Managing the pasture phase as a high value crop

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Abstract. Pastures do not look profitable when rated against high value crops grown in the best yielding paddocks. However, pastures are usually sown at the end of cropping phase so should be compared with the value of crops in low yielding paddocks.

In addition to high value grazing, pastures can have many tangible benefits to the farming system that are not valued. Pastures may improve soil fertility, increase organic matter, control weeds, lower the watertable, improve soil health and control erosion.

Latest technologies and agronomic advice are used in cropping, but if pastures were managed as a high value crop, higher levels of performance can be expected.

Introduction

Pastures in farming systems or pasture leys are not new to agriculture. For centuries this system has been the traditional management for sustainable farming (Weston *et al.* 2000). "A sustainable system is conventionally defined as one which meets the needs of the present generation without prejudicing the capacity of future generations to meet their own needs" (Humphreys 1991).

In temperate farming regions, pasture leys have been well accepted, but as farming has spread west and north into more tropical regions the practice has not been as widely adopted. This could be because pastures are not viewed as profitable as crops, a lack of infrastructure, or initial attempts have failed.

The most important contribution pastures can make to farming is to slow the rate of fertility decline, as defined by the loss of soil organic matter. Loss of organic matter results in lower soil nitrate levels, loss of soil structure, poor water infiltration and reduced soil microbial activity.

Pasture and cropping legumes accumulate nitrogen (N; Crocker and Collett 2003), but the contribution by grain legumes is smaller in comparison (Wylie and Clarke 1992). Pastures in our variable environment still remain one of the more efficient ways of supplying N to crops and increasing grain protein of wheat (Wylie 1996; Roesner 1998). Annual dryland lucerne production of 7-9 t/ha of dry matter added 140 kg N/ha/yr on black soil and 110 kg of N/ha/yr on red soil (Holford 1980). Across a number of experiments, Wylie (1996) suggested accumulation of N from lucerne ranged from 80-140 kg N/ha/year where conditions were favourable, while annual legume crops delivered less N to the system (5-25kg N/ha).

Pasture phases containing both legumes and perennial grasses make a bigger contribution to total dry matter than legumes-only and a greater contribution to soil organic matter. They also have the potential to maintain higher ground cover levels. Grass pastures and mixtures with legumes accumulate organic matter when they are not over grazed. When soil organic matter is reduced the soil particles are less stable and surface sealing increases limiting water infiltration and crop growth (Whitbread *et al.* 1996). Unstable aggregates are more easily eroded.

There are many other tangible benefits from pastures, including a significant reduction in annual weeds and reduced incidence of herbicide resistant weeds. Black oat numbers were significantly reduced to <1 plant/m^2, under a 3-year pasture phase of grazing lucerne as compared to the 17.5 plants/m^2, under 3 years of wheat (McDonald *et al.* 1998). Herbicide resistance is very much a problem in northern NSW. In seed from wild oat populations supplied by farmers, 42% showed resistance to Group A herbicides (O'Donnell 2004) and wild radish and 57% to Group B herbicides (Moylan 2004). A competitive pasture, grazed in combination with different herbicides is a proactive step toward reduced resistance.

In high watertable situations, a strong perennial pasture can assist in drying the profile and reducing the watertable. On the Liverpool Plains, Ringrose-Voase *et al.* (2003) demonstrated that lucerne and a tropical grass pasture could significantly dry the profile and concluded where rainfall was <800 mm/year there would be almost no deep drainage under a permanent pasture. In southern NSW, at Temora, lucerne lowered the watertable by more than 0.5 m in <1 year (Peoples 2004).

Profit from pasture is considered inferior to crops because pastures are usually sown at the end of a cropping phase to give the country a rest and improve structure and fertility. Realistically the profitability of a pasture rotation should be compared with the profit from low yielding paddocks. If we consider current management of pastures then it is clear why they are often inferior. During droughts and dry periods they can be overgrazed with loss of species and ground cover.

A review of soil testing by producers who only cropped and those who only grew pastures showed that 65% of croppers were using soil tests for decisions on fertiliser. Of the producers who grew both pastures and crops, soil testing for pasture fertiliser decisions only made up 27% of their soil tests (S. Murray, pers. comm.). On the North West Slopes, most new pastures surveyed were sown with fertiliser but only a small percentage had adequate maintenance applications in the following years. (McCormick, unpublished data).

In a mixed pasture, on the Liverpool Plains water use efficiency was only 30% of that recorded for cereal crops. Much of the difference in water use efficiency was attributed to the fact that only 50 kg N/ha/yr was applied to the pasture compared with 80-100 kg N/ha/yr to the cereals (Ringrose-Voase *et al.* 2003).

