

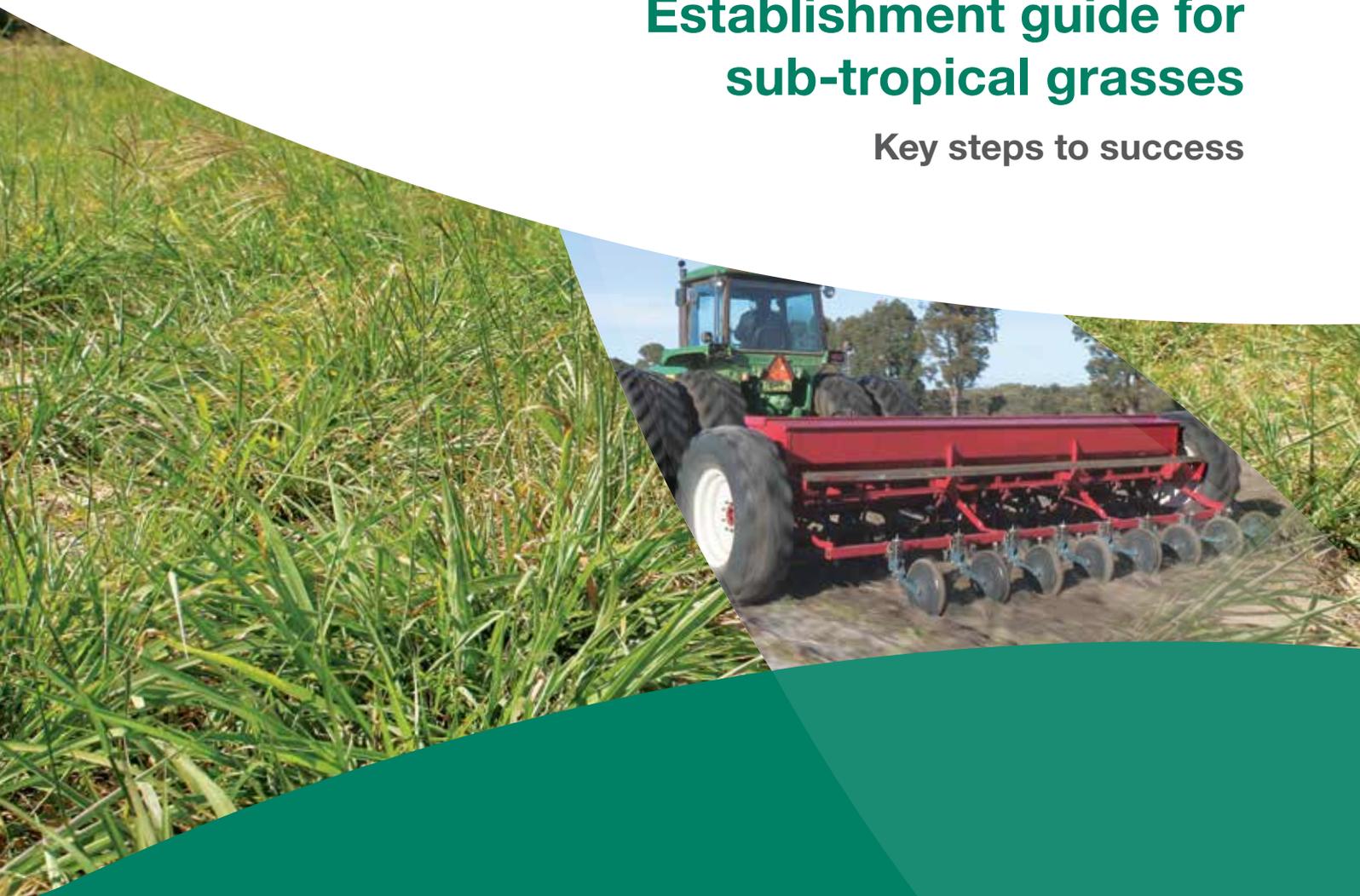


Department of
Agriculture and Food



Establishment guide for sub-tropical grasses

Key steps to success



Supporting your success

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Establishment guide for sub-tropical grasses

Key steps to success

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Introduction

Sub-tropical perennial grasses are now widely sown in the Northern Agricultural region (NAR) and on the south coast of Western Australia (WA). Since 2000, more than 50 000 ha have been sown to perennial grasses in the NAR and about 150 000 ha on the south coast, mainly kikuyu.

Perennial grasses have multiple production and natural resource management (NRM) benefits. Benefits for animal production come through increased productivity of poor sandy soils, lengthening of the growing season in both autumn and late spring – early summer and provision of green feed outside the growing season. NRM benefits are reduced potential for wind and water erosion and mitigation of the effects of dryland salinity.

Until the mid-2000s, establishment of perennial grasses in WA at the paddock scale was typically patchy, with areas of good plant density interspersed with many areas of poor density. Seeding failures also were common. However, a few producers were regularly having success, which showed that uniform establishment at the paddock scale was possible. Overall, the establishment success of sub-tropical grasses has improved dramatically since then.



Sub-tropical grasses are transforming productivity on deep sands in both the Northern Agricultural region and the south coast of WA.

Major contributing factors have been furrow sowing, better weed control and the development of an establishment package for sub-tropical grasses as described in this bulletin.

By adopting key elements of the package, producers can expect much higher and more even plant establishment. Leading producers are now regularly achieving uniform establishment across the paddock each year, in spite of variable seasonal conditions.

This bulletin describes the steps for the successful establishment of sub-tropical perennial grasses. It describes each step in detail and provides results from research and development to support the recommendations. The descriptions are followed by a series of case studies from leading producers. The bulletin is applicable for a wide range of sub-tropical grass species, including panic grass, Rhodes grass, kikuyu, signal grass, setaria, digit grass and Bambatsi panic, either sown alone or in mixtures. It is primarily aimed at the NAR and south coast regions of WA but is also applicable to other areas of Australia with winter-dominant rainfall climates that are not prone to frosts.



Grant Bain, from Walkaway (25 km south-east of Geraldton), was the first person to put key elements of the package together and achieve good, even establishment of sub-tropical grasses at the paddock scale. He played a key role in demonstrating the benefits of furrow sowing and using press wheels. This photo was taken in 2004.



Newly sown paddock in early February after favourable seasonal conditions



Perennial grasses at Moora on June 1st after spring sowing

Summary – key steps for establishment

The following 10 points summarise the key steps or ‘must-dos’ for successful establishment. They need to be followed closely for success, which we define as a density of 8–10 plants per square metre in the autumn after sowing. The main causes of failed or suboptimal establishment are summarised under ‘Troubleshooting’ in Section 12.

1. Plan ahead	A year ahead of sowing, reduce weed seedset, especially of difficult-to-control weeds and commence control of rabbits and kangaroos if they are a potential problem. On erosion-prone sites, consider sowing a cereal crop, so that perennial grasses can be sown into standing stubble.
2. Species selection	Select suitable species and varieties for your soils and climate.
3. Seed quality	Purchase good-quality seed. Consider buying species with postharvest dormancy (e.g. panic grass) the year before seeding (see Section 3).
4. Presowing weed control	Fully control weeds. However, do not sow into a bare paddock. The final knockdown herbicide should be just prior to seeding to ensure there is some above-ground plant material and decomposing root matter to hold the soil together. Apply a broad-spectrum insecticide with the final knockdown or immediately after sowing.
5. Sowing time	Sow into a full profile of soil moisture in late winter to early spring (the sowing window depends on the district). If stored soil moisture is limiting, then consider deferring sowing until the following year.
6. Machinery set-up	Set up the seeder to sow seed into large furrows, with following press wheels for good seed-to-soil contact and with a row spacing of 50–60 cm (see case studies in Section 13).
7. Sowing rate and depth	Sow 2–5 kg/ha of seed, depending on seed quality and whether seed is coated or uncoated. Sow at a depth of 5–10 mm as most sub-tropical grasses have very small seeds that will not emerge from depth.
8. Sowing speed	Don't sow too fast, which can result in excessive soil movement and reduce the accuracy of seed placement.
9. Post-seeding checks	Control weeds and pests, including insects, kangaroos and rabbits.
10. Grazing management	Defer the first grazing until the grasses are well established.

1. Plan ahead

For best results, plan at least one year ahead of sowing. Assess the paddock for three factors: (a) weed burden; (b) risk of wind erosion; and (c) potential pest problems. In addition, if the paddock has a low legume content then consider sowing companion annual legumes the year before establishing the sub-tropical grasses.

Reduce weed seedset by grazing and spraytopping, especially for weeds that can be difficult to control, such as silver grass, annual ryegrass, erodium, ice plant and wild radish. Germination of annual ryegrass can be triggered by the soil disturbance from seeding and they will compete strongly with the perennial grass seedlings.

In exposed sandy paddocks that are highly susceptible to wind erosion, consider sowing a cereal crop the year before establishing sub-tropical grasses. The sub-tropical grasses can then be sown into the standing cereal stubble, which reduces the potential for soil erosion while they are establishing.

Rabbits and kangaroos can severely damage perennial grass seedlings. If they are likely to cause problems on your paddock, start control the year before sowing.

Panic grass and setaria have high levels of seed dormancy for a period after harvest so consider buying seed the year before (see Section 3). The other grasses have little or no seed dormancy.

A productive perennial grass pasture requires a companion legume to provide nitrogen, which drives the productivity of the system and improves feed quality during the growing season. On sandy soils, where sub-tropical grasses are often grown, the best companion annual legumes are hard-seeded French serradella, yellow serradella and rose clover, while on infertile, pale deep sands, blue (sandplain) lupin are the best option.

If the paddock has a low legume content then consider sowing annual legumes the year before establishing the sub-tropical grasses. This is the preferred method as the legumes can be managed as a seed crop in the first year to maximise seedset.

With the annual legumes it is important to control insect pests, especially in the first year, as redlegged earth mite (RLEM), aphids and particularly native budworm, which attack green pods, can greatly reduce the seed yield. In year 2, heavily graze the regenerating annual legume pasture and then brown manure in winter before establishing the sub-tropical grasses. The annual legumes will regenerate from hard seeds in the seedbank in the subsequent year.

Another option for introducing annual legumes into perennial grasses is summer sowing hard-seeded French serradella pod in the first summer (February–March) after establishing the perennial grasses. This would take advantage of the reduced weed competition from annual grasses and broadleaf weeds in autumn due to the weed control the preceding year.

2. Species selection

Select perennial grass species and varieties suited to your district, soil type and to meet an identified need, in terms of the livestock enterprise (e.g. wool, meat, maintain weight), a critical feed gap and/or soil conservation requirement.

A range of sub-tropical grass species and cultivars is available in Australia. However, some are either not adapted to the climate and soils in WA or are not recommended because of their 'weed risk'. Over the past seven years, widespread evaluation in field trials and farmer experience has demonstrated which species can be grown successfully in different environments and soils of WA.

In general, sub-tropical grasses are limited to the south coast, west coast and NAR (Figure 1). When grown in other regions most species will either have poor persistence over winter or low productivity.

Select species and varieties suitable to the climate and soils of the paddock to be sown. Table 1 outlines suitable species for different soil types on the south coast and in the NAR.

Northern Agricultural region

In the NAR, panic and Rhodes grass have been the main species sown and are usually sown together in a mix. The grasses complement each other as they have slightly different growth responses—depending on seasonal conditions

and, while panic grass is more palatable, Rhodes grass will spread and fill gaps in the pasture.

Panic grass is a highly palatable, leafy bunch grass that is drought tolerant and responds rapidly to rain following a dry spell. It has good persistence and production on sandy soils in the NAR, including deep pale sands, but does not tolerate waterlogging or flooding. Panic grass can contain steroidal saponins, which may cause secondary photosensitisation.

Two commercial varieties of panic grass are grown in WA—Petrie or green panic (public variety) and Gatton panic (public variety). Field trials show that while green panic has the same or higher biomass production than Gatton panic, it flowers more readily, which reduces feed quality.

Gatton panic is a robust bunch grass that is agronomically similar to green panic, but has darker green foliage, often with red-purple colouration near the base of the stems.

Green panic is an erect bunch grass that is distinguished from Gatton panic by its light-green foliage. The lower surfaces of its leaves and leaf sheaths have sparse, long hairs compared with the short down-like hairs of Gatton panic.



Panic grass is a palatable, leafy, bunch grass



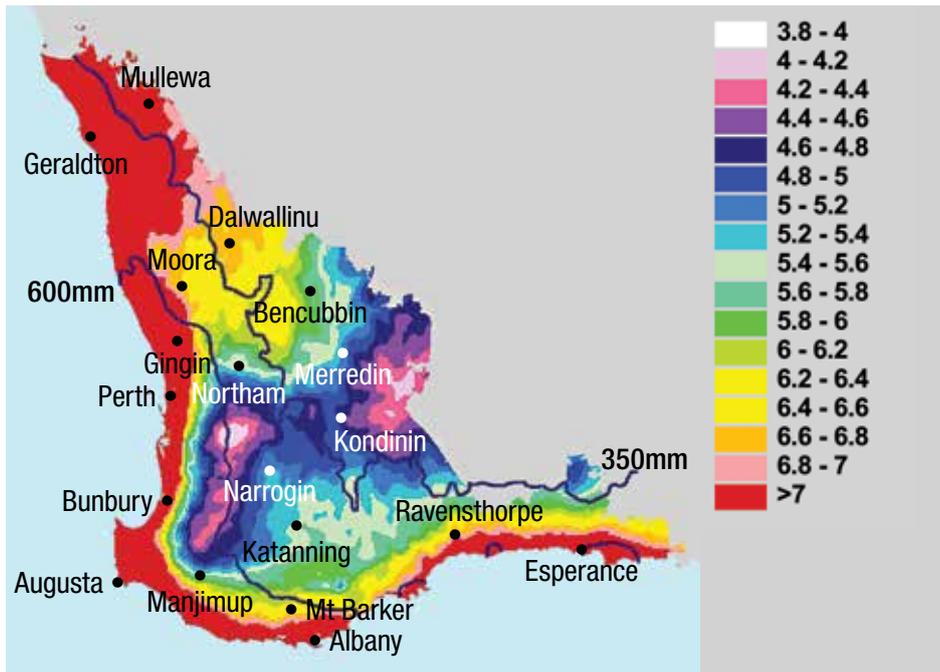


Figure 1 Map of southwestern Australia showing August mean minimum temperatures (°C). The areas shaded in red, orange and yellow approximate the adaptation zone of sub-tropical grasses, while there has been low persistence over winter in areas shaded with blue-purple, which denotes the 'cold zone'. Source: D van Gool, DAFWA

The Department of Agriculture and Food, Western Australia (DAFWA) and the Future Farm Industries CRC are releasing two new panic grass varieties through Heritage Seeds with increased biomass production and excellent persistence.

