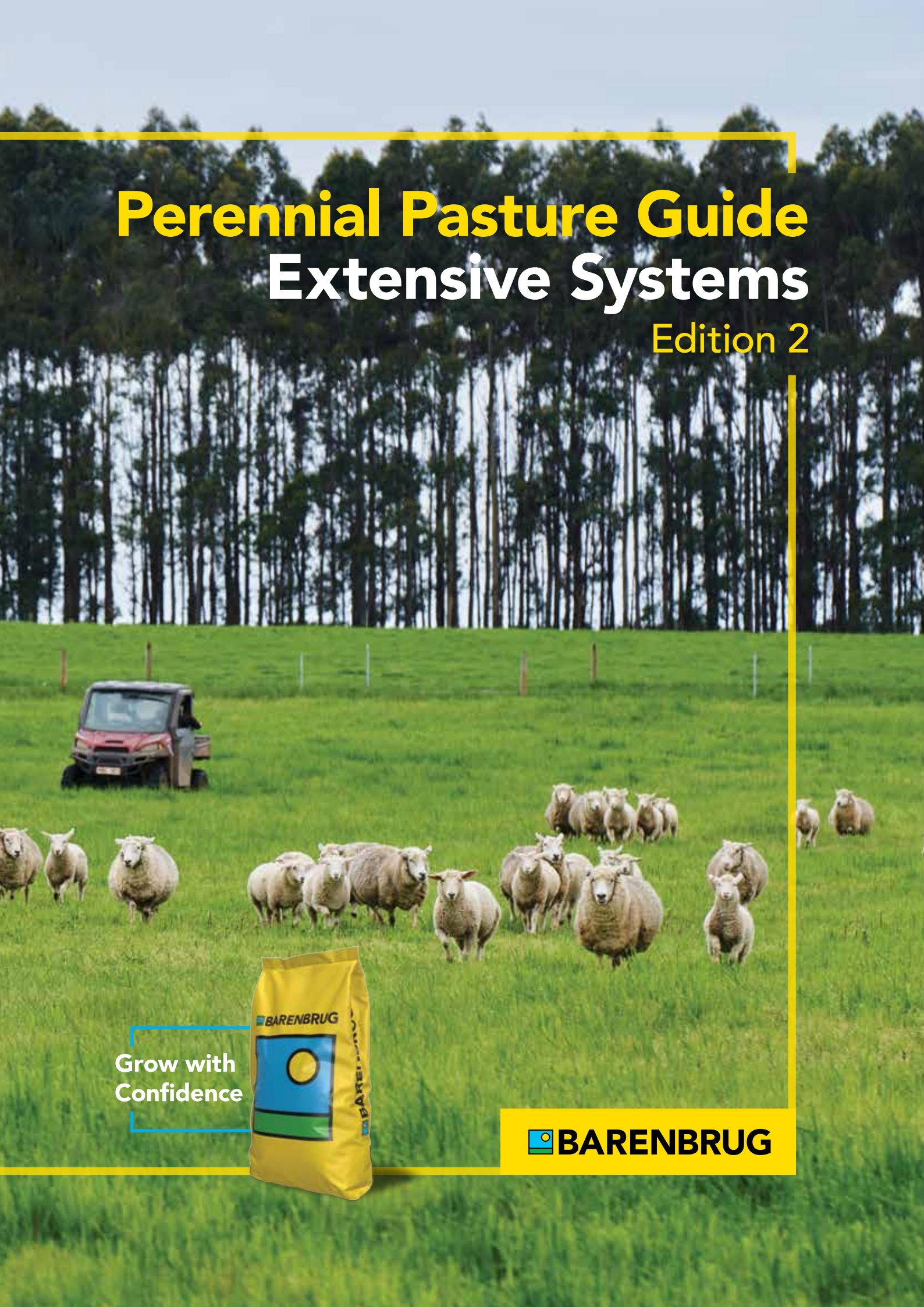
Perennial Pasture Guide
Extensive Systems

Edition 2



BARENBRUG

Dryland Pastures in Temperate Australia

Dryland perennial pastures form the backbone for many grazing operations in the temperate, low to medium rainfall zones that constitute the greater part of our agricultural landscape. At Barenbrug we strive to assist farmers to be as productive as they can be to maximise farm output. These grazing areas provide various income streams from livestock sales, wool, hides, red meat, dairy products, fodder, and make an important contribution to cropping enterprises through stabilising and building soil fertility.

Pastoral productivity is challenged through various climatic events and economic circumstances. Consequently, our pastures are in various conditions of performance: from semi-native or neglected pastures, partly improved pastures, to highly productive and well maintained paddocks.

Extensive Perennial Pasture Guide describes the methods, options and opportunities for improved pasture performance in the medium-lower rainfall, dryland (extensive) regions of temperate Australia. There are also applications for this information in the more challenging sites within higher rainfall areas. It is also important to consider new science relating to pasture management, contemporary options for weed and pest control and the significant advances in plant breeding that have taken place.

Sound preparation techniques, correct cultivar selection and active management should see such pastures endure and be productive for many years.

Talk to your Barenbrug Territory Manager to refine your program further.

Contents

Successful Perennial Pastures

Reliable perennial pastures are the cornerstone of extensive grazing systems. The success or underperformance is related to a combination of many factors:

- The outcome being sought by the farming operation
- How the pasture fits in with other farming operations
- Stock type
- Soil type
- Soil fertility/nutrient levels inc. pH
- Aspect and slope
- Paddock size, orientation, shape
- Heat and cold
- Water points, stock movements and similar
- Approach to pasture establishment
- Latitude/photoperiod –
- Weed control strategies
- Species selection
- Cultivar selection
- Moisture – rainfall, timing, irrigation, dry periods
- Grazing management
- Fertility maintenance
- Insect and invertebrate pests
- Vertebrate pests
- Maintaining weeds and pests below problematic thresholds
- Extreme environmental events.

In most circumstances it is desirable to try and achieve a pasture with a composition of about 60-80% grasses and the balance pasture legumes. These levels may vary throughout the year, with clover dominant at some times and grasses at others. In some instances more-or-less pure legume stands are warranted as the best choice, for example sub-clover, medic or lucerne pastures in lower-rainfall cropping areas.

Grasses are largely the main source of energy, dietary fibre and the bulk of feed. When grasses are in leafy growth they will offer a relatively good balance of animal nutrition. In most circumstances, grasses will become reproductive and stemmy through spring, reducing the feed value. Animal performance will also be somewhat reduced. Conserving quality silage and hay will help manage the spring excess and provide reasonable supplementary feed in times of low pasture growth. In some cases specialty summer pastures may be developed to offer green summer feed. Here lucerne is the king, but other summer active options such as some varieties of cocksfoot, fescue, phalaris and perennial clovers may be considered.

In mixed grass-clover pastures legumes are a valuable and high quality part of feed, and importantly, fix nitrogen from air in the soil, which in turn feeds the growth of the grasses. A well-balanced pasture with productive legumes will in time develop a nitrogen fertility base that should in most cases preclude the need for additional nitrogen fertiliser.

Depletion of legume content from under-fertilising, over-grazing, selective grazing, pests, competition or removal of nutrients through animal products, cropping and fodder production will certainly challenge the fertility of the pasture and productivity will likely decline rapidly. If a pasture is managed to develop and retain a good legume base and weedy grasses are controlled, then the pasture should be productive in the long term.

Legumes

pH, phosphorus, potassium trace elements, soil balance, management:

> Develop nitrogen base
>> Support grass growth
>>> Monitor and manage weeds, pests, grazing, fertility
>>>> Successful perennial pasture

Inspection of pasture composition needs to be done on a regular basis, and action taken if the desirable grasses and clovers are lower than acceptable thresholds. In some cases this may be related to fertility decline, weed incursion, pest pressure or grazing management. In such cases, action to remedy may include how paddocks are managed, address weeds or pests appropriately or soil test and make alterations to the ferliiser programs. When such actions are unlikely to be enough to restore productivity, complete or partial pasture renewal should be undertaken. Pasture measurement or grazing records will help empower such decisions.

Many of these factors can be addressed through appreciating the environmental potential and constraints, adopting good farming practices, understanding the levels of risk for reward, and by considering the need for inputs to enable a good pasture to work properly and be maintained.

Annual rainfall and carrying capacity

Carrying capacity is usually referred to in terms of Dry Sheep Equivalents (DSE). A DSE represents the energy requirement of a dry 50 kg ewe. In terms of a potential carrying capacity, often reference is made to the French – Schultz equation:

Carrying Capacity (DSEs) = (Annual rainfall–250)x1.65/25.

This equation has been modified and adapted over time, with the co-efficient of 1.65 possibly too high for most situations, and commonly a rate of 1.0 to 1.3 adopted instead:

Carrying Capacity (DSEs) = (Annual rainfall–250)x(1.0 range 1.3)/25.

It may be useful to consider this refinement and application as:

Year-round growth/rainfall, modest country with an Olsen P 10-15, use 1.0

Year-round growth/rainfall, good country maybe an Olsen P of >18, use 1.3

For example, for 650mm country, modest P levels:

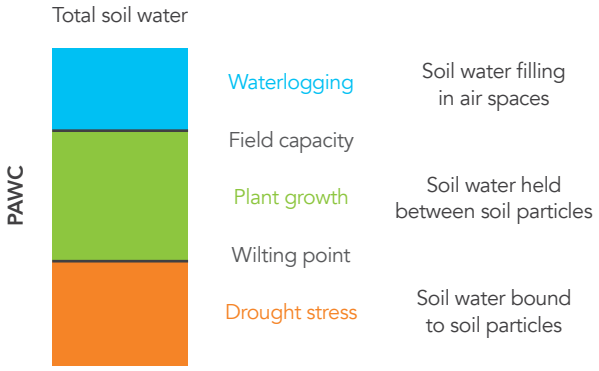
Carrying capacity DSE/ha = (650mm–250x1.0)/25=15.2

Once estimated potential carrying capacity is calculated, compare where the current carrying capacity sits. It can be estimated from the situation above that a site has a potential carrying capacity of 15 DSE/ha. Currently the site is under performing: it may be under-fertilised, unimproved pasture consisting of some weedy and native grasses with little to no legume content. After some calculations from grazing records, it can be determined that the pasture is currently carrying 7 DSE/ha and therefore has an opportunity cost of 8 DSE/ha. To illustrate the point, the gross margin per DSE may vary year to year and season, but a $50/DSE will potentially provide $400/ha/yr (gross margin).

Soil water holding capacity

Soils will have a bearing on some factors around what to expect in terms of pasture growth. Soil depth, soil profile, texture, organic matter, clay content, slope and variability will affect how plants can respond to potential moisture availability. When the soil profile is full, plants struggle to grow from waterlogging. When free soil water filters away to a certain point, the soil is said to be at field capacity. Between the field capacity and the wilting point, is the Plant Available Water Capacity (PAWC). There will also be soil moisture bound more tightly that is not plant available. The PAWC is typically only about 30-50% of the total soil moisture.

With lighter soil types, pastures will be less resilient to periods without rain, and as spring warms up, pasture will brown off somewhat earlier. Implied too is that shallow-rooted, long-season varieties such as many ryegrasses are not suited to low-rainfall light soil paddocks; and deeper rooted perennials will offer more growth potential, better resilience through a dry spell and performance later into spring or early summer.



Soil type	PAWC per 10cm soil depth	Days of spring pasture growth at 5mm/day water use, 60cm effective soil depth
Sandy-light soils	6-8mm	7 to 8 days
Light loams-clay loams	12-15mm	14 to 18 days
Heavy clay	20mm	approx. 24 days

Example of time to wilting point of pasture in active growth. Individual circumstances may differ widely.

Site Preparation

Successful pasture establishment is the result of correct preparation and planning, starting at least six months before any pasture is sown. The more time spent on preparation, the better the final result will be. Reducing competition from existing weeds is one of the most important first steps. Key to this is identifying which weeds are present and then following a well-planned program.

Year 1 – Winter/Spring

If silver grass (vulpia) is a problem, the most effective method of control is to spray with simazine in the winter months when the plants are small and the soil has adequate moisture.

An alternative or additional option is to spray-top the paddock in spring to prevent annual grasses and broadleaf weeds setting seed. Heavily graze the paddock in late winter/early spring to encourage an even emergence of seed heads prior to spraying. Spray-top pasture with paraquat or glyphosate. Grazing after this will help to prevent any further emergence of seed heads (ensure to follow chemical withholding periods). The addition of an insecticide will help break the life cycle of redlegged earth mite (RLEM). Check the soil test analysis and apply lime if needed.

Continue to graze the paddock over spring and summer. In the event of summer rainfall, another knockdown herbicide may be required to conserve any moisture. In regions that have extended seasons or available irrigation, a summer break crop such as millet or a brassica is a good opportunity to control weeds and also provides extra summer feed.

Witholding Periods: the minimum length of time that must elapse between the last application of an agricultural chemical to a crop and the harvest, sale or use of the agricultural produce to which the chemical was applied. (Agriculture Victoria 2021)

Year 2 – Autumn

After a summer fallow and when temperatures are suitable, or perhaps after a decent rain event, wait for the weeds to germinate and then spray out paddock with knockdown herbicide to kill existing weeds and pasture cover. If possible, cultivation of old ley paddocks will help control underground pests as well as encouraging a germination of weeds.

If the weed burden looks acceptable, consider going straight into a new pasture. In many cases it is advisable to sow an annual ryegrass or a cereal, or perhaps an autumn brassica or a grain crop. Which species is chosen will depend upon the location of the paddock, what weeds are likely to be present and the desired outcome. For example, those in a cropping zone may prefer growing a cereal, whereas a beef farmer may choose an annual ryegrass. A forage crop such as forage rape may suit a lamb producer.

This break crop will give the best weed control option prior to the following year's permanent pasture. Another good way to control weeds is to cut for hay or silage, or consider crop-topping.

Year Before		Summer
Pasture	Winter cleaning Silage Pasture topping Insect control	Forage/fodder crop + in crop weed control **or** Spray-fallow Control weeds Conserve soil moisture
Crop	Selective weed control Silage Crop topping	

Soil Fertility

Soil fertility is about having the right organic matter, the pH, the essential nutrients and minerals. A soil test is essential to achieve production expectations, and may often save money on unnecessary fertiliser or more correctly target expenditure. The following fertility targets will suit many applications, although an experienced advisor should be engaged to work through specific circumstances.

pH ($CaCl_2$)	4.5 – 5.4 is adequate for grass/ clover (approx 5.4 – 5.9 pH in water) 5.6 + for lucerne (6.0 in water)
P (Olsen)	target range 15-20ppm, ideally 18+, 25-30 for dairy/intensive production)
K	130-150ppm for lighter soils 150-220ppm for medium clay/silts/loams 200-250ppm for clayey types

S	12-20 ppm about right
Mg	Don't over-look, especially if applying solid rates of K
Mo	Needed for legumes to function: 50-60 g/ha of Mo every 3-5 years. Apply in conjunction with Cu
B	Needed for legumes
Co	Sometimes needed in small amounts
Se	May be needed (animal performance)

Soil pH

pH is most commonly referred to from a measurement taken in a solution of calcium chloride, as this tends to provide an approximation of the soil conditions experienced by plants, and is a more reliable test in general. To convert a pH in water to $CaCl_2$, as a rule of thumb subtract about 0.7 from the pH water result. pH in Barenbrug documents is always described as a $CaCl_2$ result.

The soil pH will determine the relative solubility of various nutrients and toxins. Generally a pH range of around 4.5 to 6.5 ($CaCl_2$) (5.2 – 7.2 water) will be suitable for the majority of pasture types. Some species or specific varieties within species will extend this range and the individual cultivar's preferred range is described in our literature.

Whilst there are some large areas of alkaline soils in southern Australia, soil acidity is more frequently a limiting factor. At low pH levels aluminium, iron and manganese may be at toxic levels, and some trace elements become tied up or less available. Liming may be a feasible option in many circumstances to help create a more nutrient balanced range, or if liming is not a realistic option, select varieties with improved tolerance to low soil pH.

Phosphorus

Phosphorus is often the most vital limiting factor in legume and grass production. Whilst soil test reports often utilise Colwell P in analysis reports, most pasture work is referred to in Olsen P, as it is an indication of the most immediately plant available phosphorus estimate. Colwell results are still useful however and as an indicative guide, to convert Colwell to Olsen:

1. Divide by 3 for heavier soils: clay and clay-loams
2. Divide by 2 for medium loam soils
3. Divide by 1.6 for lighter and sandy soils.

In some districts, critical P levels have been developed for pastures, and as such these levels should be a useful guide for more specific circumstances.

There are a number of other important elements, factors and potential interactions to possibly consider. This may include some nutrient ratios in terms of balance depending on soil clay type and content, as well as soil-type response rates to fertiliser application and liming. Seek skilled advice to assist with interpreting your pasture soil test and to help make appropriate investment decisions.

Species Selection

Components in a pasture mix will by necessity need to be able to survive and produce under specific circumstance that suit the environment, soil conditions, management and expectations. In most cases a grass-legume pasture is the aim, in which case there is some consideration needed for the co-compatibility of the species and their individual management requirements for best results. The table on pages 12–13 describes the suitable rainfall ranges, soil type and pH for the main species and types within a species. There are also a number of unique varieties developed by breeders that have attributes that extend the range of the species.

