PASTURE OPTIONS FOR EYRE PENINSULA

CARING FOR OUR COUNTRY

Government of South Australia

Grain & Graze™ Profit through knowledge EYRE PENINSULA

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This publication is a collaboration between the Eyre Peninsula Sustainable Cropping and Grazing project and Eyre Peninsula Grain and Graze 2, and endeavours to help farmers explore available pasture options that reflect their land capability, maximise profitability and give them the confidence to make adaptations to their farming system.

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Introduction

Annual grass and medic pastures have formed the basis of livestock grazing systems on Eyre Peninsula since the late 1940s. Pastures help maintain the productivity and environmental sustainability of farming systems, yet often do not receive the same level of inputs or consideration as crops. Poor cropping seasons, falling commodity prices, increasing fertiliser costs and increased interest in livestock industries has renewed interest in pastures on Eyre Peninsula.

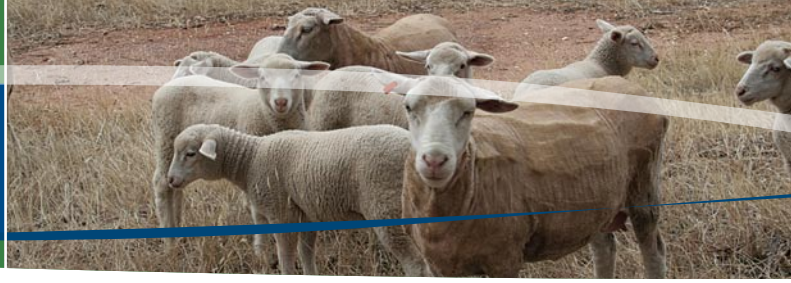
Projects such as Cropping and Grazing - a Sustainable Balance and Eyre Peninsula Grain and Graze aimed to reduce the risks associated with cropping high risk landscapes and soil types. These projects also examined improved pasture management practices, including rotational grazing and increased use of perennial pasture systems on light textured soils to reduce the risk of wind erosion.

In low rainfall environments, the production potential of traditional pastures can be limited by herbicide residues used in the cropping phase, and extreme seasonal conditions. Finding alternative pastures, both annual and perennial will provide greater choice and flexibility for farming on Eyre Peninsula.

This publication aims to be a first port of call for landholders looking to establish pastures on Eyre Peninsula. It provides information on different pasture species, adaptation to rainfall zone and soil texture, advantages and disadvantages and cost of establishment to help landholders identify the most appropriate pastures. It also provides information on establishment procedures for each species to assist landholders with planning.

The pasture species included in this publication are those that have been most successful in demonstrations around Eyre Peninsula in recent years and which seem to best fit the areas where farming enterprises include a mix of cropping and grazing (250 - 500 mm rainfall zones). It is recognised that differences between varieties and sub-species of the pasture options described will suit specific soils differently and it is recommended that landholders seek further advice on the best variety for their specific circumstances.

Costs of establishment are indicative only and are provided for comparison between different pasture options.



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Getting the most from your pasture

Benefits of a Pasture Phase

A pasture phase provides the opportunity for increased organic matter, improved livestock feed, diversification of income and efficient use of resources. Improvements in soil structure and controlling palatable broadleaf and grass weeds cheaply and effectively are additional benefits. Pastures can also provide a disease and insect pest break and increase soil biota diversity.

Pastures offer an alternative method of weed control to chemical applications, thus reducing the risk of herbicide resistance. Where deep-rooted perennial pasture species are used, the incidence of salinity may be reduced. Additional benefits can be achieved through the use of perennials including year-round productivity and ground cover.

Assessment of Current Pasture

Pasture assessment involves assessing the quantity and quality of available pasture. Pasture assessment can also involve surveys of species composition and estimates of percentage ground cover.

Pasture is assessed to;

- Match stocking rate to pasture production.
- Accurately budget feed supply and demand.
- Plan supplementary feed requirements.
- Effectively manipulate pasture production and composition.
- Ensure sufficient ground cover to protect soil from wind and water erosion.

The critical parameters for pasture assessment are;

- Pasture quantity (herbage mass/plant height).
- Pasture quality (protein/digestibility).
- Species composition.
- Matching feed supply to enterprise feed requirement is essential.

Assessing Pasture Potential

- Regeneration of existing pasture or pasture improvement.

Assessing Potential Pasture Improvement Sites

Areas for pasture improvement may include;

- Paddocks following cropping with a low density of useful pasture species. This may include an assessment of the amount of pasture seed already present in the paddock.
- Run-down perennial pastures that do not contain adequate density of useful pasture species.
- Native pastures.

Before any pasture is sown, consider;

- Is it necessary to sow new pasture and if so what pasture type is best suited to the soil and topography?
- Can the existing pasture be improved/rejuvenated by tactical grazing and/or the use of selective herbicides, fertilisers etc?
- Can production from the paddock be boosted by simply broadcasting some legume seed or topdressing with fertiliser?
- Will the new pasture meet the livestock enterprise feed requirements?
- Will forage crops be a better alternative?

Development and management decisions for individual paddocks should not be made in isolation. Pasture options and management should fit into a whole farm system.

Selecting the Right Pasture Species

Selecting the right pasture species and variety for individual paddocks is extremely important. No perfect grass or legume species exist to suit all situations; all species have strengths and weaknesses in terms of both livestock production and environmental management. The needs of the whole farm and its enterprises should be considered to determine the most suitable pasture with emphasis on filling the feed gaps. If the feed gap is in late summer/autumn a summer active species such as lucerne may be appropriate. If feed is in short supply during winter, then winter active species such as ryegrass/medic should be considered.

Climatic factors such as effective rainfall, rainfall pattern, summer and winter temperatures and frost susceptibility will help determine which species are

most appropriate. These factors will vary from paddock to paddock depending on slope and aspect. Soil characteristics such as texture, salinity, drainage, depth and pH also need to be considered when selecting the most appropriate pasture species for a site.

Many pasture species require a high level of soil fertility and in most cases these species will require regular fertiliser applications for good production.

Where different land classes exist in large paddocks, it may be worth considering fencing off areas of different land class and tailoring pasture species and management to suit.

In short, consider the following criteria when selecting pasture species;

- Suitability for local climate and soil types.
- Ease and cost of establishment.
- Productivity of the pasture.
- Match feed quality to livestock enterprise.
- Herbicide tolerance.
- Extent of management required.
- Compatibility with the whole of property management.
- Seed longevity and recruitment.
- Resistance to diseases and pests.
- Competitiveness to resist weed invasion.
- Level of persistence.
- Availability and quality of seed.

Preparation and Sowing - Establishment Plan for Successful Pastures

Successful establishment is key in determining the productive capacity of a pasture paddock. Planning is critical in the success of pasture establishment and should commence at least 12 months before sowing. Some tips for success include;

- Assess and plan ahead. Select the paddock 12 to 18 months ahead and assess for existing pasture and weed composition and density.
- Take a soil test to determine fertiliser requirements.
- Control weeds and pests in the year before sowing. Herbicide options for new pastures can be limited, so weed control before pasture establishment is essential.
- Maximise weed germination prior to sowing and control with an appropriate knockdown.
- Only sow pasture when there is adequate moisture both at the surface and deeper in the profile.
- Inoculate legume seeds - particularly on new ground or after a long cropping phase.
- Ensure accurate seed placement. Sow at the correct depth to maximise germination. For most small pasture seeds the seeding depth should be less than 1cm.
- Provide correct nutrition.
- Avoid grazing until the pasture is well established and unable to be pulled out by stock (perennial pasture should not usually be grazed in the first year of establishment).
- Monitor for insect pests including Red Legged Earth Mite (RLEM), lucerne flea and snails, particularly at early establishment. Once established perennial pastures generally have some tolerance to insect pests.

