Greener Pastures

for south west Victoria

second edition

Editors
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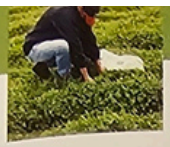


Integrating legume pastures and crops

Pedro Evans and
Penny Riffkin

Key points

- A pasture-crop rotation provides a profitable farming system for mixed cropping-livestock enterprises in south west Victoria, with benefits of sufficient nitrogen fixation in pasture years for the crop phase, and grass-free pasture providing a disease and weed break
- At Hamilton, a 1 year pasture-1 year crop rotation system averaged 7 t/ha of wheat over the first three seasons in trials, and canola yields under this system have reached 4 t/ha
- The rotation system has shown high self-regeneration of pasture after crop – the pasture seed bank increasing from 0.5 t/ha to over 2.0 t/ha, which in turn has lead to high forage dry matter production
- The pasture-crop rotation has worked well with subterranean, balansa, Persian and arrowleaf clovers

Legume pastures are a valuable component of mixed cropping-livestock enterprises in south west Victoria. Legumes are important in the rotation system for fixing nitrogen and building up soil nitrogen reserves for subsequent crops. Legumes also provide disease and weed breaks, improving subsequent crop yields. To get the maximum benefit from the pasture-crop rotation system, it is critical to maintain the legume pasture as a pure stand. Legume pastures are valuable to livestock production and offer high rates of weight gain and milk production.

Some legume species are particularly well suited to a pasture-crop rotation. Subterranean clover (sub clover), which is sown to about 20 million hectares in southern Australia, is well adapted to the rotation in high rainfall areas. In cool-temperate environments, such as south west Victoria, sub clover seed softens (prior to taking in water for germination) at a much slower rate than it does in regions with a Mediterranean climate, such as Western Australia and South Australia. As a result, in high rainfall environments, seed can persist in the soil for a number of years. After 6 years, more than 20% of the seed initially set, may remain the ground. In contrast, in Mediterranean areas at least half the sub clover seed will soften over the first summer, and less than 20% of the initial seed population persists beyond the third summer.

In a 1:1 pasture-crop rotation in which all regenerating pasture is killed with herbicide in the crop year, the seed bank should be sufficient for successful germination of sub clover in subsequent years.

Alternative annual legume species, such as balansa, Persian and arrowleaf clovers, are increasingly being incorporated into pasture-crop rotation systems in south west Victoria, as these species are also able to regenerate after each cropping year.

Typically a pasture-crop rotation may consist of 1 year of pasture and 1 year of crop. At DPI Hamilton, a successful pasture-crop rotation trial with sub clovers ran for 7 years from 1997. The sequence of the rotation was pasture establishment (renovating an existing legume-grass pasture to a pure legume stand) then alternation of crop and regenerating pasture. The pasture in which the trial was conducted was established in 1990 and never resown. Crop yields averaged 7 t/ha of wheat over the first three seasons of the trial and canola in the same system has yielded 4 t/ha. The sub clover seed bank increased under the 1:1 pasture-crop system from 0.5 t/ha to over 2.0 t/ha, forage dry matter production after the crop phase was high.

A further set of trials with sub clover, balansa, Persian and arrowleaf clovers in the pasture-crop rotation was conducted at Streatham and Gnarwarre, and the system was then tested on 20 commercial farms. The trials and farm tests have all demonstrated the benefits of legume pasture in rotation with crops.

The crops grown in the pasture-crop system in south west Victoria include, but are not limited to wheat, canola and barley. Many of these crops do not tolerate waterlogging, therefore the pasture-crop rotation system is not recommended for low lying areas.

Year 1: Establishment of the pasture-crop rotation

The objective of the first year is to manage the sward to obtain good clover seed yields so that the pasture needs to be sown once only. Once a good seed bank is established, the pasture should be able to successfully regenerate in autumn after 1 or 2 years of cropping. The pasture-crop system can then continue to function indefinitely, provided there is a pasture phase every 2 or 3 years.

