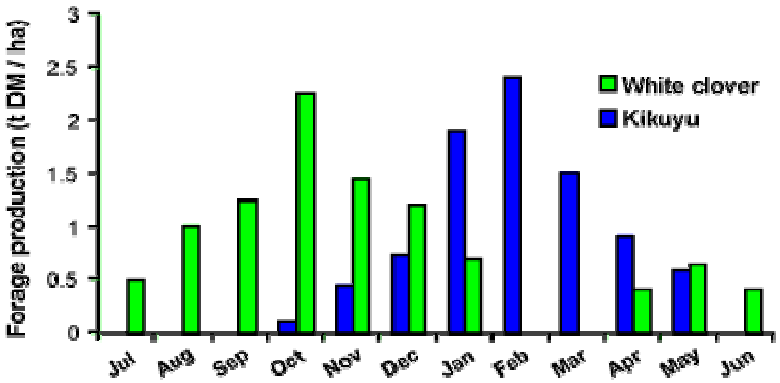
Most pastures are sown to a mixture of species, and commonly include more than one cultivar of some of the species. Why do we use mixtures, rather than monocultures? Monocultures should be easier to establish and manage, but are seldom used. There are several reasons why mixtures are generally preferred:

1. The mixture may produce a greater annual yield than a monoculture of any one of the species that are suited to the environment and the management system.

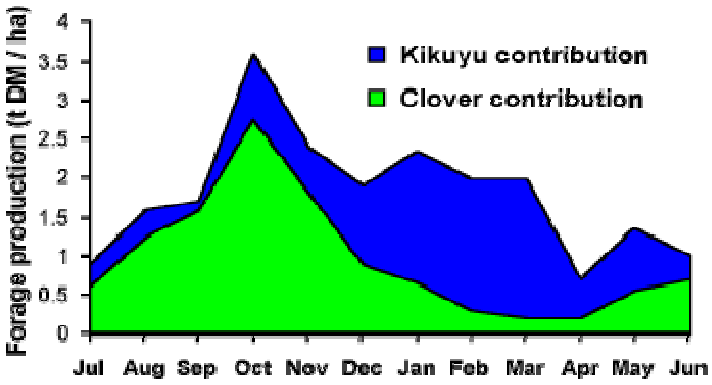
In the example below, from northern NSW, the white clover monoculture grew about 10 tonnes DM / ha during the year, the kikuyu monoculture grew about 9 tonnes, but the clover / kikuyu mixture grew 21 tonnes.

In this sub-tropical environment, the temperatures in winter are ideal for white clover growth, while the C_4 kikuyu grass responds well to the warmer summer temperatures. The mixture exploits the different temperature optima of these two species.

Seasonal production of monocultures



Seasonal production of a mixture



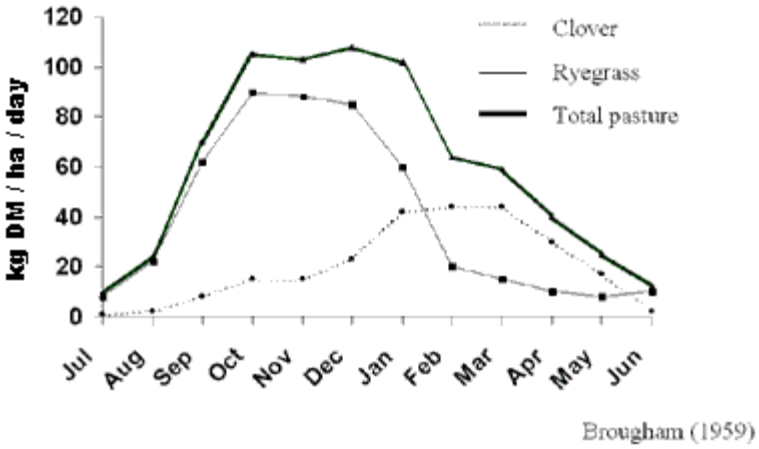
2. The mixture may produce a better *seasonal distribution* of pasture growth. That is, the supply of feed is more-evenly distributed over the year, or arrives when it is most needed for animal production.

The white clover / kikuyu example illustrates this point. So does the example below of white clover and ryegrass growing together in a temperate, high-rainfall environment. In this case, the extra growth of the mixture, compared to grass alone, comes from the clover in the summer. This extra feed is of high nutritive value, and is extremely valuable for milk production, or for finishing lambs or beef cattle.