Rhodes grass is a creeping perennial that spreads through above-ground runners (stolons). It has moderate to high drought tolerance. The feed quality is generally suitable for maintaining rather than growing animals. No livestock disorders have been reported. Good grazing management is essential for persistence in the medium to long term.



Rhodes grass on a sandy rise in the NAR

Rhodes grass can dominate when sown in a mixture due to its good seedling vigour and its ability to spread through runners. When sown as part of a mix, it will typically be the most productive species in the first two years, but there is uncertainty about the longevity of Rhodes grass in the medium term under stressful conditions—for example, low fertility, drought, cold-wet soils, frost, overgrazing or competition from annual pastures. Resting the paddock and allowing the stolons to root down and form new plants can thicken stands.

There are a large number of Rhodes grass varieties and these can be separated into diploid and tetraploid types.

Diploid types flower over a long period, as they are insensitive to day length. Varieties include Katambora, Pioneer (public varieties), Finecut[®] and Topcut[®].

Tetraploid types flower late in the season (i.e. late summer into autumn) in response to shorter days, so feed quality is maintained longer. The main variety in Australia is Callide (public variety).

'Salt tolerant' Rhodes grass varieties have been released. However, these were specifically developed for irrigation with brackish water and may not have the combination of salt and waterlogging tolerance required for most saline sites in WA.

Table 1 Soil and climate requirements and suitability of sub-tropical grasses for the Northern Agricultural region and the south coast of Western Australia (adapted from 'Perennial pastures for Western Australia', DAFWA Bulletin 4690)

Species	Drought tolerance	Frost tolerance	Soil type	Minimum soil pH _{Ca}	Water-logging tolerance	Livestock disorders	Suitability to NAR (rainfall requirements)	Suitability to south coast (rainfall requirements)
Bambatsi panic	High to very high	Low to moderate ¹	Fine-textured clays	5.0	Moderate	Can contain high steroidal saponins	Niche (fine-textured soils) ³ (>375 mm)	Niche (>325 mm)
Consol lovegrass	High to very high	Moderate	Range including coarse-textured soils	4.0	Low to moderate	None reported	Moderately well adapted ² (>375 mm)	Moderately well adapted ² (>350 mm)
Digit grass	Moderate to high	Low to moderate ¹	Range except deep pale sands	4.2	Low	None reported	Moderately well adapted (>450 mm)	Moderately well adapted (>400 mm)
Kikuyu	Moderate to high	Good (top-growth affected, but regrows from rhizomes)	Range including deep sands	4.0	Moderate	Kikuyu poisoning	Niche (shallow groundwater) (>500 mm)	Well adapted (>400 mm)
Panic grass	High to very high	Low to moderate ¹	Range including pale deep sands	4.3	Low	Can contain steroidal saponins	Well adapted (>325 mm)	Well adapted (>350 mm)
Rhodes grass	High	Low to moderate ¹	Range including deep sands	4.3	Moderate	None reported	Well adapted (>425 mm)	Well adapted (>400 mm)
Setaria	Moderate	Low to moderate ¹	Range, especially duplex soils	5.0	Good	Contains moderate to high oxalate (unsuitable for horses)	Niche (>550 mm)	Well adapted (>475 mm)
Signal grass	Moderate to high	Sensitive	Sands	4.0	Low to moderate	Contains high steroidal saponins ³	Moderately adapted ³ (>450 mm)	Not suitable

¹ Top growth is affected by frosts (browned off), but plants are rarely killed by frosts. However, these species can have poor persistence over winter due to a combination of cold, wet soils and occasional frosts (e.g. cold zone).

² Widely adapted, but lower feed quality and palatability, and closely related to the wild African lovegrass, which is a widespread weed in WA.

³ Caution: Preliminary results from samples of signal grass and Bambatsi panic from field sites in WA show high concentrations of steroidal saponins that can cause secondary photosensitisation in stock (Moore, Spadek and Ewald, unpublished data).



Signal grass can contain high concentrations of steroidal saponins

Signal grass is a spreading grass from tropical regions that can form a dense sward under favourable conditions. But, in the WA environment, it generally acts like a bunch grass.

It has often been included in the mix for non-wetting sands, as its larger seeds and ability to germinate from depth act as insurance against establishment failure from sowing too deep or following sand infill due to strong winds after seeding. However, caution is needed in growing this grass. Preliminary data suggests that signal grass growing in the NAR can contain high concentrations of steroidal saponins (Moore, Spadek and Ewald, unpublished data), which can lead to liver damage in stock resulting in ill-thrift or secondary photosensitisation. Signal grass is also very sensitive to cold and frost and will not persist in areas that receive frequent frosts.

Digit grass is a persistent, drought-tolerant bunch grass adapted to a wide range of soils. Digit grass has had limited commercial testing in WA, although it has been evaluated in replicated trials since 2005. It has not been as productive or persistent as the panic grasses, however it does grow strongly in response to summer rainfall.

In northern NSW digit grass has persisted and performed well on a wide range of soils and environments. It has survived severe droughts and persisted in the long-term under commercial grazing and as a result is the most widely sown summer-active perennial grass.

Digit grass would be worth testing (e.g. test strips or include in mix over small area) if establishing perennial grasses on well drained medium-textured soils or sandy soils, apart from deep pale sands.

Consol lovegrass is a persistent, drought-tolerant, tufted perennial which is suited to well drained, sandy and loamy soils.

African lovegrass or weeping lovegrass is a variable species native to southern Africa and includes both the pasture cultivar 'consol' and strains with low palatability that are serious weeds in many parts of Australia. Wild African lovegrass is naturalised on roadsides throughout south-western Australia and is an aggressive coloniser of disturbed areas.

Consol lovegrass was selected for superior palatability and is less competitive than the naturalised type. However, in grazing trials in WA it has lower palatability than panic grass and Rhodes grass.

Consol lovegrass has not been widely evaluated in WA, however the widespread distribution of the naturalised type indicates that it could be grown over much of the NAR.

South coast

On the south coast, kikuyu is widely sown, while panic grass, setaria and Rhodes grass are also well adapted and have the potential to complement kikuyu.

Trial results on the south coast demonstrate the bunch grasses (panic grass, setaria) and Rhodes grass are more productive than kikuyu if there is significant summer rainfall (Figure 2).



Panic grass on the south coast at Wellstead (about 100 km east of Albany) following good summer rain



Kikuyu is widely sown on the south coast

These grasses are drought tolerant but do require some form of rotational grazing to persist in the medium term. They have not been widely sown. On waterlogged sites, setaria is an option worth evaluating, while on well-drained sandy soils consider evaluating a mix of panic grass and Rhodes grass.

Kikuyu is a creeping sub-tropical grass that forms a dense turf with above-ground runners (stolons) and below-ground runners (rhizomes). It is tolerant of continuous, heavy grazing and is very persistent but needs to be well managed to maintain feed quality. Kikuyu can be highly productive, especially when grown with a companion annual legume, and is excellent for stabilising soil and erosion control.

Kikuyu is a productive pasture option on sandy soils, including the deep pale sands on the south coast. This success can be attributed to a deep root system that confers drought tolerance and the rhizomes, which give cold tolerance.

‘Whittet’ (public variety) is the main variety sown in WA. It persists well under low fertility conditions and is free seeding.

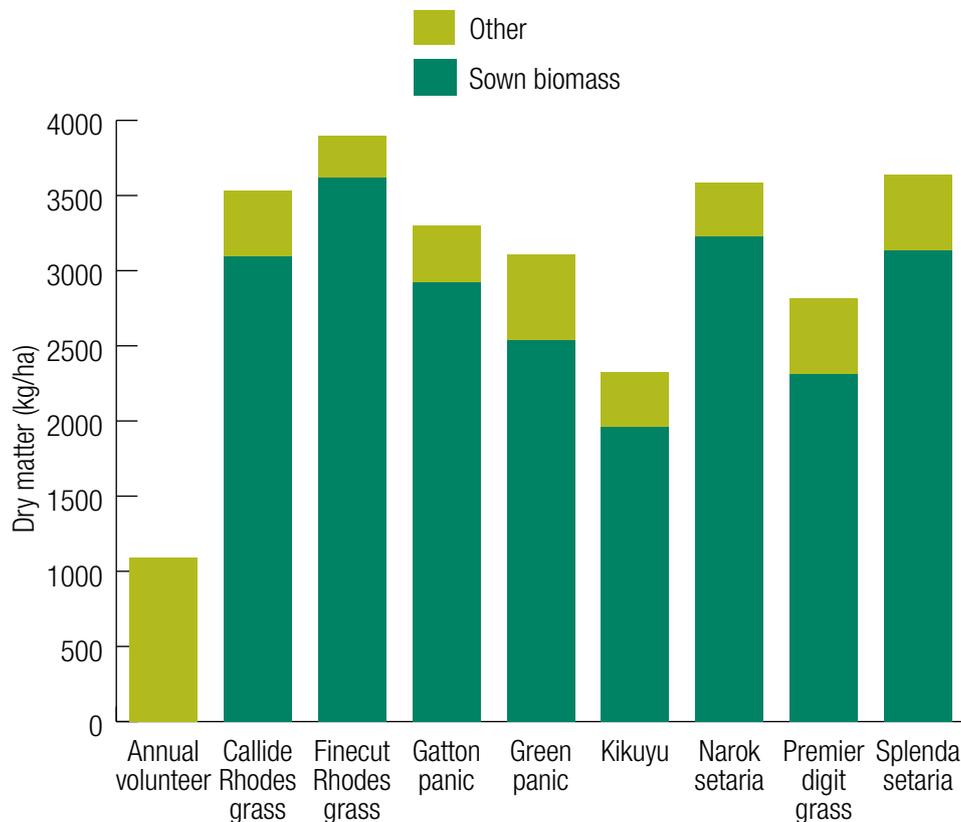


Figure 2 Average summer biomass (sown perennial species, other annual pastures) for the main sub-tropical grasses and annual volunteer pasture control in the Quantity and Quality trial at Esperance Downs Research Station from 2006–08

3. Seed quality

The quality of sub-tropical grass seedlots can vary widely in terms of germination, purity and dormancy. Poor seed quality can be a major limitation to successful establishment. With the absence of national standards for seed quality, purchasing seed can be a case of 'buyer beware'.

The germination of sub-tropical grass seedlots can vary from as low as 10% to more than 60%, but is rarely higher than 70%. This compares with annual pasture legumes and grasses where germination is usually above 80%. An exception is kikuyu, which normally has excellent germination (>80%).

Commercial seed batches often contain empty florets, immature seed, dormant seed and dead seed, in addition to germinable seed. Some seed merchants use the term pure live seed (PLS) when referring to seed quality (Appendix A).

Low seed quality is partially offset by the small size of most sub-tropical grass seeds. For example, one kilogram of uncoated panic grass seed contains about 1.2 million seeds. Therefore, sowing a seedlot of panic grass with 45% germination at 2 kg/ha equates to about 110 viable seeds per square metre. A strike rate of 10–20% achieves the establishment target of 10–20 seedlings per square metre in early spring.

The grasses can be sown alone or in mixtures (some seed merchants supply ready-made sub-tropical grass mixtures). Read the seed label on the bag carefully and understand the proportion of each species or variety in the mix (% weight) and their germination percentage. As a rule, low germination equates to poor quality seed, unless there is a high proportion of fresh (dormant) seed.

For species that have high levels of seed dormancy after harvest (especially panic grass), consider purchasing seed the year before sowing.

Postharvest seed dormancy

Seed of panic grass, setaria and signal grass display a period of postharvest dormancy (also referred to as 'after ripening dormancy'). In this state, seeds are viable but are not able to germinate. On seed labels and certificates, the term 'fresh seed' equals dormant seed.

High levels of seed dormancy at sowing present a problem for two reasons. First, establishment is likely to be much lower than expected given the seeding rate. Second, seeds that later come out of dormancy and germinate long after the optimum sowing window are less likely to establish successfully.

After a period of storage, germination improves as the seeds undergo biochemical and physiological changes. As the loss of dormancy continues, the range of environmental conditions over which the seed will germinate gradually increases.

The time required to reach acceptable germination levels varies between species. In addition, the rate of dormancy loss has been linked to temperature and moisture conditions during storage.

In general, setaria seeds require 4–5 months of storage after harvest to reach acceptable levels of germination, while 'green' and 'Gatton' panic require 8–10 months to achieve maximum germination. Signal grass also has a long period of after-ripening dormancy and may take 9–12 months to reach maximum germination. Rhodes grass, digit grass and kikuyu exhibit little or no seed dormancy.

Seed dormancy is a particular issue for sub-tropical grass seed coming into WA from northern Queensland, where most seed in Australia is produced. The time from harvest (January–April) to the recommended sowing time in WA of August–September may be insufficient for the seed to reach acceptable levels of germination. This differs from the situation in sub-tropical areas of eastern Australia, where sowing does not generally occur until November–February, by which time postharvest seed dormancy has largely broken down.

Guide for purchasing panic grass seed

- Find out the germination percentage.
- If the germination is good, buy and sow the seed this year.
- If the germination is low, either do not purchase the seed or if the seedlot contains a high proportion of dormant (fresh) seed, then consider purchasing and storing in a dry place for sowing the following year (see Appendix A, Figure A1).

If in doubt about the quality of a seedlot, obtain a current germination test result through an accredited seed testing laboratory, such as AGWEST Plant Laboratories. A home germination test can provide an approximate idea of the germination.

Storage conditions can affect seed quality. It is important to re-test the germination if the seed analysis statement is more than 12 months old.

Home germination test



A home germination test* can give an approximate germination of your seedlot. To conduct a simple test, all you need is a plastic container with a lid (e.g. a takeaway food container) and some paper towel. The test should be done 2–4 weeks before the intended sowing date.

- Place a few layers of paper towel in the bottom of the container, wet them with water and pour off any excess (free) surface water.
- Sprinkle ~100–200 seeds evenly across the surface.
- Close the lid tightly to minimise moisture loss.
- Place the container in a warm location (>20°C).
- Check regularly to ensure the paper towel is moist and carefully remoisten as required. (It is very important the paper towel does not dry out. Providing the lid fits tightly, moisture loss will be limited.)
- After about 10–14 days, count the germinating seedlings.

