



Species and cultivars for improved pastures

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A wide range of species and cultivars of annual and perennial grasses and legumes is available for inclusion in pastures in south west Victoria. Selection of a species or cultivar should be based on matching the pasture plant to the environment in which it will be growing.

The key environmental considerations are:

- annual rainfall, and the distribution of rainfall throughout the year
- maximum and minimum temperatures
- length of the growing season
- soil type and the drainage characteristics of the paddock
- soil chemistry – fertility, pH, aluminium levels, salinity
- likely pests and diseases.

Selection of a species should also be on the basis of meeting the production or environmental requirements of the pasture. A pasture may be required to:

- supply a high level of feed throughout the year
- fill a feed gap at a specific time of year when other species or cultivars are not productive
- supply high quality feed at specific times of the year for particular classes of stock
- persist indefinitely
- provide ground cover for erosion control
- provide ground cover for saline and/or waterlogged areas
- out-compete difficult to control weeds.

Key points

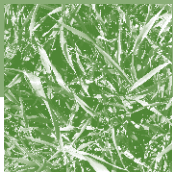
- Pasture species should be selected so as to match the plant to its growing environment, in terms of rainfall, temperature, length of growing season, soil characteristics and likely pests and diseases
- The species selected should meet the production and environmental management purposes of the pasture system, e.g. to provide high levels of feed year round or provide protection against soil erosion
- The success of a species will depend on understanding and carrying out the appropriate management requirements, e.g. fertiliser, liming and grazing management
- Advice on the suitability of species for a particular situation can be obtained from farmers and agronomists

The pasture species or cultivar should be selected with a full understanding of its management requirements, especially grazing. Species and cultivars vary in their tolerance to grazing. Some species are tolerant of continuous grazing, many require strategic spelling, and some must be very carefully managed and only grazed for short periods of time.

Most good pastures represent a mix of grass and clover. In large paddocks containing a range of micro-environments it is not unusual to sow two or more grass species. Two or three cultivars of sub clover may be grown in the one paddock, to ensure

productivity is maintained in a range of seasons and conditions. It is important to maintain clover as a significant component of the pasture in the long term as it is a major determinant of the level of animal production that can be obtained from the pasture. Good establishment of clover is dependent on the density of competing grass seedlings. The seeding rate for grass should be selected with this in mind.

The development of many new cultivars has significantly broadened the ability of a pasture species to overcome its traditional limiting factors. Therefore it is often difficult to generalise when describing the characteristics of a pasture species. The choice of available plants is diverse and while there is ample information on production characteristics, there is relatively little objective information about persistence. Practical advice on newer pasture species should be sought from agronomists and from farmers growing that species/cultivar in a similar environment. Planting a small area of a new species or cultivar



also provides an opportunity to assess pasture performance before making a large-scale investment.

This chapter describes the pasture species used in south west Victoria. Some of the species are represented by 30 or more cultivars. The Department of Primary Industries (DPI) does not evaluate or recommend cultivars but those mentioned in this chapter have performed satisfactorily in DPI projects.

Perennial ryegrass

Perennial ryegrass (*Lolium perenne*) is the most widely sown perennial grass in south west Victoria and it provides large quantities of high value feed across the many growing environments of the region. It is a readily established, densely tillered plant, native to Europe.

Environment

Perennial ryegrass is well suited to medium and heavy textured soils with adequate soil phosphorus levels (Olsen P greater than 12 mg/kg), annual rainfall of more than 650 mm, a growing season of a least 7 months and mild summers. It is well adapted to basalt soils (*Sodosols* and *Chromosols*) but may not persist on lighter soils or north of the Glenelg Highway.



Ripening seed head of perennial ryegrass

Perennial ryegrass is the most widely sown perennial grass in south west Victoria

Cultivars

The cultivars suited to south west Victoria offer a 40-day range in time of flowering from September to November. The earliest flowering cultivars are of New South Wales origin, selected or bred from Kangaroo Valley, an early-maturing winter-active type that evolved in the summer rainfall region of southern New South Wales.

Fitzroy is a new cultivar with good persistence. It was bred in south west Victoria from Kangaroo Valley material.

Early-flowering types are used in lower rainfall areas to ensure persistence. They often exhibit vigorous cool-season growth. Late-maturing cultivars provide continued growth in situations where late rain can be expected.

There are many mid- and late-season cultivars that have been bred in New Zealand and these are useful in the higher rainfall districts of south west Victoria.

Two cultivars have been developed specifically for Australia from plants collected from old pastures of the ecotype Victorian – mid-season Bolton and late-season Avalon. Both of these new cultivars have outperformed Victorian, which has low resistance to disease.

Some cultivars of perennial ryegrass contain twice the number of chromosomes (tetraploid) of conventional cultivars (diploid). The tetraploid cultivars are generally of high feed quality and are more compatible with clover than the diploid cultivars.

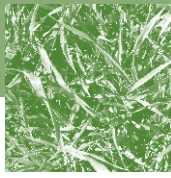
New cultivars of perennial ryegrass are introduced regularly. The Grassland Society of Southern Australia maintains a database which lists cultivars of this species and provides information on the uses and applications of each cultivar: www.grasslands.org.au/gsv/newSite/index.asp

Management

Perennial ryegrass is easy to establish but its persistence is greatly affected by soil fertility, grazing management and cultivar selection.

Perennial ryegrass will not persist where soil fertility has been depleted.

Overgrazing in summer and autumn will reduce plant vigour but undergrazing in winter can lead to invasion of the stand by weeds such as fog grass. Allowing ryegrass to seed occasionally will increase the recruitment of new plants from



seedlings and increase the number of tillers from established plants.

