Proc. Ann. Conf. Grassld. Soc. NSW, pp 24- 30.

PERENNIALS IN THE TABLELANDS & SLOPES:

DEFINING THE BOUNDARIES & MANIPULATING THE SYSTEM

David Kemp

Senior Research Scientist, NSW Agriculture & Fisheries
Agricultural Research & Veterinary Centre, Forest Rd., Orange, NSW, 2800

Abstract: *The composition of pastures is less than desirable for maximum animal production. A survey of pastures in central NSW has shown that the proportion of legumes is lower than ideal and that annual grasses frequently account for more than a third of the pasture. Temperate perennial grasses and legumes can survive when rainfall is as low as 600 and 700 mm respectively, but rainfall needs to be above 900 mm for grasses or 800 mm for legumes before the perennials exceed the proportion of annual species in the pasture. Below these limits for dominance of perennials, management is critical to ensure their productive contribution to the pasture. At the limits where species grow, management is critical for persistence. Even where perennials are dominant, good management is required to increase the proportion of legumes or decrease weeds. Grazing management can affect the quantity and quality of forage on offer. Over recent years, 'controlled' grazing practices have been developed to help ration the fodder on offer. 'Strategic' grazing practices are being developed more to manipulate and improve pasture composition. These separate practices can be combined to help manage pastures within a 'pasture management envelope'. The 'envelope' sets upper and lower limits for the fodder on offer and legume content. Grazing pressure is increased or decreased to maintain pastures within the 'envelope'.*

Perennial grasses form the most stable components of pastures on the tablelands and nearby slopes. The grasses are more successful than legumes, but in many instances the productivity and composition of these pastures is less than desirable. Poor performance of legumes has been apparent for some time (Wheeler *et al*, 1987). To improve the productivity of pastures we need to know more about how they function ecologically and to use this knowledge to manage them better. We need to be able to define the boundaries where species are useful, where management is critical and how to positively manipulate the system. In this paper I want to first consider what we know about the composition of pastures in central NSW and then go on to examine grazing management - the principles that have been developed and what we are learning from current experiments.

DEFINING THE BOUNDARIES - PASTURES IN CENTRAL NSW

The less than desirable composition of pastures in central NSW has been regarded as a restriction on their productivity. However, there has been no objective information on the composition of species in 'typical' pastures, on how those species are distributed around the region, or on how they relate to one another. In the spring of 1988 and 1989, we surveyed the composition of pastures in an area from Turondale to Molong to Canowindra to Rockley (Kemp and Dowling, 1991). Pastures that were more than two years old and showed signs of 'improvement' were surveyed. The same parts of the same paddocks were surveyed in each year. This 7000 square km area covered a wide range in rainfall (600-1000 mm), altitude (300-1400 m) and the boundary where perennial and annual species overlap. The years of the survey were good years for pasture growth. Legumes, in particular, were probably at their best. In drier years we would expect to find fewer species and a lower proportion of the more drought sensitive ones.

LEGUMES

The distribution of legumes changed with altitude and rainfall, though not quite as expected. The effects of altitude are largely due to the decline in temperature and evaporation as altitude increases. Across the region the total proportion of legumes in pastures, averaged less than 40%. Legumes were in greater proportion on the slopes, where producers used more grass control practices, than on the tablelands. Subterranean clover (*Trifolium subterraneum*) was the most common legume (mean of 34% of the pasture) and occurred in all parts of the region, especially in the western part. White clover (*Trifolium repens*) was found above 700 mm rainfall and replaced subterranean clover in increasing amounts, though it was only a greater proportion of the pasture above 800 mm rainfall or 900 m altitude. White clover replaced subterranean clover on a 1:1 basis suggesting that both use the environment with equal efficiency. Which species was dominant depended upon rainfall and altitude. On the tablelands, where both subterranean and white clover were present, the total proportion of pasture legumes rarely exceeded 30%.

Lucerne (*Medicago sativa*) was only a very minor component (3%) in some pastures on the slopes, and absent on the tablelands, despite often being sown in mixtures. Annual legumes other than subterranean clover (*eg.* black medic - *Medicago lupulina* & ball clover - *Trifolium glomeratum*) were also very minor components (3%) in most swards.

