Plant / management interactions

This tutorial considers the management requirements of pasture species, and some of the management factors to consider when choosing pasture species for a particular end purpose.

In this tutorial, 'management' mainly refers to grazing management. Grazing management includes the species and class of livestock, stocking rate, and grazing method (set stocking, rotational grazing etc.) used on a property.

A large mob of sheep being rotationally grazed on hill country.

Grazing imposes a limitation on plants by interrupting their growth – it removes leaf area and therefore cuts the energy supply coming from photosynthesis. The grazing process can also physically damage plants, through trampling and the effects of dung and urine deposits which can bury or scorch plant tissues. These events are often occurring at the same time as the plant is dealing with other limitations, like sub-optimal temperatures, nutrient deficiency, or low water availability. Management recommendations for pasture species are based on knowledge of how they cope with these limitations, which in turn is related to their physiology and morphology.

Intensive strip grazing by dairy cattle can leave pastures bare. However, well-fertilised pastures will generally recover quickly from this sort of treatment.

There is great diversity among the species used for pasture production, for example in their life cycle, growth habit and morphology, physiology, and adaptive range. We have touched on some of this diversity in the previous tutorials.

Tall fescue (right), although closely related to perennial ryegrass (left), should not be managed in exactly the same way as ryegrass.

Because pasture species differ in so many respects, it is not surprising that they each perform best under certain management inputs. A single management recipe will not suit all plant species, just as all plant species are not suited to all environments. Thus, it is not a good idea to apply the same management used for common species like, for example, perennial ryegrass, to other species like, eg. tall fescue. This is true even when species are quite closely related taxonomically, as is the case with ryegrass and tall fescue.

It is important to match the management requirements of pasture species with the management system and skills of the property when designing pasture mixtures. If the management of the property is rigid, then the chosen species must be compatible with that management system. However, if the management system is flexible, a wider choice of species will be available, and there will be more options available to meet the goals of the farm business.

A Grasslands Productivity Program group considers pasture management requirements and options.

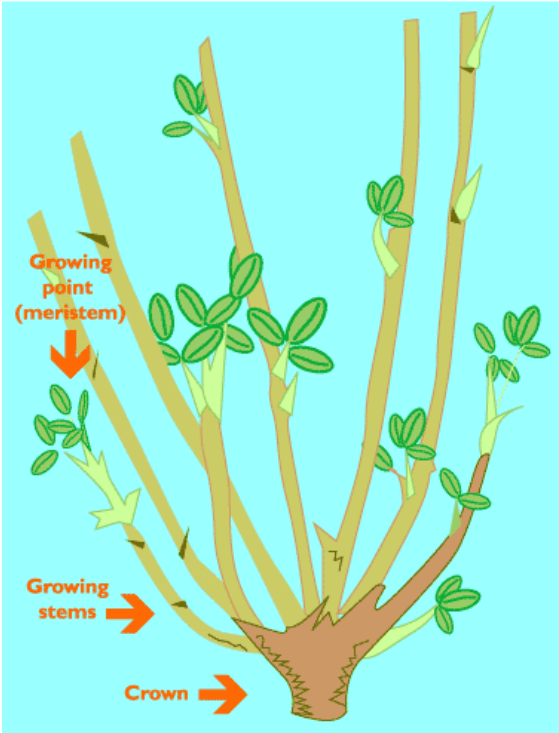
Source: C. de Fegely.

An example with lucerne

One of the best examples of a species that needs careful and specific management is lucerne. Lucerne is a high quality, drought-tolerant perennial legume and a very valuable animal feed. To be used successfully, it must be rotationally grazed, allowing 30 – 40 days between grazings. If it is set stocked, the lucerne stand is depleted, leading to an ingress of weed species and loss of productivity.

A good example of a healthy, well-managed lucerne stand.

The reasons for this are found in the physiology and morphology of the species. Lucerne is a crown-forming plant. It produces erect-growing stems from the base of the crown usually at or just above ground level. The growing point, or meristem, of the stem is located in the tip which is in the grazed layer of the pasture and can be easily removed by livestock. If this happens to a high proportion of the stems on a plant, the plant must produce new stems from older bud positions in order to re-establish leaf area and photosynthesis.