A pasture in the cropping system will only deliver its full potential if it is managed as a high value crop like canola. As part of this, pasture management objectives need to be set to reflect the type of pasture species sown, length of pasture phase and ultimately the class of livestock used. The range of objectives may include N accumulation, reducing the watertable, improving soil structure, increasing organic matter and ground cover, improving VAM, crop disease break, weed control and managing herbicide resistance.

Once objectives have been set there is a series of 9 steps that give the best possible chance of success.

1. Planning phase

The planning phase should ideally start 1-2 years prior to sowing. This allows for major management decisions on weed control, storing soil moisture, decisions on planting machinery, nutrition and seed sources.

Remember the most expensive pasture is one that fails to establish properly. Such pastures have reduced productivity and carrying capacity, are more prone to weed invasion and have a reduced capacity to combat various aspects of soil degradation. These deficiencies continue throughout the entire life of the pasture. Pastures that fail to establish will rarely pay back the cost of establishment and will eventually need to be re-sown.

2. Weed and pest control

Good planning before the pasture phase will reduce the weed burden and limit the need for expensive selective herbicides. Planning also ensures that residual herbicides detrimental to pastures are avoided.

Sowing on the second rainfall event will help control annual grass weeds which germinate on less rainfall or at cooler temperatures, giving an opportunity to again reduce weed competition to the new pasture.

Monitoring insect pests such as blue oat mite and mollusc's (slugs) is essential for young pasture survival. Early control is essential. Insecticides and molluscicides are available for control. Fungal diseases can affect the seedling survival of lucerne, particularly in cool wet conditions. Fungicides are available for seed dressing.

3. Soil moisture

Adequate soil moisture for sowing is ideal, but because seed placement is shallow the reality is the surface is usually dry and this is definitely the case when sowing tropical species.

Subsoil moisture is a more critical requirement for tropical grasses as evaporation in spring and summer is very high and germinated plants will quickly develop their secondary root system. A moist subsoil is necessary if a plant is to be given the best opportunity for establishment and survival.

4. Sowing time

Sowing time varies depending on the district, but generally temperate species are sown in autumn, from mid-April to end of May. Tropical species are sown in spring and summer, usually before the best rainfall months.

There are minimum soil temperatures for germination of tropical grasses as there are for summer crops, for example the minimum soil temperature for buffel grass (*Cenchrus ciliaris*) is 13°C, Rhodes grass (*Chloris gayana*) 14°C, Bambatsi panic (*Panicum coloratum* var. *makarikariense*) and bluegrass (*Dicanthium* spp.) 17°C, and purple pigeon grass (*Setaria incrassata*) 25°C.

5. Species selection

The species selected will depend on the objectives, such as using perennial legumes to maximise N accumulation, increasing water use or to provide a disease break for crops. Lucerne provides high quality pasture for prime lambs and cattle, but bloat is often seen as a high risk. Perennial grass mixtures in combination with a legume are very beneficial in a longer rotation for the accumulation of litter, ground cover, organic matter, improved soil health and increased water use.

The area of adaptation also plays a key role in what will grow best in a particular area so you need to check district recommendations.

Legumes need to be inoculated with the correct strain of rhizobia. This increases their chance of survival and greatly improves N production.

6. Seed placement

Seed placement is still one of the weakest links in pasture establishment. The seed is small and depending on the species should not be sown at more than 1 cm deep. In heavier cracking soils, it is possible to go a little deeper because of the soils cracking nature. Some grass species even prefer surface sowing.

Crop sowing technology has been well researched and although pasture sowing technology and machinery has developed more slowly it has advanced markedly in recent years.

If cropping equipment is to be used for sowing pastures it needs to be checked to ensure the seed can be sown at a shallow, even depth at the required sowing rate. Conversions can be made to existing machinery and a range of components and machinery are now available.

Even with the latest technology in pasture sowing equipment it is still imperative to check sowing depth the old fashioned way – get off the tractor and look.

7. Seeding rate

Seeding rate is more often than not a weak link in establishing a productive pasture. The conflict of seed cost and benefit is often solved by many producers sowing less than recommended rates and substituting cheaper cultivars for the best species.

Recommended seeding rates are usually a result of research and grower experience and are designed to give a plant population that will contribute to a productive pasture. It is not an option to be waiting for a sown pasture to thicken up and become productive when you consider the effect on the cumulative balance over 15 years (McDonald *et al.* 1998).