Post Establishment Management

Pasture should be regularly monitored for weeds and insect pests, particularly in the first year. Herbicide applications post establishment will depend on a number of factors including;

- Pasture and companion species tolerance to herbicide.
- Weeds present and growth stage.
- Pasture growth stage.
- Soil moisture conditions.

Before using herbicides and insecticides seek advice from your agronomist, chemical reseller or appropriate professional on chemical products, label rates and registration, plant back periods etc for your specific situation.

Grazing management after establishment will depend on the type of pasture sown and how it fits into your farming system. Most pasture species are generally more productive if rotationally grazed with high stocking rates in small (20 ha) paddocks. Some perennial species will have reduced persistence if set stocked. Monitor stock condition regularly and supplement pasture feed with hay or grain if feed quality is not meeting livestock requirements.

GETTING THE MOST FROM YOUR PASTURE

Features of PERENNIAL and ANNUAL PASTURES

Though annual legumes have been traditionally used for pasture phases on Eyre Peninsula, perennial species (such as phalaris, lucerne, puccinellia and saltbush) may be a more appropriate option in some circumstances.

ANNUAL PASTURES	PERENNIAL PASTURES
Short growing season can mean seed production even when there is a harsh finish to the season.	Year round production where there is adequate moisture.
High hard seed percentages can give an instant seed source for a pasture phase.	Perennials have a longer growing season. They do not go to seed as quickly as annuals.
High levels of winter and spring dry matter production.	Can respond to summer rains.
Some annual pasture options are self regenerating. They do not need to be sown annually.	Persistence can be a problem in severe drought conditions.
Weed free annual pastures are very high quality feed.	Often are deep rooted. They can access ground water or use stored subsoil moisture.
Cereals sown for grazing provide high amounts of early feed.	Can lower water tables and reduce risk of salinity.
High early vigour.	More permanent ground cover and improved soil structure.
Highly competitive against weeds.	Greater pasture competition can reduce weeds and weed control costs.
Easy to establish.	Can be slow to establish with little production in first year.

RAINFALL ISOHEYTS AND SOIL TEXTURES

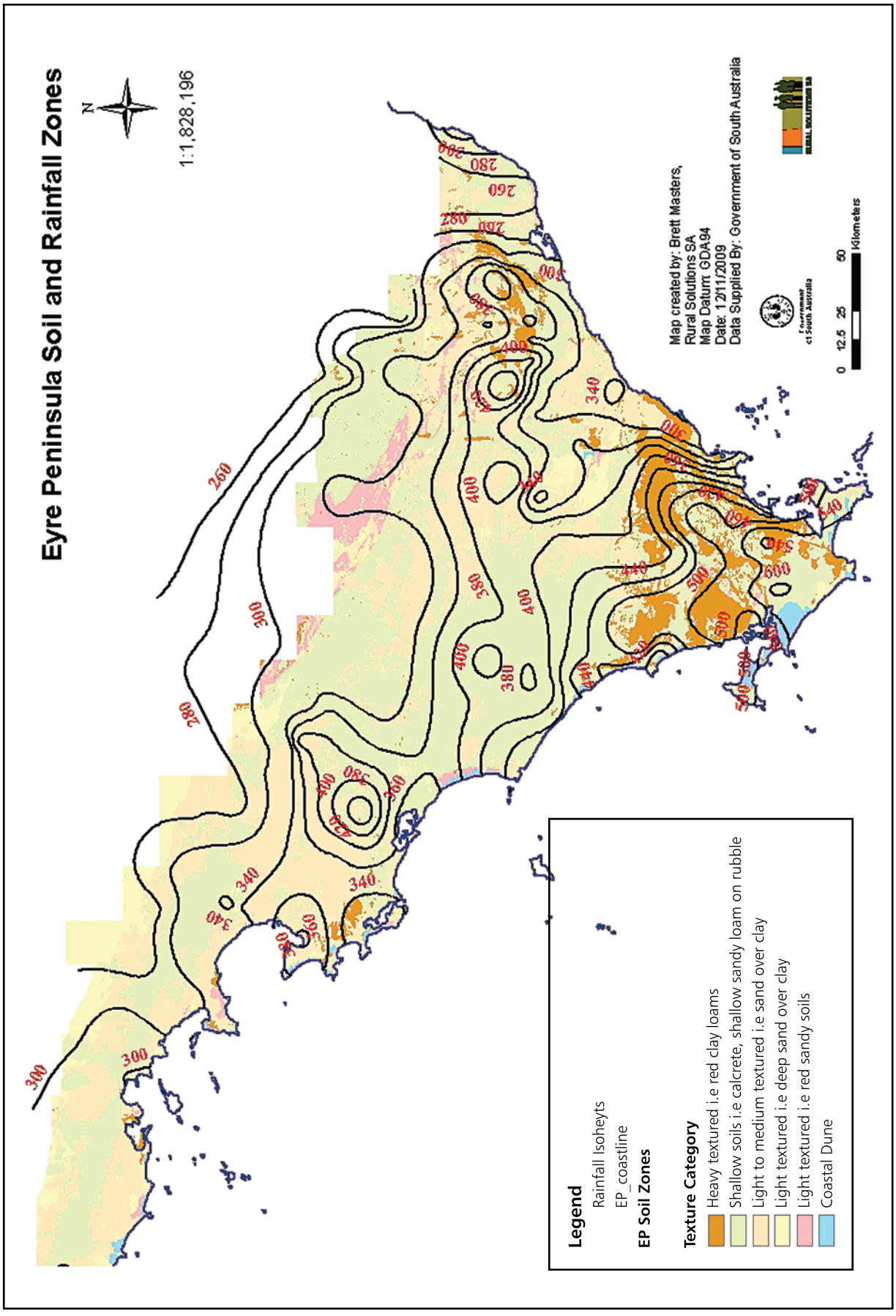


Figure 1 Rainfall isohyets and soil textures

Pasture Options by Soil Type and Rainfall

Pasture selection will depend on soil PH, salinity levels and water logging potential.