Plant breeding and evaluation efforts by strong R&D companies over the last 20-30 years have achieved some great advances. Breeding objectives may depend on the species, use pattern, or to address other challenges or opportunities. Some examples of improved productivity and benefits include:

Phalaris	Winter activity and drought hardiness: Advanced AT, Holdfast GT Improved grazing tolerance: Holdfast GT Acid tolerance to very low pH: Advanced AT
Cocksfoot	Finer leaves: Safin, Howlong, Summadorm Summer dormancy: Summadorm
Ryegrasses	Improved yield potential by over 30-40% compared to old types No staggers: endophyte technology including NEA series Improved feed quality: later season types, reduced aftermath
Sub-clover	Increased winter yield: brachycalycinum genetics – Antas, Mintaro Improved hard-seededness: Campeda, Monti and others
White clover	Increased yields, cool season growth and stolon density: Storm
Lucerne	Greater pH range: SARDI 7 Series 2 Improved grazing tolerance: SARDI-Grazer Improved disease and pest resistance: SARDI range generally.

Species' rooting depth and mass

A deeper and larger root system will improve the ability of a species to survive dry conditions, insect attack and improve and extend the growth season. Deeper roots will be able to draw on moisture at depth and keep the pasture productive to some extent as summer comes on. A more extensive root system will also allow plants to access and utilise nutrients. Root mass is also strongly influenced by grazing management. Continuous grazing with few or little rest-periods will reduce root mass and deplete plant reserves. See details under Grazing Management.

Root depth under suitable soil conditions for various species:

Ryegrasses	15-30cm
Most clovers	30-60cm
Cocksfoot	80cm approx.
Fescue	1m approx.
Phalaris	1.5–2m approx.
Lucerne	over 1.5m

Length of growing season

Most parts of temperate Australia have a distinct winter dominant rainfall pattern. As a result, an important aspect of selecting suitable species and varieties is to create the best growth opportunities in the cooler months and the characteristics to cope with hot, dry periods from late spring to early autumn.

Conversely, in areas with a reliable early start to autumn and perhaps a more generous spring, mid-season or longer season varieties may capture the growth potential. Hence varieties are often described as being early, mid or late season types, and minimum required rainfall figures offer a guide to suitable growing environments for different varieties.

A short season type planted in a late area will often work, but not capture the full returns potentially on offer. A late type planted in a shorter growing season area may have a reduced peak in growth and then fail to either set seed or not exhibit a strong enough level of summer dormancy to cope with the dry season.

Dryer areas, shorter spring, hotter summers = shorter season types

Higher rainfall, longer spring, milder summers = longer season types

Seasonal dormancy

Perennial species are often described as having some form of seasonal dormancy. Winter active grasses and clover varieties will tend to shut down entirely or partially in summer, whereas summer active types have potential for summer growth provided moisture is available and temperatures are not too high.

Summer active varieties tend to slow down in winter, however summer active grasses and clovers used in hot, dry climates will have a tendency to grow, but will struggle to persist.

In reliably summer dry areas, winter active varieties with some level of summer dormancy are usually the preferred option. The mechanism of a variety entering summer dormancy is not entirely understood, although it is probably related to plant physiological responses to temperature, day length and moisture availability. Typically, varieties with very strong summer dormancy have a shorter growing season, hence may not be quite as productive over an entire year. Partial summer dormancy is a term applied to longer-season winter active varieties with some capacity for a summer shut-down, and such types, with appropriate management often offer the best compromise between productivity and plant persistence. With appropriate management these types can often offer the best compromise between productivity and plant persistence. It is worth noting that all lucerne is summer active, it is the level of winter dormancy that varies.

Self-regenerating legumes and hard-seed

In most cases, legumes are regarded as a key element of long term pastures for their capacity to survive and re-seed from year to year. Most dryland pastures will have some component of annual, self-regenerating legumes such as sub-clover, aerial-seeding annual clovers or medics. Perennial clovers are generally expected to survive through the original plant or by setting new plants from their stolons. This usually means that perennial clovers are most suited to slightly higher rainfall and cooler summer areas, although white and strawberry clovers do have some capacity to annualise and set seed.

Hard-seed is a feature of self-regenerating legumes in particular. Hard seeds require a combination of time, extra moisture, scratching or some other process for germination to occur. The soft-seeds will usually germinate fairly quickly after conditions are suitable, typically after the first late summer or autumn rains. Varieties with a high percentage of hard seeds will offer the pasture an ability to have a reserve of seed to allow for unsuccessful initial establishment. This mechanism offers some resilience and the pasture is able to be productive despite possible early, false seasonal breaks. Some species have very high levels of hard seed (often >98%), the legume may in fact be absent or in very low numbers in the second year until some of the hard seed breaks down in following years. Modern sub-clovers have increased hard seed to around 20-40% which is a useful range to generate good pasture reserves as well as germinate reliably every autumn.

Salinity

Many species will tolerate some level of soil salinity, although there are thresholds at which productivity will decline below acceptable levels, even if the variety or species persists. Often salinity is associated with watercourses, low-lying seaside areas or other wet sites. If salinity and water-stress are both occurring, a species needs to be assessed over both challenges.

Salinity Tolerance					
Low Tolerance	Some Tolerance	Moderately Tolerant	Tolerant	Very Tolerant	Highly Tolerant
<2 dS/m	<2-4 dS/m	<6-8 dS/m	<10-12 dS/m	12-25 dS/m	>25 dS/m
Ryegrass	Cocksfoot	Phalaris	Tall fescue	Tall wheatgrass	Puccinellia
White clover	Sub-clover	Persian clover	Strawberry clover		Saltbush
Red clover	Lucerne	Balansa clover			

Waterlogging

Water-stress will cause some species to decline or die out. In soil types and situations that are known to become seasonally wet for some periods the following scale may act as a guide to species selection:

Waterlogging Tolerance				
Low Tolerance	Some Tolerance	Moderately Tolerant	Tolerant	Very Tolerant
< Few days	Days - few weeks	Wet season	Regularly wet site	Marshy
Cocksfoot	Ryegrass	Phalaris	Tall fescue	Tall wheatgrass
Lucerne	Most sub-clovers	Yanni sub-clovers	Strawberry clover	
	White clover	Persian clover	Balansa clover	
	Red clover			

Seasonally wet sites with a low pH present a particular problem, as cocksfoot and other grasses generally struggle. Advanced AT phalaris has been developed for just such situations, and will also perform very well at more reasonable pH levels.

Timing of Sowing

Deciding on a sowing time will be influenced by several factors and options including variations between sites, regions, climates, species, varieties, soil types and paddock condition.

Soil moisture and temperature

In an ideal situation, seed is evenly placed into warm, moist soil and covered, then followed by a few showers or some rain. Most temperate species are best sown at soil temperatures of between 12-20°C. Grasses and cereals will however often germinate and grow reliably below about 8-10°C, whereas clover growth is usually very slow to nothing at these lower temperatures. A late-sown autumn grass-clover pasture may have a reduced clover component because of the relative growth rates, allowing the grass to out-compete the legumes. In winter-cold, hoar frosts kill young seedlings through lifting and tearing the roots. In such locations, early autumn sowing or spring sowing may be the best options.

To assist with sowing earlier in autumn, strongly consider foregoing a summer crop and/or terminating your prior crop by around mid-spring in the year prior to sowing your new pasture. Fallow the paddock for 2-3 months, control the weeds, and conserve some moisture in the soil profile. This will help to enable an earlier autumn sowing time: sow into some moisture and some dews and the odd shower will see the new pasture on its way. Waiting for an autumn break that may or may not come, or come too late is often a false proposition and in many cases a wasted opportunity. Sometimes there may be merit in waiting until after the first germination of weeds, then spraying these off and sowing a little later. The benefits of this will need to be weighed-up against the risk of sowing too late though. A late-sown, slow developing pasture may be strongly challenged by weeds and pests, giving little opportunity for clover establishment, and offer little value for grazing until the following spring.

In areas that usually have a long, hot summer however, waiting for soil and air temperatures to decline may be critical. Sowing new pastures with anticipated air-temperatures of over 30-32°C should be avoided. Around the autumn equinox in mid to late March will see high daily temperatures on the decline.

Planting and Dormancy

Generally, winter-active species with partial or full summer dormancy ought to be autumn sown, as they may have insufficient time to establish before their summer dormant period commences. In some long-spring, mild summer areas, late winter or early spring sowing may be appropriate. This is also the case in many elevated areas which may be too dry and cold in autumn for reliable pasture establishment. This category includes most phalaris cultivars, winter active cocksfoot, fescue, early maturity ryegrasses, sub-clovers, and medics. These types can often be successfully sown through most stages of autumn provided moisture is not limiting. Self-regenerating pasture legumes such as sub-clovers and medics need a minimum length of growing season in order to grow, flower and set seed.

Species or varieties with summer growth potential, are usually slow growing in winter and need to be sown in early autumn to develop. They are usually best sown early in autumn to enable some development before soil temperatures decline. Alternatively they may usually be reliably sown in late winter through early-mid spring provided sufficient development occurs before the onset of dry or hot conditions. This group of species includes summer active varieties of phalaris, cocksfoot, fescue, later maturity ryegrasses, perennial clovers and lucerne.

Winter active species = Autumn sowing

Summer active species = early Autumn sowing, Spring sowing

Long-Term Pastures Species & Variety:

Selection Chart

Varieties	pH Range ($CaCl^2$)	Soil Types	Sowing Rates (kg/ha)		Page
			Main Species	Mixed Species	
Phalaris					
Horizon	4.5 – 8.0	Most Types	4–6	2–3	16
Advanced AT	3.9 – 8.0	Most Types	4–6	2–3	16
Holdfast GT	4.5 – 8.0	Most Types	4–6	2–3	17
Australian (types)	5.5 – 8.5	Med–Heavy	4–6	2–3	17
Cocksfoot					
Summerdorm	4.0 – 7.5	Light–Med	3–4	1–2	19
Howlong	4.0 – 7.5	Light–Med	3–4	1–2	19
Safin	4.0 – 7.5	Light–Med	3–4	1–2	19
Bareno	5.5 – 8.0	Light–Med	15–30	10–15	20
Tall Fescue					
Prosper	5.2 – 8.0	Most Types	10–15	5–8	21
Fortune	4.5 – 8.0	Most Types	10–15	5–8	21
Perennial / Long-Term Ryegrasses					
Barberia	4.8 – 8.0	Most Types	12–15	6–10	23
Kidman	4.8 – 8.0	Most Types	12–15	6–10	23
Governor	4.8 – 8.0	Most Types	12–15	6–10	23
Maxsyn	4.8 – 8.0	Most Types	12–15	6–10	23
Impact 2	4.8 – 8.0	Most Types	12–15	6–10	23
Rohan	4.8 – 8.0	Most Types	12–15	6–10	23
Viscount	4.8 – 8.0	Most Types	20–30	10–15	24*
Bealey	4.8 – 8.0	Most Types	20–30	10–15	24*
Sub clovers					
Losa	4.5 – 7.0	Most Types	6–8	3–4	26
Mawson	5.0 – 8.5	Most Types	8–10	5–6	28
Monti	4.5 – 7.0	Most Types	6–8	3–4	27
Mintaro	5.0 – 8.5	Most Types	8–10	5–6	28
Campeda	4.5 – 7.0	Most Types	6–8	3–4	26
Gosse	4.5 – 7.0	Most Types	6–8	3–4	27
Antas	5.0 – 8.5	Most Types	10–12	5–6	28
Denmark	4.5 – 7.0	Most Types	6–8	3–4	26
Perennial clovers					
Storm, Weka	5.2 – 8.0	Most Types	4–6	1–3	29
Morrow	5.4 – 8.0	Most Types	6–8	2–4	30
Palestine	4.8 – 8.0	Most Types	2–3	1–2	30
Annual clovers (hard-seeded)					
Nitro Plus	5.5 – 8.5	Most Types	6–8	2–4	32
Vista	4.5 – 7.5	Most Types	2–3	1–2	32
Zulu II, Cefalu	4.5 – 7.5	Light–Med	6–8	2–4	32
Medics					
Sultan SU	5.7 – 8.5	Med–Heavy	6–10	2–4	32
Jester SU	5.7 – 8.5	Med–Heavy	6–10	2–4	32
Scimitar	5.2 – 8.5	Med–Heavy	6–10	2–4	32
Lucerne					
Sardi Grazer	5.4 – 8.0	Most Types	10–20	4–10	36
Sardi 7 Series 2	5.0 – 8.0	Most Types	10–20	4–10	37
Sardi 10 Series 2	5.4 – 8.0	Most Types	10–20	4–10	37

Highly Acidic | Moderately Acidic | Slightly Acidic – Neutral | Neutral – Slightly Alkaline | Alkaline

Sowing Rates

The species' seed size, plant growth habit, environment and pasture management are important to consider when formulating a pasture blend. When sowing perennial pasture mixes, usually work on approximately 20-25kg/ha for a typical medium rainfall mix, and often around 12-18 kg for a lower rainfall site.

Allow for variations in seed size:

- Cocksfoot and phalaris are smaller in seed size than ryegrass, and individual plants are often much larger.
- Tetraploid ryegrasses need approximately 30-40% higher sowing rate than diploids.
- Fescue ratios are approximately 75% of diploid ryegrass rates, as fescue is a larger plant.
- Sub-clovers are very large seeded, and need good numbers to set seed for next years' pasture.
- Balansa and white clover seeds are quite small.

In lower rainfall areas, reduce the grass sowing rate as the plant population capacity will be lower.

Cocksfoot and phalaris are smaller seeded as well; it is recommended legume percentage is increased, especially if using subs due to the much larger seed size. Do not skimp on sowing rates for sub-clovers. A higher initial sub-clover plant population will increase productivity, and future pasture resilience due to a better seed-bank to help cover false autumn breaks.

In mixed grass/clover pastures the aim should be to achieve approximately 30% legume on average ground cover through the year, once established.

Dryland forage species seed weights, sowing rates and sowing depths							
Group / species	Seeds/gram	Sowing rates kg/ha as mix component		Sowing rates kg/ha as sole/main component		Preferred sowing depths mm	
		lower	upper	lower	upper	min	max
Pasture grasses							
Phalaris	500 - 550	2	3	4	6	5	15
Cocksfoot	1000 - 1100	1	2	3	4	5	15
Tall fescue	400 - 450	5	8	10	15	5	15
Brome grasses	100 - 120	10	15	15	30	5	25
Ryegrass - diploid	500 - 600	6	10	12	15	5	20
Ryegrass - tetraploid	250 - 300	10	15	20	30	5	20
Pasture legumes							
Sub-clover	90 - 150	3	6	8	12	5	15
White clover	1500 - 1800	1	3	4	6	5	10
Red clover - diploid	500 - 550	2	4	6	8	5	10
Strawberry clover	650 - 700	1	2	2	3	5	10
Balansa clover	870 - 1100	1	2	2	3	5	10
Arrowleaf clover	650 - 750	2	4	6	8	5	10
Persian clover	750 - 900	2	4	6	8	5	10
Barrel and burr medic	230 - 300	2	4	6	10	5	15
Lucerne	400 - 480	4	10	10	20	5	15

Note: many seed sizes and weights will vary markedly depending on seed growing conditions, seed processing and cultivars.

Planting equipment and surface conditions will create some variation in depth of seed placement. Seeds sown a little deeper or shallower are often fine to germinate and establish. The sowing depth should be regarded as a target to guide decisions.

Sowing Methods

There is a great diversity of sowing equipment available and methods and approach will be influenced by a number of factors such as paddock physical factors including slope, soil depth, rocks, soil type, moisture levels as well as local knowledge and experience.

Broadcasting onto cultivated soil

Seeds are broadcast on to the cultivated soil surface, often in a mix with fertiliser. The paddock is then harrowed and usually rolled to enable seed coverage and soil-seed contact. Avoid allowing seeds and fertilisers to remain mixed for more than a few hours as seed may be desiccated by the salts in some fertiliser compounds.

Pros: Often allows more space for slower establishing species. Only basic gear needed.

Cons: May be inefficient in terms of reliable seed placement. Multiple passes / working of paddock. Higher erosion risk. Higher risk of frost-lift or pulling due to grazing in the first instance.

Notes: Differing seed sizes and densities, as well as fertiliser physical properties may result in a varied or banded establishment pattern. Cross-spreading may be beneficial in many cases. Aerially sown pastures may need extra time to become well anchored prior to grazing as seed coverage is often less than desirable.

Cross spreading/sowing. Sow the paddock in one direction then again in another direction compared to the first pass.

Drilling into cultivated soil

Seeds are drilled with a tine, knife-point or disc drill, usually followed by press-wheels or a roller. In many circumstances this method offers the best chance for success.

Pros: Usually offers best result for accurate seed placement and seed contact. In many circumstances this is the best chance for success. Best opportunity for pest control and pre-emergent herbicides if appropriate.

Cons: For mixes, the slower germinating or establishing species may be outcompeted within the drill-rows. Higher erosion risk.