Seed coating technology has been used for many years to improve, among other things, the flow of fluffy tropical grass seeds. The weight of the seed coating needs to be taken into account when calibrating your sowing machinery as seed coat weights can be as high as 80% of the mixture.

8. Nutrition

Nutrition is essential for productive and sustainable pastures. The most productive pastures have the highest nutrient level; this is why they achieve high animal growth rates. How much fertiliser pastures need is generally misunderstood and programs such as the "Triple P Program" demonstrated the profitability in getting the nutrition, as well as management right (de Fegely 2000).

Duncan (1995) suggested a range of 0.6-2.1 kg phosphorus (P)/DSE was lost from grazed pastures

Table1. Loss of phosphate (P) from a grazed perennial pasture on medium textured soil

Stocking rate (DSE/ha)	P removal (kg P/ha)
5	6
7	8
10	12

and a guide (Table 1) was developed for medium textured soils.

Soil testing is a good guide to the P and sulfur (S) requirements which are needed by the legume component to produce adequate N for grasses in the pasture. Soil testing is also available for potassium and can be confirmed with test strips. Maintaining a legume in the pasture system will be discussed under grazing in a later section.

In low N situations grass will produce less dry matter, of lower quality. The survival of perennial grass species can be threatened and grasses such as Rhodes grass and purple pigeon grass will disappear from the pasture (B.R. McGufficke and W.J. Scattini, pers. comm.)

Table 2. Nutrients exported with a range of farm products

Product	Typical nutrient removal (kg)		
	P	S	K
Legume hay (1 t)	2.5	2.0	10.0
Wheat (3.5 t)	12.3	4.0	14.0
Wool (5 kg)	0.02	0.2	trace
Meat (50 kg)	0.4	0.4	0.3
Milk (1000 L)	1.0	0.6	1.5

Nutrient is being exported in animal and farm products (Duncan 1995; Bell 2003) and Table 2 shows the value of these exports.

Lamb and beef products account for 0.8 kg of P and S/100 kg of product. Put another way, 200 steers bought in and grown a further 100 kg will take off the property about 160 kg of P and S.

9a. Grazing management - new pastures

Grazing management for newly sown pastures is slightly different to established productive pastures and I highlight *productive* because if it is not productive then we are in compensation mode.

Sown perennial grasses, in northern NSW, are generally not grazed in the first year. This is so they can develop a large root system, grow bigger and go into dormancy with a higher number of regenerative buds for the following growing season. Phalaris, for instance, ungrazed in the establishment year had 80% more regenerative buds in spring before dormancy (G. Lodge, pers. comm.) and tropical grasses behave similarly. Reproductive buds are next season's tillers after the plants dormant period. Increased tiller production would be expected from a greater number of buds.

Exceptions to the "no-graze" rule will occur in high N situations and good seasons where growth is abundant and subsoil moisture is high. Light grazing under these conditions will help increase tiller numbers and promote additional bud development.

9b. Grazing management - established pastures

Established pastures need to be managed to achieve your objectives. Grazing will need to maintain botanical composition, and maintain the productive species you have sown in the pasture. Grazing should also be planned to promote the quantity and quality of forage required for your livestock classes and maintain ground cover and litter levels to manage soil health and water. The combination of plants and detached plant material, i.e. litter, are referred to as ground cover.

Botanical composition is often one of the hardest areas of grazing management because of variable rainfall and growing seasons. A proposal to manage tropical grass and legume pastures for evaluation was initially put forward by Spain *et al.* (1985). Pastures should be managed within limits that maintained a minimum of 15% and a maximum of 50% legume. Spain *et al.* (1985) also suggested limits to the minimum and maximum levels of feed on offer.

The setting of these limits for percentage legume combined with green herbage mass limits for the perennial grass and legume mix, led to the development of the pasture management envelope. When legume increased rest periods were used to increase grass growth. As herbage mass increased more stock would be put in and *visa versa*.

Research by Kemp *et al.* (1996) clarified this proposal for temperate species at Orange NSW. Their research showed a minimum level of 15% legume was required in early spring to make a significant contribution to the N level and suggested an upper level of 60%, however, legume only exceeded 50% when annual grasses were controlled. The maximum limit for phalaris was set at 60%. A herbage mass of 1.5 t green DM/ha was set as the minimum as below this legume content was <15%. The upper limit was set similarly at 3.5 t green DM/ha. Tactical grazing could be used to achieve these outcomes and an understanding of how grazing influences botanical composition allows decisions to be made on maintaining the integrity of the pasture.

Maintaining legumes in tropical grass pastures is a major problem given the rapid growth in summer. If legumes are not contributing to soil N there will be a decline in dry matter production and fodder quality. This will be most noticeable in moderate to low fertility soils.