Germination can be assessed as poor (<10%), fair (15–30%) or good (>35%), where:
Germination % = (no. germinated seeds)/(total no. seeds) x 100.

If you are assessing a seed mix, identify the seeds of each species from photos. This will allow you to determine the germination of each species in the mix.

* To obtain a precise germination, submit a sample for testing through an accredited seed testing laboratory, such as AGWEST Plant Laboratories.



Seed of the main sub-tropical grass species grown in WA in comparison with wheat and subterranean clover seed (actual size)

Coated seed and mixes

Sub-tropical grass seeds are often sold with brightly coloured coatings, which consist of polymers that pelletise the seed and bind together a range of chemicals, such as fungicides, insecticides, nutrients, seed primers and lime.

Coated seeds have several advantages over naked seeds. They are easier to handle and flow more easily through seeding machinery; this is particularly the case with fluffy-seeded species, such as Rhodes grass and digit grass. By comparison, uncoated seeds of these species need to be mixed with a carrier, such as fertiliser, to enable the seed to flow through machinery. The bright colour of the seed coating also enables easy checking of seed placement.

The main disadvantage of seed coatings is that they markedly increase seed size, which means a large reduction in the number of seeds per kilogram. Data from a New South Wales study found coated seeds of Bambatsi panic grass and Premier digit grass were 4–5 times heavier than uncoated seeds, while coated seeds of Katambora Rhodes grass were up to 12 times heavier (G Lodge, unpublished data). In these examples, there was only 1 kg of actual seed in every 4–5 kg of the Bambatsi or Premier seedlot and only 1 kg of actual seed in every 12 kg of the Katambora Rhodes grass seedlot. Furthermore, coated seedlots can hide the presence of other seeds, empty florets, straw and other debris in the sample.

For coated seed, sow at the higher recommended rates to compensate for the lower number of viable seeds per kilogram.

Some commercial seed coats contain priming agents, which are chemicals (e.g. ethylene, kinetin, gibberellic acid) aimed at reducing seed dormancy. However, independent testing by Dr C Loo from Kings Park and Botanic Garden has demonstrated that while these priming agents can sometimes be effective at overcoming dormancy in the laboratory or glasshouse, their effect is not reliable under field conditions. While seed coatings often contain fungicides, insecticides and nutrients, their effectiveness at delivering these benefits to establishing seedlings has not been independently tested.

Seed storage and its effect on germination

Panic grass seed has postharvest seed dormancy. The most effective method to break this dormancy is time, whereby seed is stored until the dormancy breaks down naturally.

Wholesale seed merchants may be unwilling to store panic grass seed for more than 12 months after harvest without substantially increasing the price of seed to cover additional storage costs. One option for producers who want to sow panic grass seed with maximum levels of germination is to purchase seed 12 months in advance of planned sowing.

This raises the question: what storage conditions are best to maintain the viability of both panic grass and Rhodes grass seed? An experiment was conducted by B Wintle (DAFWA) using seed of green panic and Katambora Rhodes grass stored under different conditions. Seed was harvested from Medina Research Station in early March 2007 and graded to ~100% viability using a gravity-fed aspirator and then confirmed with an X-ray machine. The seed was then stored for 12 months under three different sets of conditions:

- (i) in a temperature-controlled seed storage facility with a relatively constant temperature of 18°C (range 14–26°C)
- (ii) in a laboratory at room temperature (average 22°C and range 14–32°C)
- (iii) in a garden shed (average 18°C and range 6–38°C).

Seed was germinated every two months under optimal conditions (alternating day/night temperatures of 26/13°C) and the results are shown in Figure 3.

Germination of green panic immediately after harvest was ~13%, in contrast to almost 100% for Katambora Rhodes grass. Germination of green panic increased over time under each storage condition, with maximum germination reached by November for seed stored in the shed and at room temperature, and by January for seed stored in the temperature-controlled facility. Germination of both species stored in the shed declined somewhat after November, suggesting that high summer temperatures reduce viability. However, germination for Rhodes grass was still greater than 80% after 12 months.

Note that seed stored for more than 12 months may decline in quality, and germination should be re-tested before sowing. Therefore, it is very important not to store seed for too long, because once dormancy is over, seed quality deteriorates over time.

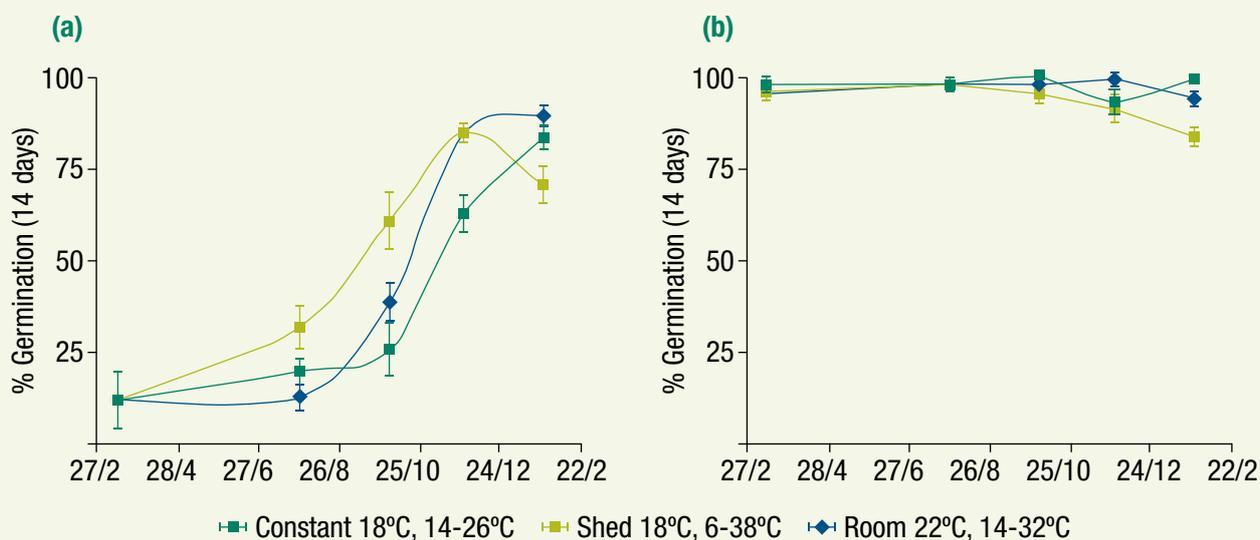


Figure 3 The effect of storage on germination for: (a) green panic, showing loss of dormancy over time; and (b) Katambora Rhodes grass, which does not have postharvest seed dormancy. Seeds were stored in: (i) a controlled temperature storage facility; (ii) a laboratory at room temperature; and (iii) in a shed. The average temperature and temperature range are shown for each storage situation.

4. Presowing weed control

Fully control weeds and apply a broad-spectrum insecticide before sowing. It is essential to sow sub-tropical perennial grasses into a weed-free seedbed, as the seedlings are weak competitors with both established winter-growing pasture plants and newly germinated summer-growing weeds.

There are several ways of achieving a weed-free seedbed, each of which needs to be balanced against the potential erosion risk, particularly immediately after seeding when the paddock can be susceptible to wind erosion. The aim should be to minimise this risk, especially on exposed sites with loose sandy soils. Depending on seasonal conditions and soil type, there is a trade-off between the method and timing of weed control and the amount of decaying root biomass remaining to bind the soil after seeding.

For erosion-prone sites, develop a weed control strategy that ensures complete weed control at seeding but leaves some above-ground plant material and decaying root mass to help bind the soil and prevent erosion. Alternatively, sow a cereal crop in year 1 and then sow the sub-tropical grasses into the standing stubble in year 2.

Weed control strategies

The ideal paddock preparation is to assess the paddock a year ahead of sowing and, if necessary, reduce the weed seedset for problem weeds that can be difficult to control by grazing and spraytopping. On the other hand, annual grasses—such as brome grass—that are readily controlled should be retained. In the sowing year, the broadleaf weeds can then be sprayed early while the annual grasses can be killed just prior to seeding to retain some groundcover at seeding.

Six to eight weeks before the intended sowing date, assess the paddock for pasture composition. Identify weeds that will be difficult to kill with a single knockdown herbicide, such as silver grass, erodium, subterranean clover, capeweed, wild radish, doublegee and Paterson's curse.

The three general weed control strategies detailed in Table 2 are:

- (i) single knockdown herbicide around two weeks before sowing
- (ii) broadleaf selective spray around six weeks before sowing, followed by a knockdown herbicide two weeks before sowing; or a
- (iii) double knockdown strategy with applications of knockdown herbicide at around six weeks and two weeks before sowing.

In each case, excess biomass should be removed by grazing pre – and/or post-spraying. A broad-spectrum insecticide should be added with the final knockdown to ensure insects are controlled before sowing.

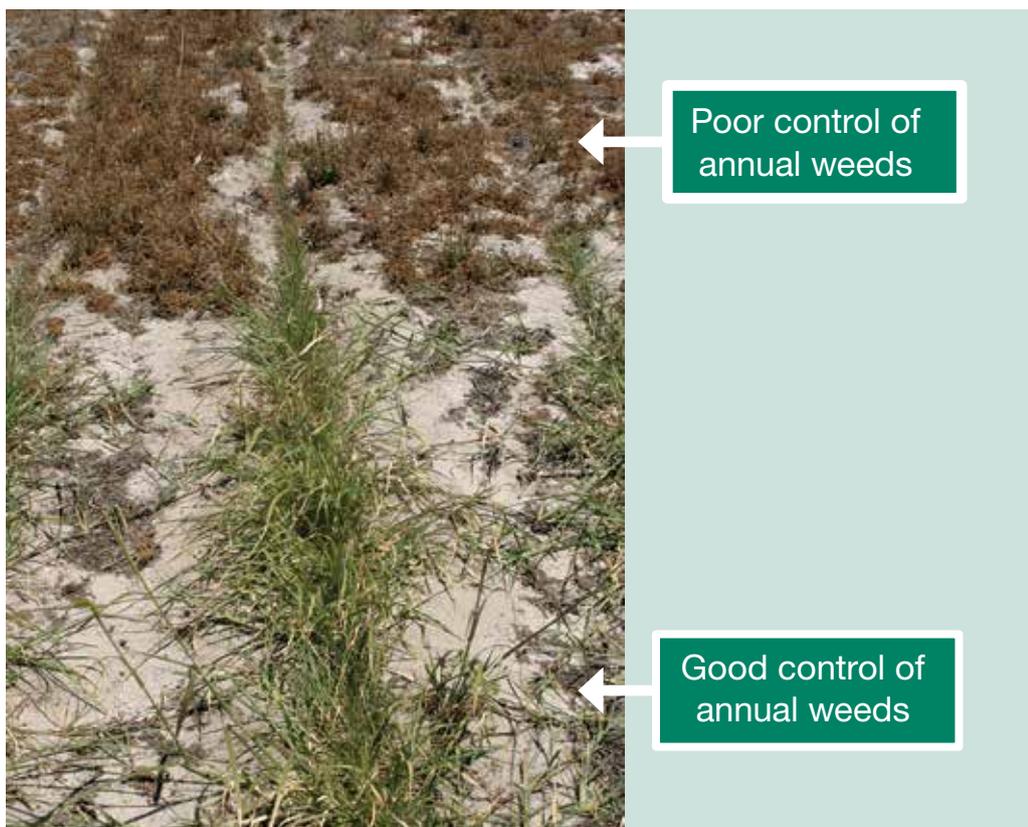
Existing pasture must be killed before sowing perennial grasses. Annual pasture plants are much larger in late winter than earlier in the growing season, so they require higher rates of knockdown herbicide (with appropriate additives) to achieve complete weed control. In general, glyphosate is more effective at controlling large weeds than Spray.Seed®.

Producers commonly add selective broadleaf herbicides to the knockdown along with adjuvants to improve the spray efficacy, especially for difficult-to-control weeds (refer to case studies).

Applying an early knockdown herbicide (about six weeks before sowing) means the effectiveness of the spray can be assessed and there is the option of applying a second spray to any areas with incomplete weed control. Applying the knockdown herbicide early also can result in a small amount of additional stored soil moisture.



Wind erosion – the result of sowing into a bare paddock with minimal above-ground plant material and decomposing root matter to hold the soil together



An illustration of the importance of complete weed control for successful establishment and strong early growth of sub-tropical grasses. The plot in the foreground had a double knockdown with glyphosate @ 2 L/ha, six weeks and again two weeks before sowing, which achieved excellent weed control. The rear plot had a single knockdown one week before sowing (glyphosate @ 2 L/ha), and the established annual pasture plants recovered from the spray and competed with the perennial grass seedlings that subsequently died over summer. Photo taken at Geraldton in early December after sowing on 25 August.

Table 2 Weed-control strategies for establishing sub-tropical perennial grasses

Strategy	When to use ¹	Description of strategy	Advantages	Disadvantages
(i) Single knockdown	Low density of difficult-to-control weeds when assessed 6 weeks before sowing	<p>Graze to reduce excess biomass</p> <p>Use a single knockdown herbicide (glyphosate + additives) at least 2 weeks before seeding²</p>	<p>Decaying annual pasture roots help bind the soil together during establishment</p> <p>More time to assess seasonal conditions and defer seeding if seasonal conditions are unfavourable</p> <p>Additional winter grazing compared with other strategies</p> <p>Lower cost than other strategies</p>	<p>Full weed control may not be achieved, resulting in increased competition for establishing grasses</p> <p>More difficult than double-knockdown strategy for precise seed placement, as soils tend to be more cloddy</p> <p>Slightly less stored soil moisture for establishing seedlings</p>
(ii) Broadleaf selective spray followed by a knockdown	Moderate density of difficult-to-control weeds when assessed 6 weeks before sowing	<p>Use a broadleaf selective spray or the spray-graze³ technique to target difficult-to-kill broadleaf weeds at least 6 weeks before seeding</p> <p>Quickly graze to reduce excess biomass, and then spell to allow annual grasses to recover and provide groundcover</p> <p>Apply a knockdown herbicide (glyphosate) over the paddock at least 2 weeks before seeding²</p>	<p>Decaying annual grass roots help bind the soil together during establishment</p> <p>Seeding can be deferred after selective spray, if seasonal conditions are unfavourable for sowing, while still maintaining grass cover</p> <p>Additional winter grazing compared with double-knockdown strategy</p>	<p>Cost of additional herbicide application, compared with single knockdown</p> <p>More difficult than double-knockdown strategy for precise seed placement, as soils tend to be more cloddy</p> <p>Slightly less stored soil moisture due to additional annual pasture growth than with the double-knockdown strategy</p>
(iii) Double knockdown	Many weeds which are difficult to control when assessed 6 weeks before sowing and paddock less susceptible to wind erosion	<p>Graze to reduce excess biomass</p> <p>Apply first knockdown herbicide ~6 weeks before seeding (glyphosate)</p> <p>If further weed control is needed, apply a second knockdown (glyphosate) 1 week before seeding²</p>	<p>Excellent weed control normally achieved</p> <p>Lack of decaying root biomass reduces cloddiness, making precise seed placement easier</p> <p>More stored soil moisture for establishing seedlings from extended weed kill</p>	<p>Increased erosion risk due to less decaying root biomass binding soils together</p> <p>Reduced winter grazing with early knockdown</p> <p>Cost of additional herbicide application, compared with single-knockdown strategy</p> <p>More difficult to defer seeding to the following year if seasonal conditions are unfavourable</p>

¹ Assess paddock six weeks before planned sowing date.