Notes: Cross-sowing is often beneficial but will require more planning and an extra pass

Direct drilling (minimum till)

Seeds are drilled into existing spray-fallow or recently harvested and sprayed crop or stubble.

Pros: Relatively quick. Nutrients retained in top-soil. Soil not disturbed thus offering more solid footing for stock during establishment. Lower risk of erosion. Less risk of frost-lift.

Cons: Trash-cover may preclude use of pre-emergent herbicides and/or be a source of slug or snail population.

Drilling into existing sward (undersowing/oversowing)

Seeds are drilled into existing pasture cover. Useful for topping-up existing pastures. Tight grazing management, and some weed control prior to sowing are usually needed.

Pros: Retain valuable remnant pasture. Low cost. Less time out of production.

Cons: Competition from existing cover may reduce rates of new seed establishment. No pest or disease break from previous pasture.

Broadcasting onto existing cover

Seeds are broadcast on to the existing pasture, often in a mix with fertiliser. The paddock may then be harrowed and rolled to enable seed coverage and soil-seed contact, or stock admitted to trample the seed into the surface. This may be a useful technique for introducing clovers or other species. Usually best performed in autumn or late winter to avoid new seedlings drying out or being challenged for space and resources by existing cover.

Pros: Time-efficient. May be only option for some situations.

Cons: Results can be variable.

Phalaris *(Phalaris aquatica)*

Phalaris is a deep-rooted, vigorous perennial that is best suited to heavier soils, but will produce well on a range of soil types. Early released varieties were most suited to neutral and alkaline soils, although newer varieties have been developed to produce well in more acidic conditions. Phalaris has some tolerance to salinity and is very tolerant of periods of water-logging. It is relatively resistant to pasture grubs when compared to other grasses.

Establishing a perennial pasture based on phalaris will improve farm productivity compared to systems relying on annual grasses. Nitrogen produced by pasture legumes, usually grown with annual grasses, leaches down through the soil profile, taking nutrients with it, and leaving acidic elements behind. The deep-rooted perennial nature of phalaris draws these nutrients back up to help prevent or slow down the onset of acidification. Another major benefit of the deep-root system of phalaris is it improves persistence and productivity under drought conditions.

Phalaris has a small seed, reflected in the low sowing rate. It is often used in combination with sub and white clovers, strawberry clover and other legumes, and in many cases has a good fit with cocksfoot and fescue. It may be mixed with ryegrasses in medium-higher rainfall areas if well-proportioned and managed, as care is needed not to smother the slower-establishing phalaris.

There are two main groups:

Winter active: summer dormant (to varying levels), more erect, more acid tolerant, summer dry sites.

Winter dormant: more prostrate often denser crown, neutral pH, summer moisture likely.

Phalaris variety adaption and usage chart

	Soil Type		Rainfall Pattern			Grazing Management		Soil pH		
	Light skeletal soils	Medium – Heavy soils	Winter dominant, short spring	Winter dominant, longer spring	Even distrib./ some summer moisture	Rotational	Lax/ set-stocked	Very acidic <4.5	Acidic 4.5 - 5.5	Neutral – alkaline 5.5 - 8.5
Horizon										
Advanced AT										
Holdfast GT										
Australian (types)										

Key:		
		Good option
		Often suitable
		Not recommended

Sowing Rate: 3-5 kg/ha (as only grass), 1-3 kg/ha (mixes with other grasses). Typical companion species: sub-clover, white clover, strawberry clover, cocksfoot, fescue (and ryegrass if well executed).

Holdfast GT
Phalaris
Winter Active

PBR | 500+mm | 4.5–8.5 | Most Soil Types

- Grazing tolerant winter active phalaris bred by the CSIRO
- Exhibits excellent seedling vigour to aid successful establishment
- Selected for long term persistence under grazing (both set stocking and rotational grazing)
- Increased productivity over the life of the stand
- Lower levels of stagger causing alkaloids
- Its ability to grow in moderately acidic conditions increases its area of adaptation
- CSIRO released Holdfast GT as a grazing tolerant replacement for Holdfast. It has been bred from Holdfast and other winter active varieties. Once established, Holdfast GT can be set stocked and will provide a productive long term stand.

Advanced AT
Phalaris
Winter Active

PBR | 450+mm | 3.9–8.5 | Most Soil Types

- Winter active phalaris with superior establishment and root penetration on acid soils, especially in tougher seasons
- Will tolerate pH $CaCl_2$ 3.8 and Al^{3+} of 20-50%, providing better production and persistence on these soils than other phalaris varieties, cocksfoots and perennial ryegrass, (CSIRO, 2007)
- Higher second year dry matter yield than Holdfast on acid soils (40-80% across all CSIRO trial sites) and higher than closest acid tolerant variety, Landmaster (36%)
- Suited to rotational grazing and improved fertility, regardless of soil acidity
- Best managed by rotational grazing
- Gives producers with high acidity soils a productive and persistent pasture option that has not been previously available
- Will increase productivity on highly acidic soils with aluminium content as well, although due to its broad breeding background will also produce well in soils of a pH above 4.0.

Phalaris grazing management

Grazing of a newly sown pasture should be avoided until plants have become established. Grazing prior to effective establishment can cause plants to be pulled out reducing the population and pasture performance. Once established, phalaris will tolerate periods of set stocking, although more erect varieties will benefit from good rotational grazing systems. Many older phalaris varieties have high levels of alkaloids which can cause phalaris toxicity (phalaris staggers). New varieties contain lower alkaloid levels in the leaves and therefore provide a safer grazing alternative. However, in areas prone to phalaris toxicity pastures should be grazed cautiously in the autumn and early winter.

Once stands are established it is recommended that the following be observed to maximise the benefits and persistence:

- Lime acid surface soils if pH < 4.5 if needed/plausible, or use Advanced AT
- Apply superphosphate if Olsen P is 8-10ppm or less. Phalaris will respond well to higher P levels
- Graze winter active cultivars rotationally with 4 - 6 week spells in autumn–winter
- Do not graze too hard or too often after stem growth starts in spring, especially in a dry year
- Flowering allows basal buds to be set for future growth
- Allow to produce seed heads in the first year, and at intervals in future years
- Clean up stem residues in summer to admit space for clover germination and growth
- Set stock after late spring to utilise feed and open the sward for clover growth
- Do not heavily graze new stems from early autumn regrowth.

Horizon
Phalaris

Drought Tolerant

PBR | 400–700mm | 4.8–7.5 | Lt/Med–Heavy

- New CSIRO-bred winter-active phalaris
- Strong summer dormancy
- Improved persistence in medium rainfall regions
- Exceptionally high winter growth and fast establishment (for phalaris)
- Replacement for Atlas PG
- Lower total alkaloids than Australian.

Australian
Phalaris

550+mm | 5.5–8.5 | Med-Heavy

- Prostrate summer active cultivar
- Tolerates waterlogging and mildly saline conditions
- Very persistent, suited to set stocking conditions
- Now outclassed by Holdfast GT.

Australian phalaris is a prostrate, semi-dormant and summer active variety. It has been one of the important varieties over many decades to provide feed in lower rainfall areas due to its tolerance of close grazing. It is however most suited to neutral to alkaline areas and is relatively high in alkaloids compared to new varieties. The capacity for set-stocking that Australian phalaris offers has been incorporated into Holdfast GT, which has far more winter growth, some acid soil tolerance and fewer concerns about phalaris poisoning by comparison.

Phalaris toxicity

An important species for extensive pasture systems throughout Australia, phalaris can present toxicity issues. Pastures should be grazed cautiously and with vigilance in the autumn and early winter, especially when grazing on fresh growth after breaking rains. Stock is at the greatest risk when grazing on short, frosted plants, which mainly occurs during the autumn or the early winter period. The greatest risk to animals is when they are able to ingest a high level of herbage in a short period of time, and the pasture is dominated by short phalaris shoots. Typically, the classic effects are mostly presented in sheep, although evidence supports some cases of ill-thrift and weight loss in cattle. There are no cures, but good management will help markedly.

There are three main syndromes, which are understood to varying degrees:

Phalaris Staggers

Direct cause: methylated tryptamine alkaloids
Signs can develop within 1-3 weeks after introduction to the pasture, but may take 2-3 months.

Sudden Death Syndrome

Direct cause: Unknown toxin, although it is thought that ruminants have ability to metabolise or detoxify the toxin. Signs can develop within 24 hours following introduction to the pasture.

Peracute PE-like sudden death

Direct cause: Unknown. Mortalities seem to occur within 48 hours following introduction to the pasture.

Management options:

Do:

- Keep records of incidents, conditions and paddocks where outbreaks occur
- Use cobalt bullets in regions known to have these issues
- Keep up to date with vitamin B12 injections
- Sheep likely to go onto phalaris in autumn should have phalaris in the summer diet
- Consider using sentinel animals to test suspected problematic paddocks
- Sow new pastures with varieties know to have lower levels of problematic toxins
- Encourage recruitment of companion species in pastures.

Don't:

- Put hungry sheep onto new phalaris shoots, especially in autumn where phalaris, especially older cultivars, dominate the pasture.

Cocksfoot *(Dactylis glomerta)*

1-2 kg/ha in a mix,
3-4 kg/ha as dominant species

Cocksfoot is a tussocky, true perennial grass that suits lighter, well drained soils and tolerates acidic conditions and will produce well where many other grasses may not. Cocksfoot will also suit higher rainfall areas with free-draining, low pH soils, such as granites and deep sands. It will perform best where reasonable fertility can be maintained and rotational grazing adopted, although cocksfoot pastures may be set-stocked for periods through spring if required.

Cocksfoot is slow to establish as the seed is small and light-weight. Cocksfoot is used in a wide range of rainfall areas from very low to very high, as a component in a pasture mix with clovers and other grasses. Higher sowing rates will result in the cocksfoot becoming dominant over time. It is generally used in extensive sheep and beef production, although there is scope for use within dairy systems. Cocksfoot does not contain any substances harmful to grazing animals.

Maintaining higher levels of soil fertility will help to increase production, persistence and feed quality. There are many varieties available, with some more noted for having a dense crown, and tolerant of drought and close grazing; others being less dense, more upright and better companions for clover. Cocksfoot varieties are available over a spectrum of seasonal growth activity, with cultivar Summadorm dormant through summer, while Safin is summer active and Howlong is the intermediate variety.

Cocksfoot can be very persistent and become the dominant pasture if not carefully managed. Levels of Cocksfoot in the pasture mix should be monitored as animal performance may decline if it becomes the dominant species. It is suggested that Cocksfoot is used in mixtures with other grasses such as ryegrass, phalaris or tall fescue. Other companion species include lucerne, white clover, red clover, strawberry clover and sub-clovers.

600mm+ / irrig		500mm+			400mm+
Very Fine Leaves	**Safin**				**Summadorm**
Finer Leaves			**Howlong**		
		Wana	Porto		
Broad Leaves				Currie	
Summer Growth Potential			Intermediate Partial Summer Dormancy		Strongly Summer Dormant

Safin
Cocksfoot

Summer Active

600+mm
4.0-8.0 | Free | Draining

- Super fine leaved cocksfoot
- 40-50% higher tiller density than most other cocksfoots
- Increased early spring production with high total DM
- Suits lambing and calving patterns in medium rainfall dryland systems
- Reliable, palatable feed where summer rainfall is anticipated.

Howlong
Cocksfoot

Intermediate

400+mm | 4.0-8.0 | Free Draining

- Bred from Porto specifically for Australian conditions
- Improved autumn / winter growth
- Fine leaves and tillers
- Less likely to form clumps
- High total yield and good autumn winter growth
- More compatible with other species
- Versatile, hardy all-rounder.

Summadorm
Cocksfoot

Summer Dormant

PBR | 400mm | 4.0–8.0 | Free Draining

- Hardy, deep-rooted perennial grass that is well suited to dry conditions and acid soils
- Good seedling vigour and early growth producing tillers
- Classed as a Mediterranean type (summer dormant), which is more tolerant of harsh dry conditions
- Maximum herbage production is during the autumn and winter period
- Excellent summer dormancy compared to other Mediterranean types.

Cocksfoot establishment and management

As cocksfoot plants are slow to establish, paddock preparation is extremely important. Any (weedy) annual grasses need to be controlled before sowing. Spray topping in the spring prior to sowing is often effective. Failure to ensure proper weed management can result in either partial or complete failure of the stand. Plants will benefit from light grazing during the first 6-8 months after an autumn sowing, provided the root system has developed adequately.

Light rotational grazing will encourage root development and allows it to compete with any legume which may have been sown as a companion species. If sowing with ryegrass, reduce the ryegrass sowing rate, and manage new pastures to ensure the cocksfoot can establish effectively. This may involve one or two initial on-off grazings with good monitoring.

In summer dry areas, avoid over grazing during the late spring/summer period. If grazing with sheep, extra care must be taken through dry periods as they can damage young and established crowns due to cocksfoot's erect growth habit. Poor management will lead to reduced plant numbers and persistence. Over grazing during this period, in combination with moisture stress, can cause the stand to thin out significantly and allow weed invasion. This is particularly the case for summer-active (Mediterranean) types such as Summadorm.

Intermediate types such as Howlong and Porto, due to moderate capacity for summer growth, will require some level of summer grazing pressure to be applied. If this is not done, plants may become tall and rank as the autumn period approaches, thus reducing the quality of the overall pasture, encouraging selective grazing of emerging sub-clovers and other more palatable types.

Summer active types such as Safin offer productivity in lower fertility areas subject to summer rain or complemented by irrigation. Safin may be readily grazed as part of a mixed pasture in a summer active sward.

Brome grasses

This group of several distinct species is large-seeded and varies from short-term to perennial in nature. They are mostly used on well-drained soil types of moderate fertility.

Brome grasses are usually sown as a sole stand, but could be used with cocksfoot, phalaris or tall fescue. One of the key attractions is that bromes are endophyte-free do not create animal health concerns such as ryegrass staggers or phalaris toxicity. They remain nutritious and palatable when used as standing feed in summer. With the inclusion of clovers, brome grass pastures are productive and useful for many stock classes.

Pasture Brome *(Bromus valdivianus)*

10-30 kg/ha

Pasture brome tolerates harder grazing than prairie grass and is suited to summer dry, well drained soils. It is more perennial in nature than prairie grass, and can be rotationally grazed or set stocked. It requires neutral pH, good drainage and reasonable fertility. In many respects pasture brome offers the grazing flexibility of prairie grass together with the persistence of a grazing brome. It is later heading than other brome grasses and offers higher quality feed over a longer period in the spring. Used in medium rainfall areas for longer-term mixed grazing.

Bareno
Pasture Brome

Hardy Perrenial

550+mm 5.4-8.0 Light to Medium

- Standout permanent pasture for summer dry free draining soils
- Highly palatable, more persistent than other prairie grasses
- Can be rotationally grazed or set stocked, late spring quality and summer growth
- Supports a high legume content
- Improved summer yield and quality where ryegrass hays off

Tall Fescue *(Festuca arundinacea)*

5-8 kg/ha in a mix,
10-15 kg/ha as dominant species

Tall fescue is a very deep rooted, true perennial that is adapted to a wide range of conditions and soil types. It will cope well with some waterlogging and has a degree of salt tolerance. Generally a pH of 5.2 or higher is needed for best long-term results, and it will respond to improved fertility. It will do best under medium to high rainfall or irrigation, although Mediterranean types will persist in summer dry areas. Tall fescue is very slow to establish, and care must be taken not to have it selectively grazed out of mixed stands in the first year. It is a good species to use as a pasture base to companion cocksfoot, phalaris and clovers. Stock acceptance may be slow initially when introduced from ryegrass pastures. It performs best on heavier soils, where its deeper rooting ability can utilise more soil moisture than ryegrass.

There are two distinct sub-groups:

Mediterranean

Mediterranean types are cool season (winter) active. It is summer semi-dormant to dormant, giving improved persistence in summer dry regions. It is faster establishing than summer active tall fescue and has strong winter and spring production and fine leaves, maintaining better feed quality. It suits dryland, lighter soils and slopes.

Continental

Continental (summer active) tall fescue is a perennial grass more tolerant of hot summer, poorly drained and saline conditions than perennial ryegrass. It is mainly sown under flood irrigation where high summer temperatures limit ryegrass growth, or where summer rainfall is expected, for example New England Tablelands, coastal Victoria and Tasmania. It performs best on heavier soils, where its deeper rooting ability can utilise more soil moisture than ryegrass.

Prosper
Tall Fescue

Winter Active

PBR | 450+mm | 5.0–8.0 | Most Soil Types

- Winter active forage tall fescue
- Fast establishing
- Truly summer dormant, excellent cool season growth
- Erect growth habit, with fine, soft leaves
- Rust resistant and is suited to summer dry environments
- Persistent and good legume companion
- Nil endophyte safe for all stock classes.

Fortune
Tall Fescue

Summer Active

500+mm | 4.5–8.0 | Most Soil Types

- Bred for improved survival under hot and dry conditions
- Superior persistence and yield compared to alternative leading tall fescue varieties
- Strong seedling vigour leading to successful establishment.
- Densely tillered, fine leafy growth with good stock acceptance
- Later heading offering improved feed quality
- Excellent yield in the shoulder seasons of early spring and autumn, and exceptional winter yields for a summer active type
- Suitable for all classes of livestock: nil endophyte

Both types may be autumn sown, however winter active (Mediterranean types) are only really suited to autumn sowing. Continental types are often spring sown in areas with reliable spring and early summer moisture. Any (weedy) winter grasses need to be controlled before sowing and failure to ensure proper weed management can result in either partial or complete failure of the stand.