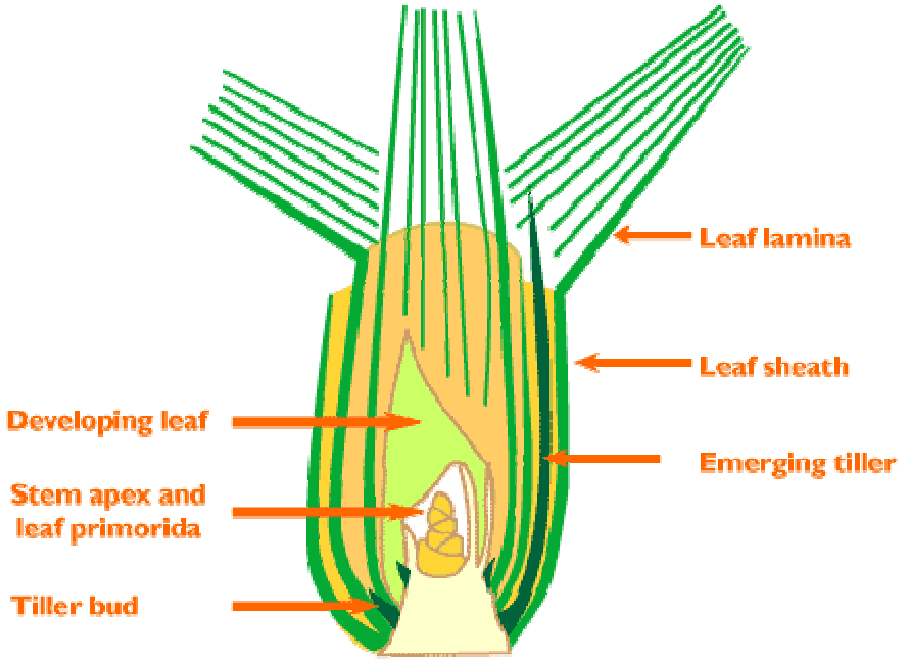
This can use up a lot of the plant's energy and protein reserves. The plant therefore needs time between defoliations to rebuild stem number, leaf area, and reserves. Some form of rotational grazing, where there is a sufficient spell between grazings, allows this to happen.

On the other hand, if the lucerne stand is set stocked, especially at a high stocking rate, plants may be re-grazed before they have had a chance to replenish their leaf area and reserves. If this occurs repeatedly, the plant may go into energy 'starvation' and eventually die, leaving a gap in the stand which might be occupied by weed species. This will happen more quickly if the plant is under additional stress, such as through low soil nutrient availability or inadequate soil water.

The grasses

In contrast to lucerne, the unit of growth in the grasses, the tiller, has its growing point, or meristem, located at the very base of the structure, often below ground level. It is further protected from grazing by the surrounding psuedo-stem of the tiller. This is a very important adaptive feature of the grasses, a result of evolution in the presence of browsing animals in environments where fire often disturbed the ecosystem too.

In addition, each site at the tiller base where a new leaf is produced is accompanied by another meristem, called an axillary meristem, where a new tiller can be produced (this structure is sometimes called the 'tiller bud'). Over time, grass plants build up a capacity to 'tiller out' from the bank of axillary meristems that have accumulated from earlier growth. This feature enables plants to quickly re-establish a dense sward following grazing or fire damage.



Because regeneration of leaf material from protected meristems and new tillers is assured in the grasses, they are generally tolerant of hard grazing (i.e a grazing event that removes a

high proportion of their leaf area). They can also withstand frequent grazing, as occurs under set stocking.

However, the perennial grasses, in particular, respond well to some form of rotational grazing. Indeed, where species are being used close to the limits of their adaptive range (for example, perennial ryegrass in a region with 650 mm annual rainfall), it is strongly recommended that they be rotationally grazed and not set stocked. This increases plant growth and persistence, leading to better long-term production and stability of the mixture.

The reasons for this are not fully understood but are probably similar to those that dictate the need for rotational grazing of lucerne. Although the grasses are better equipped for re-establishing leaf area than lucerne, they too use energy and protein reserves to do so. Where the plant is also coping with, say, poor nutrient availability or lack of water, it will struggle to replace those reserves because, in addition to growing more leaf, it must also pump energy into new root growth to sustain the supply of nutrients and water.

In other words, there are a lot of different demands being placed on energy and protein within the plant. Under these conditions, set stocking can increase one of those demands (for new leaf growth), at the expense of other 'sinks' (such as roots). Ultimately, the plant may fail to acquire enough energy or nutrients to supply all its needs to enable it to compete with other plants in the pasture.

Rotational grazing of perennial ryegrass in a 700 mm rainfall environment in western Victoria.

So, we have seen how the perennial grasses will *generally* tolerate set stocking, but also that they tend to perform better under some form of rotational grazing especially when there is a risk of other limitations to growth occurring.

However, some cultivars of some of the grass species *must* be rotationally grazed to survive. This includes the highly productive ryegrass cultivars that also have high nutritive value, such as tetraploid types like 'Quartet'. These plants can often be heavily grazed because the animals are able to maintain high intake rates while feeding on them. Skillful management is needed to avoid over-grazing them, and they should not be sown with the more-common diploid ryegrass types in the same mixture.

The productive, winter-active phalaris cultivars 'Sirosa' and 'Holdfast' also must be rotationally grazed if they are to survive for any length of time. Compared to the old

‘Australian’ phalaris, these cultivars have been bred for greater leaf production, meaning that they are less tolerant of the frequent grazing that can occur under set stocking.

In general, cultivars bred for high productivity will perform best under some form of rotational grazing. This includes most of the newer cultivars of grass species.

Rotational grazing of a phalaris / sub clover pasture in a 625 mm rainfall environment in western Victoria.

