A question of scale

In the previous tutorials, we have considered several key environmental factors that influence pasture growth and distribution, and the adaptive features of plants that enable them to exploit, or tolerate, their environment. So far we have been working at the macro level, for example in describing the major climatic and pasture zones of Australia and Victoria, or general soil types and their features.

The most important limiting factors at this scale are climatic factors, but when we come to consider what is happening at the farm scale, other factors like soil fertility may dominate. Soil characteristics can vary from paddock-to-paddock within the farm whereas the climate will be constant across the farm area (except for micro-climate variation arising from, for example, differences in slope and aspect in hill country).

Soil factors become relatively more important at the farm scale, and may interact with the climatic environment. So, for example, the growing season may be extended beyond the regional average on heavy clay soils that store and retain moisture longer than soils of lighter texture.

A thorough appreciation of the environment for plant growth *at the paddock level* is needed to make good decisions about the choice of species to use in pasture mixtures. This appreciation can't be gained from generic maps of the type used in tutorial 3: their value is in providing a conceptual framework for understanding the occurrence and distribution of different environments for plant growth. Good knowledge of the site where new pastures are to be sown is essential if the pastures are to provide an efficient source of feed for animals.

An example of variability within the landscape, at Pittong near Ballarat. Conditions for plant growth vary from the shallow, dry soils on the hill sides and ridge in the distance, to deeper soils on the flats in the middle foreground which hold moisture longer and in some cases are subject to waterlogging (as indicated by the water lying in this photo). Different species may be required in each case.

Multiple limiting factors

Previous tutorials have also focused on individual environmental factors, and how plants respond to them. However, in the real world, several factors usually limit growth during an annual cycle, sometimes simultaneously. For example, plants may experience nutrient deficiency and water stress at some stage throughout an annual cycle.

Summer – moisture deficit is the prevailing limitation at this time. This stress can be accentuated by severe defoliation. As the year progresses, the plants in this pasture may also have to deal with low or high temperatures, nutrient deficiency, and pests and diseases at various stages.

The occurrence of multiple environmental limitations, plus the direct and indirect effects of grazing, means that pasture species must be highly resilient to survive. Plant species that have evolved in the Australian landscape (the native species) are, by definition, well adapted to the stresses of the local environment. However, modern intensive grassland agriculture relies mostly on introduced species that have evolved in different environments. These species are inherently more productive but only moderately well-adapted to the local environment so there is always the risk that they will be lost from the pasture.

There are two main approaches we use to exploit the greater productive potential of introduced species:

1. Careful management of the pasture. This includes supplying adequate plant nutrients to meet the needs of the more-productive species, as well as controlling grazing, diseases, and pest damage so that they are not placed under further stress. This approach essentially seeks to change the environment to suit the plant.

2. Selecting *within* species for plant types that are better able to cope with the environment, more tolerant of intensive grazing, more productive at some time(s) of the year, or have combinations of these or other features. These are common objectives of pasture plant breeding programs. This approach essentially seeks to change the plant to suit the environment. The effect is to increase the adaptive range of pasture species - in other words, the range of situations in which they can be used successfully.

Kangaroo grass (*Themeda triandra*) is a hardy native grass species that can cope with most environmental stresses. However, it is not tolerant of intensive grazing.

Phalaris (*Phalaris aquatica*) is an introduced grass species that is reasonably well adapted to environmental conditions in south-east Australia, and productive under grazing.

The effects of scale, and multiple limiting factors

This section highlights some of the issues to remember when establishing and managing new pastures.

Firstly, the only scale that really matters in the end is the paddock scale - that is, the unique features of the paddock to be sown (for example, the critical soil properties within the paddock boundary, and the topography of the paddock) must be identified before any decisions are made about what to sow in the paddock.

Secondly, when it comes to understanding what factors could limit pasture growth, we must remember that there is usually more than one factor at work all the time. It is the ability of plants to cope with *multiple* limitations which eventually determines their success. The introduced plant species which we rely upon for pasture production in southern Australia all originated in quite different environments to the ones where we grow them. They require careful management if they are to be used successfully.