Plants will benefit from light grazing during the first 6-8 months after an autumn sowing, provided the root system has developed adequately.

Through summer, autumn, and winter, fescue behaves in much the same manner as ryegrass with reasonably palatable leafy growth of good quality. Grazing at about the 3-4 leaf stage appears suitable for good performance and persistence. Management through spring needs to take into account that fescue tends to become reproductive quickly and for an extended period from about late August. Stems are quite tough and fibrous, and grazing rotation should be shortened to intervals of about 10-14 days in order to help maintain quality, or alternatively target excessive growth for silage production. Animal acceptance may be very slow if stock are introduced from pastures that predominate in other species: so having one or two fescue pastures on say, a largely ryegrass based property, can present production challenges in some cases.

Perennial Ryegrass *(Lolium perenne)*

10-30 kg/ha

In the higher rainfall and irrigated regions of southern Australia, perennial ryegrass is the grass of choice for permanent pastures. It is relatively easy and quick to establish, easy to manage and has excellent animal feed attributes, although it struggles under high summer temperatures and needs appropriate management to ensure long term persistence. Ryegrass is an important pasture species in temperate pastoral regions, but it will not typically suit medium-low rainfall areas or districts subject to lengthy, hot summer conditions. In marginal ryegrass areas, grazing management is crucial to help assure longevity.

Early Varieties

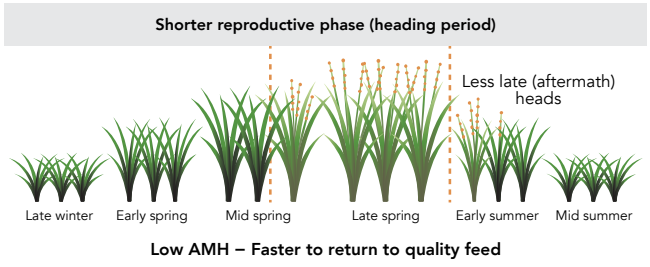
- Suit paddocks or locations that typically finish earlier e.g. north facing, lighter soils
- Maximise the potential from rain-fed (dryland) production with an early spring flush
- Likely to complement later paddocks by providing comparatively more feed in late winter/early spring
- Allow for allocation of paddocks for fodder conservation, with later paddocks being grazed
- Often can be considered for sites with shorter growing seasons or where lower input costs are justified.

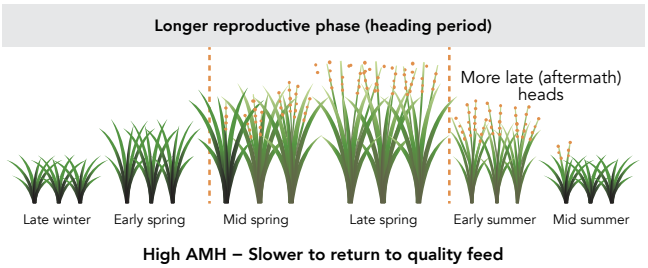
Later varieties:

- Suit sites where the spring season holds on longer
- Offer higher feed quality and animal performance over an extended period
- Maximise the potential value from summer irrigation or moist summer conditions
- Potentially spreads the silage/hay season risk and workload
- More usually suited to sites where higher outputs are being targeted
- Often considered more easily managed to maintain spring and summer quality.

Ryegrass Heading Period

Increasingly, ryegrasses are selected to have as narrow a heading period as possible. For example, they are selected to run to head all at once, and then stop. This is termed 'low after-math heading' (AMH). If a variety has an extended flowering period, then the quality of the pasture is lower for a longer period due to the stalk content.





This explains part of the persistence of older type ryegrasses in some more mature pastures: it is not the original plant that survives, but the capacity for the stand to re-seed over a long flowering period, with lax grazing or through hay cutting. Nowadays, grass is more often conserved as silage, less frequently taken for hay and varieties are generally selected for low AMH. This means that to obtain true long-term perenniality, the grass must be managed to reproduce from its tillers. This can be encouraged by selecting the right variety for the conditions. Good grazing management, appropriate fertility and not grazing when the pastures are going through stress such as drought or summer heat will aid persistence.

No more staggers

Ryegrass staggers (perennial ryegrass toxicosis) is caused by a naturally occurring endophyte fungus that lives inside the grass plants. Staggers has the capacity to severely reduce animal performance and may lead to death in bad seasons. It is typical of pastures containing Victorian ryegrass or similar older and related types that were released over 20-50 years ago. Ryegrass staggers has been eliminated through the introduction of novel and nil endophyte varieties, and coupled with advanced plant breeding, varieties are now available that offer much higher yield potential and no concerns for ryegrass staggers. In many cases where claims are made about persistence of old varieties, it is the toxic endophyte that creates a situation where stock do not eat the grass. Under lax grazing management this gives the impression of good pasture production whereas in reality, overall grass productivity is in fact restricted and animal performance may very likely be quite reduced.

Kidman NEA2

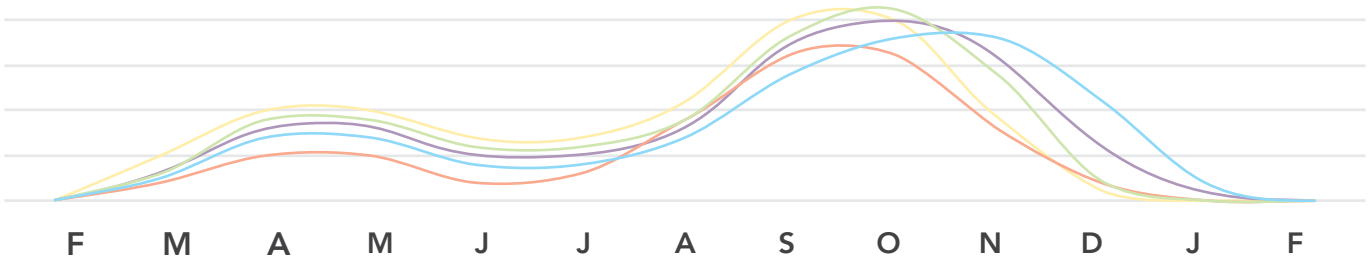
Perennial Ryegrass

Early Diploid

PBR | 550+mm | 4.8–8.0 | Most Soil Types

- Early flowering (-14 days) perennial ryegrass
- High autumn, winter and early spring production
- Good persistence and plant pulling resistance
- Low aftermath heading, quick return to high quality feed
- New generation alternative to older Victorian types
- Selected in Australia specifically for our growing conditions
- NEA2 endophyte:
  - Insect resistance
  - No staggers.

Perennial Ryegrass Seasonal Growth



Barberia: Best autumn and winter feed, early spring peak. Strong capacity for summer survival.

Victorian types: Outclassed for autumn and winter feed, yield only 70% of well developed modern ryegrasses.

Kidman: Similar growth pattern to Vic types with improved winter yield and overall yield.

Maxsyn: Mid-Late with improved winter growth

Late-very late Ryegrasses: Impact 2, Rohan, Bealey, Viscount. Good cool-season yields. Lower spring peak with extended season into early summer.

Barberia

Hybrid Ryegrass

Very Early Diploid

PBR | 500+mm | 4.8–8.0 | Most Soil Types

- Very early flowering (-21 days)
- Very fast establishing
- Winter performance like an Italian
- Potential for persistence over 5 years+ (3-5 typical)
- Highly palatable, good clover companion
- Excellent option for autumn, winter and early spring feed
- Good heat tolerance
- A good choice where prairie grass may be considered
- Suited to over-sowing
- Endophyte free = no staggers.

Impact 2 NEA2
Perennial Ryegrass
Late Diploid

PBR | 650+mm | 4.8–8.0 | Most Soil Types

- Diploid late (+16 days) perennial ryegrass
- All season growth pattern
- Excellent persistence
- Productive high yield
- Quality forage: Production with persistence
- Released as Trojan in New Zealand
- NEA2 endophyte.

NEA Endophytes

The NEA series of endophytes have come through with the breeding of a family of ryegrasses. The particular ryegrass genetics are to a large extent the natural host of NEA, thus conferring some good symbiotic benefits to the varieties in the breeding program. NEA2 and NEA4 are a mixture of endophyte strains and is available in both diploid and tetraploid cultivars.

The alkaloid profile and expression is determined by the interaction with the host cultivar and the levels of the various strains within the variety. Expression of alkaloids appear generally to be stronger in diploid grasses as a rule. NEA2 and NEA4 will express very low levels of lolitrem B, low levels of ergovaline and standard levels of peramine. This balance of alkaloid offers good insect resistance and excellent animal performance.

NEA endophytes offer the following benefits:

- Good levels of insect protection: Argentine stem weevil, black beetle, root aphid
- Freedom from ryegrass staggers
- Excellent animal acceptance and performance
- Available in well adapted, high-performance cultivars for a range of applications.

NEA2 endophyte has been used in various varieties in Australia since the late 1990's. In Australia, staggers have never been reported in any class of grazing animals, with excellent animal acceptance and performance in all seasons. NEA is a singular strain of the NEA2 complex that is present in Shogun.

The NEA type endophytes continue to be developed and more varieties are expected to be released as breeding and field testing continues.

Maxsyn NEA4
Perennial Ryegrass
Mid–Late Diploid

PBR | 650+mm | 4.8–8.0 | Most Soil Types

- New ultra-high performance mid-late diploid perennial ryegrass (+8–10 days flowering)
- Highest performing perennial ryegrass released by Barenbrug
- Excellent warm season growth and heat tolerance
- Densely tillered and persistent
- Adaptable and reliable over years of testing and development
- NEA4 endophyte for strong insect protection and excellent animal safety
- Absolute top-performer for forage yield & persistence
- Exceptional autumn, winter, summer and total forage production.

Rohan NEA2
Perennial Ryegrass
Late Diploid

PBR | 600+mm | 4.8–8.0 | Most Soil Types

- Diploid late (+18 days) perennial ryegrass
- Fine, dense spreading habit
- Excellent persistence
- Productive in tougher environments under close grazing
- Improved resilience to treading/pugging
- NEA2 endophyte: excellent insect tolerance, no staggers.

Bealey NEA2

Perennial Ryegrass

Very Late Diploid

PBR | 700+mm | 4.8–8.0 | Most Soil Types

- True perennial ryegrass
- Very late flowering (+25 days)
- Preferred choice for highest production systems
- Excellent winter and summer growth
- Highly palatable tetraploid
- Long term persistence
- NEA2 endophyte.

Viscount NEA4

Perennial Ryegrass

Late Tetraploid

PBR | 650+mm | 4.8–8.0 | Most Soil Types

- True perennial ryegrass
- Late flowering (+19 days)
- Improved autumn, winter and early spring growth
- Excellent winter and summer growth
- Highly palatable tetraploid
- Long term persistence
- NEA4 endophyte.

Sub-Clovers *(Trifolium subterraneum spp.)*

Sub-clover is probably the most important pasture legume in Australia, providing the most robust and hardy clover component that regenerates year-after-year. They are typically used in low-medium, winter rainfall dominant areas for extensive grazing systems and also have application in higher rainfall dryland sites requiring reliable pasture legumes. Sub-clovers are annuals and re-seeding is needed to provide persistent nitrogen fixation and quality in the pasture. Once a pasture has been established with sub-clover, a couple of years of re-seeding will help create a seed bank to back-up the occasional failed season.

The term sub-clover refers to a group of three species:

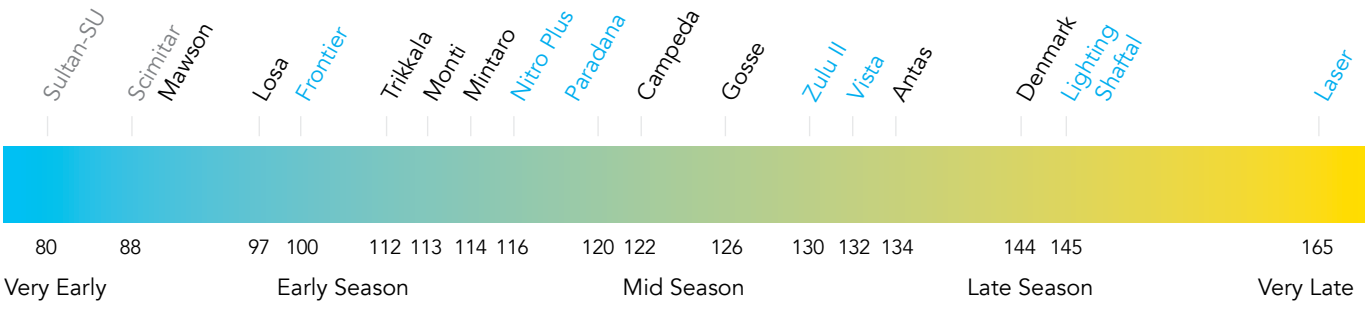
- **ssp subterraneum:** Black seeded, acidic – neutral soils, most soil textures
- **ssp yanninicum:** White seeded, acidic – neutral pH,medium- heavy soils
- **ssp brachycalycinum:** Seed colour varies, mildly acidic – alkaline soils, medium-heavy soils

These features will vary a little between specific varieties, and plant breeding has extended the range of the sub-species to some degree.

Sub-clovers have been developed for varying rainfall and flowering dates. It is highly recommended to sow at least two varieties with differing flowering dates, so as to allow for a spread of flowering and seed set as frosts, drought, grazing, pests and herbicide type and timing may reduce seed set or cause failure. In areas with a typically early spring, use an early and a mid-season variety to allow for a combination of early yield and capacity to capture the benefits of a longer spring should that occur. In higher rainfall, later season or sites with a high likelihood of later frosts, use a mid-late season type in tandem with a late variety to enhance the prospects for spring growth and early summer pasture quality. Examples:

Late areas, higher rainfall (650-700mm+):
Denmark, Antas

Mid - late areas, reliable rainfall (500-650mm):
Campeda, Antas, Gosse
Lower-medium rainfall areas (450 – 600mm):
Monti, Campeda, Mintaro
Early-mid season, lower rainfall areas (<500mm):
Losa, Mawson or medics



Medics / Subs / Annuals

Sub-clover varieties can offer farmers one or more of the following benefits compared with older varieties:

- Improved dry matter yields (better growth)
- Improved resistance to diseases (better survival)
- Lower phyto-oestrogens levels (lower risk of causing livestock fertility problems)
- Improved seed production and higher hard-seed levels to offer more long-term resilience against false breaks or failed springs.

Sub-clover seed and sowing rates

Seeds are relatively large and sowing rates need to be 2 or 3 times higher than most other clovers in order to reach a similar plant density. Sowing rate guide (coated seed):

Type	Varieties	Sowing Rate (as component of a mix)	Sowing Rate (as a straight sward)
Sub.	Losa, Campeda, Denmark	3-6 kg/ha	6-10 kg/ha
Yanni.	Monti, Gosse	3-6 kg/ha	6-10 kg/ha
Brachy.	Mawson, Mintaro, Antas	4-8 kg/ha	8-12 kg/ha

Purchasing pre-inoculated coated seed from Barenbrug offers benefits over bare seed including:

- Insecticide for protection from insect attack during establishment from pests such RLEM
- Pre-inoculated with rhizobia bacteria, offering convenience
- Trace nutrients to aid rhizobia function and plant establishment
- Fungicide protection of the seed and seedling during initial establishment.

Soil fertility

The long term success of the pasture will be highly reliant on a strongly growing sub-clover base to drive overall grass growth and productivity.

Sub-clover responds well to soil fertility, so the fertiliser needs of the sub-clover will need to be considered. It can grow in moderately acid soils (down to below 4.0 pH $CaCl_2$) however it is unlikely to produce usable nitrogen under extreme acidity. For best results, a soil pH above 4.5 ($CaCl_2$) with the application of lime (brachy type sub-clovers usually require >5.0 pH).

Phosphorus (P), sulphur (S), potassium (K) are all also important and any major limitations should be addressed before sowing. Although clover produces nitrogen (N) (through its symbiosis with rhizobia bacteria), if N is severely limiting, providing a small amount of up-front N can be beneficial to establishment. Sowing with starter P is usually best, either via single superphosphate (SSP) or MAP. A program including traces such as Cu, B, Mo, Zn amongst others may be essential for good results.

Establishment

Sub-clover is relatively easy to establish, best results will occur under low-weed pressure through the use of a knockdown herbicide (e.g. glyphosate) prior to sowing. If the paddock has been sprayed herbicides that have residual effects (such as sulfonylurea (SU), dicamba, clopyralid etc), ensure that the label plant-back period has been observed.

Weeds such as capeweed can reduce establishment in the first year if left uncontrolled, so after establishment (after at least the 3-trifoliate leaf stage) control using a broadleaf herbicide. Spray-grazing can be an effective control during late autumn and winter.