Paddock preparation

A good time to sow a new pasture is after a continuous cropping rotation or when an existing pasture has a high content of weeds and becomes unproductive.

If a new clover is to be sown into an existing pasture it is important to control grasses and broadleaf weeds in the previous spring. Weeds should be under control if the paddock has been in crop for some years or it was sown to a summer fodder crop.

In the autumn before sowing, control weeds with a knockdown herbicide.

The main pest of annual legumes is red-legged earth mite and all clover pastures should be treated before sowing. An insecticide can be mixed with knockdown herbicide. Small seeded annuals such as balansa clover are very susceptible to attack by red-legged earth mite, so control is critical before sowing, and in subsequent seasons of the pasture. Damage by red-legged earth mite at the seedling stage, together with deep sowing, is the most common cause of failure to establish the pasture of small seeded legumes.

Species

Research work in the last 8 years highlighted four clovers that performed well in pasture-crop rotations in south west Victoria: subterranean, balansa, Persian and arrowleaf. The decision of which species to use will depend on soil type, and when and how forage is required.

Subterranean clover

In areas receiving more than 500 mm of annual rainfall, late maturing sub clovers such as Leura or Denmark will work well in most acid soils. If waterlogging is likely to occur, white seeded sub clovers like Napier or Gosse may be better adapted.

Balansa clover

Balansa is well adapted to most soils in which sub clover performs well but performs better than sub clover on acid soils. The best balansa clover cultivars for south west Victoria are Bolta and Paradana. Frontier should not be used, as its early maturity does not suit the long season of the region.

Persian clover

Persian clover performs well on clay loam neutral to alkaline soils. The best cultivars for a pasture-crop rotation system are Nitro Plus and Kyambro. Soft seeded cultivars such as Maral will not persist under the rotation system, and will need to be resown after the crop.

Arrowleaf clover

Arrowleaf clover is well adapted to well-drained soils and often fails if sown on soils prone to waterlogging. The species has the capacity to grow well into the summer, therefore extending the growing season well beyond the growth period of sub clover. The late maturing cultivar Arrotas can be grazed up until December, before locking up for seed production. Grazing can resume in February as standing hay. Grazing or cutting for hay can take place in October–November without affecting its seed yield, so arrowleaf could be useful to control herbicide resistant grasses.

Inoculation

For species other than sub clover, the seed should be inoculated with the appropriate commercial strain of rhizobia. Failures with arrowleaf clover can be due to either not inoculating or doing so with the wrong strain. Ensure that inoculants have not passed their expiry date.

Bolta balansa clover established well, at nearly 600 plants/m² and produced 12 t DM/ha for the year, at a trial site at Willaura in 2003

Plant establishment

High plant densities are essential for the establishment of a good pasture. Sowing rates of 10 kg/ha should be adequate to produce good plant numbers (175 and 1000 seedlings/m² in subterranean and balansa clovers respectively). While a density of 150 plants/m² may result in excellent spring growth, there will not be any significant winter production at these low plant numbers. Figure 12.1 shows winter production at different plant densities for subterranean, balansa and Persian clovers combined. At the same plant densities there is no difference in winter production between balansa and sub clovers despite the differences in seed size.

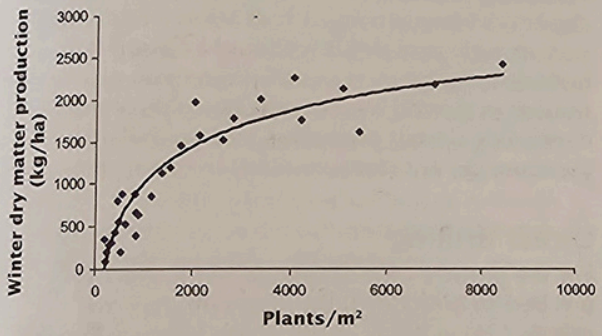


Figure 12.1 Winter production (kg DM/ha) for balansa, Persian and sub clovers at different plant densities (combined data for all species)

Year 1: Management during the first year of pasture

In the pasture establishment year, the pasture should be managed for optimum seed yield. This means grazing during winter and early spring until the sown annual legume starts to flower. Management should also include preparation for the cropping phase, such as control of grass weeds.