² Apply knockdown herbicide at least two weeks before seeding to ensure plants are dead. A broad-spectrum insecticide should be added with the final knockdown to ensure insects are controlled before sowing.

³ Spray-grazing, using phenoxy-based herbicides, followed by intense grazing is effective at controlling broadleaf weeds such as erodium, capeweed, Paterson's curse and wild radish, as the herbicide increases the palatability to stock and causes flat weeds to curl up, making them more accessible.

Effect of different weed-control strategies

To test the effect of different herbicide strategies on establishment, an experiment was conducted on a deep, non-wetting sand at Gillingarra, 135 km north of Perth. Three treatments were compared:

- a single knockdown sprayed on 15 August (glyphosate* @ 1L/ha)
- a double knockdown sprayed on 22 July (glyphosate* @ 2L/ha) and 15 August (glyphosate @ 1L/ha)
- 2,4-D Ester @ 700 mL/ha for broadleaf control on 22 July, followed by glyphosate* @ 1L/ha on 15 August.

Note: *glyphosate was 450 g/L a.i., while the 2,4-D Ester was 800 g/L a.i.

The Evergreen Northern Mix (60% Gatton panic grass, 20% Katambora Rhodes grass, 20% signal grass) was sown @ 4 kg/ha on 27 August in a replicated trial (plots 150 m x 40 m). Seedling counts and sand infill were measured 47 days after sowing (Table 3).

The double-knockdown herbicide treatment had the highest seedling establishment. Examination of the seedbed showed it was less cloddy than the other treatments, which presumably resulted in more accurate seed placement. However, the broadleaf selective followed by knockdown treatment still gave a very good establishment density, significantly higher than the single-knockdown treatment (a higher rate of glyphosate may have improved weed control).

Sand infill into furrows was highest with the double knockdown treatment but similar for the other two treatments. Had severe wind events occurred in the four weeks after sowing, the establishment in the double-knockdown treatment may have been adversely affected.

The results suggest a broadleaf-selective herbicide, followed by a knockdown herbicide, is a good compromise between the requirement for a weed-free seedbed and reduced erosion potential.

Table 3 Establishment density 47 days after sowing of perennial grasses (Evergreen mix) and sand infill into furrows following three different herbicide treatments on a loose sandy soil at Gillingarra, WA (different letters denote treatments are significantly different $P = 0.05$).

	Herbicide treatment		
	1 knockdown	2 knockdowns	Broadleaf selective then knockdown
Plant density (plants/m ²)	13.6a	27.2b	21.0c
Sand infill (mm)	6.4a	12.0b	8.8a

Can cereals be used to reduce the erosion risk during establishment?

One option for reducing the risk of wind erosion is to sow a companion cereal to act as a windbreak, either in a mixture with the sub-tropical perennial grasses or in separate rows.

To test the effect of sowing separate cereal rows, a trial was sown on a sandy soil at Geraldton on 25 August 2009. The Evergreen Northern mix was sown @ 4 kg/ha. Oats or sorghum were sown every sixth row or ninth row in place of perennial grasses.

The conclusion was that the cereal barriers were too small to be effective in minimising wind erosion during the critical first six weeks while the perennial grass seedlings were establishing. In late spring – early summer, the oats and sorghum provided an effective barrier but by this time the perennial grasses were established and the risk of erosion was low (see photo).

Other work has shown that sowing oats in a mixture with the perennial grasses directly limits the perennial grass establishment, due to competition for moisture. Producers have reached similar conclusions using cereal rye.

Two practical solutions for reducing the potential for wind erosion in susceptible paddocks are:

- sowing a cereal crop the year before sowing sub-tropical grasses—and then sowing the perennial grasses into the standing stubble, which acts to protect the soil surface from erosive winds
- using a weed-control strategy that leaves some above ground biomass and decaying root residues during establishment.

Sowing a cereal crop in the same year as the perennial grasses is likely to have limited effectiveness, as when the cereal is sprayed out the lignin content will be low.



Companion cereal trial near Geraldton, showing the Evergreen sub-tropical grass mix with sorghum (foreground) and oats (background) sown every sixth or ninth row. The usefulness of sorghum and oats in reducing the erosion risk during the critical establishment phase was limited by their slow early growth. Photo taken 2 December 2009 after sowing on 25 August

5. Sowing time

In general, sow as early as possible to maximise the opportunity for follow-up rain. The sowing window varies from late winter to early spring depending on the district. If stored soil moisture is low then consider deferring sowing until the following year—see box below.

If stored soil moisture is limiting, consider deferring sowing until the following year.

Two key factors to reduce risk of establishment failure are:

- (i) sow into a full profile of stored soil moisture. If there is limited stored soil moisture due to a dry winter then consider deferring sowing until the following year.
- (ii) sowing into moisture. If soil moisture in the topsoil is not favourable for germination (even with furrow sowing) and there is little prospect of imminent rain, consider deferring sowing until the following year.

The risks include failed establishment leaving an exposed paddock that is highly susceptible to wind erosion. If sowing into dry topsoil, there is the risk of sand infill into furrows adversely affecting establishment even if seasonal conditions are favourable from mid-spring onwards.

Factors to consider include: seasonal outlook over the next 2–4 weeks and the risk of wind erosion and sand infill, which varies with soil type. On sandy soils, the erosion risk is reduced if sowing into standing stubble.

Sub-tropical grass seed requires a combination of soil temperature (~15°C) and follow-up rain to germinate. As a guide, the grasses will germinate when the soil temperature at 9 am is above 15°C for several consecutive days. The temperature requirements for germination vary subtly, with signal grass, siratro (tropical legume) and digit grass preferring slightly higher temperatures.

Sub-tropical grass seed may germinate at suboptimal soil temperatures; however, the result can be partial germination or germination over an extended period. In addition, seedling growth can be poor and when the temperature increases, stressed seedlings take time to recover from the ‘cold shock’.

Soil temperature is also influenced by site effects; for example, the colour of the surface soil, with dark soils absorbing more heat. In addition, wet soils take much longer to warm up (i.e. up to six weeks longer to reach the critical temperature for sowing) because of water evaporating from the surface.

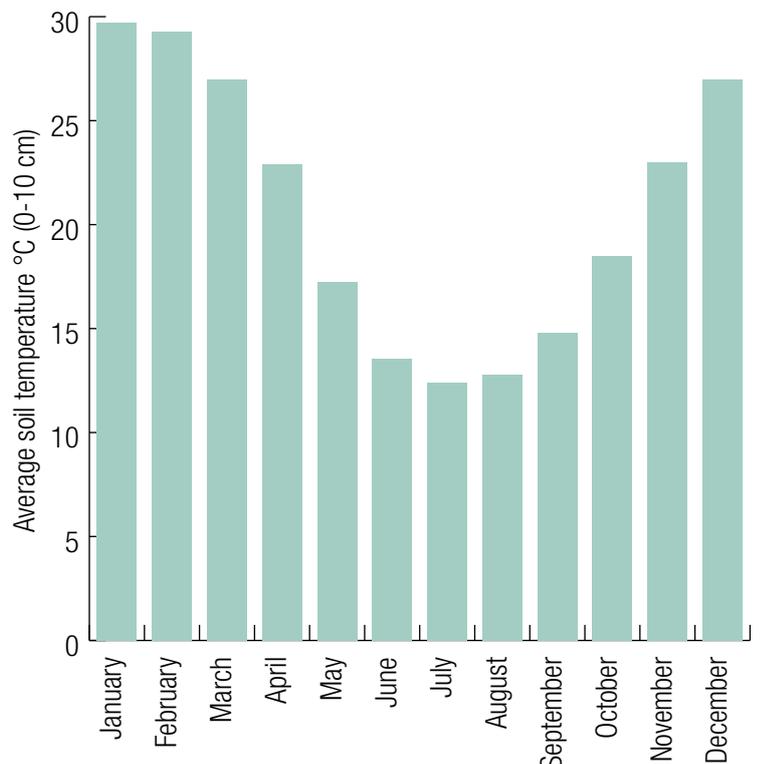


Figure 4 Long-term average soil temperatures (0–10 cm) at Badgingarra

Summer sowing: Sowing in summer – early autumn is theoretically possible as soil temperatures are non-limiting, but heavy summer rainfall is infrequent and is often followed by a return to very high temperatures, so the topsoil can rapidly dry out.

Autumn sowing: Even though soil temperatures in autumn can be adequate, the subsequent cool temperatures and competition from annual volunteer pasture makes autumn sowing risky. However, there are examples of where spring-sown grasses that failed to germinate due to dry seasonal conditions have subsequently germinated following rain in March–April and some plants have persisted over winter.

Spring sowing: This is by far the best option in WA and has proved reliable in all years except when there is limited stored soil moisture in late winter – early spring.

The key to successful establishment is to strike a balance between rising soil temperatures in late winter and early spring versus the likelihood of follow-up rainfall after seeding (Figure 4). As a result, the ideal sowing time is a compromise between sowing early enough to enable sufficient root development before the onset of the summer drought and late enough so that low soil temperatures do not limit germination and seedling growth.

This leads to a sowing window for each location, which is the range of sowing dates that maximises the chance of successful establishment. The sowing window is earlier for warmer and lower rainfall areas than for cooler, higher rainfall areas (Figure 5).

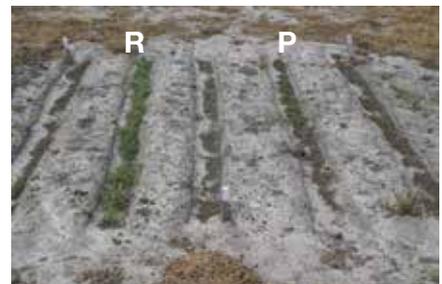
Sown 25/07/07



Sown 15/08/07



Sown 12/09/07



Establishment of Rhodes grass (R) and panic grass (P) showing annual weed residues from sowing on 25 July, 15 August and 12 September in 2007 at Gillingarra, Western Australia. Photo: 1 November.

As a guide, sowing windows for the main regions in WA suited to sub-tropical grasses are:

- Dongara–Kalbarri districts: early to late August
- Perth–Eneabba districts: mid-August to early September
- South coast: early September to early October.

All areas have adequate soil temperatures some time between early August and early October for the germination of sub-tropical grasses. However, in low rainfall districts, the likelihood of adequate rain after seeding decreases, so there is a higher risk of poor or failed establishment.

Sub-tropical grasses must be sown into moist soil or where there is a very high probability of rain in the next few days after sowing. They can establish successfully with post-seeding rainfall from September to November of only 25–50 mm, provided there is good stored moisture in the soil profile for the seedlings to access, allowing the plants to establish before the onset of the summer drought.

If soil moisture conditions are not favourable for germination and there is little prospect of imminent rain during these sowing windows, sowing should be deferred until the following year.



Figure 5 Sowing window for sub-tropical grasses in Western Australia

6. Machinery set-up

Excellent establishment of sub-tropical grasses has been achieved with a range of seeding machinery and configurations (tynes, discs) providing the key principles are followed: sow seed into large furrows, with following press wheels for good seed-to-soil contact with wide row spacing.

Sub-tropical grasses in WA are often sown on infertile, sandy soils that have non-wetting surface soil and a low water-holding capacity. For successful establishment, the non-wetting surface soil needs to be scalped away and seeds need to be placed so that developing seedlings can make use of any soil moisture.

Successful establishment of sub-tropical grasses can be achieved with a range of seeding machinery and configurations (tynes, discs) provided that the machine:

- forms stable furrows that scalp away non-wetting sand, remove weed seeds and harvest rainfall
- uses press wheels to provide good seed contact with moist soil
- is set for wide row spacing (typically 50–60 cm).

For example, many producers are using converted culti-trash combines with widely spaced discs and press wheels to sow sub-tropical grasses (see case studies). Triple disc drills, conventional combines and airseeders that are widely used for sowing crops may need some modifications to give reliable establishment.

In years with favourable rainfall in spring to early summer (maybe one in five years), good establishment of sub-tropical grasses can be achieved using conventional seeding equipment used for annual crops (e.g. airseeders). However, when the post-seeding rainfall is marginal (maybe three out of every five years), then using conventional seeding equipment will

almost certainly result in patchy or even failed establishment. In contrast, using a seeder set up for sowing perennial grasses (i.e. furrow sowing, press wheels and wide row spacing) can result in good establishment in all years, except when there is limited stored soil moisture at seeding (maybe one in five years).

Furrow sowing

On sandy soils, furrow sowing is important to scalp away the non-wetting sand; to remove weed seeds from near the perennial grass seedlings; and to harvest rainfall. Furrows harvest rainfall and increase seedling survival, particularly in years with dry conditions in spring. They act to turn relatively small rainfall events into useful soil moisture for growth and survival. For example, 3–5 mm of rain can effectively become 10–15 mm for seedlings in the bottom of a furrow.

Furrow depth can be varied according to seasonal conditions. The key is to sow into moist soil. Furrows of 50 mm depth are sufficient



A combine modified for sowing sub-tropical grasses with furrow sowing, press wheels and a row spacing of 50-60 cm



A furrow illustrating sowing into moisture in non-wetting sands

if the soil surface is moist, while deeper furrows can be used if the soil surface is dry or highly non-wetting.