Best results occur when subs sown around 5-15mm seeding depth. In some circumstances sub-clover can be broadcast, however soil-contact is required for best results. In situations where a high proportion of sub is desired, consider reducing the amount of grass sown in the pasture seed mix to thereby allow sufficient space and light for the clover to establish well in the first year.

Redlegged earth mite (RLEM), lucerne flea and various pasture grubs can be a problem for sub-clover. AgriCote™ coated seed will protect clover establishment during the first 4-6 weeks. Ensure new sub-clover pastures are monitored for pests as high mite numbers may warrant further attention.

Getting the most from sub-clover

Sub-clover is a high quality protein feed. Sometimes stock that are not used to an enriched diet will need greater management. In mixed swards, graze pasture according to grass stage e.g. introduce stock at 3 leaf stage of ryegrass or 4-5 leaf stage of phalaris.

Sub-clover will survive as long as there is an accompanied "spelling" phase. Timely close grazing will help to open up the sward and thereby allow sunlight and space for the clover to grow and compete.

Sub-clover can cause bloat, and some animal management may be needed to reduce the risk of bloat in pastures with a high proportion of clover or when bloat conditions occur.

Sub-clovers can contain varying levels of phytoestrogens that may affect fertility in sheep, although these concerns are largely eliminated in more modern varieties.

Longer-term maintenance of sub-clover pastures should include appropriate use of maintenance fertilisers each year when possible and including some molybdate every few years. Autumn or spring application of insecticide may sometimes be needed to assist with mite control. Broad-leaved weed control is best completed in autumn or winter. If possible, avoid using herbicide sprays through spring as this may cause flowering to abort, thus reducing the opportunity for seed set.

Losa
Sub-Clover
Black Seeded

350+mm | 4.5–7.0 | Wide Range | C or AgriCote™

- Early season maturity – 97 days to flowering (Perth)
- More productive replacement for Dalkeith and Daliak
- High hard seeds (30%) for good regeneration and persistence
- Much improved early vigour
- Very leafy variety forming a dense and erect stand
- Suited to lower rainfall areas and cropping rotations.

Campeda
Sub-Clover
Black Seeded

475+mm | 4.5–8.0 | Wide Range | C or AgriCote™

- Mid season maturity – 123 days to flowering (Perth)
- Greater winter vigour and growth than Woogenellup
- Higher total herbage production and disease tolerance
- Increased disease resistance
- Much higher level of hard seeds (29%)
- High total seed yield and excellent regeneration
- Replacement for Goulburn and Woogenellup
- Alternative for Seaton Park.

Denmark
Sub-Clover
Black Seeded

550+mm | 4.5–8.0 | Wide Range | C or AgriCote™

- Late season maturity – 144 days to flowering (Perth)
- Replacement for Karridale and Mount Barker
- Greater full season dry matter production
- Resistance to clover scorch and root rot
- One of the few subs that can continue to grow after flowering
- Highly productive high rainfall/ irrigation option.

Gosse
Yanninicum
White Seeded

500+mm | 4.5–7.0 | Wide Range | C or AgriCote™

- Mid season maturity – 126 days to flowering (Perth)
- More productive replacement for Trikkala
- Much greater seedling vigour than Trikkala
- Improved growth in both winter and spring
- Higher level of hard seed (25%) more than Trikkala
- Improved resistance to clover scorch and root rot
- Excellence forage for grazing, hay or silage.

Monti
Yanninicum
White Seeded

PBR | 450+ mm | 4.5–7.0 | Wide Range | C or AgriCote™

- Excellent adaptation to shorter growing seasons
- Produces excellent seed yields and regenerates reliably with a high level of hard seeds (36%)
- Flowers earlier than Trikkala and Gosse
- Has better tolerance to phytophthora root rot and clover scorch than Trikkala
- Produces excellent early winter growth
- Well suited to areas receiving an annual rainfall of more than 450mm and prone to waterlogging.

Mawson
Brachycalycinum
White Seeded

PBR | 325+ mm | 5.0–8.0 | Wide Range | C or AgriCote™

- Early (88 days) to flower sub-clover bred in Australia by SARDI
- Suitable for a long-term permanent pasture in shorter growing season environments
- Excellent long-term persistence
- Suited to both alkaline and mildly acidic soil types
- Higher levels of hard seed (43%)
- Improved seed yield than other similar maturity varieties
- Excellent seed burial (65%).

Mintaro
Brachycalycinum
White Seeded

PBR | 400+ mm | 5.0–8.0 | Wide Range | C or AgriCote™

- Mid season maturity – 114 days to flowering (SA)
- Sets a new standard in mid maturity sub-clover
- Extremely vigorous establishment and winter growth
- High hard seed (45%) and very good regeneration
- Large leaved, upright very productive variety
- Particularly well suited to mildly acidic to alkaline soils.

Antas
Brachycalycinum
White Seeded

500+mm | 5.0–8.0 | Wide Range | C or AgriCote™

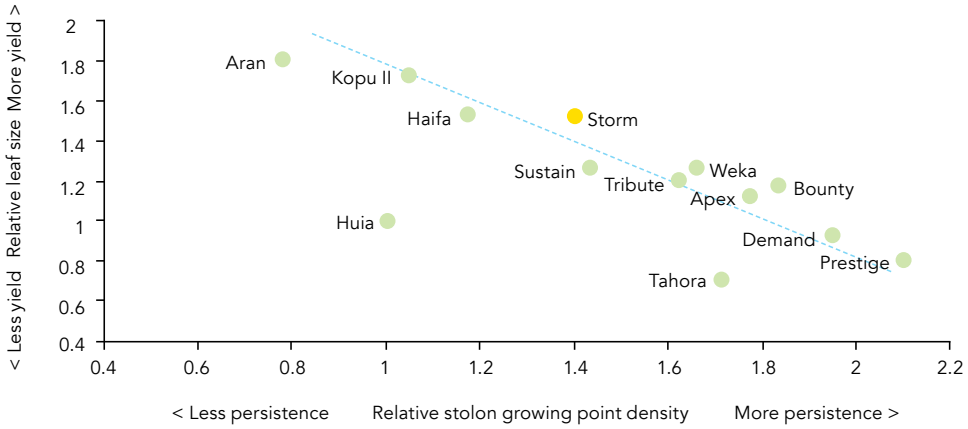
- Mid to late season maturity – 134 days to flowering (Perth)
- Exceptionally vigorous establishment
- Amazing winter growth and total production
- Most productive sub-clover available
- Higher level of hard seed offering better persistence
- Widely adapted – mildly acid to alkaline soils
- Has very large leaves offering good grazing and hay production.

White Clover *(Trifolium repens)*

White clover is included in most pasture mixes for higher rainfall and irrigation areas as it is a highly productive and nutritious feed. It will offer high quality feed through summer, when grasses may be less nutritious, or can be used as part of a specialty finishing paddock. Its ability to fix atmospheric nitrogen makes a substantial contribution to the growth of companion grasses. White clover will grow over a wide range of soil and fertility conditions although a pH of 5.2 or higher with reasonable phosphorus levels is required for good results.

It has poor tolerance of drought conditions and is best suited to medium-high rainfall (650mm+) or irrigation, where it will respond well to spring and summer moisture. White clover has relatively little winter growth, is slower to grow in the spring than grasses and is susceptible to shading. Spring management aimed at keeping pastures short and leafy is therefore important to maintain good clover content and to capitalise on its good growth and feed value in summer.

White Clover Leaf Size Versus Stolon Density*



*Base graph data produced by AgResearch. Storm and Haifa's position estimated using stolon growing point and leaf size measurements taken at Howlong by Barenbrug in 2013. Weka's position estimated using growing point density and leaf size measurements by Agriseeds 2005-08.

A large leaf size generally means less stolons, but more potential yield within a sward. However a high stolon density and smaller leaf size may offer better tolerance of adverse conditions, such as drought, pests, close grazing or pugging. It's important to select the right clover for the situation based on these attributes. Small-medium leaf size varieties will offer better persistence and often greater nitrogen fixation under sheep and extensive beef enterprises, whereas the larger leaf varieties are better suited to dairy and beef operations with good rotational grazing. It is often useful to use a smaller and a larger variety in a pasture blend. Some varieties have been developed to de-link this pair of features to a degree, including Storm. **Sowing rate: 1-4 kg/ha in a mix.**

Storm
White Clover
Large Leaf

PBR | 650+ mm | 5.4–8.0 | Wide Range | C or AgriCote™

- Australian bred white clover
- Tall plant that can aggressively compete in a mixed sward with ryegrass
- Excellent seedling vigour and is quick to establish with very high yield potential across all seasons
- Stolon density of Storm is high compared to other large leaf types
- Persistent under cutting and remains dense
- High production in winter and summer.

Weka
White Clover
Medium Leaf

PBR | 650+ mm | 5.4–8.0 | Wide Range | B or AgriCote™

- Medium leaved white clover suited to all grazing systems
- Good growth in all seasons, particularly through autumn and winter
- High stolon growing point density
- High tolerance to clover root weevil
- Good growth in all seasons
- Sow in pasture mixes at 2-4 kg/ha.

Apex
White Clover
Medium-Small Leaf

600+mm 5.4–8.0 Wide Range B or AgriCote™

- Medium-small leaf size
- Adapted to summer dry conditions and close grazing
- Increased stolon growing points, for improved drought and pest tolerance
- Good option for tougher sites and lighter soil types
- High yields shown particularly in the winter-spring and autumn periods..

Red Clover *(Trifolium pratense)*

Red clover is a tap rooted, short-lived (2-5 year) perennial legume with high feed value. It has good summer growth and some drought tolerance, but generally little winter growth. Lax grazing and some re-seeding through mid-late summer will significantly aid stand life. Red clover is suited to areas with summer moisture, responds well to improved fertility and is best suited to a pH range of about 5.4 – 8.0.

It performs best on free draining soils under moderate stocking rates, long summer grazing rotations or hay production. Under high stocking rates or quick rotations its persistence is reduced. Red clover may be sown as a component of a permanent pasture, to boost late spring and summer growth and feed quality. Red clover is regarded as a premium option for live-weight gain and is often used as a component in specialty finishing pastures. Red clovers contain phytoestrogens so care should be taken if feeding to breeding stock during mating (this mainly applies in the late summer and autumn periods when red clover is growing well). Phytoestrogen levels vary between red clover varieties, and contribute to aiding pest tolerance. Diploid and tetraploid varieties are available. **Sowing rate: diploid: 2-5 kg/ha in a mix, tetraploid: 3-6 kg/ha in a mix.**

Morrow
Red Clover
Large-Medium Leaf

700+mm 5.4–8.0 Wide Range B or AgriCote™

- High yield with improved persistence under grazing
- Ideal late spring and summer finishing feed
- High yield as grazing, hay or silage
- Adds significantly to hay and silage quality
- Suitable for all farm types in higher rainfall areas.

Strawberry Clover *(Trifolium fragiferum)*

Strawberry clover is very successful in areas where a long term, hardy pasture is required. It is especially useful in developed swamp country where soil types and drainage vary across a paddock. This is a true perennial clover that tolerates waterlogging and drought, and is suitable for neutral to alkaline soils, although it will survive in more acidic conditions. Strawberry clover is often used in slightly saline areas, as it is more salt tolerant than white clover and most sub-clovers. It is quite slow to establish, but will form a large crown in 2-3 years, and can become the dominant legume in a pasture sward. It is often used in extensive grazing areas as a component in ryegrass, tall fescue or phalaris pasture. It is very tolerant of close grazing by sheep and extensive beef once established. There is good scope for increased usage in many areas.

Sowing rate: 1-3 kg/ha in a mix

Sowing time: early-mid autumn or spring

Palestine is regarded as the most appropriate cultivar for persistence and long-term productivity.

Annual Clovers

Annual clover offers a range of grazing, hay and silage options with multiple benefits including nitrogen fixation, weed control rotations and disease breaks. The addition of annual clovers to grass or hay mixes can increase feed quality, feed protein levels and provide nitrogen for grass or cereal to grow.

Paddock and grazing management

Annual clovers are suited to rotational grazing. When used in a mixed sward, graze to manage grass but ensure animals do not re-graze areas, as this will greatly affect the recovery of annual clover. In pure stands, avoid grazing in the middle of winter. Don't graze below 5–8cm to allow maximum recovery. Avoid pugging.

In general, growth period between grazing will be around 50–60 days in winter and 30–40 days in spring. These clovers are generally annual options only, however hard seeded varieties (e.g. balansa) can be locked up just prior to flower initiation. They will then flower and set seed, and providing there is initial dry matter, graze hard prior to the autumn break to allow maximum germination.

Monitor stock – especially relating to issues such as bloat and excess protein. Certain weather conditions, lack of fibre and other energy sources can cause some stock issues. Remove stock during such times. Allow access to good quality water.

Suitable sowing rates for inclusion of annual clovers in a pasture mix:

Balansa: 1-2 kg/ha

Arrowleaf: 2-4 kg/ha

Persian: 2-4 kg/ha

Use 2-3 times these rates where a higher legume percentage is sought.

Zulu II
Arrowleaf Clover
Late Maturing

400+mm | 4.5–7.5 | Well Drained | C or AgriCote™

- Approximately 130 days to flowering
- Excellent tolerance to acid soils
- Excellent spring and early summer growth
- Not known to cause bloat.
- Well adapted to loamy and deep acidic sandy soils
- Deep taproot which can increase growth in drier seasons
- High level of hard seed ensures good regeneration

Cefalu
Arrowleaf Clover
Early Maturing

400+mm | 4.5–7.5 | Well Drained | C or AgriCote™

- Early maturity – approximately 110 days to flowering
- Excellent tolerance to acid soils
- Deep taproot can reach perched water tables increasing growth in drier seasons
- Early maturity – 20 days earlier than Zulu II
- Not known to cause bloat
- Excellent regeneration from hard seed
- Suited to green manuring
- Upright growth habit making it well suited to grazing or hay.

Vista
Balansa Clover
Late Maturing

PBR | 450+ mm | 4.5–8.0 | Wide Range | C or AgriCote™

- Late season maturity – approximately 130 days
- Superior spring/early summer growth
- Tolerates waterlogging and mild soil salinity
- Highly tolerant to clover scorch
- Well suited for annual/short term ryegrass mixes
- High quality hay or standing feed
- High hard seed levels aid regeneration
- Replaces and supersedes Bolta and Paradana.

Nitro Plus
Persian Clover
Hard Seeded

PBR | 325+ mm | 5.5–8.5 | Wide Range | C or AgriCote™

- Prostrate to semi-prostrate self-regenerating annual clover
- Early-mid season maturity – as early as 68 days to flowering
- Average 114 days to flowering
- High hard seed level – excellent regeneration
- Tolerates waterlogging and mild soil salinity
- Resistant to clover scorch and phytophthora root rot
- Suitable for haymaking and grazing
- Excellent cereal rotation legume
- Supersedes Kyambro.

Laser
Persian Clover
Soft Seeded

450+mm | 5.5–8.0 | Wide Range | C or AgriCote™

- Late season Persian – approx. 165 days to flowering
- Well suited to irrigation and summer rainfall
- Suitable for multiple grazing and hay cuts
- Superior quality to Maral/Shaftal
- Used for fodder cropping and high density legume (HDL) mixes
- Improved rust resistance compared to Maral/Shaftal
- Suitable for mixes with short term ryegrass
- Typically 20–30% more yield than Shaftal.

Plantain *(Plantago lanceolota)*

3-5 kg/ha

A drought tolerant, deep tap-rooted perennial herb with high digestibility. Sprin or autumn sown, with potential for year round growth. Usually sown as a specialist paddock when weed control options in mixed pastures may be limited. Suitable for wet and slightly acidic sites where lucerne persistence may be compromised.

Captain
Plantain

550+mm 4.5–7.5 Most Soils C or AgriCote™

- Upright, narrow-leaf plantain for good animal acceptance
- Improved cool season activity over other plantain cultivars
- Leading total forage production
- High forage quality and mineral content
- Fibrous root system which aids in recovering soil N
- Well adapted to lighter, more acidic soils
- Improved breeding selection from Tonic.

Chicory *(Cichorium intybus)*

5-8 kg/ha

Chicory is a persistent leafy herb lasting 2–3 years with a large tap root. It performs best in fertile, free draining soils in regions of greater than 550 mm rainfall. It has potential for high dry matter of excellent quality with most growth through warmer periods.

Chicory should be sown at 5–8kg/ha as a sole stand or at 2–3kg/ha as part of a grass clover mix. Often used as an annual (summer) forage in combination with millet, clover or forage brassicas.

Chicory requires a well prepared seed bed and soil temperatures of greater than 10°C for successful establishment. Chicory should be rotationally grazed on a 4–6 week rotation and will require added nitrogen for maximum performance.