Spelling paddocks in late summer and autumn, especially after the autumn break, will improve persistence. See Chapter 6, *Grazing pastures*, for more detail on grazing management.

The persistence of perennial ryegrass varies greatly with choice of cultivar. Early flowering, genetic background and endophyte status are all important in determining persistence. Cultivars bred from Australian or some Mediterranean regions are generally the most persistent in south west Victoria.

Perennial ryegrass endophyte

An endophyte is a microscopic fungus that lives inside the plant. Toxins produced by the perennial ryegrass endophyte can cause staggers, heat stress and death. Animals are usually affected when they graze perennial ryegrass in late summer and early autumn. There is also evidence that ingestion of subclinical amounts of the toxins can cause ill thrift and restrict animal production.

While the endophyte can cause health problems in livestock, it also improves vigour and persistence in ryegrass. Most commercially available seed is infected with a wild endophyte and so is potentially toxic to livestock. The endophyte can be killed by storage of the seed at high humidity over one to two summers. Also endophyte-free pastures can be established using low endophyte seed, which is harvested from endophyte-free plants. Plants free of endophyte do not survive stress as well as endophyte-infected plants and if old seed remains in the ground it will germinate causing endophyte-free pastures to become contaminated with toxic plants.

Ryegrass is also available with a beneficial/select endophyte (e.g. AR1 developed by AgResearch in New Zealand) that provides a growth advantage to the plant but does not produce toxicosis in the animals grazing it. For animal welfare and productivity considerations it is preferable to use perennial ryegrass cultivars that contain a beneficial endophyte. This technology is available in New Zealand cultivars (e.g. Meridian AR1, Extreme AR6). In order to develop a toxin-free perennial ryegrass pasture, a program of cropping and spraying is needed prior to sowing seed of a cultivar containing beneficial endophyte. Subsequently, careful paddock hygiene is necessary to prevent seed of perennial ryegrass containing wild endophyte from contaminating the new pasture.

Phalaris

Phalaris (*Phalaris aquatica*, previously *Phalaris tuberosa*) is the second most widely sown perennial grass in south west Victoria, after perennial ryegrass. It is the most drought tolerant grass species sown in the region, and is suited to areas where summers are too hot for perennial ryegrass. Phalaris is also important for controlling erosion and stabilising water tables.

Phalaris is a perennial grass with short rhizomes (underground stems that produce new tillers) and erect stems. It remains relatively dormant over summer and will tolerate heavy grazing once properly established. It is native to southern Europe, north west Africa and the Mediterranean region.



Phalaris is the most drought tolerant grass species sown in pastures in south west Victoria

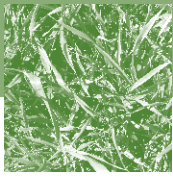
Phalaris has distinctive auricles wrapping around the stem

Environment

Phalaris grows best on heavy textured, fertile soils, it withstands waterlogging and is tolerant of moderate salinity. It is sensitive to aluminium toxicity induced by soil acidity ($\text{pH}_c < 4.2$) except where the subsoil is only mildly acidic. Soil testing to 60 cm depth, where acidity is likely to be of concern, is important to determine if the use of lime is needed to aid persistence. On black, cracking flats (*Vertosols*) phalaris is able to withstand the crickets that can destroy other pasture plants.

Cultivars

CSIRO plant breeders have greatly improved phalaris by reducing alkaloid levels, and by increasing seedling vigour, winter growth and seed retention. Current cultivars suitable for



south west Victoria include Australian II, Holdfast (which has superseded Sirosa), Atlas PG and Landmaster.

Australian II is a semi winter-active cultivar, which has a prostrate growth habit and broad crown and gives less winter growth than other cultivars but is better adapted to continuous grazing. While it has poor seedling vigour and a higher risk of phalaris staggers, Australian II is the most persistent cultivar under heavy continuous grazing.

Holdfast is a winter-active cultivar, which has an erect growth habit. Holdfast is similar to Sirosa, with excellent seedling vigour, winter growth and persistence. Rotational grazing is beneficial to phalaris but is especially important for capturing the yield potential and longevity of these winter-active cultivars.

Atlas PG is suitable for areas with a short growing season. It has an erect growth habit and is suitable in 400–550 mm annual rainfall areas.

Landmaster is the most tolerant phalaris cultivar for acid soils. It is a reliable cultivar and is able to perform on shallow soils with low fertility. It has good persistence and seedling vigour.

Establishment

Thorough weed control is desirable for achieving good establishment. Autumn sowing is best in areas with an annual rainfall of less than 600 mm. Early spring sowing in higher rainfall areas can give excellent results, avoiding the risk of establishment through a cold wet winter and competition from annual weeds. For Australian II spring sowing is the preferred option.

Establishment can be poor if a phalaris pasture is grazed hard, too soon after sowing, even if there has been an excellent strike. Some grazing in winter will encourage tillering, however once tillers begin reproductive development the newly sown pasture should be spelled until the following autumn to enable the development of roots and basal buds. The buds that develop at the base of each reproductive tiller are carbohydrate stores and vital for summer survival. In autumn, once soil temperature falls, the buds initiate new growth and well-developed buds ensure vigorous winter growth.

A phalaris pasture takes 2–3 years to reach its peak. During this time, conservative stocking over winter and spring, adequate fertiliser application, and the control of annual weeds contribute to the successful establishment of a long-term pasture.

Management

Management of phalaris will vary depending on the environment in which it is grown. North of the Glenelg Highway in lighter soils, continuously grazed phalaris pastures thin out and become dominated by annuals. In these situations, careful grazing management that allows seed set will assist persistence.