GRASSES

Grasses were the dominant species across the region, accounting for over 50% of the pasture in spring. Annual grasses were found throughout the region and made up 40% of the pasture in the north-west and north-eastern parts. Soft brome (*Bromus molliformis*) was marginally more common than *Vulpia* spp. or annual ryegrass (*Lolium rigidum*), both of which were more common than barley grass (*Hordeum leporinum*). Each of these annual grasses averaged 8-15% of the pasture and the total proportion of annual grasses was 35%.

Perennial grasses comprised 21% of the pasture, ie. approximately half the proportion of annual grasses, and were most common in the central and southern parts of the region. Perennial ryegrass (*Lolium perenne*) was more common than phalaris (*Phalaris aquatica*) or cocksfoot (*Dactylis glomerata*). The proportion of these species varied from 9- 16%. Yorkshire fog (*Holcus lanatus*) and native grasses were 6-7%. Native grasses (*Elymus scaber, Aristida spp., Bothriochloa macra, Chloris truncata, Danthonia spp., Eragrostis spp., Microlaena stipoides, Panicum spp., Poa sieberiana, Stipa spp.)* were more prominent to the north east of Orange where the climate is drier and the pastures less developed. No native grasses were found in sown pastures or those where several phases of pasture development, or cropping, were evident.

Perennial grasses were found down to 600 mm rainfall, but only exceeded the proportion of annual species where the rainfall was greater than 900 mm or altitude above 900 m. Perennial grasses replaced the annual grasses on a 1:1 basis, like white and subterranean clover, as rainfall or altitude increased. On the tablelands, the total proportion of grass (*ie.* annual and perennial), where both groups of species existed, averaged 55%. It seems that, like the legumes, annual and perennial grasses use the environment with similar efficiencies. Which group becomes dominant depends upon rainfall and environment, though it is possible to modify these effects by management.

COMMENT - THE BOUNDARIES

This survey confirmed previous suspicions that the legume content of pastures in central NSW was less than desirable, accounting for only one third of the pasture. This low proportion of legumes is especially significant given that these measurements were taken in good years for pasture growth. Soils in the region are acid (Helyar *et al.*, 1990), but this may not be the main reason for low legume contents as subterranean clover was widespread and it is tolerant of the general levels of acidity. Ideally we need a higher proportion of legumes and perennial species. How to achieve this is uncertain. Climate has an over-riding influence, but within that constraint, management can be important. Management of a species is easy within the areas where that species is dominant. However towards the boundaries of where a species is adapted, management needs to be specifically designed to insure that that species survives and makes a productive contribution to the pasture. The boundaries which are important are those near the edge of the regional distribution of a species and also within a property arising from differences in topography or geology. Pastures on drier hills generally need more careful management to maintain species than those on the flats.

Native grasses were only a minor component of most pastures in central NSW. They have not survived past management practices. To utilise native grasses better we need to develop improved management practices and select more grazing tolerant ecotypes as is being done on the northern tablelands.

The survey confirmed the rainfall limits used to recommend where perennial species can be grown, but it also showed that at that limit those species were a low proportion of the pasture. Improved management is needed at those limits to enable species like white clover to make a more substantial contribution to pasture production and stability. Under normal circumstances some species do not make any significant contribution to the pasture until the rainfall is significantly higher than that required for persistence.

Grassland managers need to appreciate, that species and cultivars selected to survive and produce

under current management practices, are not perfect. To get the best out of pasture plants we need to adjust management to their needs, especially when near the boundaries of their adaptation. Continuous heavy grazing will kill most of them, but more subtle effects can occur as discussed below.

Pastures in this survey were managed by the usual practice of set stocking for most of the year at conservative stocking rates. We need to ask the question if the composition of pastures that was observed reflects this common management. There is some evidence that it does.

MANIPULATING THE SYSTEM - GRAZING MANAGEMENT

Grazing management of temperate pastures is necessary because seasonal patterns of pasture growth and animal requirements do not match. Producers aim to utilise as much forage as possible while satisfying animal demands. To achieve this aim, and minimise risk, most pastures are stocked conservatively. This can lead to low pasture quality and poor composition. At low stocking rates selective grazing by animals leads to overgrazing of some parts and undergrazing of others. Desirable species are often selected in preference to others which causes a shift in the botanical composition of pastures to less desirable species. Usually this pattern starts in spring when it is difficult to control the high pasture growth rates.