SOIL TYPE			
Rainfall	**Light Texture** i.e. deep sand	**Medium Texture** i.e. sand over clay or red brown earth	**Heavy Texture** i.e. red clay loam or brown cracking clay
300-325 mm	Cereals Native grasses Perennial Veldt Grass Saltbush	Annual Medics Cereals Native grasses Saltbush	Annual Medics Native grasses Saltbush
325-350 mm	Annual Medics Cereals Perennial Veldt grass Saltbush	Annual Medics Cereals Native grasses Perennial Veldt grass Saltbush	Annual Medics Cereals Native grasses Saltbush
350-400 mm	Annual Medics Cereals Lucerne Perennial Veldt grass Saltbush	Annual Medics Cereals Vetch Lucerne Saltbush	Annual Medics Cereals Vetch Native grasses Saltbush
400-450 mm	Annual Medics Cereals Lucerne Phalaris Cocksfoot Saltbush	Annual Medics Sub - Clover Balansa Clover Cereals Lucerne Chicory Phalaris Cocksfoot Tall Wheat Grass Saltbush	Annual Medics Lucerne Phalaris Italian Ryegrass Balansa Clover Puccinellia Tall Wheat Grass Saltbush
450-500 mm	Annual Medics Cereals Lucerne Phalaris Cocksfoot Saltbush	Annual Medics Sub - Clover Cereals Lucerne Phalaris Italian ryegrass Cocksfoot Saltbush	Balansa Clover Sub - Clover Lucerne Phalaris Italian ryegrass Tall wheatgrass Puccinellia Saltbush

Characteristics of Pasture Species

SPECIES															
	Annual Legumes			Annual Grasses			Perennial Legumes or Forbs		Perennial Grasses				Species specific to saline land		
Attributes	**Annual Medics** page 8	**Clovers** page 11	**Vetch** page 14	**Cereals** page 16	**Italian Ryegrass** page 18	**Forage Sorghum** page 21	**Lucerne** page 23	**Chicory** page 26	**Perennial Veldt Grass** page 28	**Native grasses** page 31	**Phalaris** page 34	**Cocksfoot** page 37	**Puccinellia** page 40	**Tall Wheat Grass** page 42	**Saltbush** page 44
Relative persistence (years)	A	A	A	A	1 - 3	1 - 2	3 - 5	3 - 5	>7	>7	>7	>5	>7	>7	>7
Minimum rainfall (mm)	250	400	350	250	450	Opp	350	400	350	250	400	425	350	350	250
Drought tolerance	n/a	n/a	n/a	n/a	L	H	M	M	H	H	H	H	H	H	H
Summer dormancy	n/a	n/a	n/a	n/a	L	L	L	L	L	L	H	H	M-H	L	L
Response to summer rain	n/a	n/a	n/a	n/a	L-M	H	H	H	M	M-H	L	L	M-H	M	M
Pest tolerance	M[1]	L-M	M	M[1]	M	L-M	L-M	H	M-H	M-H	H	M-H	H	H	H
Productivity on light textured soil	M[1]	M-H[1]	M	M-H[1]	L	H	H	M-H	H	M[1]	M-H	L-M	L	n/a	M-H
Waterlogging tolerance	M[1]	M-H[1]	M[1]	L	M-H	M	L	L	L	L-H[1]	H	M-L	M-H	L	L
pH range ($CaCl_2$)	>6.5	4.5-7	5-8[1]	5-8[1]	5.5-7.5	5-7	6.5-8	4.3-7	4.5-7	4.5-8.5[1]	5-8	4.5-7	5-8.5	4.5-8	6-7
Salinity tolerance	L-M[1]	L-M[1]	L-M	L-M[1]	M	L	L	L-M	L-M	L-H[1]	M	L	H	M-H	M-H
Ease of establishment	E	E	E	E	E	Md	Md	Md	Md	D	Md	Md	Md	Md	D
Time to first grazing (months)	1	1	2	1	1	1	12	9	12	12	12	12	12	12	12
Animal health risks[2]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes
Establishment Cost/ha[3]	$145	$135	$310	$225	$187	$160	$180	$170	$115	$530	$180	$180	$180	$310	$227-900

L	Low	E	Easy	n/a	Not applicable
M	Medium	Md	Moderate	A	Annual
H	High	D	Difficult	Opp	Opportunity forage crop only

1 *Tolerance will vary between species and cultivar. Seek advice on options for your specific circumstances.*

2 *Where animal health risk identified refer to species information for further details.*

3 *Cost of establishment current 2009*

Annual medic *(Medicago spp.)*

Rainfall: >250 mm

Soil Types: Prefers light to medium textured, neutral to alkaline (pH > 6.5) soils with moderate fertility, but broadly adapted across many soil types depending on species and cultivar.

Main Productive Period: Winter and early spring. Seeds and dies down in late spring.

Description

Annual species of the genus *Medicago*. Highly productive, high quality winter feed with the ability to fix a large amount of nitrogen from the atmosphere. The main species used for improved pasture on Eyre Peninsula include;

- Strand medic (*M. littoralis*)
- Burr medic (*M. polymorpha*)
- Barrel medic (*M. trunculata*)
- Disc medic (*M. tornata*)
- Snail medic (*M. scutellata*)

Each species has specific attributes which suit them to specific soil types and rainfall i.e cultivars of Spineless burr medic (a subspecies of *M. polymorpha*) have mild waterlogging and salinity tolerance. Disc medics seem to be the most adapted for sandy soils.

Medics can be distinguished from clovers as they have a longer stem on the central leaflet whilst on clovers all leaflets have stems of the same length.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Suited to a wide range of soil types. Tolerance to low soil pH, salinity and available boron varies between species and cultivars.	Generally intolerant of Group B herbicide residues (except for cultivars bred specifically for tolerance i.e. Angel).
	Easy to establish.	Intolerant of high levels of aluminium.
	Self regenerating pasture if allowed to set seed. Medic 'seed bank' should increase with appropriate management.	End of season surface cover often very unstable and can present wind erosion risk.
ECONOMIC	Nitrogen fixing.	Limited options for broadleaf weed control.
	Highly productive, quality winter feed source.	High hardseed percentage of many cultivars can cause it to be viewed as a weed in cropping rotations.
	Will use residual nutrients from cropping phase.	Bloat can be an issue when pasture is lush and does not have grasses or other roughage present.

Establishing and Managing Annual Medic Pasture

ESTABLISHMENT	**Pre-sowing**
	Most medics are intolerant of Group B herbicide residues. Consider paddock herbicide history and plant back periods prior to sowing medics.
	Ensure good weed control with a knockdown prior to seeding to reduce competition.
	Sowing
	Buy pre-coated seed (seed coated with insecticide, fungicide and inoculum) or inoculate seed with appropriate legume inoculum (Group AL or AM) depending on species (Brown and Revell 2005).
	Sow <1 cm deep into moist seed bed, at 6 kg/ha if sowing alone (3-4 kg/ha if in a pasture mix).
	Ensure good seed to soil contact using press wheels, harrows or a roller.
	Monitor for insect pests, particularly lucerne flea and red legged earth mite.
	Control post emergent weeds. Seek advice from your agronomist, chemical reseller or Primary Industries department on threshold levels and chemical control options.
POST ESTABLISHMENT MANAGEMENT	Winter cleaning/grass-freeing medic pastures can improve dry matter production and provide a disease break.
	Stock should be removed from paddocks prior to flowering to allow plants to set seed for the following year. The medic 'seed bank' will rapidly increase over time.
GRAZING MANAGEMENT	Graze when plants are well anchored and have good ground cover. Approximately 8 leaf stage.
	Feed production and utilisation is best when rotationally grazed.
	Ensure that stock are removed from the paddock prior to reaching minimum residue cover levels to reduce the risk of wind erosion.
	Medics under disease or moisture stress can have increased coumestrol levels. These can have phyto-oestrogenic properties which can result in reduced livestock fertility (Croker 2007).
ANIMAL HEALTH	Monitor stock for bloat when medic pasture is lush. Ensure stock have access to a supply of fibre (i.e. baled cereal straw).
	Wethers can get pizzle rot due to the higher nitrogen content in the urine compared to grass dominant annual pastures (Devenish *et al* 2003).
	Enterotoxaemia (pulpy kidney) may cause animal losses on high quality feed or grain supplements. Stock can be vaccinated against pulpy kidney.
	Redgut is a possible cause of sudden death in lambs grazing legume dominant pastures in late winter/spring (Trengove 2004).