The seed heads of phalaris start to elongate in September–October, as new buds develop at the base of the stalk. Bud survival over summer ensures regeneration in autumn and the number and size of buds influences winter yield. If conditions favour growth, and management enables the seed head to develop and mature, the buds will be large and exhibit a high level of dormancy. If the seed head is poorly developed and does not produce mature seed, the buds will be smaller and have a lower level of dormancy. High dormancy means that summer rain is less likely to weaken the plant by causing tillers to commence growth – and subsequently die if dry conditions prevail. Australian II and Holdfast are the most likely to grow after rain in summer whereas Atlas PG is more summer dormant.

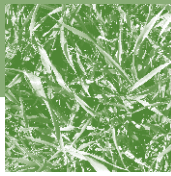
On the basalt plains, old phalaris pasture can become extremely dense and crowd out clover. In this situation, grazing to 1200 kg DM/ha is needed during spring and early summer, to prevent the phalaris becoming rank and unpalatable. Continuous grazing at a high pressure in spring should favour clover over the phalaris.

Phalaris poisoning

Toxic alkaloids contained in phalaris may cause poisoning in sheep, and occasionally in cattle. There are two syndromes caused by the alkaloids, phalaris staggers and phalaris sudden death.

Phalaris staggers develops gradually due to the ingestion of alkaloids that are found in all cultivars but at much lower levels in winter-active cultivars. In the chronic form, tremors, head nodding, incoordination and an inability to keep legs straight, may be observed in sheep. These symptoms may persist for several weeks after the sheep are removed from the pasture. With cattle, signs include difficulty in chewing/swallowing, protruding tongue and drooling of saliva.

Phalaris sudden death syndrome has two forms. The heart failure form usually only affects a few animals in the flock when the flock is mustered or the animals become excited. These animals may collapse, have difficulty breathing and die. The



polioencephalomalacia-like form is more common. It is observed when animals have been deprived of food for 1–2 days, such as shearing time, and then are put to graze on short phalaris that is stressed (by lack of moisture and light, or frost) but has recently had a fresh shoot of growth. Hundreds of sheep have died in some instances with this form of phalaris toxicity and careful management is necessary to avoid the circumstances that lead to the syndrome.

Cocksfoot



Cocksfoot is useful in areas of south west Victoria with low rainfall and strongly acidic and low fertility soils



Cocksfoot has a prominent ligule rising at the top of the leaf sheath

Cocksfoot (*Dactylis glomerata*) is a perennial grass that is well suited to free draining soil. Its feeding value over the year is usually 5–10% lower than for other grasses, however it is useful in south west Victoria, particularly in areas of low rainfall and strongly acidic and low fertility soils, because of its ability to persist and its lack of substances toxic to grazing stock. The summer growth of cocksfoot is better than perennial ryegrass and phalaris, although it is generally less drought tolerant than phalaris.

Cocksfoot is a deep rooted plant, with an upright growth habit. It is native to Europe, northern Africa and temperate Asia.

Environment

Most cocksfoot cultivars have poor tolerance of waterlogging. In areas where the soil pH and aluminium level limit the growth of phalaris, cocksfoot may be more persistent and should be included in the seed mix. It is well suited to the stony and gravelly rises and granitic soils (sandy and loamy *Chromosols*, and *Tenosols*) in south west Victoria.

Cultivars

Currie is the most persistent cocksfoot cultivar in low rainfall areas (Table 3.1). Above 500 mm annual rainfall, a more productive cultivar, Porto, is most commonly used. These cultivars were developed in Australia from Algerian and Portuguese material respectively. Victorian and Tasmanian cultivar experiments in the 1990s confirmed the ongoing productivity and broad adaptation of these two cultivars.

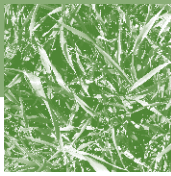
Table 3.1 The performance of a range of perennial grass cultivars, relative to perennial ryegrass, cv. Ellett, in a rotationally grazed experiment conducted during the mid 1990s at Harrow, south west Victoria

Species, cultivar	4-year DM yield relative to Ellett	Persistence* (%)	Digestibility (%) mid Nov
Perennial ryegrass, Ellett	100	11	68.3
Tall fescue, Demeter	55	4	69.2
Tall fescue, 'Fraydo'***	102	16	70.7
Cocksfoot, Currie	82	20	60.8
Cocksfoot, Porto	94	15	66.5
Phalaris, Sirosa	116	22	70.2
Phalaris, Australian	90	20	65.6

* after 4 years, relative to plant population that germinated

** this line was a prototype of Fraydo - a Melik selection

Source: Anderson *et al* (1999)



Management

In new pasture, cocksfoot plants need to be firmly anchored before grazing commences. To thicken up a weak cocksfoot pasture, spell over summer and allow seed set, and then restrict stocking after the autumn break to allow the new seedlings to establish. Continuous grazing of a cocksfoot and phalaris pasture can cause stock to selectively graze phalaris in preference to cocksfoot, placing phalaris in danger of being overgrazed. Increasing the stocking rate temporarily, by mob stocking or rotationally grazing, will reduce the animal's ability to selectively graze.

Cocksfoot is best grazed at the 4-leaf stage following spelling to maximise its nutritive value. Management to encourage clover includes adequate fertiliser and grazing to stop cocksfoot becoming too dominant. Avoid undergrazing and ensure nutrients, such as molybdenum and potassium are not deficient.

Tall fescue

Tall fescue (*Festuca arundinacea*) is a perennial grass, closely related to but more drought tolerant than perennial ryegrass. Tall fescue extends the period of high value feed at the end of the growing season, especially on later finishing, low lying areas. It is quite palatable and compatible with white and sub clovers providing it is not allowed to dominate the pasture. It can develop a tough sod, resilient to heavy trampling and frequent grazing.