Again, the different temperature optima of ryegrass (about 18°C) and white clover (about 24°C) are important factors governing the combining ability of ryegrass and white clover, and the yield advantages of the mixture.

Perennial ryegrass / white clover in a mixture

(moderate - high summer rainfall)



3. One component of the mixture may supply growth resources that enhance the growth of other components, and replace the need for artificial inputs.

Perhaps the best example of this is the grass / legume association, where the legume supplies nitrogen (through biological N fixation) which is used by the grass.

Root nodules in *Lotus corniculatus*. The nitrogen fixed by bacteria in these nodules, and transferred to grasses through the decomposition of legume plant material and via the grazing animal, is a cornerstone of low cost, pasture-based production systems in Australia.

Legumes, grown with grasses, are the cornerstone of pastoral agriculture in Australia. They save farmers many millions of dollars annually in the cost of N fertiliser that would otherwise be needed to support grass growth. This nitrogen can be equally useful for crop growth, in crop / pasture rotations. Legumes also produce high quality feed for animal production.

4. Some components may be included because they improve the nutritive, or feeding, value of the pasture in some way, and therefore lead to better animal performance.

The legumes, and other species like chicory, are especially valuable in this regard.

Lamb growth rates can exceed 0.3 kg per day on mixtures containing species with high nutritive value like chicory.

5. Including several different species and cultivars in the mixtures increases the gene pool (the distribution and frequency of genotypes or genetically-distinct individuals) of the pasture.

Each genetically-distinct individual in the mixture has certain environmental and management tolerances. Combining these may help minimise the risk of adverse establishment or growing conditions eliminating the pasture altogether.

The value of this insurance policy will be greatest when the environment imposes limitations on plant growth, or is highly variable in space and time.

Seed of common pasture species. Clockwise, from top left: phalaris, perennial ryegrass, sub clover, and white clover.

Competition

Growing a mixture means that the different species in the mixture will *compete* with each other for growth resources. Competition, acting along with environmental variation and management factors, can cause instability in the composition of the mixture, and unpredictability in the yield of the pasture.

This problem can be overcome to some extent by considering the combining ability or compatibility, of different species. Combining ability depends on the seasonal rhythms of growth of different species - species that combine best will generally be those that grow at or near their maximum rates at different times of the year, because they are not competing so directly with each other for growth resources.

We must also consider the different management requirements of each species, because we can use management tactics to control the interactions between species.

This mixture of chicory, red clover, a large-leaved sub clover, and Italian ryegrass contains species with similar management requirements, and different seasonal growth peaks. All the species are have high nutritive value. Therefore, it should make an excellent, short-term pasture for growing bull beef, which is how it is being used on this farm in western Victoria.

Pasture establishment

The success of mixtures can be determined by what happens at the very beginning of the life of the pasture - the establishment period after the seed is sown.

Some species establish (i.e. germinate from seed, and develop into a mature plant) faster than others. For example, annual clovers like sub clover are faster than perennial clovers like white clover. Among the grasses, perennial ryegrass establishes faster than other perennial grasses like cocksfoot, phalaris and tall fescue.

Fast-establishing species may crowd-out slower establishing species as the pasture forms. This is because they can 'capture' more of the available growth resources and space. As a result, slow-establishing species may never contribute to pasture production, and the money spent on purchasing seed has been wasted.

A new pasture being established by over-sowing into an existing pasture. Source: C. de Fegely.

A pasture in early stages of development, with the drill rows still evident.

Principles and practice

From this, we can see that several factors should be considered if pasture mixtures are to be used successfully, including:

- Total and seasonal pasture production potential and requirements, and the nutritive value of the pasture;
- The combining ability of the different components of a mixture;
- The establishment characteristics and requirements of the different mixture components;
- The management requirements of the different mixture components.

The following general rules of thumb can be used to help design and manage successful pasture mixtures:

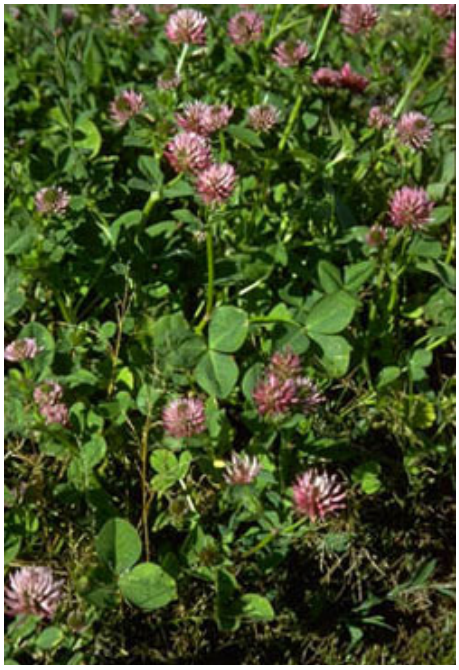
1. Mixtures will be most successful when they are based on species with peak growth periods that are separated in time.