Cost of Establishing Annual Medic Pasture

ANNUAL MEDIC			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	6 kg (pre coated seed with fungicide, insecticide and inoculum) @ $7/kg	42
	Inoculum	In seed coat	-
FERTILISER AND APPLICATION	At sowing	DAP - 60 kg/ha @ $0.55/kg	33
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) - 1.5 L/ha @ $7/L	10.50
	At sowing	Trifluralin (480 g/L a.c) - 1.7 L/ha @ $7/L	12
	Post Emergent	Flumetsalum (800 g/kg a.c) -25 g/ha @ $0.80/g	20
INSECTICIDE APPLICATION	Bare earth at seeding	Alphacypermethrin (100 g/L a.c) - 0.1 L/ha @ $9 L	1
	Post Emergent	Omethoate (290 g/L a.c) - 0.1 L/ha @ $40/L	4
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	10.50
	Machinery	$8.50 sowing + $2.00 per additional pass	12.50
TOTAL ESTABLISHMENT COST		**$145/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Annual medic and cereals make ideal companion species for grazing or hay production.

Chemically removing grass weeds from a medic pasture can be useful in preparing a paddock for cropping.

Clover *(Trifolium spp.)*

Rainfall: >400 mm

Soil Types: Clovers are broadly adapted across a range of soil types, with tolerance to waterlogging, salinity and pH depending on species and cultivar.

Main Productive Period: Winter and early spring.

Description

High quality winter feed source of the genus Trifolium. Highly productive pasture for the medium to high rainfall zones on neutral to slightly acid soils. Some of the clover species suited to the medium rainfall zone include;

- Sub clover (*Trifolium subterraneum*)
  - *ssp. subterraneum,*
  - *ssp. yanninicum,*
  - *ssp. brachycalycinum*
- Balansa Clover (*Trifolium michelianum*)
- Persian Clover (*Trifolium resupinatum*)

Each species has specific attributes that enables it to be best adapted to specific soil types and rainfall i.e cultivars of Balansa Clover and Persian Clover have waterlogging and mild salinity tolerance. The three sub-species of Sub clover also exhibit different characteristics i.e *ssp. subterraneum* is well adapted to moderately acid well drained sandy loam to clay loam soils, *ssp. yanninicum* performs well on moderately acidic waterlogging soils, and *ssp. brachycalycinum* is adapted to slightly alkaline soils.

Clovers can be distinguished from medic species as the leaf stems on all leaflets are the same length.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Suited to a wide range of soil types. Tolerance to waterlogging, pH and salinity varies between species and cultivars.	Legume pasture in highly leaching environments (light texture soils/high rainfall) can contribute to soil acidification.
	Tolerant of acidic soils. Particularly *T. subterranuem ssp. subterraneum and yanninicum.*	Generally intolerant of alkaline soils. Though *T. subterraneum ssp. brachycalycinum* is adapted to slight alkalinity.
	Self regenerating pasture if stock are removed to allow seed set.	Little residue surface cover at the end of summer.
ECONOMIC	Highly productive, high quality winter feed source.	Bloat can be a problem.
	Nitrogen fixing. Fertiliser requirement is greatly reduced. Will use residual nutrients from cropping phase.	Some sub-clover species can have high oestrogenic properties which can cause pregnant ewes to miscarry.

Establishing and Managing Clover Pasture

ESTABLISHMENT	**Pre-sowing**
	Ensure good weed control with a knockdown prior to seeding to reduce competition.
	Sowing
	Buy pre-coated seed (seed coated with insecticide, fungicide and inoculum) *or* inoculate seed with appropriate legume inoculum (Group B, C or O) depending on species (Brown and Revell 2005).
	Sow into moist seed bed. Seeding rate and depth of sowing will vary depending on species used. Small seeded species such as sub-clover are sown shallow (<1 cm) with low seeding rates (1-2 kg/ha) whilst larger seeding species i.e. Balansa clover are sown deeper with a higher seeding rate (2 to 4 kg/ha).
	Clover seeds are generally very small in size and as such require good seed to soil contact for good establishment.
POST ESTABLISHMENT MANAGEMENT	Monitor for insect pests, particularly lucerne flea and red legged earth mite.
	Control post emergent weeds. Seek advice from your agronomist, chemical reseller or Primary Industries department on threshold levels and chemical control options.
	Stock can be removed from paddocks prior to flowering to allow plants to set seed for the following year. The clover 'seed bank' will rapidly increase over time.
GRAZING MANAGEMENT	Feed utilisation is best when rotationally grazed.
	Ensure that stock are removed from the paddock prior to reaching minimum residue cover levels to reduce the risk of wind erosion.
	Monitor stock for bloat when pasture is lush. Ensure stock have access to a supply of fibre.
ANIMAL HEALTH	Wethers can get pizzle rot due to the higher nitrogen content in the urine compared to annual grass pastures (Devenish *et al* 2003).
	Some cultivars of clover can contain high levels of formononetin, a phyto-oestrogenic compound that can lead to reproductive disorders (Croker *et al* 2007).
	Enterotoxaemia (pulpy kidney) may cause animal losses on high quality feed or grain supplements. Vaccination can help with this.
	Redgut causes sudden death in lambs grazing legume dominant pastures in late winter/spring (Trengove 2004).

Cost of Establishing Clover Pasture

CLOVER			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	4 kg (pre coated seed with fungicide, insecticide and inoculum) @ $8/kg	32
	Inoculum	In seed coat	-
FERTILISER AND APPLICATION	At sowing	DAP - 60 kg/ha @ $0.55/kg	33
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) - 1.5 L/ha @ $7/L	10.50
	At sowing	Trifluralin (480 g/L a.c) - 1.7 L/ha @ $7/L	12
	Post Emergent	Flumetsalum (800 g/kg a.c) -25 g/ha @ $0.80/g	20
INSECTICIDE APPLICATION	Bare earth at seeding	Alphacypermethrin (100 g/L a.c) - 0.1 L/ha @ $9/L	1
	Post Emergent	Omethoate (290 g/L a.c) - 0.1 L/ha @ $40/L	4
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	10.50
	Machinery	$8.50 sowing + $2.00 per additional pass	12.50
TOTAL ESTABLISHMENT COST		**$135/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Ryegrass and clover as companion species can be a highly productive, high quality pasture.

Vetch *(Vicia spp.)*

Rainfall: >350 mm

Soil Types: Broadly adapted across many soil types with pH between 5.0 and 8.0 ($CaCl^2$) depending on species and cultivar.