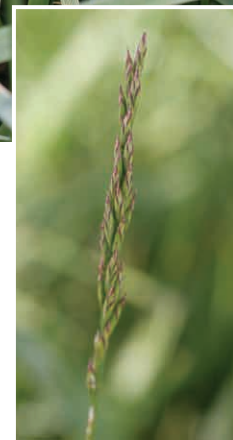
Tall fescue is a tufted, coarse-leaved species with erect tillers arising from rhizomes (underground stems), and is native to Europe, Asia and Africa.

Environment

Tall fescue is well suited to areas receiving at least 600 mm rainfall. It is particularly able to respond to summer rain/irrigation. It is adapted to a wide range of soil types (medium to heavy texture), and a wide range of soil fertility and soil pH levels. Tall fescue is the most tolerant grass for waterlogged areas and is well suited to shallow *Calcarosols* and peaty soils with high pH, where it combines well with strawberry clover. Like perennial ryegrass and white clover, it is most productive if soil fertility is high. It is quite tolerant of soils with high aluminium content and is also tolerant of moderate salinity.



Tall fescue is closely related to but more drought tolerant than perennial ryegrass



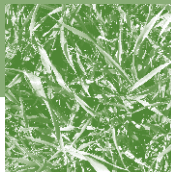
Ripening seed head of tall fescue

Cultivars

There are two distinct types of tall fescue, summer-active and winter-active, and 15 cultivars available for use in south west Victoria. Decisions about establishment, selection of paddocks and management of tall fescue need to consider the differences between the summer- and winter-active cultivars.

Summer-active cultivars require at least 600 mm annual rainfall and are very productive in spring and respond well to summer rain but have poor winter growth. They are best suited to the lower lying heavy soils and will give good growth well into summer. These cultivars have been developed from continental European parent material. Examples of current cultivars are Quantum and Jessup.

Winter-active cultivars originated in places with a shorter growing season, mainly the Mediterranean basin, and are able to grow rapidly in autumn and winter. The winter-active cultivars, Fraydo and Resolute, have proved persistent in the 550–650 mm rainfall areas of south west Victoria. Winter-active cultivars are best suited to better-drained areas where the potential for winter growth is high. They are sometimes used in mixtures to complement the strong summer growth of lucerne.



Turf type cultivars of fescue should never be sown on farms as they may contain wild endophyte (a microscopic fungus that resides inside the plant) that will cause animal health problems.

New cultivars of tall fescue are introduced regularly. The Grassland Society of Southern Australia maintains a database which lists cultivars of this species and provides information on the uses and applications of each cultivar: www.grasslands.org.au/gsv/newSite/index.asp

Establishment

Tall fescue has a reputation for poor establishment. It has a relatively weak seedling and competition from weeds or other sown grasses can seriously compromise the new pasture. Good weed control before sowing is essential for establishment success. Tall fescue is best sown with a legume only, and not other perennial grasses.

Timing is important for establishment – ideally, summer-active cultivars should be sown in spring to ensure weather conditions favour establishment; winter-active cultivars should be sown in autumn. Tall fescue has a large seed compared with other grasses, so a high seeding rate (10–15 kg/ha) is required. A light application of a fertiliser including nitrogen, such as mono-ammonium phosphate (MAP), will provide readily available nitrogen to promote seedling growth.

Newly sown fescue should not be grazed until it is firmly established, and a 4–6 week spell after grazing in summer is necessary.

Management

Grazing hard every 10–14 days in spring is essential to encourage tillering, development of clover, and to prevent tall fescue becoming rank and unpalatable. Established tall fescue plants are quite hardy and unless heavily grazed can exclude clover and decline in nutritive value.

Tall fescue endophyte

Seed of some cultivars of tall fescue is now available containing the beneficial MaxP endophyte selected by AgResearch. MaxP endophytes enable the plant to better tolerate stressful conditions but do not cause problems for animal health. Cultivars with select endophyte are preferable for use in marginal rainfall conditions where persistence may be a problem.

Italian and hybrid ryegrass

Italian ryegrass (*Lolium multiflorum*) is a most nutritious, short-lived grass (2–3 years) used for winter fodder, and for silage and hay crops. It is a biennial grass, native to Europe.

Compared with crops such as oats, Italian ryegrass generally is not as productive between sowing time and late winter, but in spring it is far more productive, and can provide good yields for silage or hay. It is more tolerant of waterlogging than oats and recovers better after grazing.

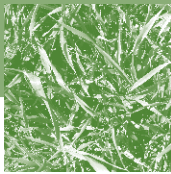
Italian ryegrass has vigorous seedlings and excellent early growth where soil phosphorus levels are greater than 18 mg/kg (Olsen P) and annual rainfall is above 650 mm.

There are many cultivars available varying in longevity (some are annuals) and suitability for different farming operations. Seek advice from local agronomists about the most suitable cultivars for specific situations.

Plant breeders have developed tetraploid Italian ryegrass cultivars with twice the number of chromosomes of the normal (diploid) species. Compared with diploid Italian ryegrass, tetraploid ryegrass has seeds 2–3 times heavier, bigger but fewer tillers and often, a high sugar content. If the grass is well managed, stock may eat more than they would of diploid cultivars. Some cultivars represent one or two crosses back to perennial ryegrass and these are referred to as short- or long-rotation hybrid ryegrass, respectively. Some of the long-rotation hybrids are relatively long-lasting and are available with beneficial endophyte (a microscopic fungus that resides inside the plant).