Grazing management

Ideally pasture should be kept low (1–2 cm) until the beginning of flowering (October for Leura sub clover and Bolta balansa, early December for Arrotas arrowleaf clover). At the start of flowering, the aerial seeding clovers (balansa, arrowleaf and Persian) should be locked up for 6–8 weeks to allow full seed set. Following this, hard grazing is necessary to allow for direct drilling of crops after knockdown herbicides have been applied.

Sub clover can be grazed throughout its flowering period without severe adverse effect on seed yields providing the feed on offer (FOO) in spring does not go below 1500 kg DM/ha.

Sheep will digest a significant percentage of the sub clover seed. However, as seeds of balansa and Persian clovers weigh less than 1 mg, a high percentage will pass through the sheep unaffected. To ensure the persistence of aerial seeders certain management practices need to be adhered to. These include not grazing during flowering, and the avoidance of dense ground cover or competition from other species during germination.

Weed control

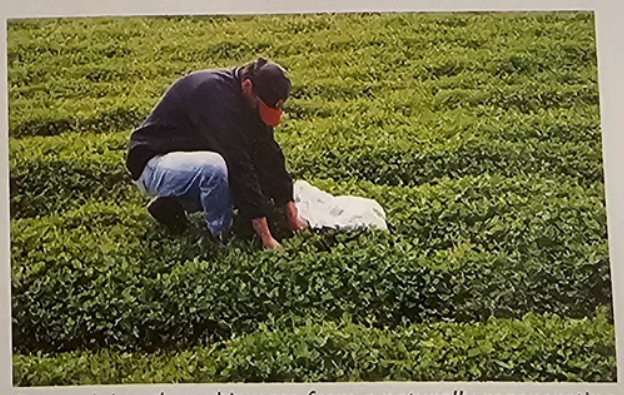
Grasses can be taken out of a legume pasture with a grass selective herbicide. Removing grasses in the pasture phase can increase clover seed yields by about 30%.

Removal of the grass component does not affect total forage production, as in the same growing conditions a pure grass or clover or a grass/clover mixture will yield the same.

Grass control in the establishment year however, allows for greater build-up of nitrogen in the soil, helps reduce the seed reserves of grass weeds for the following cropping phase, and helps reduce carry-over of diseases.

A low cost method to remove broadleaf weeds from the pasture is to use low rates of MCPA, followed by very heavy grazing by sheep a week later. For best results this should be done in late autumn or early winter. Silver grass needs to be controlled with simazine.

Chapter 7, *Keeping weeds under control*, explains weed control methods in more detail.



Determining clover biomass from a naturally regenerating sub clover pasture at Ararat in November 2003 – regenerating pastures tend to produce more biomass than newly sown pastures due to higher plant density

Pasture quality

Figure 12.2 shows the decline in pasture quality (crude protein and digestibility) as the season progresses. The difference in digestibility of arrowleaf clover is due to the later flowering time of this species.

Seed set

High seed yields are dependent on a number of factors including sufficient plant numbers and good climatic conditions during seed set. Clovers such as balansa and Persian are cross-pollinating species and therefore require insects to achieve adequate seed set. In some species the absence of bees can result in only 10% of the potential seed yield.

Differences in crop maturity between arrowleaf cv. Arrotas (left) and balansa cv Bolta (right) clovers at Hamilton in December 2003. Arrotas produces most of its biomass in late spring/early summer when other species are senescing, therefore it has higher feed quality during this period.