Commander
Chicory

550+mm 4.5–7.5 Most Soils

- Chicory for high performance sites
- 15–20% higher yield than prostrate types
- Performs all year round including winter
- Fast establishment and regrowth after grazing
- High quality winter active forage chicory
- Erect growth habit offers high utilisation
- Responds to summer rain and irrigation
- Low crown gives good persistence over 2–3 years
- Alternative to brassicas for summer forage
- Sown at 5–8 kg/ha with legumes and 2–3 kg/ha as part of a pasture mix

Medics *(Medicago Spp.)*

In southern Australia's semi-arid agricultural zones, annual medics (Medicago spp.) may often be useful to provide feed for livestock. They also improve soil fertility through nitrogen fixation and act as a disease break for various cereal root pathogens. These self-regenerating pasture species have relatively high levels of hard seeds. This enables them to persist through cropping phases and regenerate in subsequent years as pasture. In an exciting recent development, Barenbrug has released varieties that have tolerance to residual Group B (Sulfonyl-urea) herbicides, which are commonly used in areas normally suited to medics.

Barrel Medic *(Medicago Truncatula)*

2-4 kg/ha (in a mix)

Barrel medics are an annual forage legume that suits neutral to alkaline pH range and low to moderate rainfall extensive grazing areas. It is suited to long term cereal or pasture rotations with growth mainly autumn through to spring. Typically very hard-seeded it regenerates by re-seeding. Sultan SU and Jester SU are tolerant to sulfonylurea residues from prior cropping or chemical fallows.

Sultan-SU
Barrel Medic

Early Maturing

PBR	275–450+mm	5.5–8.5	Loam–Clay	AM or AgriCote™

- Approximately 130 days to flowering
- Excellent spring and early summer growth
- Well adapted to loamy and deep acidic sandy soils
- Excellent tolerance to acid soils
- Deep taproot which can increase growth in drier seasons
- High level of hard seed ensures good regeneration

Jester-SU
Barrel Medic

Mid Maturing

PBR	350–450+mm	5.7–8.5	Wide Range	AM or AgriCote™

- SU (sulfonylurea) residue tolerant
- Hard seeded barrel medic
- Similar flowering time to Jester
- Good aphid resistance (BGA & SAA)
- Comparable disease tolerance to Jester
- Australian bred.

Burr Medic *(Medicago Polymorpha)*

2-4 kg/ha (in a mix)

Annual forage legume that suits heavier soils of neutral to alkaline pH range. Suits low-very low rainfall extensive grazing/ cropping areas. Good for cereal/pasture rotations that have a longer pasture phase. Can tolerate some waterlogging. Regenerates by reseeding. Higher level of soft seeds than strand or barrel medics.

Scimitar
Spineless Burr Medic ***Early-Mid Maturing***

PBR	350+ mm	5.3–8.5	Wide Range	AM or AgriCote™

- Early to mid season – approximately 90 days to flowering
- Erect growth habit with high herbage and seed production
- Maturity is seven days later than Santiago
- Adaptable variety which grows on a wide range of soils
- High percentage of soft seed (24%) – Santiago (8.5%)
- Excellent ley farming option with denser regeneration
- Increased salinity tolerance over other medics
- Better waterlogging tolerance.

Lucerne *(Medicago sativia)*

Lucerne is used as a long-term pasture for grazing and/or hay production, a short term stand in cropping rotations, or as the legume component of mixed pastures. Lucerne has the ability to fix atmospheric nitrogen, providing nitrogen for its own growth, to companion species or increasing soil nitrogen levels for subsequent crops.

Lucerne can utilise more rainfall and dry the soil profile with a large taproot that can easily grow to three metres depth or more to access deep soil moisture. This taproot also acts as an energy store for the plant making established lucerne very hardy. Lucerne has a moderate tolerance of salinity, which combined with its ability to dry the soil profile and lower the water table makes it a useful tool in managing soil salinity, particularly as an option in recharge areas. The main limitations to lucerne's use in Australia are soil waterlogging and high soil aluminum (Al^{3+}) levels which inhibit root development and cause difficulties with establishment.

Modern lucerne varieties are now available that have been developed in Australia under grazing for Australian conditions. They have superior resistance to key pests and diseases verified in Australia, ensuring they have the best chance of performing in our unique environment. Selection of the right lucerne variety is a crucial component of establishing a successful, productive and profitable lucerne stand.

Dormancy Groups

There are three main dormancy groupings for lucerne. The ratings are based on how much growth the variety produces in the winter months (all dormancy groups grow actively in summer if moisture is available). The suitability for purpose of each is largely dependent upon its dormancy rating.

Winter dormant lucerne with a rating of 5 or less are sometimes considered for low-stock density, extensive systems or specialty hay cutting. However, they are infrequently used due to lower overall productive potential when compared to contemporary dormancy 6–10 rated varieties.

Dormancy 1–5 varieties are only suitable for early autumn or spring sowing. Those with a rating of 6–10 are suitable for later autumn sowing under most circumstances.

Dormancy 6–7 varieties are generally termed winter active (WA) or alternatively semi-winter active. This group offers the most flexibility and productive potential longer-term, general purpose grazing or fodder production. Furthermore, in circumstances where a winter dominant rainfall pattern is the norm, 6–7 rated lucerne probably has the opportunity to capture the potential growth in cooler seasons compared to those rated 5 or lower.

Dormancy 8–10 varieties are termed highly winter active (HWA). They may suit a short-term pasture phase to capture some year-round grazing opportunity, although are most frequently used where fast rotation fodder production is being practiced. HWA lucerne will typically have a shorter life-span of around 3–4 years, although some varieties, including SARDI 10 Series 2, have exhibited improved persistence in many circumstances.

Dormancy 6–7

- Grazing tolerance + fine hay quality
- SARDI-Grazer, SARDI 7 Series 2, Genesis II

Dormancy 8–10

- High hay yields
- Short-medium term winter grazing
- SARDI 10 Series 2

Dormancy Ratings

4 6 8

Examples of relative growth following cutting after autumn equinox.

Seed Coating

It is recommended to use a coated seed that includes the correct inoculants and an insecticide for early protection from red legged earth mite (RLEM) and lucerne flea. With sensible storage, AgriCote™ seed coating will last for six months and will be useful for up to 12 months or longer.

Seed coating will decrease the seed count from approximately 400,000/kg to 330,000/kg, but this should not affect the sowing rate as establishment should be higher due to the benefits and protection afforded by the seed coating.

Establishment

The ideal soil temperature for establishing lucerne is 12°C and rising. Lucerne seed is small so ensure to sow close to the surface at approximately 10–15mm deep. It is also important that there is enough soil moisture to support germination. Roll lightly if the soil is fluffy.

For spring-sown dryland crops, sow late August – early October (target the earlier end of the range in regions with higher temperatures and shorter springs). In mild summer areas with irrigation, lucerne can be sown right through spring and summer. In hot summer areas, lucerne is best sown through autumn. Direct drilling or full cultivation are both suitable. Young lucerne plants are fairly sensitive to frosts however once established, plants can survive temperatures below zero Celsius.

Fertility

It is important to test the soil for phosphorus, potassium, aluminium and calcium. Lime is also critical to adjust soil pH, so ensure to conduct a soil test to check to see if it is needed. A pH ($CaCl_2$) should be > 5.0, ideally > 5.3. Aluminium at depth should also be considered and paddock avoided if judged potentially problematic. A lower pH with low Al^{3+} (<5%) may still be a suitable site however.

Sow with low nitrogen, good phosphorus and possibly potassium fertiliser. Molybdenum and boron should be considered where soils are typically low or application has not occurred for some years. A small amount of nitrogen may be needed until plants are established, but excessive nitrogen at sowing can have a negative impact on rhizobia infection/ nodulation of the lucerne roots.

Increasing plant numbers in a thin stand

After a lucerne stand has been established for a year or two, there usually tends to be an accumulation of toxins in the soil from plant litter and trash. This process of autotoxicity from the exudates of decaying plant material can prevent the establishment or recruitment of new lucerne seedlings. If required, re-sowing is best attempted in autumn due to competition from the existing crop in spring growth.

Usually, however the best plan is to start again as there is likely a disease, pest or nutrition problem which has led to low plant numbers. Alternatively, a thinning stand can be over sown with an alternative species to complement production and give extended life and performance.

Weed control

A lucerne crop needs to be well managed to out compete weeds and produce high yields for hay and or grazing. Any problems should be identified and rectified promptly.

Pests

A lucerne crop takes a year to fully establish and a young lucerne crop needs to be monitored for pests. Using resistant varieties and coated seed should be strongly considered. Always check for red legged earth mites (RLEM) and use bare earth insecticide controls. Once established, lucerne may be afflicted by a number of pests including mites, lucerne flea, aphids, cockchafers, armyworm and, in some environments, slugs. Monitoring and swift treatment should be adopted to help assure productivity and feed quality.

Cutting

Cutting lucerne needs to be done at or a bit before 10% flowering, but note the height of new shoots at the base of the crop, and ensure that they are not damaged as they will be the next crop (best method of assessing cutting timing). Conditioner rollers are useful for quick drying. Double conditioning has been used. Re-cutting depends on seasonality, climate and dormancy.

Pre-planting	First year - post-emergence	Second and subsequent years
Knock down spray to remove actively growing weeds. Trifluralin should be used to curtail early weed competition at rates depending on soil type. Pendimethalin can also be used.	The following options can be used up to the 8th leaf stage: 1st trifoliate leaf – 2,4-DB, bromoxynil. 2nd trifoliate leaf – Flumetsalum, Imazamox, Imazethapyr. 3rd trifoliate leaf – bromoxynil, + diflufenican, prometryn	Spray-seed + Diuron (take some care with the winter active varieties). Simazine (may be a better option for winter actives). Saflufenacil and Terbuthylazine may also be considered. Options as per 1st year, but check for weed size and rates vary. Group A grass herbicides.

Key times for weed control are:

Preparation phase: Weed control in prior crops or pastures.

Pre-planting: A pre-emergent program, well executed will aid a good start.

Post-emergence: Monitor for weeds and address early competition earlier rather than later.

Annual maintenance: A winter clean program is usually very effective. Spring/summer weeds may need attention under some circumstances.

For specific herbicide and rate advice contact your local Barenbrug territory manager.

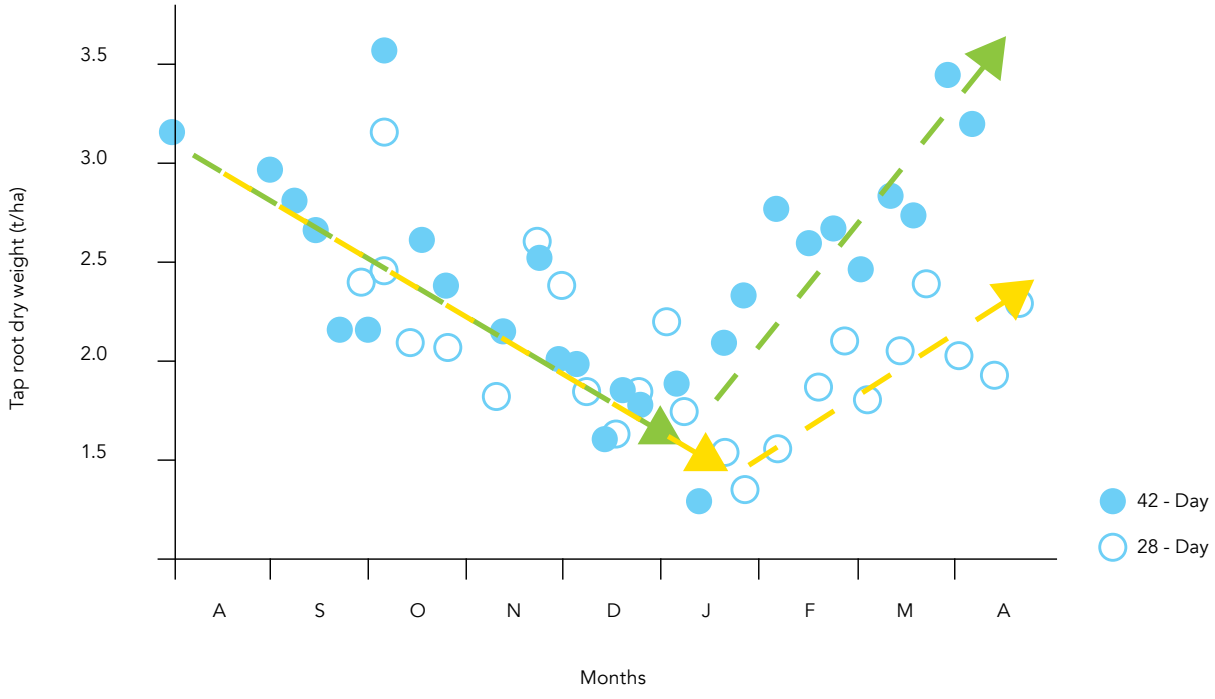
Grazing Lucerne

Ideal management of grazing would require a short-sharp grazing period of 2 – 3 days, followed by a rest and regrowth period of around 20 – 25 days over summer and longer over winter. The stock should then be introduced at around 5 –10% flowering and the crop evenly defoliated. This is however rarely achievable due to various factors, but the principles born in mind and grazing management adopted which tends towards this regime. In practice, lucerne will handle limited set-stocking for a period of weeks or a month or two. If periods of set-stocking or lax rotational grazing are likely to occur, there are a number of key things to bear in mind and include in the program.

Stock will have a preference for grazing the leaves in preference to the stems. This may lead to excessive protein intake leading to issues such as red-gut, and potentially bloat. In terms of stock performance, lax grazing may see an initial increase in performance, then the production levels fall off as stock are left with a high proportion of stalks on offer. Try to adopt a system where the entire stalk is consumed along with the leaves. Stock density will be important. Modern cultivars selected for high leaf:stem ratio such as the SARDI range will also help. Consumption of the leaf and stalk together is a relatively balanced diet for ME, CP and fibre.

Allowing the crop to have at least one good flowering per year will aid replenishment of root reserves. This will ideally take place in mid-late autumn, as the plant will then contain good reserves to come away the following spring. The feed reserve built up over the rest period in autumn can be fed off as valuable early winter feed, prior to winter cleaning sprays.

The autumn rest-phase appears to be most important to build root reserves. A 6 week rest period in autumn appears to increase root mass by around 100% compared to a 4 week rest phase. A rest phase is of lesser or negligible value over spring or early summer. Lucerne with a good root reserve will be stronger over winter and rebound more readily in the following spring.



Lucerne tap root mass under two defoliation regimes, showing little if any difference in late winter-spring-early summer, but important to recharge root mass in autumn with a rest-phase.

From Moot et al, Lincoln University 2003

Grazing Tolerant Lucerne

Most lucerne cultivars can be grazed with success, however periods of continuous or repeated close grazing will quickly thin out stands of varieties not specifically developed and evaluated for this purpose.

True grazing tolerant varieties have been screened and re-selected under protocols which provide such features as a low and broad crown, high numbers of crown buds and have been subjected to very high grazing pressure for extended periods. This does not mean that such varieties ought to be treated in such a brutal fashion as a rule, but allows the producer a longer-term stand that will have greatly improved capacity to survive and produce where periods of set-stocking and/or lax grazing are likely. Appropriate fertiliser, weed and pest maintenance will still be required for best results. Also consider that some level of winter-growth activity is appropriate, as this will enable forage production through the typically cool-season dominant rainfall pattern of much of Australia. A properly evaluated cultivar developed for and selected under grazing in Australia with a 6 or 7 dormancy rating is more often appropriate for a long-term grazing option.

Sardi-Grazer
Lucerne

Dormancy 6 Winter Active

PBR | 325+ mm | 5.4–8.0 | Deep, well drained | AM or AgriCote™

- The most grazing tolerant commercial lucerne variety in Australia
- Persists under periods of set stocking up to two months once established
- Exceptional persistence across a range of environments from low to high rainfall, dryland and irrigation
- Broadly adapted to a variety of farming systems including quality hay
- Requires minimal rotational grazing management
- Well suited to mixed swards with perennial grasses such as winter active tall fescue, cocksfoot, phalaris or sub-tropical grasses.

SARDI-Grazer offers increased persistence in mixed grazing/cropping systems, where large paddocks limit the use of rotational grazing. SARDI-Grazer is well suited to permanent pastures systems in the medium to high rainfall areas, where long periods of continuous grazing (over four weeks) by sheep or cattle is common practice. It provides a long-term lucerne stand where a permanent pasture of volunteer grasses or mixtures with phalaris, cocksfoot or tall fescue is required. SARDI-Grazer is an ideal fit for wool, prime lamb and beef production areas where mob sizes prevent the use of strict rotational grazing

Grazing tolerance and recovery of SARDI-Grazer

1. SARDI-Grazer continuous grazing trial near Roseworthy, SA.

2. SARDI-Grazer after eight months of continuous grazing.

SARDI-Grazer | Winter active control (Hunterfield)

3. Recovery from grazing six weeks later.

Winter Active Lucerne

Winter active lucernes are the most versatile, providing good growth into late autumn and hold their quality longer than highly winter active varieties. Best suited to medium-term mixed farming situations that require grazing tolerance and the ability to make reasonable quality hay. They are ideal for irrigated or dryland production and are useful as a pure stand or as a perennial legume component in pasture blends for regions with 450 – 650 mm winter dominant rainfall. These lucernes also make excellent permanent summer forage crops in the high rainfall dairy regions because they provide feed over a longer period than summer brassicas without the same insect problems.