To achieve high production over autumn and winter, Italian ryegrass must be sown early in the season into a weed free, fertile seedbed. It is best to let it grow to a 3-leaf stage before grazing. In established pastures, Italian ryegrass will quickly run to head if not grazed frequently over spring, leading to a reduction in nutritive value. If grown for silage or hay it should be grazed short in late August–early September before closing the paddock. Italian ryegrass responds well to spring applications of nitrogen.

New cultivars of Italian and hybrid ryegrass are introduced regularly. The Grassland Society of Southern Australia maintains a database which lists cultivars of this species and provides information on the uses and applications of each cultivar: www.grasslands.org.au/gsv/newSite/index.asp



Tall wheatgrass

Tall wheatgrass (*Thinopyrum ponticum*) is tolerant of high levels of salinity and is used in soils where other improved perennial species will not grow. On saline land, it produces good quality forage over summer and assists in managing saline discharge areas. Tall wheatgrass will also grow on non-saline land, alkaline and waterlogged soils and is very drought tolerant. It is a perennial grass, native to the Balkans, Turkey and southern Russia.

The cultivars Tyrell and Dundas were developed in Victoria. Dundas was selected for improved leafiness and digestibility, and is the preferred cultivar in most situations.

Newly sown tall wheatgrass should not be grazed until it has flowered to ensure strong root growth. Established tall wheatgrass is best spelled, or only lightly grazed, during winter when growth is slow and the paddock may be waterlogged. Grazing pressure should then be increased in late spring and early summer as the growth rate increases. If well utilised at this time, the nutritive value of tall wheatgrass is comparable with other grasses. Close grazing maximises tillering, feed value and legume content. Tall wheatgrass seed can lose its viability rapidly during storage so only fresh seed should be sown.

More information on tall wheatgrass and its management in saline areas is presented in Chapter 10, *Managing pastures in saline areas*.



Ripening seed head of tall wheatgrass

Tall wheatgrass is tolerant of high levels of salinity

Subterranean clover



Subterranean clover is the most important annual legume sown in south west Victoria

Subterranean clover (*Trifolium subterraneum*) or sub clover is the most important annual legume sown in south west Victoria. There is a wide range of cultivars adapted to a wide range of soils and climate; and through its habit of burying seed, sub clover is uniquely persistent under heavy stocking and continuous grazing.

Sub clover is native to the Mediterranean basin. It requires soil phosphorus levels above 12 mg/kg (Olsen P) to grow well.

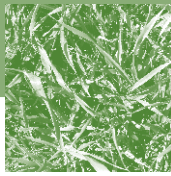
Cultivars

Sub clover is divided into three subspecies. The two subspecies relevant to south west Victoria are *Trifolium subterraneum* ssp. *subterraneum* and *Trifolium subterraneum* ssp. *yanninicum*.

Subspecies *subterraneum* has black seed and its cultivars are suited to well drained, slightly acid, loamy soils.

The early-season cultivars, including Seaton Park and York, are suited to an annual rainfall of 400–600 mm. Seaton Park has a high level of hard seed and therefore is able to withstand false autumn breaks.

The mid- to late-season cultivars, Leura, Goulburn and Denmark, are most suitable for 600–900 mm rainfall areas. They all have low levels of hard seed except Goulburn, which has moderate levels. Goulburn and Denmark start to flower in late September whereas Leura commences flowering in



early October and stays green longer into summer than other cultivars. Leura has outstanding spring growth and its autumn–winter production is similar to that of other earlier-flowering cultivars. Its long season growth allows it to compete well with perennial grasses and it is a most important cultivar for ensuring quality in hay.

Subspecies *yanninicum* has cream coloured seeds, performs well on slightly acid, predominantly clay soils and tolerates waterlogging. It persists in crabholes and other wet areas. Some *yanninicum* species should be included in all seed mixes where waterlogging is likely to occur.

Cultivars Gosse and Napier are suited to areas with at least 450 mm of rainfall. They are moderately hard seeded and autumn–winter growth is excellent. Gosse flowers intermediate between the older cultivars, Trikkala and Larisa, has some resistance to root rot and is tolerant of clover scorch. Napier is a later flowering type, widely suited to south west Victoria.

New cultivars of sub clover are introduced regularly. The Grassland Society of Southern Australia maintains a database which lists cultivars of this species and provides information on the uses and applications of each cultivar: www.grasslands.org.au/gsv/newSite/index.asp

In many situations it is advisable to sow a mix of two or three cultivars of sub clover. A mix of cultivars may extend the season of growth to overcome feed gaps, ensure that a satisfactory seed set occurs irrespective of when the season finishes, that more hard seed is set and that resistance is provided against occasional disease threats. It also takes advantage of different cultivars growing well in certain environments within a paddock.

Management

The seed produced by sub clover survives over summer and germinates the following autumn. Generally, the shorter the pasture at the autumn break, the higher will be the density of germinating seedlings. Plant litter that shuts out light reduces germination, so dry pasture residue should be grazed hard over late summer and early autumn.

Grazing should be managed so that *feed on offer* is about 1000 kg DM/ha at the autumn break. During winter and early spring, the pasture should be kept 1000–1500 kg DM/ha to reduce shading of the clovers. Seed production can be maximised by grazing the paddock to about 1500 kg DM/ha just before flowering and then reducing the stocking rate.

Sub clover is susceptible to red-legged earth mite, lucerne flea and aphids. The two main plant diseases which can affect sub clover are root rot and clover scorch. Sub clover can also be infected by several viruses and by leaf rust. Cultivars vary in their resistance to these diseases.

Chapter 8, *Keeping pests and diseases under control*, provides information on the pests and diseases affecting pastures, and measures of control.