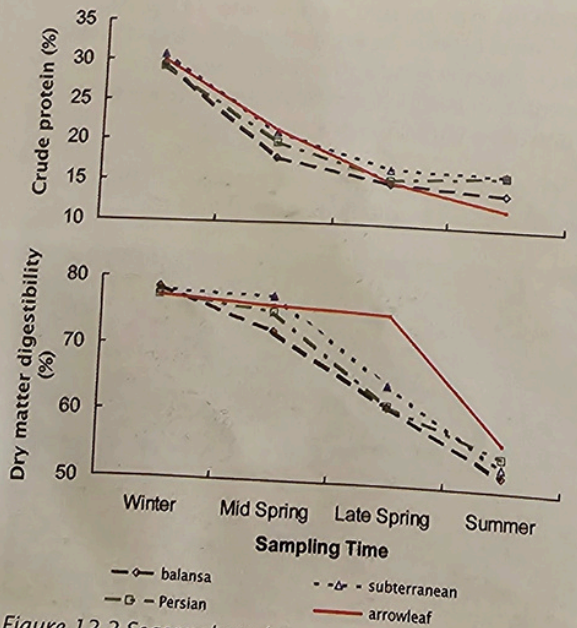


Figure 12.2 Seasonal crude protein and digestibility of balansa (Bolta), Persian (Nitro), subterranean (Leura) and arrowleaf (Arrotas) clovers in experimental plots at Streatham in 2000

Year 2: Management of the cropping phase

The aim of the cropping phase is to grow a high yielding, weed-free cereal or canola crop, taking advantage of the nitrogen build-up during the legume phase, which significantly reduces or eliminates the need for nitrogen fertiliser. The legume pasture phase should also reduce the grass weed burden in the crop and provide a disease-break for cereal/grass borne diseases. Trial work in south west Victoria has shown that 7 t/ha wheat crops can be achieved after a pasture phase.

Paddock preparation

Following germination after the autumn break, the clover is removed using a knockdown herbicide such as a glyphosate/dicamba mix. Group B herbicides (sulphonyl ureas) can remain as a residue in the soil for extended periods of time depending on soil properties and rainfall and therefore are not recommended in this system.

Direct drilling

For the pasture-crop system to work effectively, it is best to direct-drill the crop with narrow points. Clover seeds, particularly balansa, Persian and arrowleaf are very small. Soil disturbance caused by convention cultivation before sowing can result in seeds being buried too deep, which will significantly reduce germination in the year following the crop.

Fertiliser

One of the benefits of the pasture-crop system is the contribution of 'free' nitrogen provided to the crop by the clover in the previous year. The amount of nitrogen supplied from the legume phase is largely dependent on clover dry matter produced, with approximately 25 kg of nitrogen fixed per tonne of herbage. There is a positive relationship between the amounts of clover dry matter produced and the yields of subsequent crops. It should therefore not be necessary to apply nitrogen fertiliser following a high yielding pure clover pasture.

As a rule of thumb, for every tonne of wheat produced (at 10.5% protein), 40 kg of nitrogen is required. Half of this figure will be exported from the paddock after harvest, while of the remaining

20 kg of nitrogen some will go back into the soil pool as organic matter and some will be lost to the atmosphere (this figure will vary due to how the stubble is managed). With canola, 80 kg of nitrogen is required to grow a tonne of grain.

Other nutrients (e.g. phosphorus, potassium, sulphur) need to be applied at recommended rates depending on soil nutrient levels, as indicated by soil tests, to ensure optimum crop and pasture yields.

Year 3: Regeneration of the pasture

The purpose of this phase is to achieve high rates of self-regeneration of the legume seedling. This should allow good winter and spring pasture production, which will help achieve good animal production. The grazing animal is an integral part of weed control for subsequent crops. This phase breaks the disease cycle of crops and allows the use of herbicides different to those used under cropping, to help reduce the development and incidence of herbicide resistance.