This means they won't be competing directly with one another, and that their combined growth is distributed more-evenly over the year.

2. Where a suitably adapted legume is available, growing grasses and legumes together will generally bring benefits in the form of high quality pasture, better animal performance, and the supply of nitrogen for grass growth from biological N fixation.

It may also improve the seasonal distribution of pasture growth.

Combining ryegrass and white clover means pasture growth is spread more evenly throughout the year compared to growing either species in a monoculture.



Legumes are an important source of nitrogen for the growth of associated grasses.

3. The value of having a broad-based mixture of species and cultivars will be greatest when the environment imposes limitations on plant growth, and/or is variable in space and time.

Simple mixtures (eg. ryegrass and white clover) should be successful when the environment is relatively uniform and growth resources are abundant (eg. laser-graded irrigation systems). In these situations, the two or three species that best fit the purpose of the pasture can be chosen and used with confidence, and there are unlikely to be benefits from including more components in the mixture.

A laser-graded, irrigated pasture on the Dookie dairy farm. Simple pasture mixtures are appropriate for this relatively uniform environment. The hill in the background would, however, be a different story.

The mixture of slopes and flats in this scene, from western Victoria, incorporates a lot of variability and therefore many different conditions for plant growth. A broader-based seed mixture would help fill all micro-sites within paddocks with improved plant species.

4. Species that have markedly different grazing management requirements should not be grown in a mixture, since it won't generally be possible to manage a pasture to suit all the components.

In practice, most of the pasture species used in Victoria are tolerant of quite a wide range of grazing frequency and intensity. However, there are situations where management problems can arise.

For example, lucerne has quite strict management requirements. It must be rotationally / intermittently grazed. Set-stocking eliminates lucerne stands if it continues for too long. This can lead to management problems if lucerne is sown with a species like perennial ryegrass which, although generally well-suited to rotational grazing, requires fast rotations or set stocking in spring to maintain its quality.

5. Perennial grass species that are slow to establish, like tall fescue, cocksfoot and phalaris, should not be sown with faster-establishing grasses like the ryegrasses. This is because the ryegrass seedlings will out-compete the seedlings of the other species, leading to a ryegrass-dominant pasture.

A newly-sown pasture needs careful management to establish successfully.

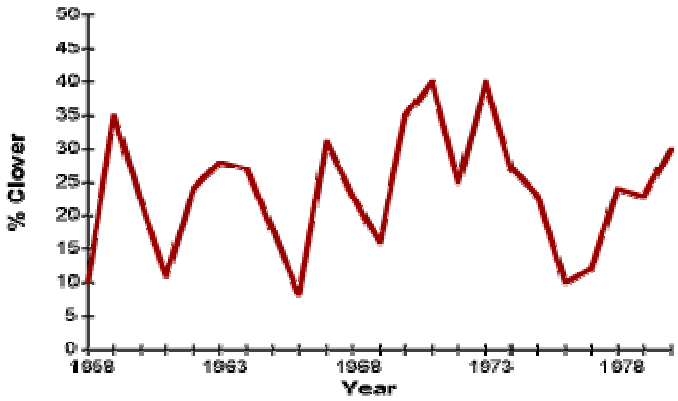
6. The sowing rate of mixture components should be reduced as the number of cultivars in the mixture increases, so that no one component out-competes others during the establishment phase

However, even when we follow all the rules, there will still be situations where the composition of the pasture fluctuates from year-to-year. The example below illustrates the sort of oscillations that can occur. Variability in pasture composition is one of the 'facts of life' when working with pastures, and it often creates problems for animal production.

The clover content of pastures is particularly variable, for reasons that are not fully understood. Variation in the weather will obviously be important in many situations, but subtle changes in factors like grazing management, nutrient availability, and pests and diseases could all be important too.

One of the challenges for the future is to gain a better understanding of why pastures 'wax and wane'. This should lead us to management strategies that counter the problem, and give better, more-reliable animal production.

'Good' and 'bad' clover years



Year-to-year variation in the content of white clover in a grazed pasture. Source: Steel, K. & Shannon, P. 1985