Main Productive Period: Winter and early spring

Description

Highly productive, high protein winter feed source. Can be sown with a winter cereal for hay production. There are three main vetch species suitable for use as pastures on Eyre Peninsula. These are;

- Common Vetch (*Vicia sativa*)
- Purple Vetch (*Vicia benghalensis*)
- Woolly Pod Vetch (*Vicia villosa*)

Vetch species are well adapted to acidic soils. Different species and cultivars have specific attributes which which suit them to different soil and use situations i.e. Purple Vetch (*V. benghalensis*) is moderately tolerant of heavier textured waterlogging soils with sodic subsoils. Woolly Podded Vetch (*V. villosa*) is well adapted to lighter textured soils. Common vetch (*V. sativa*) is well adapted to loams and clay loams and does not tolerate extended periods of water logging. Some cultivars have high levels of soft seed making them a better fit into cropping rotations.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Many cultivars are mildly tolerant to waterlogging.	Vetch seed can contain toxic compounds. Stock should not graze vetch once plants have start to form pods.
	Many cultivars are resistant to many diseases that affect other legume crops and can provide a disease break for cropping rotations.	Can become a weed in cropping situations (especially hard seeded varieties).
	Vetch produces a very high amount of dry matter. It can be a useful green manure option or if sown with a cereal can produce high quality hay.	Legume pasture in highly leaching environments (light texture soils/high rainfall) can contribute to soil acidification.
ECONOMIC	Highly productive, high quality winter feed source.	Palatability is variable between cultivars.
	Nitrogen fixing. Fertiliser requirement greatly reduced. Will use residual nutrients from cropping phase.	Bloat can be a problem. Provide extra source of fibre when grazing stock if vetch is lush.

Establishing and Managing Vetch Pasture

ESTABLISHMENT	**Pre-sowing**
	Carefully consider cultivar options prior to sowing a paddock with vetch. If the paddock is to be sown as a break in a cropping rotation use a soft-seeded variety to minimise the risk of vetch germinating in the following crop. If the paddock is used permanently for pasture, a hard-seeded variety may be an option to protect the seed bank against false breaks.
	Ensure good weed control with a knockdown prior to seeding to reduce competition.
	Sowing
	Inoculate seed with Group E inoculum.
	Sow <2.5 cm deep into moist seed bed, at 20 to 25 kg/ha if sowing alone (10 to 15 kg/ha if sowing with a cereal companion species).
	Ensure good seed to soil contact with press wheels, harrows or a roller.
POST ESTABLISHMENT MANAGEMENT	Monitor for insect pests, particularly lucerne flea and red legged earth mite.
	Control post emergent weeds. Seek advice from your agronomist, chemical reseller or Primary Industries department on threshold levels and chemical control options.
GRAZING MANAGEMENT	Vetch is best grazed lightly. Set stocking with a low stocking rate will minimise damage to the growing points. Plants should only be grazed from 10 node stage to pod set (Matic *et al* 2009).
	Vetch is extremely susceptible to over grazing as the growing points are located well above the soil surface.
ANIMAL HEALTH	Monitor stock for bloat when pasture is lush. Ensure stock have access to a supply of fibre.
	Vetch seed contains toxins which can be harmful to many animals. **Stock should be removed from vetch stand before plants have started to set pods** (Matic *et al* 2009).

Cost of Establishing Vetch Pasture

VETCH			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	25 kg @ $9/kg	225
	Inoculum	Bag of inoculum treats 25 kg of seed @ $5/bag	5
FERTILISER AND APPLICATION	At sowing	DAP - 60 kg/ha @ $0.55/kg	33
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) - 1.5 L/ha @ $7/L	10.50
	At sowing	Trifluralin (480 g/L a.c) - 1.7 L/ha @ $7/L	12
INSECTICIDE APPLICATION	Bare earth at seeding	Alphacypermethrin (100 g/L a.c) - 0.1 L/ha @ $9/L	4
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	10.50
	Machinery	$8.50 sowing + $2.00 per additional pass	12.50
TOTAL ESTABLISHMENT COST		**$310/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Cereals

Rainfall: >250 mm

Soil Types: Broadly adapted across a range of soil types depending on species and cultivar.

Main Productive Period: Late autumn, winter and early spring.

Description

Due to their very high early vigour cereal crops sown for feed can provide large amounts of feed early in the season giving annual pastures a chance to establish. Cereals commonly sown for grazing on the Eyre Peninsula include;

- Oats (*Avena sativa*)
- Barley (*Hordeum vulgare*)
- Wheat (*Triticum aestivum*)
- Triticale (*X. Triticosecale spp.*)

Different species and cultivars have specific attributes which suit them to different soil and use situations, i.e. barley is the most salinity tolerant cereal and triticale is well adapted for managing wind erosion on deep sands due to its vigorous early growth. Specific cultivars of wheat are more tolerant of high boron levels.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Well adapted to a range of soil types and rainfall zones.	Can be host to root diseases which may be a problem in the cropping phase.
	Tolerance of salinity, boron and low pH soils varies with species and cultivar.	Can be susceptible to a range of root and foliar diseases depending on cultivar attributes.
	Rapid growth during winter. Provides a high level of surface cover.	Bare over summer, risk of erosion.
	Improved early vigour over other annual pasture species.	
ECONOMIC	Able to be sown with relatively low inputs. If feed is plentiful the paddocks can be left to mature with a hay cut or harvest grain.	Need to resow each year.
	Highly productive, high quality feed.	Generally will not respond to late rains once seed set has started in late spring.

Establishing and Managing Cereals for Grazing

ESTABLISHMENT	**Pre-sowing**
	Ensure good weed control with knockdown prior to sowing.
	Sowing
	Cereal crops can be direct drilled with minimal rainfall in mid autumn. Sow 5 to 7 cm deep at 90 to 100 kg/ha with 60 kg DAP at sowing.
POST ESTABLISHMENT MANAGEMENT	Control post establishment weeds. Seek advice from your agronomist or chemical reseller on appropriate herbicides for your situation.
	Top dress with urea fertiliser (@ 50 to 100 kg/ha) depending on seasonal rainfall and grazing management for improved productivity.
GRAZING MANAGEMENT	Wait until plants are well anchored before grazing.
	Feed utilisation and production can be increased from cereals by splitting large paddocks into smaller grazing units using temporary electric fencing and rotationally grazing with high stocking rates.
	Growing tips of plants can be easily damaged by overgrazing. Ensure stock do not graze plants below 5 cm height.
ANIMAL HEALTH	Ensure stock have access to adequate supply of fresh water.

Cost of Establishing Cereal Crops for Grazing

CEREALS			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	90 kg @ $1.00/kg	90
FERTILISER AND APPLICATION	At sowing	DAP - 80 kg/ha @ $0.55/kg	44
	Post Emergent	Urea - 100 kg/ha @ $0.50 /kg	50
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) -1.7 L/ha @ $7/L	12
	Post Emergence	MCPA LVE (250 g/L a.c) + Diflufenican (25 g/L a.c) - 500 ml/ha @ $21/L	10.50
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	7.50
	Machinery	$8.50 sowing + $2.00 per additional pass	10.50
TOTAL ESTABLISHMENT COST		**$225/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Italian Ryegrass *(Lolium multiflorum)*

Rainfall: >450 mm

Soil Types: Loam to light clay soils. Italian ryegrass does not perform well on heavy clays.

