Perennial pastures in cropping rotations – a discussion paper for Grain and Graze

The national feedbase project team

August 2007

Phase-farming systems in which perennial pastures are rotated with grain crops are attracting attention in many parts of the cereal-livestock zone. A number of the Grain and Graze regional projects are examining perennial forage options. This paper is designed to stimulate discussion and raise a number of farming systems issues that we believe should be borne in mind when thinking about perennial pastures in cropping rotations.

Why use perennial pasture phases?

As with any farming technology, perennial pasture phases have advantages and disadvantages. The main advantages are:

- Perennial forages generally have deeper roots than annuals, and so they can extract soil water and nitrogen from below the root zone of annual crops and pastures. Many of the perennials can also grow on rain that falls outside the annual growing season. As well as increasing the amount of pasture grown, this greater capture of water and nutrients can reduce losses of water and nitrogen through deep drainage, and so slow the onset of dryland salinity and subsoil acidification.
- Perennials tend to have a longer growing season. This, together with their capacity to produce "out of season" forage, can smooth out the feed supply curve. If managed appropriately, therefore, they can reduce the need for supplementary feeding and/or enable better utilization of other pasture resources, and so enable more livestock to be carried.
- Perennials – especially perennial grasses – provide more ground cover and/or anchored plant bases, reducing the risk of soil erosion.
- They provide an additional option to manage weed populations outside the cropping phase.

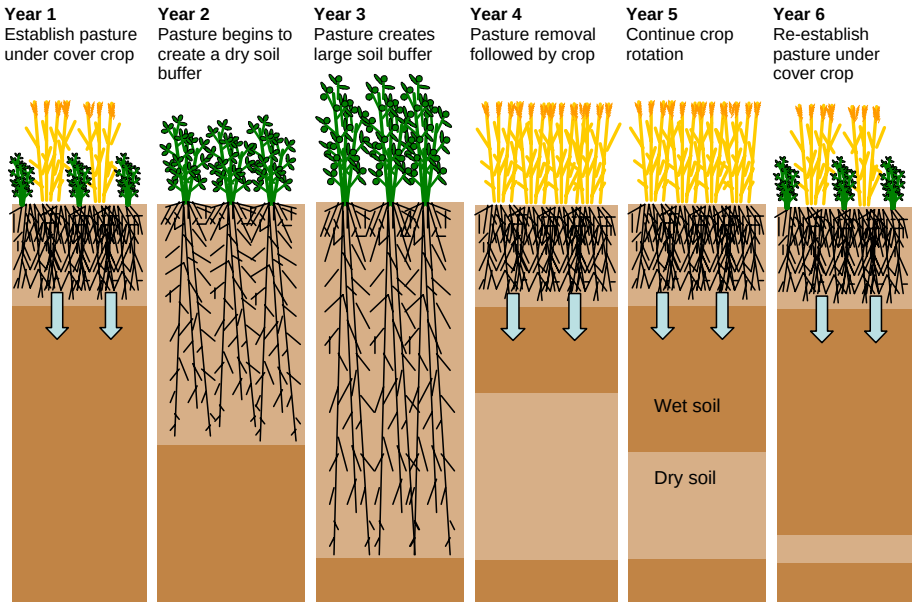

Figure 1. An example of how a perennial pasture can be rotated with a crop, and the way it will use deep soil water.

The corresponding disadvantages are:

- Perennial forages also use more of the water within the annual crop rooting zone. The drier soil profile at the end of the pasture phase can result in lower yields of following crops.
- They have higher costs of establishment than annual pastures, and the risk of establishment failure is greater. Perennial forages can also be more difficult or expensive to remove at the end of the pasture phase.
- Out-of-season growth is generally less reliable; more attention to risk management is required as a result.
- The residues of many of the perennials – including lucerne – are slow to break down, with the result that they can tie up soil nitrogen needed by a following crop for early growth.
- Some of the perennial pasture species are sensitive to grazing pressure, and require careful grazing management if they are to persist.

It is important to realise that the inclusion of perennial pastures in a mixed farming system will only make economic sense if the livestock enterprise is adjusted to take account of the resulting change in feed supply.

What perennial pastures might be suitable?

Several kinds of perennial pasture are used across the cereal-livestock belt.

Perennial legumes provide an advantage in a crop-pasture rotation because of the soil N inputs they provide and the high nutritive value of their forage. Lucerne is the major perennial legume grown in Australia's cereal-livestock belt; other perennial legumes such as birdsfoot trefoil, sulla, sainfoin, burgundy bean, butterfly pea are emerging or are used less widely.

Lucerne is the deepest-rooting of the perennial forage options and so uses the most water (for good or ill). It responds to summer rainfall by producing out-of-season green feed, but grows more slowly in winter than annual pastures. Too much lucerne on a property can therefore exchange an autumn feed gap for a winter one.

Pure stands of lucerne tend to have lower ground cover than other pastures – including annuals – but lucerne's perennial rooting system acts to reduce erosion risk. Animals grazing pure lucerne stands are also at risk of bloat. Lucerne is sensitive to low soil pH, to waterlogging and to saline soils, and it requires rotational grazing to maintain plant density and production.