There are a number of options for increasing legume content in pastures, including the selection of more upright species which grow with the canopy using newer tropical legumes which are being evaluated (Crocker 2004) and reducing herbage mass with high stock numbers on fewer paddocks. This may have to be an objective in alternate years. Excess forage can be baled on arable areas for use in dry years or with bloat prone pastures.

Table 3. Minimum herbage mass (kg green DM/ha) to maintain satisfactory production levels

Animal class	Pasture at 75% digestible dry matter
Ewe in late pregnancy	700
Cow in late pregnancy (7-8 months)	900
Growing at 90% potential growth rate	
Lambs 225g/head/day	1600
Steers 1.12 kg/head/day	2200

Matching stocking rates and forage requirements of the animal class, requires the manager to have an understanding of the effect quality and quantity of pasture has on animal production. Pasture benchmarks used in PROGRAZE™ set guidelines for animal needs.

An example of the herbage mass benchmarks used in PROGRAZE™ is presented in Table 3.

To maximise intake for animal production sheep require a pasture with green herbage mass between 800-1600 kg DM/ha and cattle 1200-2300 kg DM/ha (75% digestible) (Bell 2003). The guidelines developed by Kemp *et al.* (1996) for managing botanical composition are within these limits, so they may be a useful tool in maintaining production and the life of the pasture as well as meeting expectations for animal growth.

Rates of pasture growth vary with season and pasture type, however, the challenge is to match the animal demand to the quantity and quality of pasture. In good growing seasons, higher stock numbers will be required to maintain feed quality. In poorer seasons, or in long dry spells, animal numbers may need to be reduced or stock put into sacrifice paddocks to protect the majority of the pasture resource.

Good growth rates are achievable on tropical pastures. A property west of Narrabri, with an Inverell purple pigeon grass dominant pasture, achieved growth rates of 1 kg/head/day with steers stocked at 10 DSE/ha (B. McGufficke, pers. comm.).

More detail on matching animal requirements and pasture is contained in the PROGRAZE™ manual and workshops are available to assist in understanding the interaction.

Ground cover is recognised for its contribution to reducing runoff and soil erosion (Lang 1979). As ground cover is increased to 70%, runoff and soil erosion are significantly reduced.

Increasing ground cover and reducing erosion is species dependent with perennial grasses being superior to perennial legumes such as lucerne. On the Liverpool Plains runoff from April to September 1998 was on average 14% higher on the lucerne pasture compared to the Bambatsi panic/wallaby grass (*Austrodanthonia* spp.) pasture with ground cover levels of 25 and 60%, respectively. In July of the same year, 96 mm of water was lost as run off from the lucerne area as opposed to 19 mm from a grassed area (Young *et al.* 1998).

Similarly on a native redgrass (*Bothriochloa macra*) pasture site (at Barraba in the same year) with rainfall of 717 mm run off of 0.6-4.4 mm was lost from the 90% ground cover plots as compared with 63.1 mm from plots with 45% ground cover. The contribution of litter and the quality of litter was also demonstrated at this site with changes in the value of soil micro-organisms and earthworm numbers, as shown in Table 4 (McCormick *et al.* 2001).

Table 4. Litter quality and the effect on levels of soil fauna

Indicator species	Continuous grazing	4-paddock rotation	Native grass + sub and super
Soil micro-organisms (kg/ha)	160	480	720
Earthworms (number/ha)	200,000	750,000	1,100,000

Litter in pastures increases ground cover, reduces runoff and water infiltration, provides a valuable source of food to soil fauna and also reduces evaporation by as much as 50% per annum (McCormick *et al.* 2001).

In grazing management, there are always trade-offs between animal production, stocking rate and pasture sustainability. Understanding the impact of the trade-offs will make management decisions easier.

Conclusions

Pastures afford many benefits to farming systems, both direct and indirect, and unfortunately it is difficult to do them all justice in the context of this paper. Research is still progressing our understanding of the soil and pasture interaction.

To capitalise on the benefits from pasture in farming systems, pastures have to be managed as a high value crop. Attention must be given to the pasture agronomy as described in the 9 points above if the operation is to succeed.

Soils are the basis for pasture and cropping systems. They are the most important resource and management should reflect this importance. Pastures can make a significant contribution to the sustainability of a farming system and if managed as a high value crop can provide profitable grazing.

Our understanding of pasture technology is improving. New technologies are being put forward at conferences such as this, but do not forget that it is essential to get the basics right as outlined by the current agronomy recommendations in the 9 points highlighted in this paper.

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