Main Productive Period: Early winter to early summer. Italian ryegrass will continue to produce into early summer if adequate rainfall and mild conditions.

Description

Short lived annual/biennial grass with broad, soft, bright green leaves.

Although the plant will carry over summer if conditions are favourable it is most commonly grown as an annual to best utilise dry matter.

Diploid and tetraploid forms of Italian Ryegrass exist depending on cultivar. In general tetraploid cultivars have broader leaves, more tillers, higher moisture and carbohydrate levels than diploids.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Rapid growth makes it highly competitive against weeds.	Can become a weed issue in cropping phase.
	Moderately tolerant of salinity, waterlogging and frost.	Italian ryegrasses can be controlled in cropping phases at present using grass selective herbicides however there is a risk of herbicide resistance developing if chemical mode of action groups are not rotated.
ECONOMIC	Highly productive, high quality feed source. High in protein, energy and has good digestibility.	High fertiliser requirement for maximum production.
	Rapid growth response to warmer temperatures in early spring. Where conditions are favourable it may be cut for hay or silage three or four times in a season.	To get best production from Italian ryegrass it should be sown each year.
	Rapid regrowth after cutting or grazing. Will respond to late spring rain when other annual pastures have completely died off.	
	Able to sow in high quality pasture blend with other species such as annual medic.	
	Does not pose an ARGT (Annual Ryegrass Toxicity) threat like some cultivars of annual ryegrass (*Lolium rigidium*).	

Establishing and Managing Italian Ryegrass Pasture

ESTABLISHMENT	**Pre-sowing**
	Ensure good weed control (particularly of grass weeds such as brome and barley grass) with a knock-down prior to seeding.
	Sowing
	Sow seed <5 cm into moist seedbed at 15 to 20 kg/ha.
	Ensure good seed to soil contact using press wheels, harrows or a roller.
	Apply 60 to 80 kg/ha DAP fertiliser at sowing.
POST ESTABLISHMENT MANAGEMENT	Top dress with nitrogen fertiliser if in high leaching environment. Monitor paddock for nitrogen deficiency symptoms such as yellowing of leaves.
	Broadleaf weeds can be easily controlled. Seek advice from your agronomist, chemical reseller or Primary Industries department consultant for appropriate control options for your situation.
	Red Legged Earth Mite can cause considerable damage to seedling ryegrass at establishment. A "bare earth" insecticide spray included with the knockdown herbicide application can provide some protection.
GRAZING MANAGEMENT	Ensure plants are well anchored before the first graze.
	Graze when plants reach 3 leaf stage, aim for a plant height no shorter than 4 cm. Older leaves die quickly. Plants should be grazed whilst leaves are fresh to maximise grazing production.
	Italian ryegrass loses feed quality rapidly when it starts to run to seed. Grazing with a high stocking rate will increase the grazing benefit.
	Subdividing large paddocks using temporary electric fencing and rotationally grazing "cells" with a high stocking rate will improve feed utilisation and productivity.
	Remove stock and allow to produce seed if regeneration is required the following year. (N.B. Italian ryegrass will not set the same volume of seed as a true annual ryegrass *Lolium rigidium*).
	Excess dry matter production can be cut for hay. Ensure that the paddock is free of 'Wimmera' annual ryegrass (*Lolium rigidium*) in order to minimise the threat of ARGT from the hay.

Cost of Establishing Italian Ryegrass Pasture

ITALIAN RYEGRASS			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	20 kg/ha @ $3/kg	60
FERTILISER AND APPLICATION	At sowing	DAP - 80 kg/ha @ $0.55/kg	44
	Post Emergent	Urea - 100 kg/ha @ $0.50/kg	50
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) -1.7 L/ha @ $7/L	12
	Bare Earth prior to sowing	Alphacypermethrin (100 g/L a.c) - 0.1 L @ $9/L	1
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	9
	Machinery	$8.50 sowing + $2.00 per additional pass	10.50
TOTAL ESTABLISHMENT COST		**$187/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Italian Ryegrass pasture at Lake Hamilton.

Forage Sorghum *(Sorghum spp.)*

Rainfall: Opportunity forage crop where significant rainfall is received in late spring.

Soil Types: Broadly adapted to a range of neutral to slightly acidic soils.

Main Productive Period: Summer.

Description

Forage Sorghum refers to a number of sorghum species generally grown for grazing or hay cutting. It is able tolerate hot and low moisture environments.

Forage sorghum on Eyre Peninsula is generally grown as an opportunity summer forage crop where significant rainfall events (>50 mm) occur in late spring/early summer.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Can be used to diversify rotations, provide breaks to current crop types and compete with summer weeds.	Use of soil moisture over summer can use up any stored subsoil moisture that may be used by following years crop.
	Deep aggressive roots to access water in the soil profile not used by winter crops and pastures.	Sensitive to Group B herbicides.
ECONOMIC	High quality summer feed.	Leaf rust can have a significant effect on grain yield.
	Highly drought tolerant but will respond quickly to summer rains with a high level of dry matter production.	High levels of prussic acid in some varieties can cause animal health problems.

Establishing and Managing Forage Sorghum for Grazing

ESTABLISHMENT	**Pre-sowing**
	Deep rip paddocks where subsoil compaction may be an issue.
	Consider paddock herbicide history and plant-back periods before planting as forage sorghum is highly sensitive to Group B herbicides.
	Remove green material in paddock to be sown to forage sorghum as early as possible (use a knockdown in July to August to retain soil moisture).
	Control weeds prior to sowing with a knockdown spray.
	Sowing
	Sow in early spring when soil temperatures are >16 °C (Etherton 2006).
	Sow seed 2 to 5 cm deep into moist profile at a rate of 3 to 10 kg/ha.
	Press wheels or rollers are recommended to achieve good seed to soil contact at establishment.
	Apply fertiliser at sowing as per a cereal grain crop (60 to 80 kg/ha DAP). Top dress with urea as appropriate for seasonal conditions and grazing management.
POST ESTABLISHMENT MANAGEMENT	Adequate control of summer weeds is necessary to minimise moisture competition. Control weeds within 4-5 weeks after planting.
	Monitor seedlings for damage from soil insects such as wireworm and cutworm. Seek professional advice on insect pest thresholds and control options.
GRAZING MANAGEMENT	To maximise quality and quantity, rotational "cell" grazing is recommended. Grazing below 15 cm height will significantly reduce regrowth (Etherton 2006).
ANIMAL HEALTH	High prussic acid levels may cause animal health problems, particularly in young (<40 cm) or stressed crops. Prevent problems by introducing stock slowly onto larger (>75 cm) plants, have sulphur blocks available, ensure adequate water supplies and access to dry feed (i.e. stubbles) (Etherton 2006).