Oestrogens

Old cultivars of sub clover contain a high oestrogen content. For example Yarloop, Dwalganup, Geraldton and Dinninup can reduce the fertility of grazing sheep. These varieties sometimes dominate old seed crops and may heavily contaminate sources of uncertified seed. Purchasing certified seed is the only way of being sure sub clover seed is not contaminated with high oestrogen seed.

White clover

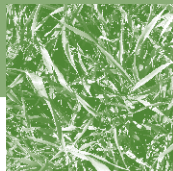
White clover (*Trifolium repens*) is a perennial legume that produces herbage of the highest nutritive value of any species. It contains no oestrogenic compounds but can cause bloat in cattle. White clover is a stoloniferous plant, i.e. it has a horizontal growing stem that bears adventitious roots at the nodes, native to Europe and the Mediterranean area.

White clover requires at least 700 mm annual rainfall and persists on a wide range of soils provided moisture is available through the growing season. It responds well to improved soil fertility but does not like highly acidic soil. At the low rainfall limit, white clover is sometimes



White clover produces herbage of the highest nutritive value of any species

White clover flower



sown as a monoculture on low lying/late finishing country. This provides a high quality special purpose summer pasture that may remain valuable for 2–3 years.

Cultivars

White clover cultivars tend to be rated on leaf size:

- Large leaves – Haifa, Tamar, Grasslands Kopu II and Aran
- Intermediate leaves – Irrigation, Mink, Grasslands Huia, Grasslands Pitau, Grasslands Sustain, Grasslands Prestige and Grasslands Demand
- Small leaves – Grasslands Tahora and Prop

Large-leaved types grow taller and upright, have thicker but fewer stolons, and require lax infrequent grazing. Small-leaved types produce many but smaller leaves and stolons, tolerate frequent close grazing and are generally more persistent under stressful environments.

Irrigation and Mink are the only cultivars developed from Australian naturalised material. They were selected from material collected in northern Victoria, display good tolerance to heat and are well suited to the Victorian climate.

It is a common observation that the long-term vigour of white clover is poor, due to viral diseases that seriously weaken white clover after a few years. Virus-resistant material being developed by DPI looks very impressive and resistant cultivars should be available soon.

Management

White clover should be grazed to 3–5 cm, to prevent perennial grasses shading out the growing clover, which will lead to a decline in the clover content of the pasture. The rate of regrowth of white clover depends on the area of leaf remaining after grazing. A good balanced pasture should contain approximately 30% clover. In dry summers, stocking rates should be reduced to avoid overgrazing white clover when the plant is under moisture stress. Over summer, cattle are far less damaging to white clover than sheep.

Lucerne

Lucerne (*Medicago sativa*) is suitable for forage conservation and is often grown as a pure stand for hay production or grazing. It is also a valuable species to provide quality forage over summer.

Lucerne is a perennial legume with a long tap root, which enables it to use soil water available at depth, and it is very drought tolerant. It grows best on deep, well drained soils and will not tolerate waterlogging. It originates from Europe and Asia Minor.

Lucerne is sensitive to soil acidity and exchangeable aluminium. If the exchangeable aluminium level in the top 10 cm of soil is above 15 mg/kg (KCl extract), liming prior to sowing is critical for the establishment, persistence and productivity of lucerne. If the level of exchangeable aluminium in the subsoil is greater than 15 mg/kg, the soil is not suitable for lucerne production. The success of lucerne in south west Victoria depends on establishing lucerne on suitable soils or modifying the soil, especially with regards to soil pH and drainage. On gravely loam crests on the basalt-derived soils at Hamilton, lime incorporated at 5 t/ha doubles the yield of lucerne over the long term. The use of lime is described further in Chapter 5, *Fertilising pastures*.

Lucerne flower

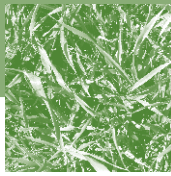


Lucerne provides quality forage over summer, uses soil water at depth, and is very drought tolerant

Cultivars

There are four cultivar groups based on winter production. Generally semi winter-dormant cultivars perform best in the higher rainfall areas. High resistance to *Phytophthora* root rot is most desirable.

Winter-dormant cultivars, (e.g. WL325HQ and L54 Q53), make some growth in autumn and winter but give high hay yields due to their pronounced spring–summer growth. Lower yielding than other cultivars in the first year, they are often superior after the third year due to their excellent persistence.



Semi winter-dormant cultivars are a little more productive in the cool-season than winter-dormant cultivars, and generally persist as well as winter-dormant cultivars (e.g. WL 414).

Winter-active cultivars (e.g. Aquarius, Super 7, Hallmark, UQL1, WL 525HQ) have moderate winter growth and respond quickly to summer-autumn rains. They make rapid regrowth after grazing or cutting for hay. They may have a shorter stand life than more winter-dormant cultivars but can persist under strict rotational grazing.

Highly winter-active cultivars (e.g. Super 10, WL 612) have good winter growth and vigorous seedlings that enable them to establish quickly. High production occurs for at least 3 years but stand life may be limited. They are valuable where winter grazing is needed and summer rainfall is uncertain. Strict rotational grazing is crucial.

Establishment

Apply lime to the paddock in autumn prior to cultivation. Lucerne seed should be inoculated and lime coated then sown at a very shallow level in spring into a finely worked, clean seed bed. If sowing in a mixture with winter-active grasses, early sowing is needed. Otherwise late spring sowing can be quite successful (viz. plants 10 cm tall by late December) if the land has been fallowed over winter. Protect seedlings from lucerne flea and red-legged earth mite and spray broadleaf weeds during the establishment phase.