Cool-season perennial grasses such as phalaris & cocksfoot have a growth pattern that is more similar to annual pastures than the other options. Because they are deeper-rooting than annual species, though, they will grow longer into late spring or summer. These grasses are more tolerant than lucerne to continual grazing pressure, but are not as deep-rooted and do not provide soil N inputs. Cultivars with different degrees of summer dormancy available: the more dormant varieties will persist better in drier areas, but will provide less out-of-season growth in response to summer rainfalls.

Warm-season perennial grasses include the panic species, kikuyu and Rhodes grass. They will, relatively speaking, provide more summer growth and much less winter growth than lucerne. Their overall productivity is more dependent on spring and summer rainfall; in summer-dominant rainfall environments their growth is therefore greater and more reliable than cool-season pastures, while in winter-dominant rainfall environments their growth will be very variable from year to year.

The forage quality of warm-season grasses is not as high as lucerne or cool-season grasses. Species are available that are adapted to a wide range of soil conditions; they tend to be tolerant of continuous grazing if not overgrazed.

Short-lived perennial herbs such as chicory and plantain are a relatively new option. They provide high-quality feed without the risk of bloat, and can be undersown into the crop prior to the pasture phase. These herbs are limited to the higher-rainfall parts of the cereal-livestock zone.

Shrubs such as tagasaste & saltbush are not really options for phase farming; they are better used as permanent forages, for example in alley farming systems.

Monoculture or mixture?

Monocultures of perennial species are most likely to be successful in favourable environments, where a higher density of perennials can be supported. Monocultures simplify management by removing the need to manage different species at the same time; for example, cool-season perennial grasses can compete strongly with lucerne, or one species in a mixture may be selectively grazed by livestock.

In many situations, however, mixtures with annuals or other perennial species will be desirable. The benefits of legumes in mixtures for biological nitrogen fixation, maintaining productivity and improving forage quality are widely recognised. In lower rainfall areas, only low densities of perennials can be maintained and perennials may need to be grown with annual species to obtain adequate system productivity.

A useful tactic is to grow a pasture mixture containing species with complementary growth patterns, such as combining warm-season perennial grasses with temperate annual legumes or cool-season perennial grasses that grow during winter and early spring.

Where on the farm do perennial pastures make sense?

The answer to this question depends upon whether they are primarily being considered in order to increase economic return, or as a way of improving the sustainability of a farming system while continuing to grow crops. In particular, where salinity is a major concern, perennial pastures would be planted on land that is at imminent risk of becoming saline and where amelioration of salinity can be achieved.

If economic returns are the main driver, then (at current prices) perennial pasture-based rotations will probably only be optimal on those soil types that are relatively less suited to cropping. These will typically be the less-productive soils, and the pasture species chosen need to be adapted to the soil conditions. For example, the sensitivity of lucerne to low pH, waterlogging and existing salinity may mean that it is difficult to grow on those soils where the economic case for a perennial pasture is strongest.

In some cases, however, there can be “win-win” scenarios. For example, in the Northern Agricultural region of WA, Grain & Graze results suggest that warm-season grasses do best on the pale deep sands that are less suitable for cropping.

When should perennials be sown and removed?

There are three options for timing the sowing of perennial pastures in crop rotations:

- **Undersow** into the final crop. This option is likely to reduce the yield of the final crop, and possibly reduce the likelihood of successful establishment. On the other hand, undersowing reduces the cost of weed control and minimizes the time required before the pasture establishes and the land can be returned to livestock production.
- **Early-season sowing** avoids the crop yield penalty and will result in the next-smallest delay in returning the land to livestock production. It carries a higher risk of establishment failure from a false break to the season, and there are fewer opportunities to control weeds prior to sowing.
- **Late-season sowing** may be required when temperature may limit earlier sowings, for example warm-season grasses in southern Australia. It results in the land being out of production for longer. The availability of initial soil water is more certain, and there is an opportunity to control previously-emerged weeds prior to sowing; but there is also a higher risk that soil water will run out before the perennial sward establishes properly. Spring sowing also makes it difficult to establish annual legumes along with the perennial pasture; they may need to be oversown the next year.

When considering how many years the perennial phase should last, the main factor to take into account is the use of deep soil water. Once the perennial pasture has exhausted any water that has

drained below the rooting zone of previous crops, its productivity benefit will reduce. The time required for this to happen will depend strongly on seasonal conditions.

Once the decision has been taken to remove a perennial pasture and return to cropping, the question arises whether it should be removed in the spring or in the autumn immediately before cropping. Spring removal provides a short fallow during which soil water can build up and then be used by the following crop; autumn removal means that any summer rainfall will be used for out-of-season forage production.

Other systems for perennial pastures

Alley farming is an alternative to temporal segregation of crops and pastures, in which perennial forages are separated spatially. This approach is most suitable for shrub species such as tagasaste, saltbush or leucaena.

Polycultures – also known as intercropping, companion cropping, or pasture cropping – are systems where pastures and crops are grown at the same time and in the same space. This eliminates the costs of establishing and removing a perennial pasture at the beginning and end of a phase, but there will generally be a reduction in crop yield due to competition for light, water and/or nutrients. As a result, polycultures will be most successful when the growth of the pasture and crop occur in different seasons.