Cost of Establishing Forage Sorghum for Grazing

FORAGE SORGHUM			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	6 kg/ha @ $5.50/kg (fungicide and insecticide coated seed)	25
FERTILISER AND APPLICATION	At sowing	DAP - 80 kg/ha @ $0.55/kg	44
	Post Emergent	Urea - 50 kg/ha @ $0.50 /kg	25
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) -1.5 L/ha @ $7/L	10.5
	At sowing	2,4D amine (625 g/L a.c) - 1.2 L/ha for broadleaf or atrazine WG (900 g/kg a.c) - 550 g/ha for grass weeds.	2,4 -D - $13 Atrazine - $5
INSECT PEST CONTROL	Bare earth prior to sowing	Chlorpyrifos (300 g/L a.c) - 1 L/ha @ $12/L	12
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	10.50
	Machinery	$8.50 sowing + $2.00 per additional pass	16.50
TOTAL ESTABLISHMENT COST		**$160/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Lucerne *(Medicago sativa)*

Rainfall: >350 mm

Soil Types: Broadly adapted across a wide variety neutral to alkaline soils. Intolerant of boron, waterlogging, salinity and high levels of available aluminium.

Main Productive Period: Spring, summer and early autumn depending on summer rainfall and the cultivar's winter dormancy.

Description

Lucerne is a deep rooted perennial legume of the genus *Medicago* (medic) with trifoliate leaves.

The flower head varies colour from pale pink to blue-purple, with globe shaped flowers projecting from it.

Medic species including lucerne can be distinguished from clover because of longer leaf stem on the central leaf. Clover has leaflets with stems of the same length.

Lucerne's deep root system makes it well adapted to light textured alkaline soils as it is capable of drawing moisture from throughout the soil profile. It makes good use of summer rainfall events.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Deep tap root is able to help lower ground water tables.	Unable to tolerate water-logging or moderate to high levels of salinity.
	Assists in improving soil structure and controlling erosion.	Can be difficult to establish on sandy soils which are non-wetting.
	Has been used effectively as a fire-break.	Requires accurate seed placement for satisfactory establishment.
	Established plants are very tolerant to a range of herbicides for winter weed control.	Can be difficult to remove stand when going into a cropping phase.
	Drought hardy. Once established can withstand dry spells in years of irregular rainfall.	Intolerant of acid soils particularly where available aluminium levels are high.
	Rapid response to summer rainfall events.	Does not tolerate high levels of boron.
ECONOMIC	Increased stocking rates.	Perennial pastures are slow to establish and provide little grazing value in the first year.
	Nitrogen fixing legume can help reduce fertiliser costs for cropping phase.	Needs careful management at early establishment. Seedlings are intolerant of insect pests and competition from weeds.
	Help control weeds and cereal root disease ahead of cropping phase.	

Establishing and Managing Lucerne Pasture

ESTABLISHMENT	**Pre-sowing**
	Crop with a cereal the year before sowing lucerne to get good broad leaf weed control. Spraytop grasses in spring if lucerne is to follow an annual pasture phase.
	Clay spreading non-wetting sands can significantly improve lucerne establishment.
	Ensure weed competition is reduced with a good knockdown prior to sowing.
	Sowing
	Buy pre-coated seed (seed coated with insecticide, fungicide and inoculum) or inoculate seed with AL inoculant (Brown and Revell 2005).
	Use soil test results to determine fertiliser application at sowing.
	Sow lucerne in late autumn/mid winter, ~1 cm deep into a damp seedbed at a seeding rate of 3 to 4 kg/ha ensuring good seed to soil contact.
	Direct drill lucerne into standing cereal stubble or sow lucerne with a cover crop to provide protection for lucerne seedlings and reduce soil erosion. Cover crop will **need** to be sprayed out in early spring e.g. early tillering to conserve moisture.
	Press wheels give good seed to soil contact and create a water-harvesting furrow. This can be particularly useful when establishing on non-wetting sand.
	Apply a pre-emergent herbicide at sowing to control grass weeds.
	Post Emergence
	Apply appropriate grass selective or broadleaf herbicides to control post emergent weeds.
	Monitoring for the presence of insect pests - particularly Red Legged Earth Mite (RLEM) and Lucerne Flea early in establishment is critical.
	Lucerne is particularly vulnerable to grazing in the first year. It is recommended that lucerne be allowed to flower before the first graze, to strengthen root reserves and help increase stand persistence.
	To test the strength of newly established plants before grazing, tug at the base of the smallest plant. If they are difficult to pull out, the stand can be lightly grazed.
POST ESTABLISHMENT MANAGEMENT	Annual top dressing with single superphosphate will increase production.
	Winter cleaning the stand is an effective weed control technique on established lucerne.
	Excess production during warmer months can be conserved as hay to feed back over winter.
	Monitor for Cutworm and Brown Pasture Looper in Winter and Spring.
	Monitor for grasshopper damage and Sitonia Weevil in Spring and Summer.
	Seek advice from chemical resellers, agronomists and Primary Industries Department consultants on pest thresholds, chemical weed and insect control options.

GRAZING MANAGEMENT	To effectively manage grazing and increase stand persistence, subdivide and rotationally graze large paddocks. Aim to preserve basal buds. Remove stock when lucerne is grazed down to 5 cm high. Set stocking will damage the crowns and reduce the opportunity for the plant to replenish root reserves.
	The grazing period should be as short as possible (1-3 weeks) with high stocking rates. Spell the paddock for five to six weeks to allow plants to recover and replenish their root reserves.
	It is best to graze paddocks whilst lucerne is still green and leafy. Under dry conditions lucerne will lose leaves with a rapid reduction in feed quality.
	Supply adequate watering points (e.g. central water point) in paddocks to reduce tracking and excessive grazing pressure near the water source.
ANIMAL HEALTH	Bloat can be a potential problem when grazing fresh lucerne (particularly for cattle). Manage this by ensuring stock have access to adequate supply of fibre or by using bloat capsules.
	Wethers can get pizzle rot due to the higher nitrogen content in the urine compared to normal annual pastures (Devenish *et al* 2003).
	Reproductive disorders can occur when lucerne contains high amounts of plant oestrogens when leaves are under stress from disease or insect attack (Devenish *et al* 2003).
	Enterotoxaemia (pulpy kidney) may cause animal losses on lucerne as on other high quality feeds or grain supplements. Vaccinating stock against enterotoxaemia which they can be susceptible to when grazing lucerne will remove confusion of symptoms with bloat. Vaccinate both sheep and cattle (Devenish *et al* 2003).
	Redgut causes sudden death in lambs grazing legume dominant pastures in late winter/spring (Trengove 2004).

Cost of Establishing Lucerne Pasture

LUCERNE			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	4 kg @ $10/kg (Coated seed includes inoculum, fungicide, insecticide and lime)	40
	Companion/Cover Crop	Barley - 30 kg @ $1/kg	30
	Inoculum	In seed coat	-
FERTILISER AND APPLICATION	At sowing	DAP - 60 kg/ha @ $0.55/kg	33
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) - 1.5 L/ha @ $7/L	10.50
	At sowing	Trifluralin (480 g/L a.c) - 1.7 L/ha @ $7/L	11.90
	Post Emergent	Flumetsalum (800 g/kg a.c) -25 g/ha @ $0.80 /g	20
INSECTICIDE APPLICATION	Bare earth at seeding	Chlorpyrifos (300 g/L a.c) - 0.3 L/ha @ $12/L	3.60
	Post Emergent	Omethoate (290 g/L a.c) - 0.1 L/ha @ $40/L	4
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	10.50
	Machinery	$8.50 sowing + $2.00 per additional pass	16.50
TOTAL ESTABLISHMENT COST		**$180/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Chicory *(Chicorum intybus)*

Rainfall: >450 mm where some summer rainfall is likely.