Management

Lucerne must be rotationally grazed with a maximum grazing period of 3 weeks and a minimum spell of 6 weeks. This spelling period allows the plant to recover root reserves. Continuous grazing will cause a rapid decline in plant vigour and density. To increase the vigour of newly established lucerne, the stand should be allowed to flower and set seed in the first 1–2 years.

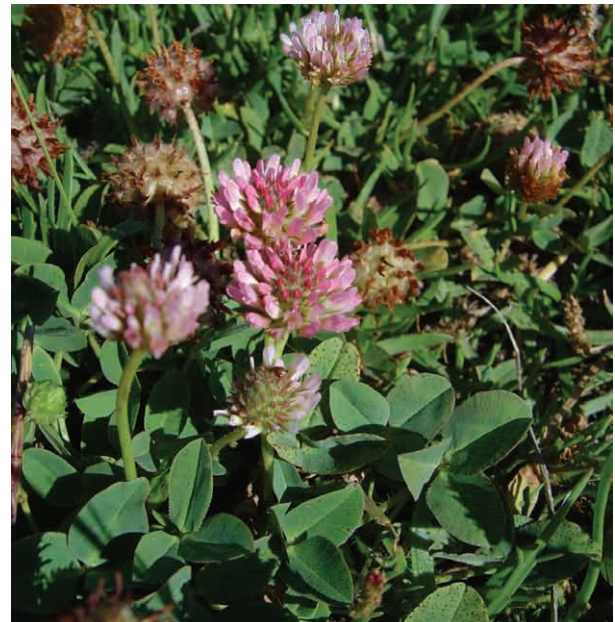
Lucerne can be attacked by a number of insect species. The most common ones, in order of importance, are spotted alfalfa aphid, blue-green aphid, red-legged earth mite, pea aphid, lucerne flea, white-fringed weevil and sitona weevil. It is important to sow cultivars that are resistant to aphids.

In established stands, a light over-sowing of a short-lived ryegrass or cereal is sometimes carried out, to provide winter feed.

Strawberry clover

Strawberry clover (*Trifolium fragiferum*) is suited to waterlogged, heavy soils where white and sub clovers grow poorly. It is also well suited to saline soil but needs at least 500 mm rainfall. Strawberry clover is a prostrate, stoloniferous perennial legume, native to the Mediterranean basin.

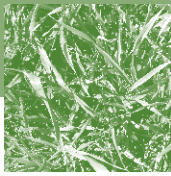
Strawberry clover has two main applications. It provides quality valuable summer feed on heavy/peaty flats that remain moist in summer. Such land often has a high pH, which strawberry clover will tolerate, however it will also encourage barley grass which should be spray-grazed in spring.



Strawberry clover is suited to waterlogged, heavy soils and also well suited to saline soils

Strawberry clover is well suited to clay flats and gilgai on the basalt plains (*Vertosols*), which get waterlogged or stay damp for long periods. In these situations strawberry clover persists and provides patches of valuable green feed over summer. On such country Palestine, the most useful cultivar of strawberry clover, should always be included in a pasture seed mix at 250 g/ha.

Strawberry clover grows and persists well under continuous grazing, which reduces competition from grasses. It has a low level of oestrogen and does not cause bloat.



Balansa clover



Balansa clover
flower

Balansa clover is highly tolerant of waterlogging and moderately tolerant of salinity

Balansa clover (*Trifolium michelianum*) is an annual legume of Mediterranean origin. It is often sown with a short-lived ryegrass, as a 1-year special purpose forage crop.

Balansa clover is highly tolerant of waterlogging, moderately tolerant of salinity and is used in areas receiving at least 500 mm annual rainfall. It has a high level of hard-seededness.

The cultivar Bolta is suited to the wetter parts of south west Victoria; Paradana should be used in the drier areas.

Provided it is allowed to flower and set seed, balansa clover will persist well. Its vigorous spring growth may shade other legumes, reducing their seed production. When grazed by sheep it has performed much better under continuous grazing than rotational grazing. Over summer, pasture trash must be removed to allow the hard seed of balansa clover to be broken allowing it to germinate in autumn. Compared to Persian clover it has no regrowth after being cut and the conserved feed is generally of lower nutritive value.

Balansa clover is highly tolerant of clover scorch and resistant to root rot. It is not affected by aphids but is more susceptible to attack by red-legged earth mites than sub clover. It has low oestrogen content.

Persian clover

Persian clover (*Trifolium resupinatum*) is an erect-growing annual legume, often sown alone as a hay crop or with Italian ryegrass or oats. Persian clover can provide high yields of high-quality feed in spring and early summer. It is high in water soluble carbohydrates and exhibits high intake characteristics. It makes very good quality hay but is quite vulnerable to rain damage and should be moved under cover quickly. Persian clover recovers well from grazing and after it has been cut for hay.

Persian clover requires an annual rainfall of at least 550 mm and can grow well on many soils. Liming to pH_w 5.8 has given significant yield increases. It grows best on fertile clay loam soils and is highly tolerant of waterlogged conditions and moderate salinity.

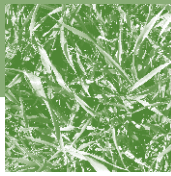
Cultivar Morbulk was developed in south west Victoria where with good rains, high quality hay yields of 4 t/ha in November and 1 t/ha in January can be expected. It does not regenerate but may last for 18 months where sown in spring. Cultivar Kyambro was developed in South Australia for a lower rainfall environment and is a hard-seeded type, able to regenerate in the autumn. Kyambro has usually been less productive than Morbulk in Victorian trials. Cultivar Nitro is also hard-seeded and grows well in areas receiving 450 mm or more of annual rainfall. Nitro is resistant to Phytophthora root rot.