Furrow shape should be designed to minimise furrow collapse and sand infill, as this buries seed at depth, which can markedly reduce seedling emergence. Wide furrows with sides that are not too steep are less prone to collapse and sand infill.

Seeding without furrows is risky, as it relies on favorable spring–summer rainfall, and is more likely to result in poor or patchy establishment, particularly in years with low spring and summer rainfall.

A number of producers have converted old culti-trash combines to form furrows (50–100 mm deep) that remove the non-wetting sand, enabling the perennial grasses to be sown into moisture in the bottom of the furrow (see case studies). The discs tend to peel the soil back, invert it and drop it in the inter-row, creating a well-defined furrow.

To form large furrows, some producers have developed modified tynes to get the required soil movement and furrow formation, but this can result in a large amount of loose soil on the soil surface, which increases the risk of furrow infill and also leaves the paddock more prone to wind erosion. This is less of an issue with smaller furrows. Another option with tynes is to use a depth wheel, which gives precise seeding depth control and compacts the side of the furrow.

Observations to date suggest that furrow sowing is more effective on non-wetting soils than using a no-till seeder with banded surfactant (wetting agent).

Press wheels

Press wheels provide good seed-to-soil contact and result in more reliable germination. The action should press soil around the seed in the furrow bottoms and minimise sand infill from the furrow sides. Many producers simply drop the seed into the bottom of the furrow and use press wheels to push the seed below the soil surface. This system positions the seed well for germination but strong press-wheel action is essential to give good seed–soil contact.

In practice, there is usually some sand infill, so a sowing depth of 2–5 mm often becomes 7–10 mm or more.

The contour of the press wheels should fit within the furrow shape to minimise sand infill. The base of the furrow should be wider than the press wheels. Rounded or flat-bottomed wheels tend to produce a better result than angular, narrow wheels, while W-shaped press wheels are the least effective. It is also important to ensure that press wheels are correctly aligned



Press wheels are important to get good seed-to-soil contact



Conventional seeders with minimal furrow formation and W-shaped press wheels are less effective

and that the arms allow consistent tracking along the furrows.

Row spacing

Producer experience has shown a row spacing of 50–60 cm is generally ideal with furrow sowing. This ensures a sufficiently wide inter-row so that any soil movement during sowing from one furrow does not cause sand infill into adjacent furrows. It means some groundcover is retained on the paddock after seeding to reduce the risk of wind erosion. It also provides space for annual pastures to grow between the rows of perennial grasses in the cooler months, thereby providing a good balance between perennial and annual pasture components.

Wider row spacing can be used in low rainfall areas to reduce competition for soil moisture. Row spacing also can be adjusted to change the



Sowing panic grass and Rhodes in a mix (left) or in alternate rows (right)

balance between winter–spring feed from annual pastures in the inter-row versus potential out-of-season production from the perennial grasses. For example, the out-of-season production from smaller rainfall events (e.g. 20–30 mm) will be higher with the perennial grasses at wider row spacing (>50 cm).

Sowing different grasses in alternate rows

In mixtures of sub-tropical grass species, pasture composition can be dominated by the species with higher seedling vigour. For example, Rhodes grass has the highest seedling vigour of the commonly grown sub-tropical grasses and often out-competes other species when they are sown together, adversely affecting their establishment.

To overcome competition, some producers sow mixtures of Rhodes and panic grasses in alternate rows to ensure the pasture composition reflects the seed mix. Simple dividers can be used in the seedbox to allow species to be sown in alternate rows (see photo).

In trials, sowing in alternate rows resulted in improved establishment of panic grass. However, having panic and Rhodes grass in alternate rows may exacerbate preferential grazing of the more palatable panic grasses if the Rhodes grass is slightly rank.



To sow different species in alternate rows, use dividers in the seedbox

7. Sowing rate and depth

Sow 2–5 kg/ha of seed – depending on seed quality. Adjust the sowing rate for coated seed which has a reduced number of seeds per kg. As a guide, sowing 2 kg/ha of uncoated seed with 40% germination is sufficient to give a good seedling density. Sub-tropical grasses require precise, shallow seeding at a depth of 5–10 mm.

Sowing rate

Sub-tropical grass seed is not cheap, so it is important to carefully calibrate the seeder to ensure the correct amount of seed is being sown.

Sow 2–5 kg/ha of seed, depending on seed quality and whether the seed is coated. As a guide, for uncoated seed with 40% germination, 2 kg/ha is sufficient to give a good seedling density (assuming all the other steps are followed, such as weed control, machinery set-up, insect control, etc.) and the site receives sufficient rainfall. Higher rates should be used for seed of lower germination. Higher rates are also required for coated seeds to sow the same number of seeds per area. Indicative sowing rates are provided in Table 4.

Kikuyu seed normally has high seed quality (>80% germination) and sowing at 1 kg/ha is usually adequate. However, full groundcover will be achieved more rapidly by sowing at 2 kg/ha.

With light, fluffy seeds such as Rhodes grass, use a carrier if the seed is not coated to ensure uniform flow through the seeder and to prevent bridging (blockages). Use fertiliser (e.g. 20–25 kg of plain superphosphate fertiliser per kg of seed) mixed with the seed for better flow through the machinery. Uncoated panic grass does not require a carrier; however, some seeders (such as combines) are not set up for sowing low rates of small seeds, so the seed needs to be bulked by adding fertiliser. It is important to calibrate the seeder for the fertiliser–seed mix, as it will flow more slowly than straight fertiliser.



Seed and fertiliser mix



Table 4 Indicative sowing rates for row spacing of 50–60 cm

Germination (%)	Uncoated seed (kg/ha)	Coated seed ¹ (kg/ha)
10	8	16
20	4	8
30	2.7	5.5
40	2	4
60	1.5	2.7

¹ Assumes the seed coating reduces the number of seeds by 50%. Adjust the sowing rate according to the ratio of actual seed per kg of coated seed.

Sowing depth

Sub-tropical grass seed requires precise, shallow seeding at a depth of 5–10 mm. Seeds sown too deep will not emerge, because sub-tropical grass seeds are small and very sensitive to seeding depth. To illustrate this point, there are ~3.3 million seeds/kg for uncoated Rhodes grass and ~1.2 million seeds/kg for uncoated panic grass, compared with ~150 000 seeds/kg for subterranean clover. Their small size means most sub-tropical grass seeds have insufficient energy reserves to emerge from depths much greater than 10 mm.



Author Ron Yates checking the seeding depth



Sand infill measured on Sept. 5 after seeding on Aug. 16 has increased the 'effective seeding depth'

Good seeding depth control can be achieved using a precision seeder designed for small seeds. However, for producers without precision seeding equipment, an alternative is to drop the seeds in the bottom of a furrow and press them into the soil using press wheels to ensure good seed–soil contact. Producers have used this method widely and effectively (see case studies). This method ensures the seed is placed at a shallow depth (2–5 mm) and, even if there is a small amount of sand infill, most of the seeds will be able to germinate. Sowing directly onto the surface with no soil cover is unreliable.

Seeding depth should be checked to ensure that the majority of seeds are being placed 5–10 mm below the surface in the bottom of furrows. The seeding depth should be checked after running the seeder at normal operating speed. When correctly adjusted, a small proportion of seeds are usually visible on the soil surface. The bright colour of coated seeds makes checking seeding depth relatively easy.

Care must be taken to minimise furrow collapse and sand infill into furrows, which can bury seeds beyond their ideal sowing depth and reduce their chances of emerging. In the first 2–3 weeks after sowing, sand infill in the furrow can often increase the 'effective seeding depth' (sowing depth plus sand infill). Shallow sowing followed by a large amount of sand infill can result in poor emergence if the effective seeding depth becomes 20–30 mm.

Effect of sowing depth on emergence

Sub-tropical grasses have small seeds but just how critical is sowing depth to their chances of successful establishment?

DAFWA research officer Ron Yates conducted a field trial under irrigation on a sandy soil at South Perth to determine the optimum sowing depth for establishment of Gatton panic, Katambora Rhodes grass, signal grass, Whittet kikuyu and Splenda setaria. Two sowing dates were used (24 August and 28 September).

The highest establishment densities for all species occurred from a sowing depth of 5–10 mm, indicating this is the optimum depth for sowing (Figure 6).

Rhodes grass and panic grass are small-seeded species and are very sensitive to sowing depth. No Rhodes grass seedlings emerged and less than half of the panic grass seedlings emerged from 15 mm or deeper. The larger seed of signal grass meant it was able to emerge over the range of 5–40 mm. Kikuyu also had some emergence from 20–30 mm.

No seeds emerged from the surface-sown treatment. However, seeds in this treatment were placed on the soil surface without being pressed or rolled into the soil.

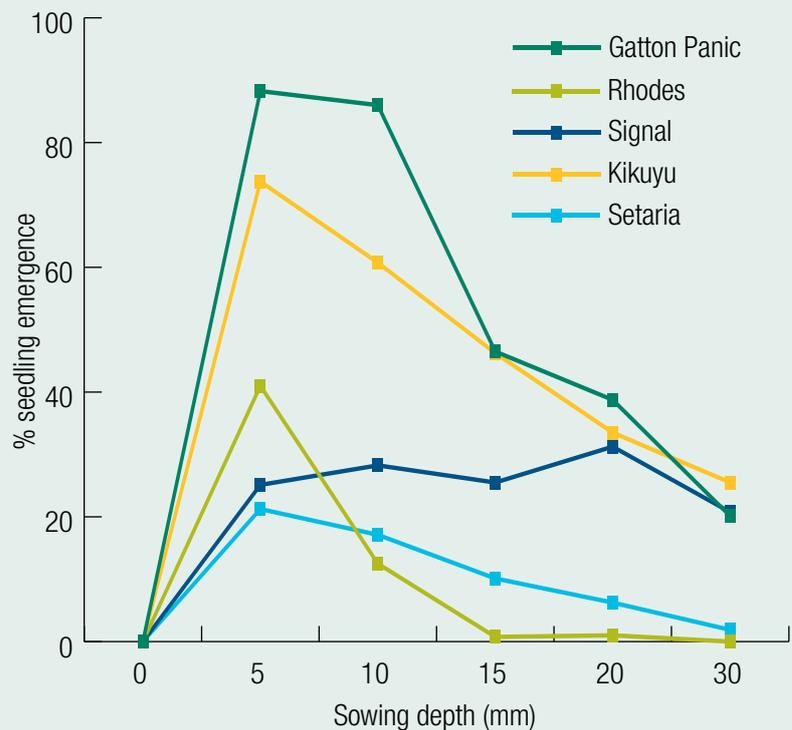


Figure 6 Seedling densities of five sub-tropical grasses at six sowing depths (surface sown, 5, 10, 15, 20, 25 and 30 mm) on a sandy soil at South Perth. Note: surface-sown seed was not pressed or rolled in.



Some producers install rubber mats to prevent soil from one furrow being thrown into adjacent furrows

8. Sowing speed

Tractor speed can impact on establishment success. Driving too fast can cause major soil movement and furrow in-fill. The optimum speed will depend on the type of machinery and good operators adjust the sowing speed according to the soil conditions and furrow formation.

Tractor speed can affect establishment success. Driving too fast can cause excessive soil movement, reducing the accuracy of seed placement. Sand infill increases and furrows can collapse, resulting in a deeper effective seeding depth and poor establishment. Optimum speed varies with the type of machinery but, from producer experience, speeds of 5–10 km/h generally give a good result.

The optimum sowing speed is often determined by furrow formation. With converted culti-trash machines, the scalped soil should land midway between each furrow. Sowing speed and sowing conditions affect the soil throw.

Firmer sands often require faster speeds, while in softer sands it is necessary to slow down. Be prepared to adjust the sowing speed according to the soil conditions.

Some machinery modifications can be made to enable sowing speed to be increased. For example, some producers have added rubber guards (mats) to prevent soil from one furrow being thrown into adjacent furrows.

To ensure the majority of seeds are being placed 5–10 mm below the surface, sow at normal operating speed, stop and check the results. Continue to check seed placement regularly and make adjustments if needed.

Speed kills ...

A field trial was conducted at Gillingarra, about 135 km north-east of Perth, to investigate the effect of different sowing times on sub-tropical perennial grass establishment.

A Massey Ferguson combine seeder with scarifier points, soil rider depth control and press wheels was set up to sow an Evergreen Northern mix at 5 kg/ha to a depth of 5–10 mm when driven at 5 km/h. In a replicated trial, plant establishment following sowing at this speed was compared with sowing at 10 km/h and 15 km/h.

The results clearly demonstrate the effect of sowing speed. The seeder was set up to sow at 5 km/h and establishment from this sowing speed was highest. When sowing speed was increased to 15 km/h, the establishment density was 25% of that at 5 km/h (Table 5).

Table 5 Establishment density of sub-tropical grass seedlings 42 days after sowing at three different speeds at Gillingarra (different letters denote treatments are significantly $P = 0.05$).

Sowing speed	Seedling density (plants/m ²)
5 km/h	42.9a
10 km/h	23.4b
15 km/h	10.8b

This shows:

- Seeding depth needs to be checked at the planned operating speed.
- Sowing speed needs to be reduced if too much soil movement is causing the seed to be sown too deep.

9. Post-seeding checks

Post-sowing – Monitor for weeds and pests including insects, kangaroos and rabbits. Regularly and carefully monitor the paddock for insect damage, especially during the first 8 to 10 weeks when the grass seedlings are emerging and vulnerable to insect attack. Control of summer growing weeds will depend on the groundcover and susceptibility to wind erosion.

The following post-seeding checks can help ensure successful establishment of perennial grasses.

Identify emerging grass seedlings

To determine whether emerging grasses are those that were sown, the different species can be identified at the seedling stage using the photographs and descriptions in DAFWA Bulletin 4775, 'Identifying sub-tropical grass seedlings'.

Insect control

There are a number of insects that can damage perennial grass seedlings. These include cutworm and webworm caterpillars, redlegged earth mite (RLEM), Rutherglen bugs, aphids and wingless grasshoppers. To control insects, apply a residual insecticide at sowing or with the last knockdown herbicide.

Regularly monitor the paddock (at least once a week) for insect damage, especially over the first 8–10 weeks when grass seedlings are emerging and are most vulnerable to insect attack.