One of the reasons for current grazing practices is the highly variable Australian rainfall. More precise utilisation of pastures is difficult to achieve where year to year pasture growth is highly variable. However, with temperate pastures there is one aspect in our favour. Pasture growth is usually at a minimum in winter and this sets the limit on the carrying capacity of many properties. Winter is also the time of most reliable rainfall. This means that grazing management practices during winter, which aim to improve pasture performance and increase the carrying capacity of pastures have a reasonable chance of success.

The aims of improved grazing management often centre on more efficient utilisation of fodder *eg*. 'controlled grazing', and/or modifications of botanical composition. The systems that have, and are being, developed emphasise monitoring plant performance and being flexible. The first step is usually to increase stocking rates. Without stocking rates that achieve a high level of pasture utilisation for at least part of the year, there are few benefits from changing grazing practices. Grazing management can be improved to increase the profitability and sustainability of pasture systems.

CONTROLLED GRAZING

Controlled grazing systems, which emphasise *optimum use of fodder during the critical winter period*, have been developed in New Zealand and implemented in some parts of Australia, most notably Tasmania and Victoria. Benefits have been demonstrated, but no direct comparisons have been made between a controlled grazing system and simply increasing stocking rates. In Victoria, farmers involved in appraising controlled grazing systems ranked better pastures and control of ewe condition as more important to them than the extra work or expense of the system (McRae and Love, 1987). In NSW we lack any comparative data on the performance of such systems.

The New Zealand systems aim to ration the fodder supply to ewes during mid- pregnancy in winter. Stocking rates are increased to 500-2000 sheep/ha and animals rotated around many small paddocks. Electric fencing is widely used to enable large flocks to be confined for only a few days in each 'paddock', such that stock may only graze an area of pasture once each winter. Estimates are made of the fodder on offer and budgets prepared of the area required, to insure that all is consumed within a few days. Animals are then moved around paddocks based on simple rules of the residual dry matter (*eg*. minimum 500 kg DM/ha). The allowance starts at 1 kg DM/ewe/day in early winter and rises to 1.5 kg DM /ewe/day in late pregnancy. High grazing intensity and frequent movement of stock results in long rotation lengths, such that an area may only be grazed once each winter. A high level of fodder utilisation is achieved, and the total amount of fodder on pastures at lambing in early spring can be greater than normal. Some Tasmanian experience agrees with this (Beattie and Thompson, 1989). Pastures are then set stocked from just prior to lambing until after the next mating. The ability to carry more stock through winter, means there are then more animals to help control the spring flush and limit the decline in legumes from grass or weed competition. Another possible benefit from the system is a reduction in annual grasses. There is some evidence that long rotations in winter favour perennial over annual grasses (Morley *et al*., 1969; Kemp and Dowling, unpublished).

From the experience with controlled grazing systems in New Zealand, five important rules of pasture management have been formulated (Sheath *et al*., 1987);

- Match supply and demand of pasture as closely as possible.
- Maintain or generate desirable pasture composition.
- Ensure a dense pasture and thus an active leaf cover. Avoid extremes of low and high pasture mass.
- Maintain a high nutritional quality pasture, within the limits set by climate.
- Be flexible in pasture management. Optimum grazing management is always a compromise.

Obviously these rules are not rigid, nor could the same criteria be used in each season of the year, but they do cover the principles involved.

STRATEGIC GRAZING - MANIPULATING BOTANICAL COMPOSITION

Controlled grazing is an intensive procedure which requires producers to develop skills to monitor pasture and animal performance continuously. If higher carrying capacities are not desirable but a change in pasture composition towards higher quality components is, then alternative procedures are available. Higher legume, and/or lower weed contents in pastures can produce higher animal growth rates. The modification of botanical composition by grazing is a viable procedure for many situations and cheaper than re-sowing a pasture or providing supplements.

Two complementary strategies are often used when seeking to manipulate botanical composition. These are, crash grazing with high stock numbers when less desirable species are at a weak point in their life cycle and the converse of lax, or deferred grazing when desirable species are at a weak point. The main weak point that most grazing strategies concentrate on is the period of reproductive development. Legume persistence often depends upon manipulating management to encourage seed set, as well as seedling regeneration and survival. Even plants like some recent phalaris cultivars can be damaged by overgrazing during flowering. More subtle strategies can also be envisaged based on differences in species growth rates. For instance; over winter legumes usually grow more slowly than grasses. Overgrazing in winter could then favour grass dominance as could undergrazing which allows the legumes to be shaded.