Sardi 7 SERIES 2
Lucerne

Dormancy 7 Winter Active

PBR | 350+ mm | 5.0–8.0 | Deep, well drained | AM or AgriCote™

- The most broadly adapted dormancy 7 lucerne currently available
- Produces many fine, upright stems which carry a high number of large leaves
- Persistent and tolerant of grazing
- Broad pest and disease resistance profile
- Higher total dry matter than more winter dormant varieties
- Suited to continual harvesting, hard grazing and treading.

SARDI 7 Series 2 is the next generation winter active lucerne. It is even more versatile, broadly adapted and persistent than SARDI 7 offering greater performance in cold, wet environments where lucerne can struggle. It has been bred specifically for the Australian climate and farming operations and will perform well in both dryland and irrigated systems. It offers superior performance where persistent, high-producing lucerne stands are required and in grazing situations where winter produced feed can be utilised. SARDI 7 Series 2 is also the only lucerne in Australia with any tolerance to the new highly virulent BGA strain.

Highly Winter Active Lucerne

Highly winter active lucernes are bred for late autumn/early winter sowing and have excellent seedling vigour for undersowing. They have a more upright crown, erect growth habit and are well suited to a 2–4 year cropping rotation system in 300–500 mm rainfall zones. They provide maximum growth from winter dominant growing season rainfall. Some of the newer Australian-bred varieties in this group have increased grazing tolerance because they were selected from and developed for broadacre grazing systems.

Sardi 10 SERIES 2
Lucerne

Dormancy 10 Winter Active

PBR | 350+mm | 5.4–8.0 | Deep, well drained

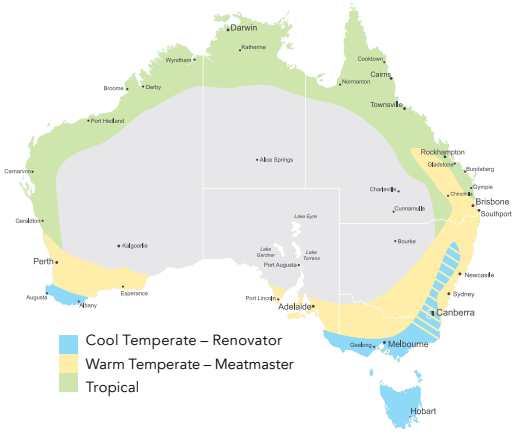
- Suited to cropping rotations, pasture mixes and year-round hay production systems
- Improved forage production and persistence over SARDI 10
- Very good seedling vigour
- High winter growth and grazing tolerance
- Highly productive 3–4 year + option
- Multiple screens for excellent disease and insect resistance.

SARDI 10 Series 2 is a highly winter active lucerne with the greatest activity rating over any other SARDI variety. During its development, the breeder was successful in focusing on improving the very popular SARDI 10. The greatest emphasis was on increasing forage production and quality, pest and disease resistance, persistence and grazing tolerance. A key physical feature is the greatly improved leaflet density down the length of each stem. These advancements allow for even greater adaptability to Australian farming systems.

Temperate Premium Pasture Blends

The Renovator and Meatmaster temperate range of pasture blends provide farmers with the right mix necessary to produce superior results and superior pastures. They are premium seed blends formulated using Barenbrug's strong agronomic, technical and research advantage. They are designed using only the highest quality seed and are 'ready to sow' providing livestock farmers with the best possible pasture outcomes.

Key to Pasture Blend Charts	
D	Dairy
B	Beef production
L	Lamb production
W	Wool and general sheep production
E	Equine – horses, ponies etc
F	Fodder production - silage and hay
C	Cropping rotation short pasture phase
I	Irrigation very suitable



In circumstances where specific varieties are not available, an appropriate alternative may be substituted that suits the agronomic application.

Meatmaster® Pasture Blends

Plan for	Min.av.rain		Contains % by weight:	
3 years+ Oversowing, high performance D B L F C I	650mm+	MM B-Double Mix 15–25 kg/ha (use 25kg/ha for a pure stand)	60% 40%	Bealey NEA2 perennial ryegrass (t) Barberia long rotation ryegrass (d)
3 - 4 years+ Specially finishing blend D B L F I	650mm+	Meatmaster® LC 6–10 kg/ha (Marginal/dryland) 15–20 kg/ha (Irrigation/high rainfall)	25% 75%	Commander chicory SARDI 7 Series 2 lucerne
5 - 10 years+ Summer rainfall D B L F C I	650mm+	Meatmaster® HP 20–25 kg/ha	75% 10% 15%	Fortune summer active tall fescue Storm white clover Morrow red clover
5 - 10 years+ Hardy blend for late areas B L W E F C I	500mm+	Meatmaster® 500 18–20 kg/ha	30% 20% 20% 10% 10% 10%	Fortune Summer active tall fescue Prosper Winter active tall fescue Holdfast GT Phalaris Monti Sub clover Campeda Sub clover Sardi Grazer Lucerne
5 - 10 years+ Extensive, summer dry B L W E F	400mm+	Meatmaster® GT 8–15 kg/ha	45% 27.5% 27.5%	Holdfast GT phalaris Monti sub-clover Campeda sub-clover
5 - 10 years+ Extensive, acid sites B L W E F	400mm+	Meatmaster® AT 8–15 kg/ha	30% 10% 30% 30%	Advanced AT phalaris Howlong cocksfoot Campeda sub-clover Monti sub-clover
1 year+ Winter feed and fodder D B L W F C I	600mm+	Meatmaster® ST 12–15 kg/ha	80% 10% 10%	Vortex annual ryegrass (t) Laser (Persian) annual clover Vista balansa clover

Renovator® Pasture Blends

Plan for	Min.av.rain		Contains % by weight:	
5 years+ Highest performance D B L F I	700mm+	Renovator® HR 25–30 kg/ha	50% 35% 7.5% 7.5%	Bealey Perennial ryegrass Impact 2 Perennial ryegrass Storm White clover Weka White clover
5 years+ Performance, wet sites, late maturing D B L F I	850mm+	Renovator® 850i 25 kg/ha *Late maturing*	40% 40% 10% 10%	Rohan SPR perennial ryegrass (d) Impact 2 NEA2 perennial ryegrass (d) Storm white clover Weka white clover
3 years+ Oversowing, performance D B L F I	700mm+	Renovator® Elite 20–30 kg/ha (use 25kg/ha for a pure stand) *Very late maturing*	50% 50%	Viscount perennial ryegrass Shogun hybrid ryegrass
5 years+ Performance, dry summers D B L W F I	650mm+	Renovator® 700+ 25 kg/ha *Mid–late maturing*	32.5% 32.5% 10% 12.5% 12.5%	Impact 2 perennial ryegrass Kidman perennial ryegrass Storm white clover Monti sub-clover Denmark sub-clover
5 years+ Marginal ryegrass regions B L W E F	500mm+	Renovator® Grazier 25 kg/ha	30% 30% 10% 15% 15%	Kidman perennial ryegrass (d) Barberia perennial ryegrass (d) Howlong cocksfoot Monti sub-clover Campeda sub-clover
5 - 10 years+ Extensive, summer moisture B L W E F I	500mm+	Renovator® 500+ 18–25 kg/ha *Summer Active*	32.5% 15% 10% 15% 10% 10% 7.5%	Fortune Summer active tall fescue Barberia Long rotation ryegrass Howlong Cocksfoot Holdfast GT Phalaris Denmark Sub clover Antas Sub clover Palestine Strawberry clover
5 - 10 years+ Extensive, summer dry B L W E F	650mm+	Renovator® GT 15–22 kg/ha *Summer Dormant*	35% 20% 15% 15% 7.5% 7.5%	Kidman Perennial ryegrass Holdfast GT Phalaris Monti Sub clover Campeda Sub clover Storm White clover Weka White clover
1 - 2 years All-year feed + hay/silage D B L F C I	500mm+	Renovator® SR 25–50 kg/ha *Short term, quality grazing & fodder*	30% 50% 20%	Tempo Italian ryegrass (d) Hogan annual ryegrass (t) Laser (Persian) annual clover
5 years+ Quality horse pasture B L W E F	500mm+	Renovator® Equine 25–50 kg/ha *All year growth*	30% 30% 40%	Fortune Summer active tall fescue Governor Perennial ryegrass Barberia Long rotation ryegrass
4–5 years+ Ryegrass-free, equine pasture B L W E F I	500mm+	Renovator® Hardy Horse Blend 30–35 kg/ha	40% 10% 10% 10% 10% 10% 10%	Bareno Pasture brome Howlong Cocksfoot Fortune Summer active tall fescue Prosper Winter active tall fescue Weka White clover Campeda Sub clover Monti Sub clover
1 year High yield silage crop D B L F C I	500mm+	Renovator® Spring Silage Blend 120–180 kg/ha	40% 60%	Express Forage oats Morgan Field peas
1 Year High yield silage crop D B L F C I	550mm+	Renovator® Oats and Rye 60–80 kg/ha	70% 17.5% 12.5%	Express Forage oats Hogan annual ryegrass (t) Fuze annual ryegrass (d)
1 Year Short term oats and vetch blend L W F	550mm+	Renovator® Oats and Vetch 100–160kg/ha	70% 30%	Express Forage oats Volga Common Vetch

Pasture establishment and after-care

The most expensive pasture is the one that fails to establish properly. Such pastures have reduced productivity and carrying capacity, are more prone to weed invasion and have a reduced ability to combat various aspects of soil degradation. These deficiencies continue throughout the entire life of the pasture. Also be aware that your new pasture may be exceptionally productive compared to existing pastures, and that there will be a temptation to get extra grazing from it. Be careful not to unduly over graze the new pasture and remember that if it is offering and producing more feed, it will need extra fertiliser and more monitoring to remain productive.

First year grazing management

Once grasses are 10-15cm tall and under good growing conditions with adequate moisture, a quick grazing will enhance tillering and root development. However, it is important not to graze too hard by leaving at least 2.5cm of growth. Do the "pull check" by grabbing the leaves of the grasses and pulling. The leaves should tear and the plants remain rooted. If the plants pull out, then postpone grazing until the plants are well anchored. In many dryland/extensive pastures, it is advisable to allow perennial grasses to set seed in the first year, especially phalaris. It is also wise to avoid hay cutting in the first year. Be careful not to graze newly sown pastures early under dry conditions, or if grasses are poorly developed as stressed plants will be slower to recover. Avoid grazing aerially sown or surface sown pastures before they are well anchored. Some pastures have specific grazing requirements (e.g. lucerne and ryegrass require rotational grazing for good persistence). Careful grazing management of the new pasture in the early stages will help set up a strong viable permanent stand.

Importance of weed and pest control

Ideally you should have some knowledge of what weeds and some of the pests to expect during the establishment phase. This is an opportunity to be on the front foot to nip problems in the bud, avoid production losses and have the right tools on hand to deal with problems in anticipation. In some cases pre-emergent or post-sowing pre-emergent options are warranted for some weeds and pests including grubs and slugs.

Once a new pasture has been sown, monitor at 10-14 day intervals for pests and diseases including leaf decolouration, insect attack and weeds. The likelihood of insect pests being present is generally greater in direct drilled than conventionally sown new pastures. Direct-drilled pasture, heavier soil types, higher pH and trash load all contribute to potential damage from slugs and snails. It is well worth considering mixing slug bait in with the seed and/or broadcast post sowing if this is a concern.

Redlegged earth mite (RLEM) and blue oat mites (BOM) can cause significant damage to new pastures in the first three months, especially in low to medium rainfall areas as temperatures decline in autumn. Correct identification is necessary as they require different rates of insecticide control. Seed coating with AgriCote™ will provide useful protection from sucking insects including mites. Cut-worms, cockchafers, armyworm, corbies and other caterpillars, plus grasshoppers and crickets may also need attention.

Weeds can prove devastating to a newly sown pasture. By following the previous year's preparation, the weed seed bank will have been reduced, especially grass weeds. In most cases however, there will need to be some broad-leaved weed-control in the new pasture. Spray with a selective herbicide when the pasture is at the correct growth stage (three true leaves for clovers, four-five leaves for grasses) and before the weeds get too big. Often it is handy to mix a couple of herbicide options for the weed spectrum presented, and it is an opportunity to include an insecticide if necessary. Observe legal requirements and stock WHP. It may be necessary to consider and allow for stock movements. Sometimes it may be best to first graze with light stock to reduce the cover, open up the sward and thereby aid spray penetration.

Quite often it may be a narrow window of opportunity to spray due to weather, soil condition, weed/pasture growth stage and stock movement. Get organised, monitor the paddocks, spray sooner rather than later to get weeds and pests early. Weeds and pests have the capacity to severely reduce the value of a new pasture, so don't take any prisoners.

Grazing Management

Grazing management is one of the most important aspects of a pasture production system. Poor grazing management can lead to lower returns, weak pastures and poor pasture persistence. In order to reach full potential, all pastures require a rest period in order to maximise growth and maintain persistence. Rest periods allow plant species to replenish energy reserves, which are depleted during grazing.

Rest periods and plant physiology

Once plant species are grazed, carbohydrate reserves in the plant's roots and base are used to initiate growth, before the plant has enough leaf area to undertake photosynthesis and accumulate plant sugars. Grazing during the regrowth phase can severely affect the plant's persistence, regrowth and production. This is due to the depletion of a plant's metabolisable carbohydrate stores before it has enough time to replenish stores that were used for the initial regrowth. When a leaf has finished growing, it will tend to start to decline and then die off (senesce). Grazing once plant reserves have been replenished and prior to leaf senescence, provides optimal quality for grazing, maximises production per hectare and improves prospects for persistence.

Rotational grazing

Rotational grazing is recommended as it allows for adequate rest periods and ultimately leads to increased plant persistence, pasture utilisation and regrowth. Grazing grasses at the correct leaf stage, results in more tillers per plant, more roots per plant and better plant survival. This ultimately reduces the amount of invasive summer and winter weeds.

Phalaris	4-5 leaf stage, allow to flower in spring, graze well through summer
Tall Fescue	3-4 leaf stage, from 10-15cm down to 2-3cm, hard in spring: 10-14 day intervals
Cocksfoot	3-5 leave stage, 6-10cm high, remove all old leaves
Brome - pasture brome	3-5 leaf stage from 10-15cm down to 2-3cm, rest over summer
Perennial ryegrass - summer dry	2-3 leaf stage from 10-15cm down to 2-3cm, 2-4 days on, rest over summer
Perennial ryegrass - summer moisture	2-3 leaf stage from 10-15cm down to 2-3cm, 2-4 days on, monitor
White clover - dryland	Preserve some stolons: lax grazing over summer
White clover and red clover - summer moisture	Utilise summer growth - graze to 2-3cm
Sub-clover	Manage flowers through seed-set period in spring, from 4th leaf stage in autumn
Lucerne	20-30 day rotation in growing period, allow re-charge mid autumn

Continuous grazing fails to provide sufficient time for replenishment of carbohydrate stores and does not allow pasture growth to be maximised. Grazing duration is also important. The time spent grazing an individual area should be short to avoid the grazing of regrowth. Ideally it should be no longer than 1-3 days. Reductions in DM production of up to 40% have been observed when pasture was grazed for 6 days when compared with 1-3 days.

Additionally, pasture utilisation generally ranges from 40-80% and can influence the potential returns per hectare. Strip grazing and high stocking rates on small areas aid with increasing pasture utilisation. In contrast continuous grazing of large open paddocks and low stocking rates result in under-utilised pasture, selective grazing of new shoots, and rank grasses and weeds.

In not all cases can this objective always be achieved due to various factors such as spring surplus, times of drought, stock management, or feed being tight in winter. It is suggested that these principles be born in mind and graziers work in that direction where possible, and that any steps taken towards greater adoption of good rotational grazing management will aid persistence and performance.

Pasture Maintenance – Weeds and Pests

Weeds and pests will commonly reduce productivity or in some cases ruin a pasture. Pastures will often be challenged and their composition affected by weeds and pests. Seasonal monitoring and timely or programed responses will keep the pastures productive, greatly aid animal performance and pasture persistence. Good pastures should be looked after and even some semi run-down ones can be brought to a higher level of productivity through good agronomy. Some key times, terms and tips that will help design a pasture maintenance program:

Autumn clean

Sometimes used in areas that have active pastures over summer and/or an early break in autumn. This may also coincide with emergence of pasture pests such as RLEM, cockchafers and corbies, and an insecticide may be added in some cases. Examples:

- Broad-leaved weeds, at early stage of growth MCPA, 2,4-D, Terbutryn
- Cockchafers, corbies, RLEM etc a-cypermethrin, Fenitrothion and others
- Annual grass weeds (in mixed pasture) Paraquat (usually done separately and after a systemic broad-leaved application).

Winter clean

Largely used in areas with late/limited autumn break as a first chance to address annual grass weeds. Often associated with using simazine to reduce population of Vulpia spp. (Silver grass). May sometimes also include Paraquat +/- Diquat in the program for other weeds. Should be completed when the pasture is both well established, with a good root system and well before clovers start to move. Should be strongly considered where Vulpia content >15-20% as Vulpia offers little nutrition and inhibits clover growth. Winter cleaning can also be used as a pre-cursor to sowing a new pasture next year i.e. tidy up as many grass weeds as possible. Utilise the remnant pasture, and with the benefit of some weed control taken place with a different chemical group, well before a knock-down later.