Panic grass seedlings

Spray, if necessary. Look out for cutworms, RLEM and aphids soon after sowing; monitor for Rutherglen bugs and wingless grasshoppers later in spring.

Summer-growing weeds

Summer-growing weeds compete strongly with sub-tropical grass seedlings for soil moisture. Control of these weeds will optimise establishment of sown sub-tropical grasses. Broadleaf weeds such as Afghan and paddy melons, wireweed, radish and fleabane can be readily controlled with broadleaf herbicides, provided they are actively growing.

Special consideration needs to be given to erosion-prone soils when the perennial grass seedling density is low (<5 plants/m²). In these situations, summer weeds should be retained to reduce the erosion risk.

Couch grass is a highly competitive summer-active perennial grass that will out-compete the more desirable sown perennial grass seedlings during the establishment phase. Couch grass often recovers from the knockdown herbicide applied in winter and competes strongly with the perennial grass seedlings in late spring.

Ensure the couch grass is actively growing when it is sprayed and if paddocks have large areas of thick couch, they may require control over more than one year before establishing sub-tropical grasses. Alternatively, select a different paddock. Small areas of couch can be tolerated.



Effect of summer broadleaf control (left) compared with no broadleaf control (right)



Couch grass is very competitive with sub-tropical grass seedlings over the first summer

Kangaroos and rabbits

Kangaroos and rabbits can damage or kill young sub-tropical grass plants, so good control is essential. Unrestricted grazing can uproot establishing plants and increase stress over summer, which may reduce their persistence. Kangaroos, in particular, will travel considerable distances to graze sub-tropical grasses, especially when other green feed is limited.

10. Grazing management

Careful grazing management over the first summer is critical to ensure a strong perennial stand in subsequent years. Sub-tropical grass seedlings have a weak primary root system and as a result are susceptible to uprooting and grazing damage over the first summer. Uncontrolled grazing during this time will also deplete carbohydrate reserves, which can result in plant death.

The timing of the first grazing will vary depending on seasonal conditions and how well the plants have grown. If late spring or summer rainfall has produced vigorous growth, the perennial grasses can be lightly grazed from early January. However, when there is little or no summer rain, the first grazing may need to be deferred until after the break of season.

The first grazing should always be deferred until the perennial grasses are well established and well anchored.



Good establishment followed by favourable conditions – photo taken in mid-January

Before the first grazing, assess whether plants are firmly anchored by testing how easily they can be pulled out by hand. What appear to be relatively large plants can have a surprisingly small root system and in that case premature grazing could significantly reduce stand density, with plants being uprooted and killed.



Good establishment in a dry summer – photo taken in April

Rhodes grass has long runners (stolons) that do not root down in dry soils and is, therefore, particularly susceptible to grazing damage in the first summer (test by pulling on the stolons).

If the plants are well anchored, then a light grazing will encourage tillering. When stock are in the paddock, monitor the perennial grasses regularly to ensure plants are not being uprooted or overgrazed.

Ongoing grazing management will vary with the species of perennial grass, grazing animal and time of year. Most perennial grass paddocks can be largely set stocked by cattle during the growing season but they will require some form of rotational grazing outside of the annual growing season.

Kikuyu is highly grazing tolerant and can be set stocked for long periods by sheep or cattle, but leading producers are now rotationally grazing cattle on kikuyu pasture, resulting in large increases in productivity.

Panic grasses are often grown as part of a mix with Rhodes grass and signal grass. Stock may preferentially graze panic and signal grass compared with Rhodes grass, especially if the Rhodes grass leaves are old and senescing, so graze the paddock before the Rhodes grass becomes rank.

If a stand is overgrazed, then allow a long rest to give the plants the opportunity to recover before the next grazing.



First grazing of perennial grasses with weaners

11. What is successful perennial grass establishment?

Successful establishment is not simply the number of perennial grass seedlings that emerge in spring but relates to the density of plants that persist through to the following autumn. Successful establishment also equates to uniform plant density across the paddock, with continuous lines of perennial grasses in each seeding row.



Successful establishment in the autumn after sowing, following a dry summer with minimal rainfall

A desirable benchmark for sub-tropical grass establishment is a density of 8–10 plants/m² persisting through to the end of the first autumn after sowing. For a row spacing of 50–60 cm, this equates to 4–5 plants per metre in each seeding row.

Bunch grasses, such as panic grass, setaria and digit grass, do not spread by runners and only occasionally recruit new seedlings from seed. In general, the plant density of these species will not increase over time, although the crowns of individual plants will get larger. Therefore, the plant density of the bunch grasses in the medium to long term is largely determined by those plants that persist through to the end of the first autumn after sowing.

However, if the initial density is poor (<2 plants/m²), allow panic grass to occasionally flower and set seed. Then spell the paddock following large out-of-season rainfall events to allow seedlings to establish.

Seedling recruitment of panic grass has been observed when there is a combination of warm to hot temperatures, good soil moisture and bare ground.

The creeping grasses, such as Rhodes grass and kikuyu, are more forgiving of poor establishment density, as they will spread and fill in gaps over time, given appropriate management. Kikuyu can also be spread readily by animals through seeds germinating in dung.

Paddock assessment in early summer

Early December is the ideal time to assess your newly sown perennial grass paddock.

Plants that are strong and well established in late spring – early summer have a high likelihood of persisting over summer, even if faced with adverse seasonal conditions with little or no rain for the next six or seven months. On the other hand, small, weak plants in late November – early December are unlikely to persist over summer, unless there is good summer rainfall.



Estimate the number of perennial grasses per metre in early December

If the results are suboptimal, then the likely cause or causes can be determined (Section 12 Troubleshooting). For instance, any competition from annual weeds will still be evident, while the furrows will have largely retained their shape and the impact of sand infill can be assessed.

To determine the success or otherwise of a newly sown perennial grass paddock, it is useful to assess the paddock at two scales:

- (i) Look for uniform establishment across the paddock with continuous lines of perennial grasses in each seeding row. This contrasts with patchy establishment where there are good areas, poor areas and areas with few or no perennial plants.
- (ii) In a representative area or areas, assess the plant density and composition (if a mixture was sown) within the immediate vicinity.

Plant density can be determined by counting the number of plants per metre of seeding row.

Pasture composition can be determined by estimating the relative number of each species, which should approximate the proportion of each species in the seed mix (i.e. relative number of viable seeds per kilogram).

Results from field trials suggest that 30–65% of seedlings in October will not persist over the first summer. Obviously, the attrition rate will vary with seasonal conditions, plant size in late spring – early summer and seedling density. If seedling density is excessive, the plants will compete strongly for moisture and the weaker plants will not survive.



Good establishment of panic grass in early December



Small stressed plants at the start of summer (early December) are unlikely to persist over summer unless there are favourable seasonal conditions.

12. Troubleshooting

When establishment is suboptimal, it is useful to diagnose what has worked and what went wrong ... The initial assessment should be in early summer with a second assessment in late autumn if the perennial density has declined over summer.

If establishment is suboptimal or the resulting composition is not as planned, it is useful to identify the contributing factors so they can be rectified for future sowing operations. A survey of commercial seeding operations in 2006 indicated the four major causes of establishment failure were: (i) sowing too deep; (ii) poor seed

quality; (iii) incorrect time of sowing; and (iv) incorrect machinery configurations (R Yates, unpublished data).

Potential causes of poor establishment, following sowing of a mixture of panic grass and Rhodes grass are listed in Table 6.

Table 6 Possible causes of sub-optimal establishment from sowing a mixture of panic grass and Rhodes grass (these principles apply to other mixes)

Paddock observations	Possible causes
Patchy or poor establishment	<ul style="list-style-type: none"> • Seed sown into non-wetting sand due to inadequate furrow formation • Poor depth control or seed sown too deep • Sowing speed too high, resulting in poor depth control, furrow collapse or sand infill in furrows • Low seed germination (either poor quality seed or high proportion of dormant seed) • Poor or incomplete weed control (will generally be obvious) • Insect damage to newly emerging perennial seedlings
Low perennial density and mainly Rhodes grass	<ul style="list-style-type: none"> • Poor seed quality of panic grass (low germination or high proportion of dormant seed) • Poor depth control or seed sown too deep, while some Rhodes grass seeds on or near surface (possibly due to seed bounce) have germinated
Good panic grass density, but little or no Rhodes grass	<ul style="list-style-type: none"> • Poor seed quality of Rhodes grass • Sowing depth too deep or sand infill has buried seed beyond 10–15 mm, resulting in little emergence of Rhodes grass
Low perennial density in the autumn after sowing, in spite of good perennial density in spring (i.e. poor persistence over summer)	<ul style="list-style-type: none"> • Plants uprooted by grazing before being securely anchored to the soil • Overgrazing by stock, rabbits or kangaroos, resulting in depletion of carbohydrate reserves and plant death • Apart from over-grazing or premature grazing, the most likely cause is a high proportion of small, weak perennial plants in late spring – early summer, followed by dry summer conditions causing death of the perennial grasses from moisture stress. Possible causes of small perennial grass plants in late spring – early summer include: <ul style="list-style-type: none"> – late sowing, resulting in limited growth of the grasses by the start of summer – seedling density in spring too high (>30 plants/m²), resulting in strong competition between plants – competition from summer weeds (e.g. wireweed, Afghan and paddy melons) – competition from couch grass that has recovered from knockdown spray(s) acting to suppress the seedling growth of sown perennial grasses – incomplete kill of annual pasture or late germinating annual grasses (e.g. annual ryegrass) outcompeting perennial seedlings

What is the optimum density of panic grass?

Two key questions relating to sub-tropical perennial grass pastures are:

- (i) What is the ideal perennial grass density in a mature stand to maximise productivity?
- (ii) What seedling density is needed to achieve this density in a mature stand?

These questions are particularly important for the bunch grasses (panic grass, digit grass and setaria), as the medium to long-term density largely depends on the density of plants persisting through to the end of the first autumn.

A replicated field trial was established at Badgingarra, 200 km north of Perth, in August 2007 using Gatton panic seedlings transplanted at six different densities (0.5, 1, 2, 4, 8 and 16 plants/m²). Biomass, pasture composition and persistence were measured at regular intervals.

Figure 7a shows the total biomass of panic grass, annual legumes, grasses and herbs in the third season after sowing, while Figure 7b illustrates the biomass in autumn 2011. At the lower densities, the panic grass plants grew larger and remained green longer over the summer period than plants in the higher density plots (Figure 8).

The results suggest the optimum plant density after 3–4 years in this environment is about 4 plants/m². However, this trial used glasshouse-



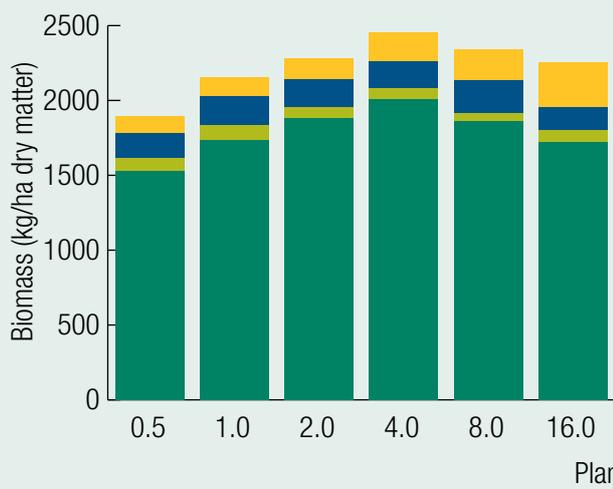
Arrangement of the panic grass density trial at Badgingarra. Plots were sown at a density of 0.5, 1, 2, 4, 8 and 16 plants/m². Photo taken on 11 June 2009 following establishment in August 2007

raised transplanted seedlings, which gave them an advantage over the first summer compared with field-grown plants from seed. To achieve this density, farmers should aim to have a minimum of 8–10 plants/m² at the start of the first summer.

This density gives high potential biomass production from the grasses in the warmer months after the annual species have senesced. It also provides sufficient space between the perennial crowns to allow good production from annual legumes and grasses in the winter months when the sub-tropical grasses are largely dormant or only grow slowly.



Impact of poor weed control (foreground) on perennial establishment



■ Annual grasses ■ Annual herbs
■ Annual legumes ■ Panic grass

Figure 7a Biomass (total of four cuts) of panic grass, annual legumes, grasses and herbs in the third season (June 2009 to May 2010) in relation to perennial densities of 0.5, 1, 2, 4, 8 and 16 plants/m² at Badgingarra

Figure 7b Biomass of panic grass, annual legumes, grasses and herbs for autumn 2011 in relation to perennial densities of 0.5, 1, 2, 4, 8 and 16 plants/m² at Badgingarra

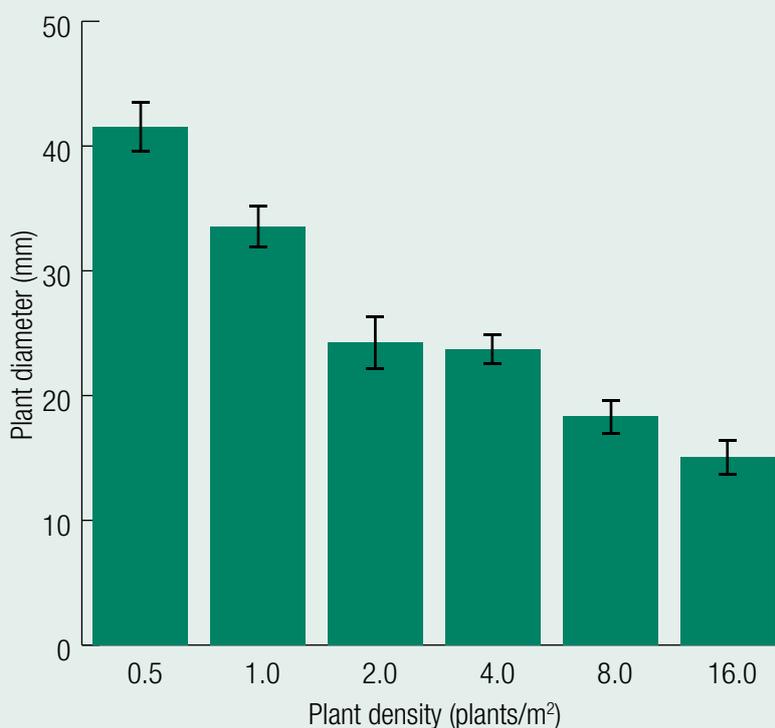


Figure 8 Diameter of Gatton panic grasses in December 2010 in relation to perennial densities of 0.5, 1, 2, 4, 8 and 16 plants/m² at Badgingarra

13. Machinery and seeding case studies

Phil Barrett-Lennard (Evergreen Farming/agVivo)

The five machinery case studies are from producers who have considerable experience with sowing sub-tropical grasses. They now regularly achieve excellent establishment at the paddock scale. Each producer describes what they have learnt as well as key things to avoid.