Crash grazing has been used in one of the more notable successes in recent times. This has been done in the wire grass (*Aristida ramosa*) program developed at Tamworth (Lodge and Whalley, 1985). Wire grass can be reduced by heavy grazing when it is flowering, followed by a rest when Wallaby grass (*Danthonia*) is in flower. Previously on the northern tablelands, crash grazing for a week in spring was shown to greatly reduce the incidence of nodding thistle (*Carduus nutans*) (Medd, 1979). The effects were enhanced if grazing was combined with the use of a cheap herbicide.

Deferred grazing is one of the easiest techniques to use as it is not difficult to take stock out of a paddock. Paddock rests are used to encourage desirable species, as in the wire grass program, but they may also be of use for shifting the balance between species in a pasture. The feasibility of this approach is being examined in a current project in central and northern NSW (Kemp, Dowling and Fitzgerald, unpublished). The emphasis is on existing pastures where problem species, apart from annual grasses, are largely in the minority, but where we wish to improve or maintain legumes. We have been able to increase the proportion of legumes in pastures of annual species by excluding stock for a period in autumn and/or winter. However autumn-winter rests in perennial grass pastures led to grass dominance. Perennial species pastures need to be kept short (*eg*. to 10cm) to insure a high proportion of legumes. Preliminary results suggest that while periods of exclusion can favour perennial grasses over annuals, they also depress legumes. To improve the legume component, after a winter rest, pastures should then be kept short in spring. This work backs up the statement made earlier that current grazing practices may be the cause of the low proportion of legumes in pastures, as spring grazing is often light and the equivalent of deferred grazing.

Fodder conservation is not always considered to be an economic proposition. However fodder conservation can be a very useful tool in manipulating pasture composition (Kaiser and Curll, 1987). Being able to remove all the rank growth, seed heads and some weeds can significantly improve the proportion of legumes. In some instances a fodder cut can remove the need for herbicides. From a pasture management point of view, silage is preferable to hay as it allows faster pasture regrowth and earlier use of conserved areas for grazing.

Implementation of a system to change pasture composition requires consideration of several points (Wilson and Hodgkinson, 1990);

- Stocking rate is the most important management variable.
- Proper timing of rest periods for desirable species and pressure for undesirable species, based on the phenology of species, is important.
- Grazing systems can reduce production per animal unless there is a desirable change in botanical composition.
- Pastures with mixtures of desirable and undesirable species represent opportunities for grazing management.
- Grazing management should always be integrated with other options.
- Changes in botanical composition may take years. The restoration path may be a different grazing strategy to the degradation path.

PUTTING IT TOGETHER - A PASTURE MANAGEMENT ENVELOPE

The various aspects of grazing management discussed above can be brought together into a pasture management system. The main emphasis is on neither under or overgrazing pastures and in maintaining legumes within workable limits. If weed problems exist, grazing may help in their management, but in some instances other control procedures will be

needed. Similarly, fertiliser applications could be necessary to produce the quantity of forage required or enable legumes to grow. Figure 1 shows a generalised 'pasture management envelope' for temperate pastures. The aim is to maintain pastures within the limits set by the forage on offer and percent legume. The values for forage allowance relate to the amount of fodder which is likely to be available to sheep at the different levels of forage on offer, or the levels necessary to allow *ad-lib* or maintenance feeding. For example if feeding at a maintenance level and the lower limit for forage on offer chosen is 500 kg DM/ha then the forage allowance needs to be increased to 2 kg DM/ha/day to allow for the extra energy costs in grazing. Forage on offer or forage allowances are based on green forage yields, rather than totals.This figure is adapted from one originally developed for tropical pastures (Spain *et al.*, 1985) and it is interesting how these contrasting pasture types can be managed in similar ways.

Grazing pressure may be increased or decreased in several ways, depending upon circumstances. This can be by changing overall stocking rates, which changes the frequency plants in the pasture are grazed or changing the intensity of stocking *ie*. the stocking rate when grazing a paddock as in mob stocking practices. A conservation cut could also be used to reduce the forage available. The exact strategy used needs to be tailored to individual paddocks.