Spray-grazing

Using a sub-lethal dose targeting broad-leaved weeds such as thistles, capeweed and erodium. Typically a Group I hormone like MCPA or 2,4-D to stress the weeds, increase sugar content, then after stock with-holding period has been observed, use the livestock to graze the remnant weeds. Look at labels for details. Can be very effective and relatively low-cost, especially for more extensive pasture systems. Other formulations of various herbicides may also be looked at. Monitor for potential nitrate poisoning of stock in heavy weed situations. Try to avoid using hormone sprays after about late July as the sub-clovers will soon be initiating flowering and spraying may affect seed-set.

Pasture topping

Usually carried out in mid spring to sterilise the seed-set in the emerging weedy pasture grasses. Graze the crop evenly to get an even re-growth, then at about 50% ear emergence apply low rates of glyphosate or Paraquat, plus a good wetter. Strong perennial species will come through, and the seed of next year's weedy grasses (and some other weeds) is significantly reduced. Works well on annual ryegrass, Vulpia, barley grass and brome grasses. Can be really good to coincide with a Time-rite* application for RLEM. Less effective on biennials such as some annual brome grasses., fog-grass and not for perennials such as kikuyu and brown-top.

Other perennial weeds

In circumstances of semi-improved, lax grazed and low-modest fertility, weedy perennial grasses, rushes and some woody weeds will need to be addressed. This may be as boom spraying, spot spraying or 2-direction wick-wiping. Some useful active ingredients are flupropanante, glyphosate, metsulfuron, clopyralid, triclopyr/picloran/aminopyralid, as a starting point.

*Bayer Crop Science

Pasture Maintenance – Fertility

It is important to monitor nutrient removal from pastures, whether it be meat, hay or silage removals so that maintenance rates of fertiliser can be applied and production is not hindered.

Maintenance fertiliser is the amount required to maintain fertility at its current level. In many situations maintenance P rates are calculated based on the stocking rate per hectare (0.6 to 1.0 kg P/DSE) or the soil buffering capacity (based on soil texture). However, whole farm nutrient budgeting is sometimes undertaken on farms to scrutinise total soil nutrient transfer. Nutrient budgeting takes into account farm inputs and outputs including:

Inputs: Bought in fodder, supplements, fertiliser and hay/silage fed out in paddocks

Outputs: Product removal (e.g. wool, milk, meat, hay, silage), soil nutrient adsorption (nutrients held in the soil profile and unavailable to plants), leaching, runoff and erosion.

Once all inputs and outputs have been considered, fertiliser requirements for particular paddocks can be calculated and fertiliser applied. Nutrient budgeting provides a more efficient and balanced use of fertiliser without over or under application.

Product (per tonne)	N	P	K	S	Ca	Mg
Mixed pasture/hay	25.0	2.5	17.0	2.5	9.0	4.0
Lucerne hay	34.5	2.7	19.6	3.2	9.1	4.6
Meat (lamb/beef)	21.0	8.0	1.8	1.5	14.0	1.5
Greasy wool	17.0	0.3	15.8	28.5	1.2	0.3
Cereal grain	16.5	3.0	3.9	1.5	0.5	1.0
Cereal hay*	20	2	18	1.4	0.6	-
1,000L milk*	6	1	1.4	0.6	1.2	-

Sources: Nutrient removal in every tonne of farm product on the NSW tablelands (Source: Incitec Pivot) *Source: Impact Fertilisers

The table above highlights the removal of nutrients from different outputs. Hay cutting removes substantial amounts of potassium, ranging from 17 – 25 units/tonne DM. It is therefore important when cutting paddocks for hay or silage that potassium be replaced with maintenance fertiliser, otherwise significant removal of K from paddocks will occur.

To extrapolate this out, a single silage cut of lucerne, yielding 3,000 kg DM/ha would remove:

P–8.1 Units K–58.8 Units S–9.6 Units

To replace what has been physically removed during harvest, requires approximately 200kg super potash 1and1 (4.4% P, 25% K and 5.5% S). During harvest calcium and magnesium are also removed, which can affect soil concentrations and acidity – for every tonne of lucerne hay harvest, approximately 70kg of lime will be required to neutralise the resultant acidification. While nutrients are physically removed from pasture in meat and wool, a large proportion of the nutrients ingested in the grazing process are recycled through urine and faeces and therefore stays within the system. In some situations 30% of sheep dung can be deposited in 5% of the paddock area. Rotational grazing in small areas results in a more even distribution of nutrients around the paddock.

It is recommended that a regular soil testing (3-5 years) take place on farm so that monitoring of individual paddocks can be undertaken. Soil testing acts as a check to make sure correct maintenance rates are being applied.

Common Pasture Pests

The incidence of pests will differ widely from year to year and place to place. The distribution, frequency and intensity thresholds of many pests are not well understood, although there are in some cases well-known locations and regions subject to specific threats on an annual basis. Management techniques and sound varietal selection will be the best long-term solution to creating resilient pasture systems. Some sort of short-term intervention with insecticide is however warranted where pastures may be establishing initially or immediate objectives and investments need to be protected.

Beetles		Description	Damage	Control
Black Beetle *Heteronychus Arator*		Scarab beetle to 15mm long, shiny black. Larvae 5-30mm, dark yellow head with legs. Found mostly in humid areas with summer moisture, but range not well known, although some areas and sites have high numbers annually.	Pasture damage caused by adults and larvae. Larvae feed on roots over summer-early autumn. Adults feed on all plant parts to just below soil surface. Can devastate newly sown or oversown pastures.	Cultivation in heavily infested sites followed by a fallow. NEA2 rygrasses or hardy perennials. Seed treatments. Spray options very limited.
Blackheaded Cockchafers *Aphodius Tasmaniae*		Black-brown shiny scarab 10-12mm in length. Adults emerge to fly in mid-late summer, laying eggs in short, (often) weaker pastures. Eggs hatch early autumn. Larvae fairly wriggly, off-white, slender body from 3-15mm. Shiny black head.	Most severe in mid-late autumn in existing or newly direct drilled pastures. Burrowing undermines roots, and grubs will surface feed on all useful pasture plants including grasses, lucerne, clovers. Burrows found near soil piles.	Cultivation, fallow or break crops may assist. Phalaris and cocksfoot more resilient than other pasture species. Readily controlled with insecticide sprays.
Redheaded Cockchafers *Adoryphorus Coulonii*		Shiny black scarab to about 15mm. Grubs off-white with red-brown head, from 5-30mm. Docile and slow moving, thicker of body than black-headed cockchafers.	Grubs from summer through autumn, over winter and then again next spring. Feed on roots 20-40mm below ground surface. Damage by large 9-10 month old grubs can become suddenly apparent and severe.	Trampling with heavy stock/rates may assist. Cultivation prior to re-sowing. Plant deep-rooted species for long-term tolerance.
Yellowheaded cockchafers *(many species)*		Brown or satin black scarabs to about 14mm long. Larvae from 5-30mm, c-shaped, off-white and dark yellow head. Some species annual, some biennial life-cycle.	Grubs feed through autumn and winter on roots below ground surface, often in limited patches but damage followed by bird activity can be severe.	Trampling with heavy stock/rates may assist. Cultivation prior to re-sowing. Plant deep-rooted species for long-term tolerance.
Wireworm and False Wireworm *Elateridae spp and Gonocephalum spp.*		Wire-worm: Dark-grey-brown-black oblong. Also known as click beetle. False wireworm: Adult similar colours but oval shape. Cream-yellow-golden larvae. Distinctly segmented body.	Eggs laid on or just below surface. Eat germinating seeds and roots of young seedlings. Usually in upper 5cm of soil. Adults may chew and ringbark seedling stems. Often a pest of weedy or trashy sites, especially lo/no till situations.	Reduce crop trash. Cultivation and fallowing. Knock-down insecticides. Suitable seed coating insecticide.
Weevils		Description	Damage	Control
Argentine stem weevil *Listronutus bonariensis*		Grey-brown adult beetles to 3.5mm, dispersing by flight. White larvae from 1-5mm long, legless, off-white with brown head. Species is known in some districts, although frequency and intensity not well documented.	Larvae will mine grass stems, especially Italian or nil endophyte perennial ryegrass, cocksfoot and spring planted cereals. Tillers wilt and yellow. Adults forage on young grass shoots. Damage in no-till re-seeding situations can be high.	Grass-free break and/or 4-6 week spring fallow. AR1 and NEA2 endophyte grasses offer protection from larvae and adults. Phalaris is also a good option.
Sitona weevil *Sitona discoideus*		Small grey-tan weevil to 3mm long. Grubs to 3mm, chubby pale and legless, often feed on or burrow into legume nodules. Adults disperse by flying.	Larvae feed on roots of lucerne and other pasture legumes and flat-weeds. Grasses rarely affected by grubs, but adults will feed on most pasture species including grasses, leaving a scalloped leaf edge. Young tillers in no-till are very susceptible.	Cultivation and fallow. Chemical control may be an option if needed in heavy infestations.
Whitefringed weevil *Naupactus leucoloma*		Adults grey-tan with dark striations, large weevil to 12mm long. Larvae to 12mm, fat, cream with pale indistinct head region with distinct chewing mouth parts.	Most often a pest of lucerne, especially 2-3 year old stand out of no-till establishment when damage may appear as wilting and plant loss in summer. Avoid close cropping with other hosts e.g. potatoes, peas, etc.	Farm hygiene, crop rotations and cultivation. Cereal break crop. Soil fumigation has been performed. Sprays ineffective.

Moths		Description	Damage	Control
Armyworm Persectania spp., *Mythimna convecta*		Adult moths 20mm long with 40-43mm wingspan, grey-yellow-brown. Eggs hatching usually mid spring. Young caterpillars cream-green-tan. Mature to 40mm long, brown, black or khaki with 3 stripes running dorsal length of body.	Prefer to lay eggs in long grass. Grasses and cereals most affected, especially hay crops. Leave margins scalloped or stripped, seed heads lopped off or drooping. Numbers and damage favoured by warm, dry spring conditions.	Keep pastures short or well grazed through early-mid spring. Chemical control is effective. Re-infestation from surrounding paddocks is common.
Corbie grubs *Oncopera spp.*		Brown-grey moths to 30mm long, 40mm wingspan. Eggs <1mm laid in long grass and trash, initially cream turning black over time. Larvae from 3mm to 60mm long, grey-purple with shiny head. Soil tunnels with clean entrance (no spoil).	Caterpillars from 30mm or so will surface feed at night to denude pastures of perennial grasses, especially from late autumn - early spring. Weakened root system and crows feeding will lead to pulling and bare patches in paddocks.	Keep pastures short or well grazed through late spring and summer. Chemical control is effective with timely application, usually mid-autumn.
Greasy, Pink, Brown (True) Cutworms *Agrotis spp.*		Often one of 3-4 species, including Bogong moth. Adults grey-brown from 36 to 45mm wingspan. Larvae up to 50mm long, grey to dark grey, often pinkish, plump, found just at or below soil surface, often curled up.	Eggs laid in moist, loose soil. Young larvae may chew foliage, larger caterpillars cut stems of seedlings at ground level. Mostly feed at night. Also feed on other crops including establishing pasture. May be found virtually year-round.	Cultivation and knock-down insecticide before sowing. Monitoring of early crops stages. Chemical control.
Pasture Webworm *Hednota spp.*		Adults yellow-tan to grey-brown small moth 20-22mm wingspan. Distinct beak-like snout. Larvae from 1-18mm light brown, often green gut line visible. Young larvae form silk lined tubes in leaves, older larvae within soil in vertical tunnels.	Adults emerge late summer. Eggs hatch mid-autumn, larvae feeding late autumn - mid spring. Feed on newly sown pastures and cereals. Young larvae chew foliage, larger take leaves into tunnels. Mostly feed at night. Pupate (dormant) over summer.	Crop rotations and cultivation. Monitoring of early crops stages, especially first 3-6 weeks after emergence. Chemical control. Seed treatment may be useful.
Others		Description	Damage	Control
Redlegged Earth Mite (RLEM) *Left* **and Blue Oat Mite (BOM)** *Right Halotydeus destructor, Penthaleus spp.*	 		Especially problematic in emerging and seedling pastures. Mites will suck the nutrients from swelled seeds, and young plants. If plants are older, a typical whitening/ silvering of part or all of the leaves is evident.	Use seed treated with correct systemic insecticide, monitoring, and an integrated spray program.
Lucerne flea *Sminthurus viridus*		Wingless, yellow-green insect from 1-3mm in size. Pale yellow eggs laid in spring and autumn or in moist summer areas in clusters at soil level. Adults have a leaping action and often called 'springtails'.	Spring and autumn, summer pastures also affected. Clover, grass and lucerne leaves initially speckled then windowed out. Severe infestations may strip leaves back to veins and petioles.	Monitoring of pastures or crops. Close grazing to admit summer heat/sunlight into canopy. Chemical control.
Root aphid *Aploneura lentisci*		Yellow-white, oval shaped up to 2mm long with 2 segmented antenna. Found in white, waxy exudates fairly deep in ryegrass root systems. Unless close inspection, may be confused with mealy bugs or other root activity.	Root aphids suck root sap. Not thought to kill plants but productivity and pasture may decline through compounded stresses. Around 10-20 colonies per spaded square of soil may represent economic damage.	Cropping break (grass-free). NEA2 or AR37 endophyte ryegrasses. Cocksfoot or phalaris pastures.
Wingless grasshopper *Phaulacridium vittatum*		Grey-brown adults to around 18-20mm. Occasionally develop wings to fly short distances. Eggs laid in autumn to 20mm under soil surface, hatching early summer. Juveniles from 4-5mm pinkish, to brown 8-10mm, size increasing with maturity.	Summer and autumn pest. Prefer to feed on broad-leaved species, especially clovers and broad-leaved weeds and often found on overgrazed sites. May do severe damage in dry years on green summer pastures.	Improve pasture growth ensuring grasses are well maintained. Chemical control.
Black field crickets *Teleogryllus commodus*		Adults shiny black-dark brown, up to 25mm long, with very long antennae. Eggs yellow, laid in loose clusers under the soil. Nymphs resemble adults, are smaller and lack wings.	Dry summer and autumn pastures on over-grazed, dry cracking soils. Infestations may eat entire plants and emerging seedlings. Ryegrass is especially susceptible; phalaris, fescue, cocksfoot, lucerne are more tolerant.	Maintain pasture groundcover. Sow more resilient species. Chemical control of infested site and surrounding areas.
Slug and Snails *(many species)*		Slugs may be black-grey to yellow-brown, from1mm to 35-50mm. Eggs often clusters in soil and trash 1-1.5mm soft, white-transluscent. Snails of various sorts including garden snails and conical (pointed).	Newly hatched, very small slugs may feed within drill-rows and not emerge to take surface baits. Damage may occur to all parts of plants at any stage. Seedlings especially vulnerable. Older leaves typically have oblong windows rasped out.	Sow seed with an approved slug-bait in problem situations. Monitor and re-apply if needed. Cultivation will assist initially.q

For more information please contact your local Territory Manager:

Western Australia

Tim O'Dea
Territory Manager
0429 203 505
todea@barenbrug.com.au

South Australia

Aston Barr
Territory Manager
0439 496 026
abarr@barenbrug.com.au

Tasmania

Rob Winter
Territory Manager and
Regional Agronomist - Southern
0427 010 870
rwinter@barenbrug.com.au

Western and Central Victoria

Mark Rouse
Territory Manager
0413 442 804
mrouse@barenbrug.com.au

Gippsland

Angus Olding
Territory Manager
0438 736 943
aolding@barenbrug.com.au

Northern Victoria and Western Riverina

Reece Hardwidge
Territory Manager
0428 178 719
rhardwidge@barenbrug.com.au

Southern New South Wales and North East Victoria

Shayne Mathews
Territory Manager
0409 709 455
smathews@barenbrug.com.au

Hunter Valley and South Coast New South Wales

Adam Meusburger
Territory Manager
0428 760 301
ameusburger@barenbrug.com.au

Central West New South Wales

Cara Metcalf
Territory Manager
0487 535 267
cmetcalf@barenbrug.com.au

Northern New South Wales Slopes and Tablelands

Nathaniel Brazel
Territory Manager
0427 010 854
nbrazel@barenbrug.com.au

North Coast New South Wales

Sam Adams
Territory Manager
0497 252 146
sadams@barenbrug.com.au

South West Queensland and Darling Downs

Chris Collyer
Territory Manager
0427 007 900
ccollyer@barenbrug.com.au

South East Queensland and Burnett

Arthur Salisbury
Territory Manager
0413 442 816
asalisbury@barenbrug.com.au

Central Queensland

Kate Ludwig
Territory Manager
0427 010 757
kludwig@barenbrug.com.au

North Queensland/ Northern Territory

Greg Forsyth
Territory Manager
0437 867 567
gforsyth@barenbrug.com.au

Commercial Manager - Northern

Adam Firth
0413 442 809
afirth@barenbrug.com.au

Commercial Manager - Southern

Tim Pepper
0417 500 911
tpepper@barenbrug.com.au

BARENBRUG

Freecall 1800 007 333 • www.barenbrug.com.au