Case study 1:

Modifying a culti-trash combine

Dan Rieusset from 'Koodiewoodie' in Dandaragan first sowed perennial grasses on his own property in 2005 and has been contract seeding since 2006.

Dan modified his International A6-2 24-run culti-trash combine following the lead of Grant Bain from Walkaway. Dan has made a number of modifications to the seeder and now consistently achieves excellent results.

'In terms of speed, I normally go about 5 km/h, but can go a bit faster in better and wetter sands,' he said.

'Initially seed and fertiliser were mixed together and sown through the fertiliser box, using approximately 20 kg/ha of super and 4 kg/ha of seed. A new method, using herbicide containers with funnels, along with changing the gearing



and moving the slide in the seed box, makes seeding much quicker and easier as I can sow straight seed.

'If I was to change anything, I would use discs that are more concave, rather than heating up and bending the journal (disc) carrying arms—to give a more consistent result.'



Machinery set-up

International A 6-2 24-run culti-trash combine

Row spacing: 52 cm (21 inches)

- Modifications to seeder:
- International 511 culti-trash undercarriage
- all back-row discs and two out of three front-row discs removed
- new discs fitted
- heated up and bent journal (disc) carrying arms to improve the disc angle (for better furrow formation)
- welded a 50 x 50 mm rectangular hollow steel (RHS) beam to rear journal (disc) carrying arms (to mount press wheels on)
- attached single K-Hart press wheels units
- fabricated new seed-tube brackets and attached these to the RHS beam
- changed to the largest cog (18 teeth) on the gearbox (to reduce seeding rate)
- moved the slide at the bottom of the seed box to the finest setting (to further reduce seeding rate)
- inserted old herbicide containers and PVC pipe funnels over the eight working seed outlets in the seed box (to enable seeding with only small amounts of seed).



Disused herbicide containers inserted into the seed box to facilitate handling low seed quantities

Case study 2:

Success using tynes

Producer: Peter Summers

Property: 'Green Grove'

Location: South of Dongara

Total area: 4000 ha
(over 2 farms)

Arable area: 3200 ha

Crop area: 2011:100 ha
(lupin),
100 ha (oats for hay)

Livestock enterprise:

Self-replacing 'multipurpose' merino flock, selling wethers as lambs or 15-month-old shippers

Livestock numbers:

Sheep: 5000 ewes, 400 wethers, 1800 ewe hoggets, 150 rams

Perennial pasture: 730 ha sub-tropical grasses

Annual rainfall: 420 mm



Peter Summers believes the benefits of sub-tropical grasses to his farming enterprise are erosion control and provision of more feed over more months of the year.

Peter first sowed sub-tropical grasses in 2008 and has now successfully established ~700 ha of sub-tropical grasses. He modified a Massey Ferguson combine with two sets of points in-line, followed by press wheels. He has since added a second machine to increase the area that can be sown each day.

'To improve the seeder, I would consider adding more downward pressure on the press wheels—probably by adding extra weight,' he said.





‘The keys to successful establishment are weed control and furrow sowing. Avoid poor weed and rabbit control. In particular, rabbit control needs to be achieved during the summer–autumn before sowing.’

‘Successful sowing is good germination with almost continuous rows, with very few gaps.’

Peter has also set up a unique device for mixing seed and fertiliser. A small hopper has been located above the elevator on his 5:1 bin. This delivers pasture seed into the elevator while the fertiliser is passing through it. It has been calibrated so that the same amount of seed and fertiliser is mixed each time. The fertiliser box of the combine can be filled with 500 kg of the seed–fertiliser mix in approximately two minutes.



The modified point on the right with the deflector plates produced excellent furrows, while the modified point on the left was ineffectual.

Machinery set-up

Massey Ferguson (MF 56) 24-run tyned combine with floats from a MF 500 combine with the following features:

- two sets of points in-line
- first point is a standard 5-inch point (to loosen the ground)
- second point is a modified 6-inch point with deflector plates (to remove non-wetting sand and create a furrow).

Row spacing: 70 cm (28 inches)

Modifications to seeder:

- moving the second tyned to be in-line with the first tyned (required a new bracket)
- deflector plates welded to points on second tynes (these measure 75 mm wide x 100 mm high, with a gap between them of ~25 mm)
- press wheels attached to the rear (unused) tyned mounts of the float (Primary Sales 100 mm V semi-pneumatic)
- seed tube directed in front of press wheel
- unused seed tubes blocked off with plastic covers in seedbox.

Case study 3:

Persistence pays off

Producer: Ken Hodby

Property: 'Rothesay'

Location: West
Badgingarra

Total area: 2800 ha

Arable area: 2000 ha

Crop area: 2009: 60–80 ha
(oats)

Livestock enterprise: Self-replacing Angus cow herd, selling calves at weaning
Merino ewe flock (bought in) joined to terminal Poll Dorset and Suffolk rams

Livestock numbers:

Cattle: 400 Angus breeding cows with calves, 60 yearling heifers

Sheep: 1200 merino ewes with lambs

Perennial pasture: 260 ha sub-tropical grasses; plus some patches of couch (including giant couch)
~15 ha of 20-year-old overgrown tagasaste

Annual rainfall: 600 mm



Persistence has paid off for Ken Hodby, who successfully established 260 ha of sub-tropical perennial grasses in 2008 and 2009 after his first attempts at establishing perennial grasses gave mixed results.

'I decided to get serious and converted a machine specifically for the job,' he said. 'I followed the best practice "recipe" after attending an Evergreen "Establishment Workshop" at Dandaragan in 2008.

'The keys for successful establishment are to sow into moisture and follow the Establishment "must-dos". Good weed control is also essential.'

Ken gauges sowing success of sub-tropical grasses as a continuous row of plants in each sowing row. Of the 2009 sowing, he said, 'The plant density is excellent and there was good dry matter production from the March rains.'

However, Ken has been on a learning curve. 'In 1995 I sowed 16 ha of Rhodes grass using a standard combine but most of the seed was sown too deep. The result was about one plant every 2–3 square metres and the bulls subsequently destroyed it.

'I had a second go in 2002 with 24 ha. The paddock was ploughed; seed dropped on top and then rolled in with a steel roller. It worked quite well but a fire then burnt out lots of fences on the farm and the stand was grazed out over summer. In 2006 I tried the same technique as in 1995 but the results were still poor.

'The risk of erosion on high sandy ridges exposed to wind from all directions is the weakness in the system. In 2009 I sowed cereal rye down one row of the combine to try to create a mini-windbreak every 5 m across the paddock to reduce the risk of erosion.

I will not repeat this in future years. If the sub-tropical grasses germinate well, there is no need for the cereal rye, but if the spring is poor and the grasses fail, it is highly unlikely the cereal rye will do well enough to reduce the risk of erosion.'

Ken uses a modified Chamberlain Mk3 culti-trash 24-run combine with 52 cm (21 inch) row spacing after the front discs were removed and two out of three rear discs were removed. The seeding tubes were extended to drop seed in the furrow just behind the disc and walking beam press-wheel assemblies were added. The remaining discs were replaced, as more curvature leads to better furrows. The unused down tubes in the seedbox were blocked off.

'The ideal operating speed depends on the type of soil, so speed is adjusted by looking at soil throw behind the machine,' Ken said.

'If too much, slow down; if not enough, speed up.' Ken sows on the contour, as some of his country is quite steep.

Asked if there was anything he would change on his seeder, Ken said: 'Possibly add the capacity to spray a soil-wetting agent in the bottom of the furrow before the press wheel or spray a slighter wider band (30 cm) so that the loose sand that falls back into the furrow is also covered in wetting agent.'

Before sowing in 2010, Ken placed a large mob of cattle in the paddock during April–May and fed them supplementary hay. This allowed other pastures to get away but also improved weed control on this paddock (particularly broadleaf weeds).

Table 7 Details of seeding program on 'Rothesay' at West Badgingarra

Year	2008	2009
Area sown	100 ha	160 ha
Paddock history	Long-term poor annual pasture	
Paddock preparation	Two sprays (8 July and 7 August) 2 L/ha glyphosate 40 ml/ha Hammer Li-700 Sulphate of ammonia	Mostly single knockdown (11–17 August) 2 L/ha glyphosate 40 ml/ha Hammer Li-700 Sulphate of ammonia Insecticide 10% of the area had a second spray with the same mix as above on 25 August. These were thicker pasture areas and bits missed by the first spray
Date of seeding	19–27 August	2–11 September
Seed mix	Evergreen Northern mix (60% Gatton panic, 20% Rhodes grass, 20% signal grass), which was mostly coated, except for signal grass. Used one bag of fertiliser for each bag of seed as a carrier, which was mixed in the fertiliser box of the combine	
Seeding rate (kg/ha)	4	2–4 (should have been 4 but some calibration issues)
Soil type	Grey non-wetting sand (pH 5.5) over yellow sand, with limestone outcrops	
Soil moisture at seeding	Surface soil dry but moist underneath	Excellent
Insecticide	No	Applied with knockdown

Case study 4:

Sub-tropical grasses complement tagasaste

Producers: Bob and Anne Wilson

Property: 'Tagasaste Farm'

Location: East of Lancelin
Total area: 2000 ha
Arable area: 1800 ha

Crop area: 2009: Nil

Livestock enterprise:
Self-replacing cross-bred cow herd

Agistment cattle brought in during the growing season—numbers vary according to the season

Livestock numbers:

Cattle: 400 breeding cows (with calves at foot), 280 yearling heifers, 500–1000 agistment cattle (adjusted seasonally)

Perennial pasture:

367 ha sub-tropical grasses
1000 ha of tagasaste

Annual rainfall: 600 mm

Cattle producer Bob Wilson is well known for promoting the benefits of tagasaste, but in recent years he has established a considerable area of sub-tropical grasses.

Bob sees the benefits of sub-tropical grasses to his farming enterprise as:

- using out-of-season rain to produce green feed
- better feed around the break of season and in late spring and early summer
- increased groundcover, reducing the risk of erosion
- smoothing out the annual feed supply—a bit less in winter but more at other times.

Bob used a Bettinson triple disc drill in 2003 and 2005 but in 2007 and 2009 he changed to a converted International 511 culti-trash combine.

'The Bettinson drill is not ideal for sowing perennials because it doesn't create decent furrows but it did produce good results in 2003 and 2005,' Bob said. 'That said, in both years there were favourable springs. The Inter 511 drill probably gives a more reliable establishment of panic, whereas the Bettinson drill was pretty good with Rhodes grass.'

'I have also changed the seed mix slightly, with less Rhodes grass and more panic grass. The key to successful establishment is to follow the Establishment must-dos.'

'One knockdown spray has always worked well, except in areas of the paddock where erodium is present. This is particularly hard to kill, so I will move to a two-spray program with a broadleaf spray first, followed by a glyphosate-based knockdown.'

'I check for insects every week or so after emergence, enough to notice insects moving in from adjoining paddocks.'

'The higher the plant density, the better. And in terms of the species mix—the more panic the better.'

Bob was happy with the 2009 sowing, as there was good plant density over the whole paddock, particularly of panic grass.

The converted International 511 culti-trash combine has 35 cm (14 inch) row spacing. The back row of discs and every second disc on the front row was removed. The remaining discs were swapped for heavier, scalloped discs, and press wheels were added.

Furrow depth is ~50 mm with a sowing speed 5–7 km/h. However, Bob said: 'In areas with erodium present, the machine does not dig in enough to create decent furrows—particularly on slightly harder soil types. I should probably adjust the sowing depth on the run.'



Producers inspect a new sowing of sub-tropical grasses between alleys of tagasaste at Bob Wilson's property near Lancelin.



Table 8 Details of seeding program on 'Tagasaste Farm' east of Lancelin

Year	2003	2005	2007	2009
Area sown	62 ha	80 ha	95 ha	130 ha (22 ha to a mixture of tagasaste and sub-tropical grasses)
Paddock history	Long-term poor annual pasture			
Weeds targeted	Capeweed, brome grass, blue lupins, erodium, silver grass (minor)			
Paddock preparation	2009: Grazed down hard until the end of July, then rested for 1–2 weeks before spraying on 17 August with 1 L/ha Roundup PowerMax + 150 ml/ha Sonic insecticide			
	Similar to 2009	Similar to 2009 with Hammer occasionally added to improve weed kill		(See above)
Date of seeding	First week of Sept.	6–26 Sept.	30 Aug–3 Sept.	2–4 Sept.
Species/Varieties	Panic grass / Rhodes grass / signal mix	Panic grass / Rhodes grass (uncoated) / signal mix	Panic grass / Rhodes grass (coated) / signal mix	Heritage Seeds Northern Evergreen mix
Seeding rate (kg/ha)	3	3–5	3	3
Soil type	Deep sand (Karrakatta sand, grey sand over yellow sand)			
Insecticide				Applied with knockdown Danadim on 23 Sept. for RLEM and aphids Regent on 9 Nov. for wingless grasshoppers

Case study 5:

Success with kikuyu on the south coast

Producers: Morgan and Debbie Sounness

Property: 'Tamgaree'

Location: Gnowellen

Total area: 1277 ha

Arable area: 1123 ha

Crop area: 2008: 400 ha

2009: 290 ha

2010: 190 ha with 150 ha oats: and 40 ha field pea (pasture cropped)

Livestock enterprise:

Self-replacing superfine merino flock

Livestock numbers:

Sheep 4950 total—1800 ewes, 1150 mature wethers, 1000 hoggets (ewe and wether), 1000 weaners

Perennial pasture: 400 ha kikuyu

Annual rainfall: 425 mm



Morgan Sounness is an experienced kikuyu grower and seed producer. He sowed his first paddock to kikuyu in 1995 and now has 400 ha of kikuyu, with plans to sow more. Morgan also had 20 ha of perennial veldt grass sown in the early 1980s but this stand thinned out and was re-sown to kikuyu in 2008.