The amount of forage on offer can be estimated from the height of the pasture as shown in the table below.

kg DM (green)/ha	Pasture height (cm)
500	5
1500	15
2500	20

Note: In spring pasture heights will be greater for the same yield. Dry forage is also likely to be higher.

The **percent legume** is easy to overestimate as clover leaves are flatter than grass. The legume content is considered on a dry matter basis. Some approximate guidelines are listed below.

Legume percent	Clover appearance
15	obvious but spaced
30	looks reasonable
50	appears dominant

With the 'pasture management envelope' it is possible to consider a whole range of possible pasture development paths. Where high growth rates for individual animals is the aim then pastures should be maintained near the top of the envelope. Stock are then fed *ad-lib*. Where maintenance levels of nutrition are

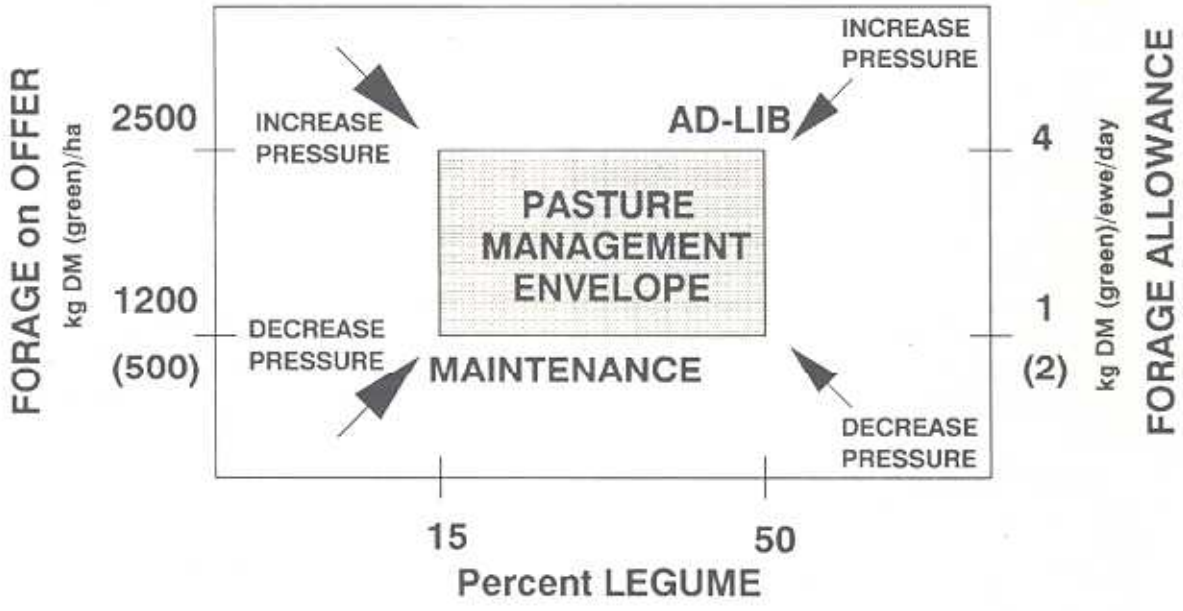

Figure 1: The pasture management envelope

This figure shows the general relationship between the percent legume and forage on offer,or allowance, that should be maintained to manage pastures for productivity and persistence. Increase or decrease grazing pressure, in the direction of the arrows, when pastures are outside the envelope by varying stocking rates, stocking intensity or the frequency of rotation. **NB:** *The forage allowance and 'on offer' is the dry weight of the green fraction.*

ses and legumes. *Proceedings XV International Grassland Congress, Kyoto, Japan* August, 1985, 1153-1155.

Wheeler, J.L., Pearson, C.J., and Robards, G.E. (1987). (Eds). 'Temperate Pastures: their Production, Use and Management'. pp 609. (Australian Wool Corporation/CSIRO: Australia.)

Wilson, A.D., and Hodgkinson, K.C. (1990). The response of grasses to grazing and its implications for the management of native grasslands. (Eds. P.M. Dowling and D. Garden) *Proceedings Native Grass Workshop*, Dubbo, October, 1990.