The clovers

The main clover species used in pastures in southern Australia, subterranean clover and white clover, are generally tolerant of set stocking. Their growth comes from laterally spreading stems or stolons, where the growing point is close to the soil surface and usually below grazing height.

They may also perform better under rotational grazing. However, because the grasses respond strongly to rotations, this can lead to some suppression of clover in a mixture. Hence the net effect may be similar or less clover in the pasture under rotational grazing compared to set stocking. It is generally considered that set stocking favours clover in a mixture, since it reduces some of the competitive pressure coming from the associated grasses.

A dense white clover population under set stocking management.

As is the case for the grasses, the more-productive clover cultivars will perform best under some form of rotational grazing. These plants usually have large, upright leaves that are able to capture a lot of light in competition with grasses (hence their greater productive potential). However, this means that when they are grazed, a high proportion of their leaf area is removed, and they must be allowed time to re-establish leaf area before grazing recurs.

Variation within white clover, from large-leaved, upright types (centre) to small-leaved, prostrate types (foreground).

Large-leaved white clover cultivars like 'Aran' and 'Kopu' are well-suited to rotationally-grazed dairy pastures, but are poorly suited to set stocked, sheep-grazed pastures. On the other hand, medium- and small-leaved cultivars like 'Prop' and 'Demand' are best suited to sheep grazing, and will not generally produce as much as other cultivars in a dairy system with rotational grazing.

This interaction between leaf size and grazing management is nicely demonstrated in the Table below, which compares the clover content of ryegrass / white clover pastures sown to different cultivars of white clover, and either set-stocked or rotationally grazed.

Cultivar leaf size	Individual leaf area (cm^2)		Clover content (% total pasture DM)	
	RG	SS	RG	SS
Small	2.09	1.30	13.3	20.8
Intermediate	2.75	1.15	11.0	13.1
Large-intermediate	4.08	1.30	15.1	7.0
Large	5.58	1.66	19.5	7.3

Interaction between grazing method and leaf size in cultivars of white clover. Four cultivars of different leaf size were grown under either set stocking (SS) or rotational grazing (RG), and the size of leaves plus the clover content of the pasture were measured for each cultivar. Source: J.L. Brock, Proceedings of the New Zealand Grassland Association, Volume 49, pages 203 – 206 (1988).

Note however, that the order of clover content among the cultivars was completely reversed under set stocking. Under rotational grazing, the larger-leaved cultivars expressed their genetic potential for producing large leaves, and maintained a greater presence in the pasture. Similar results would be expected for subterranean clover, which contains the same sort of range in leaf size as white clover does. Therefore, the choice of cultivar for a new pasture should match the intended management of that pasture.

Note also that these results came from pastures grazed at the *same stocking rate* (22 spring-lambing ewes per hectare) for all treatment combinations. The interaction is therefore entirely due to the different pattern of defoliation under each grazing treatment: uncontrolled and probably frequent defoliation under set stocking, versus controlled and less-frequent defoliation under rotational grazing.

This illustrates very clearly the importance of managing pastures correctly to not only reap the production advantages of plant material, but also to ensure they persist for long enough to recoup the costs of their establishment.

Sheep versus cattle grazing

Another consideration when choosing species and cultivars for a new pasture is whether the pasture will be used for sheep grazing, cattle grazing, or a combination.

Some plants, for example the high-producing, erect-growing ryegrass and white clover cultivars mentioned above, will do better under cattle grazing than under sheep grazing. This is because, compared to sheep, cattle do not generally graze as close to the ground, and therefore they leave behind more leaf, and don't tend to remove as much stem or stolon material either. This allows better recovery of plants after grazing.

Cattle grazing near Dunkeld in western Victoria.

Under sheep grazing, the regrowth of these erect-growing types may be reduced by heavy defoliation, even in a rotational grazing system. If a new pasture is to be used for sheep grazing, it is important to use species and cultivars that are tolerant of hard grazing by sheep, so that the persistence of the pasture is not compromised. This applies even when a combination of sheep and cattle grazing occurs.

Just choosing the most-productive plant type available may end up costing a sheep farmer money if the pasture lasts only a few years and the productive potential of the plants is suppressed by over-grazing.

Sheep grazing newly sown pasture. Care is needed to ensure young plants are not overgrazed at this early stage.

Conclusions

- Different pasture species and cultivars perform best under different grazing managements. No one management recipe suits all plants.
- The differences in management requirements are related to plant physiology and morphology.
- Mistakes in matching management and species can be costly for the farmer, just as mistakes in matching environment and species can be costly.
- To match management and species, we can either change the management on the property to suit the plant type, or select the plant type that will perform best under the existing management.
- In choosing species and cultivars for a new pasture, we must know what system of grazing management will be used once the pasture is established.
- Key factors are species of livestock (sheep, cattle), stocking rate, and grazing method (set stocking or some form of rotational grazing).
- The level of management skill on the property, and the degree of flexibility in management, are also important factors.