Morgan cites multiple benefits to his farming enterprise from growing kikuyu:

- increased stocking rate
- better wool quality
- erosion control
- extended growing season and out-of-season green feed
- compatibility with annual legumes
- soil carbon improvement
- opportunity to crop perennial grass paddocks (pasture cropping).

He uses a Great Plains 24-run no-till disc drill with double disc openers and trailing press wheels on 18.7 cm (7.5 inch) row spacing. He changed the cogs to enable lower and more accurate seeding rates, which also eliminated the need for a fertiliser carrier. Morgan said: 'I would like to add some coulters and to make the machine wider to speed up the job.'

He has made some changes to seeding over time and increased the seeding rate from 1 kg/ha to at least 2 kg/ha. 'Calibrate, calibrate, calibrate,' he said. 'The whole exercise is too expensive to get the seeding rate wrong.'

Morgan believes weed control is critical for successful establishment. 'The first paddock I sowed had much better success around the outside of the paddock due to leftover herbicide being applied there,' he said.

‘A key thing to avoid is leaving the clover and sowing kikuyu into it. It never works—the clover out-competes the kikuyu every time. I now use Dicamba with the knockdown to achieve better control of subclover and erodium.’

Morgan said seeding depth was also critical. ‘I avoid topdressing seed on the surface, as kikuyu must be sown with some covering of soil. The seeding depth now reflects soil moisture, and I will chase moisture at depth if needed, up to 25 mm.

‘I don’t use any fertiliser at seeding, as this eliminates the risk of burning the seed and the initial root system.

‘Spring sowing is the most reliable, but autumn sowing can work with kikuyu, especially if ryegrass isn’t present in the paddock. If ryegrass is present, spraytopping the year before sowing kikuyu is advisable to reduce the seedbank.’

Morgan gauges seeding success of kikuyu as an even germination across the whole paddock, which eliminates bare areas and erosion risk.

‘I assess the kikuyu density across the paddock on a sliding scale—more than 5 plants/m² is excellent establishment, 1–5 plants/m² is good, while slightly less than one plant/m² is acceptable,’ he said.

Morgan’s advice for wind erosion-prone sites is to sow French millet at 1 kg/ha as a cover crop (but only for cattle producers—sheep won’t eat it and will then target the kikuyu), or sow a winter cereal at <10 kg/ha.

He also allows the annual pastures to bulk up more before the knockdown spray to provide better cover. Morgan said he was very reluctant to spray out summer weeds that emerge with the kikuyu, as they provide protection from the wind.

Table 9 Details of kikuyu sowing on ‘Tamgaree’ in 2008

Area	20 ha
Soil type	Sand over gravel
Paddock history	Long-term annual pasture (although originally a perennial veldt grass pasture)
Paddock preparation	Grazed hard through winter Sprayed with 1.5 L/ha glyphosate + Dicamba (label rate) in early Aug. Sprayed with 1 L/ha Spray.Seed® + 200 ml/ha alpha-cypermethrin on 2 Sept.
Weeds targeted	Mainly subterranean clover, capeweed, erodium
Date of seeding	First week of Sept.
Species/Varieties	kikuyu (uncoated)
Seeding rate (kg/ha)	5 (as produces own seed, but would normally use 2 kg/ha)
Soil moisture at seeding	Dry at the surface, but moist just below
Insecticide	Just with the initial knockdown
How often do you check for insect pests?	Once every 2 weeks during the first 2 months post-seeding



Further reading and references

Department of Agriculture and Food Western Australia 2006, 'Perennial pastures for Western Australia', Bulletin 4690.

Department of Agriculture and Food, Western Australia 2009, 'Identifying sub-tropical grass seedlings', Bulletin 4775.

Department of Agriculture and Food, Western Australia 2010, 'Establishing sub-tropical perennial grasses, Farmnote 443.

Future Farm Industries CRC 2011 'Establishment of sub-tropical perennial grasses in south-western Australia', Technical Report 9, <http://www.futurefarmonline.com.au/publications/Technical_Reports>

Lodge, GM and McCormick, LH (2010) Tropical perennial grasses – seed quality. NSW Industry and Investment Primefact 1023.

Appendix A

Understanding seed labels and seed analysis certificates

Sub-tropical grass seed is not cheap and the quality varies widely, so we encourage producers to check the seed label(s) and where practical to obtain a copy of the seed analysis certificate(s) before purchasing seed. It is important to understand the terminology used on seed labels and seed analysis certificates (Table A1).

As a rule, low germination equates to poor quality seed, unless there is a high proportion

of fresh (dormant) seed. Storage conditions can affect seed quality, so it is important to re-test the germination if the seed analysis statement is more than 12 months old.

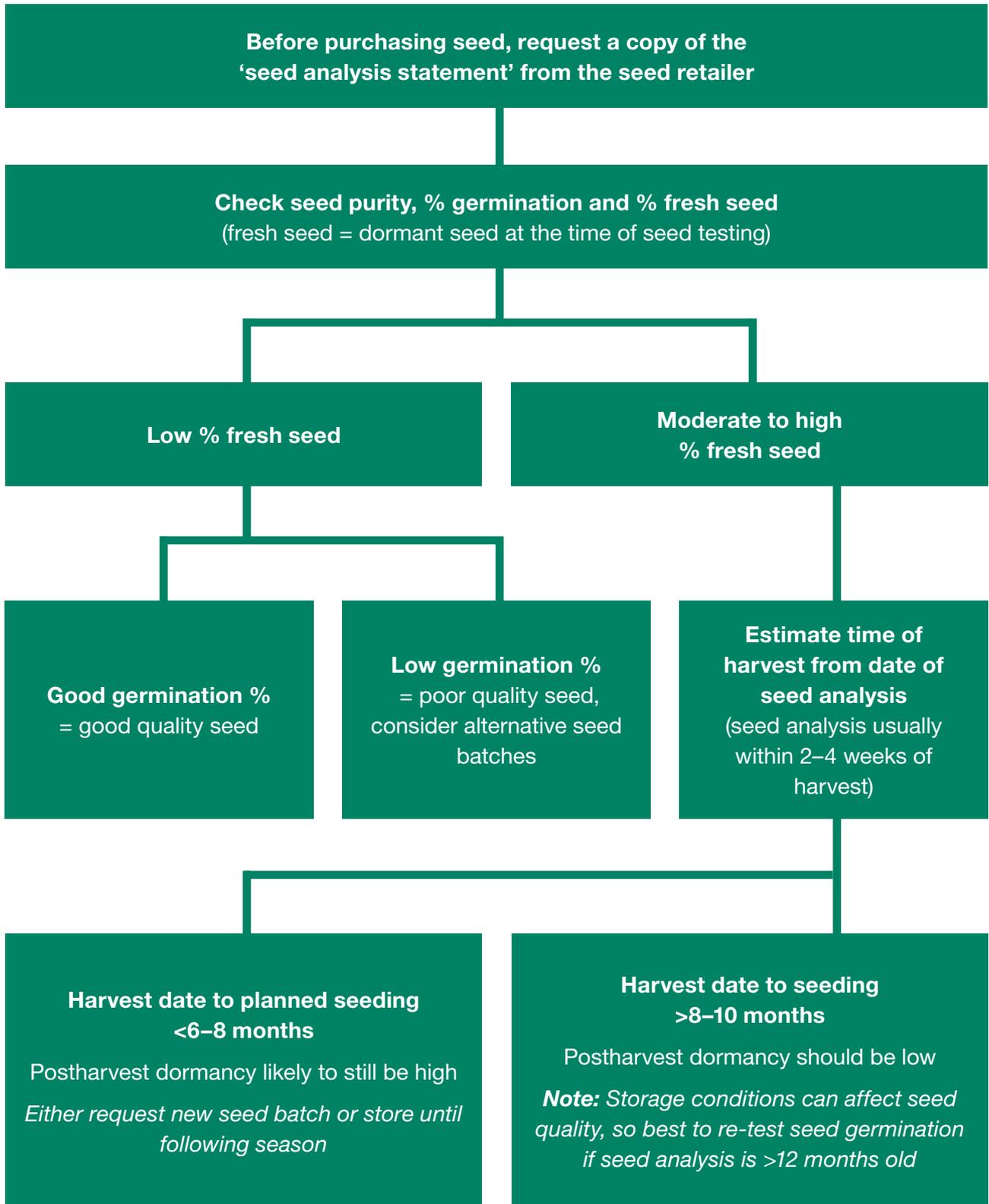
Always compare seed price on the cost per kg of viable seed (see also 'Pure Live Seed' below).

For species with post-harvest dormancy, it is useful to calculate the % viable seed = Purity x (germination % + fresh seed %).

Table A1 Guide to seed label terminology

Term	Definition
Purity	% by weight of a seedlot which is pure seed; the remainder may include 'other seeds', empty florets, immature seeds and chaff
Other seeds	Seeds other than the species specified on the label, and includes both weed seeds and contaminants (e.g. Rhodes grass is considered a contaminant in a panic grass seedlot). All seedlots coming into WA have to be passed by WAQIS (WA Quarantine), so the seedlot should not contain any prohibited weed seeds, but may still contain weeds that you do not want on your property
Germination	% seeds which germinate at the time of the test, undertaken on a sample of pure seed
Germination of seedlot by weight	Purity x % germination
Tetrazolium test	A laboratory test used for species that have postharvest seed dormancy to determine % of viable seed. It is a measure of both germinable seed plus dormant seed and is undertaken on a sample of pure seed
Fresh seed	% dormant seed at the time of the test, as determined on a sample of pure seed

Figure A1 Decision support for purchasing panic grass seed



Example A – report of analysis for Gatton panic

Figure A2 shows the Gatton panic is 97.4% pure seed, with 68% germination (normal seedlings), 16% dormant seed (fresh seed) plus 14% dead seed and 2% abnormal seedlings.

The germination test is undertaken on pure seed, so the percentage of germinable seed by weight = $68 \times 0.974 = 66\%$ (i.e. a 50 kg bag contains 33 kg of germinable seed).

The percentage of viable seed (by weight) = $(68 + 16) \times 0.974 = 82\%$

The 'other seeds' are not an issue, being Rhodes grass, purple pigeon grass, sabi grass and Bothriochloa species.

This is a high-quality seedlot suitable for sowing this year. If the seedlot contains a high proportion of fresh seed, then follow the steps outlined in the 'Decision support for purchasing panic grass' (Figure A3).

Figure A2 Gatton panic seed analysis certificate



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Report of Analysis

TW11-0

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Client:	Job Number:	
	Report Date: 8-06-2011	
	Received: 06-05-2011	
	Order Number:	
<p>Kind of Seed: GATTON PANIC Botanical Name: <i>Megathyrsus maximus</i> Markings:</p>		

PURITY			Number of Days	GERMINATION					Moisture Content (wet basis) %
% by Weight				% by Count					
Pure Seed	Inert Matter	Other Seeds		Normal Seedlings	Hard Seeds	Fresh Seeds	Abnormal Seedlings	Dead Seeds	
97.4	2.5	0.1	29	68	0	16	2	14	N

PSD: 36# # Pure seed contains a caryopsis
 Sample Weight Examined: 22 grams.
 Inert matter: Straw, Empty florets, Fungal affected seed units.
 First Count at 10 days..... 46%.
 Method: TP 15-35 Dormancy Treatment: KNO₃
 Analysed according to ISTA methodology.
 Viability tests completed on 8/06/2011.
 The Germination test was carried out on pure seed only. (PSD 36#)
 # Pure seed contains a caryopsis.

WEED SEED SEARCH
Sample Weight Examined: 22 g

Botanical Name	Common Name
<i>Bothriochloa sp.</i>	
<i>Chloris gayana</i>	RHODES GRASS
<i>Setaria incrassata</i>	PURPLE PIGEON GRASS
<i>Urochloa mosambicensis</i>	SABI GRASS

Example B – report of analysis for Rhodes grass

Figure A3 shows the Rhodes grass is 96.9% pure seed, with 62% germination, and 36% dead seed. The germination test is undertaken on pure seed, so the percentage of germinable seed by weight = $62 \times 0.969 = 60\%$

This is a high-quality Rhodes grass seedlot.

Pure Live Seed

Pure Live Seed (PLS) is a measure of seed quality of a seedlot used by some seed companies and resellers and is expressed as a number between 0 and 1.

PLS is calculated by multiplying the percentage purity by the percentage germination and then dividing by 10 000. Here, purity refers to the

percentage of pure seed in the seedlot; it does not include empty florets or other seeds.

$PLS = \% \text{ purity} \times \% \text{ germination} / 10\ 000$

Values close to 1 indicate high-quality seed, while numbers close to zero indicate poor-quality seed.

For example, Rhodes grass seed with a purity of 96% and germination of 50% has a PLS of 0.48, which means that 48% of the seedlot by weight contains seeds that can germinate. Typical PLS values for sub-tropical grasses are 0.4 – 0.6, but values as low as 0.07 have been measured. In a New South Wales study, the average PLS for Katambora Rhodes grass was 0.52 from 18 tests; Premier digit grass was 0.40 from 52 tests; and Bambatsi panic 0.57 from 39 tests (Lodge and McCormick 2010).

Figure A3 Rhodes grass seed analysis certificate

SGS

Report of Analysis

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TW11-0

Job Number: Page 1/2
Report Date: 8-06-2011
Received: 23-05-2011

Kind of Seed: RHODES GRASS
Botanical Name: Chloris gayana
Markings: HARV April 2011

PURITY			GERMINATION					Moisture Content (wet basis) %
% by Weight			Number of Days	% by Count				
Pure Seed	Inert Matter	Other Seeds		Normal Seedlings	Hard Seeds	Fresh Seeds	Abnormal Seedlings	Dead Seeds
96.9	2.9	0.2	14	62	0	1	1	36

PSD: 42
Sample Weight Examined: 12 grams.
Inert matter: Straw

First Count at 7 days..... 52%.
Method: TP 20-35
Dormancy Treatment: KNO³
Analysed according to ISTA methodology.
Viability tests completed on 7/06/2011.
The Germination test was carried out on pure seed only. (PSD 42)

WEED SEED SEARCH

Sample Weight Examined: 12 g

Botanical Name	Common Name
<i>Ageratum houstonianum</i>	BLUE MINK
<i>Urochloa decumbens</i>	SIGNAL GRASS
<i>Crassocephalum crepidioides</i>	THICKHEAD
<i>Megathyrsus maximus</i>	PANIC
<i>Mitracarpus hirtus</i>	TROPICAL GIRDLEPOD