Seed numbers

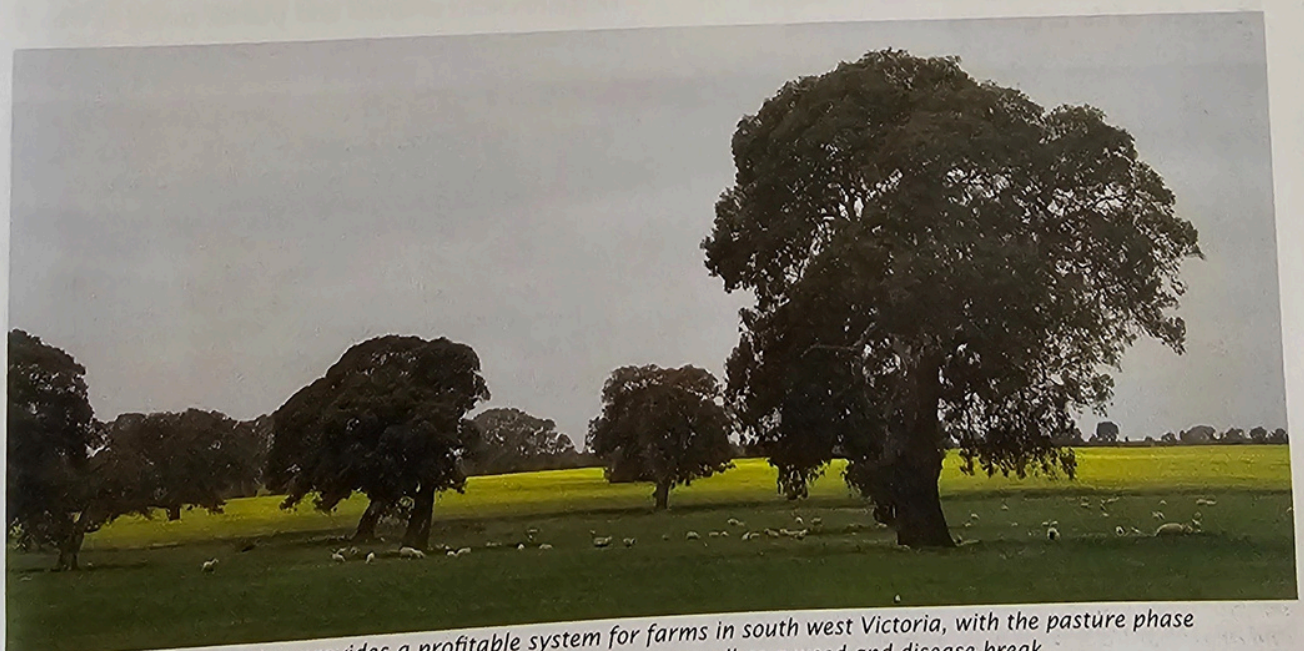
In the third year, 2 years after good seed set, balansa clover can germinate at more than 10,000 plants/m^2. At these high densities, growth rates of around 55 kg DM/ha/d in July–August have been recorded near Hamilton under grazing. Over a 5-year period of a 1:1 pasture-crop system at Hamilton, sub clover seedlings following the cropping year averaged 2000 plants/m^2. Provided plant numbers after a cropping season exceed 150 plants/m^2 there is no need to resow the pasture.

Grazing

Regenerating pastures must be continuously grazed or grazed in a short rotation for most of the season. If there is a need to replenish the seed bank of aerial seeded legumes, stock should be removed towards the end of the season to allow the pasture to go to seed.

Pest control

With small seeded annuals such as balansa clover, it is critical to control red-legged earth mite at the beginning of each season, as they can easily destroy the very small seedlings. With sub clover, control is only needed in the year of sowing.



The pasture–crop rotation provides a profitable system for farms in south west Victoria, with the pasture phase providing nitrogen for the subsequent cereal or canola crop, as well as a weed and disease break