Seed of Persian clover must be inoculated with specific rhizobia prior to sowing.

Soft-seeded Persian clovers have no dormancy period and cannot be relied upon to regenerate



Persian clover can provide high yields of high-quality feed in spring and early summer



satisfactorily in autumn, as the bulk of the seeds may have germinated and died after summer rains.

Persian clover seedlings are particularly susceptible to red-legged earth mite and lucerne flea. It is resistant to spotted alfalfa aphid but is susceptible to pea aphid and blue-green aphid.

Arrowleaf clover

First commercialised in the USA, Arrowleaf clover (*Trifolium vesiculosum*) is an annual legume suited to well-drained soil. It grows slowly in winter but grows late and provides quality feed into January–February.

Some cultivars (e.g. Zulu) have been used for some time in the summer rainfall regions of New South Wales and regions with a long growing season. The Tasmanian cultivar Arrotas has grown well in experiments at Hamilton. Seed of Arrowleaf clover must be inoculated with specific rhizobia prior to sowing.

To encourage regeneration graze the arrowleaf clover until December, spell in January and then graze the standing hay prior to germination in autumn.



Arrowleaf clover grows slowly in winter but provides quality feed into January–February

Chicory

Chicory (*Cichorium intybus*) is a highly palatable perennial herb, providing high value forage in spring–summer (Table 3.2). It has a high digestibility and is a good source of minerals. It is compatible in pasture mixes with legumes, but has poor winter growth. Chicory is a tap-rooted plant that has good drought tolerance, and has long been used as a perennial forage species in South America and Europe.



Chicory is a highly palatable perennial herb, providing high value forage in spring and summer

While chicory requires well-drained soil, compared with lucerne it is more tolerant of a wider range of winter-wet soils and is not as sensitive to soil acidity.

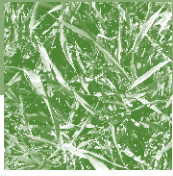
Puna chicory from New Zealand has been tested in southern Australia and is the most used cultivar in the region. More-upright winter-active cultivars such as Grouse and Chico are available. These establish quicker than Puna, but may not be as persistent.

Chicory is best sown after a strong weed control program – pre-emergent herbicides can be effective. Shallow sowing is required in spring at a rate of 4 kg/ha. If establishing chicory in a mixed pasture, sow at 1 kg/ha with summer crops, followed by over-sowing with grass seed in autumn. Red-legged earth mite and slugs may sometimes weaken the establishment. About

Table 3.2 Feeding value of chicory (cv Puna) at DPI Hamilton compared with other pasture mixes

Measure of feed value	Chicory, white clover*	Tall fescue, sub clover	Perennial ryegrass, sub clover
Liveweight gain late spring (g/d)	240	190	179
Liveweight gain mid summer (g/d)	168	16	14
Lambs finished (no./ha)	33	9	9

*Chicory was sown on one half of the treatment area and white clover on the other, and each species was grazed as a sequential system. Other treatments were sown as mixtures.



30 kg/ha of nitrogen may be used at establishment and in subsequent springs to boost summer production. Rotational grazing is required and chicory must not be overgrazed, especially in winter. However, in spring, intensive grazing for a short period is required to prevent the plant “bolting” and deteriorating in quality. Topping chicory in spring–early summer, by removing seed heads, helps extend feed quality with leafy production and improves longevity.

If left to seed, chicory will recruit seedlings and so can increase stand density but normally it is kept from seeding in order to maintain quality. Chicory is not susceptible to summer pests such as the cabbage/diamond back moth and cabbage white butterfly that usually attack *Brassica* crops.

Breeding better pasture cultivars

Department of Primary Industries conducts and participates in national pasture plant improvement programs. These programs receive support from research and development corporations, seed companies and DPI. Many of the programs have linkages with overseas organisations.

The programs aim to develop new cultivars that are better adapted to Australian environments through improved seasonal growth, palatability, persistence and resistance to pests and diseases.

Merit testing

Department of Primary Industries does not recommend/approve any cultivars. It may provide a confidential test to evaluate cultivars; results are reported to the company that commissions such work.



Pastures of mixed species and cultivars provide many benefits including extended times of feed availability and persistence through adverse seasons and pest or disease attack

Plantain

Plantain (*Plantago lanceolata*) is a palatable perennial herb that performs well in pasture and is a good source of minerals (especially copper and selenium). It is a tap-rooted species that is very heat and drought tolerant. Plantain breaks down quickly in the rumen, like legumes, and so it encourages high intake and produces good liveweight gains.

Grazing management needs to minimise the development of stem and seed heads. For a pure stand, sow plantain at 5 kg/ha using cultivars Tonic or Lancelot. It can be a beneficial component in seed mixtures at 1 kg/ha, especially in drier districts.



Plantain is a palatable perennial herb that performs well in pasture and is a good source of minerals, especially copper and selenium

Further reading

Information on establishment, pest and weed control, toxins, and fodder conservation are contained in relevant chapters of this book or DPI Agnotes (go to www.dpi.vic.gov.au/notes or request from DPI's call centre on 136 186).

The Grassland Society of Southern Australia maintains a database (hosted by University of Melbourne) that lists many of the pasture species and cultivars available. The details are supplied by the cultivars' proprietors: www.grasslands.org.au/gsv/newSite/index.asp

Perennial grasses of Mediterranean origin offer advantages for central western Victorian sheep pasture

by MW Anderson, PJ Cunningham, KFM Reed, A Byron (1999). *Australia Journal of Experimental Agriculture* 39 275-284.

Perennial ryegrass toxicosis in Australia

edited by KFM Reed, SW Page, I Lean (2005) Meat and Livestock Australia, North Sydney.