Soil Types: Chicory is well suited to well drained, neutral to slightly acidic (pH > 4.5) soils.

Main Productive Period: Spring and summer

Description

Chicory is a deep rooted perennial herb with deep green, broad, soft leaves.

Chicory is well adapted to light textured soils as its deep root system allows it to use moisture from throughout the profile. It is more tolerant of low pH (acid) soils than lucerne. Chicory is summer growing, making good use of summer rainfall and can be highly productive, particularly when grown as a companion species to a pasture legume.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Deep rooted perennial, aids in soil stabilisation and improved structure.	Should be sown with a legume species for access to a nitrogen source.
	Good pest resistance.	Can become a weed in some circumstances.
	Moderately tolerant of frost, drought and acidic soils.	Requires some summer rainfall to be productive. Will not persist in situations of extended drought.
ECONOMIC	Very high summer productivity.	High fertiliser requirement to maintain production.
	High quality feed, with high protein and digestibility.	May need to provide extra fibre source to avoid animal health issues assosiated with high protein and high digestibility.
	Self regenerating if allowed to set seed.	

Establishing and Managing Chicory

ESTABLISHMENT	**Pre-sowing**
	Ensure adequate control of broadleaf weeds in the year prior to sowing by cropping with a cereal.
	Remove weed competition prior to sowing with a knockdown spray.
	Germination test required as germination can vary from year to year.
	Sowing
	Sow seed shallow into a moist seedbed at a sowing rate of 3 to 5 kg/ha (1 kg if in pasture mix with legume).
	Apply 60 kg/ha DAP with seed.
	Ensure good seed to soil contact by using press wheels, harrows or a roller.
POST ESTABLISHMENT MANAGEMENT	Top dress with phosphorus and nitrogen annually for improved production and persistence.
GRAZING MANAGEMENT	Rotational grazing will ensure maximum production and persistence of the stand.
	If stock are removed and plants occasionally allowed to go to seed, stand density and persistence can be increased (Brouwer 2002).
	Chicory is susceptible to overgrazing. To minimise damage to the crown, do not graze below 5 cm height (Fuller 2007).
ANIMAL HEALTH	As chicory has high amounts of crude protein and energy it can pass through the rumen of livestock very quickly. Ensure that stock have access to adequate sources of fibre (Fuller 2007).
	Ensure stock have access to adequate supply of fresh water.

Cost of Establishing Chicory Pasture

CHICORY			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	5 kg/ha @ $16/kg (fungicide and insecticide coated seed)	80
FERTILISER AND APPLICATION	At sowing	DAP - 80 kg/ha @ $0.55/kg	44
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) - 1.5 L/ha @ $7/L	10.50
INSECTICIDE APPLICATION	Bare earth prior to sowing	Chlorpyrifos (300 g/L a.c) - 1 L/ha @ $12/L	12
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	10.50
	Machinery	$8.50 sowing + $2.00 per additional pass	12.50
TOTAL ESTABLISHMENT COST		**$170/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Perennial Veldt Grass *(Ehrharta calycina)*

Rainfall: >350 mm

Soil Types: Perennial Veldt Grass will grow well on light textured, low pH and low fertility soils.

Main Productive Period: Early spring.

Description

An erect tussocky perennial grass growing 30 to 80 cm high.

Leaves are dull or blue-green in colour, flattened and narrow. The leaves are often tinged in purple and frequently crinkled along one edge. Seed head is narrow, reddish purple and has many small seeds.

Perennial veldt grass is well adapted to low fertility deep sands and can be used to provide surface cover on areas prone to wind erosion. With good management veldt grass stands can provide high quality feed.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Effective in stabilising light textured soils, thereby reducing wind erosion risk.	Can be considered an environmental weed risk, particularly in roadside and bushland reserves.
	Relatively easy to establish. Will become more dense through the spread of plants by seeds and rhizomes.	May need to use wetting agent when establishing on non-wetting sand.
	Highly drought tolerant and persistent.	May harbour weeds and vertebrate pests.
ECONOMIC	Productive pasture on poor soils.	Continuous grazing decreases persistence.
	When managed well, high quality stock feed.	If not managed effectively, feed quality declines rapidly.
	Does not require large amounts of fertiliser to be productive. However will respond well to fertiliser where nutrient levels are deficient.	Perennial pastures are slow to establish and provide little grazing value in the first year.
	Year round production under favourable conditions.	Extremely competitive. Difficult to get other species established in stands for feed balance.

Establishing and Managing Perennial Veldt Grass Pasture

ESTABLISHMENT	**Pre-sowing**
	Ensure good control of grass and broadleaf weeds with a knockdown prior to sowing.
	Sowing
	Sow seed ~ 1 cm deep into moist seedbed at a sowing rate of 1 to 2 kg/ha ensuring good soil to seed contact.
	Direct drill into standing stubble or sow with a cover crop (cereal at 20 kg/ha).
	Trace element deficiencies are common on the deep sandy soils that perennial veldt grass is sown. Use soil test results to determine fertiliser application at seeding.
	Press wheels are of particular benefit in helping to achieve good seed to soil contact and creating a water harvesting furrow when sowing on non-wetting sand.
	Can be sown with an annual legume companion species. Regular fertiliser application will encourage legume component to persist (Freebairn 1989).
POST ESTABLISHMENT MANAGEMENT	Allow stand to set seed in the first year (and every few years after establishment). This will help increase stand density and persistence.
	Will respond to annual top dress with super phosphate. Monitor trace element levels using soil testing on highly leaching soils.
	Broadleaf weeds can be controlled in perennial veldt grass stands. Seek advice from your agronomist or local chemical reseller, Primary Industries Department consultant on chemical products that can be used in your specific situation.
	Perennial veldt grass once established is tolerant of pests and diseases (Freebairn 1989). Seed head can be infected by smut, however this does not seem to affect animal and can be managed by mowing stand.
GRAZING MANAGEMENT	Veldt grass when fresh is highly palatable and roots are very shallow. Care needs to be taken not to damage tillers or uproot plants by overgrazing.
	Rotational grazing will improve the productivity and persistence of the stand. Perennial veldt grass is highly susceptible to overgrazing by set-stocking.

Cost of Establishing Perennial Veldt Grass Pasture

PERENNIAL VELDT GRASS			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	1 kg/ha of seed @ $22/kg	17
	Companion/Cover Crop	Cereal 20 kg/ha @ $1/kg	20
FERTILISER	At Sowing	DAP - 80 kg/ha @ $0.55/kg	44
	Knockdown	Glyphosate (540 g/L a.c) -1.7 L/ha @ $7/L	12
INSECTICIDE APPLICATION	Bare earth at seeding	Chlorpyrifos (300 g/L a.c) - 0.3 L/ha @ $12/L	4
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	7
	Machinery	$8.50 sowing + $2.00 per additional pass	10.50
TOTAL ESTABLISHMENT COST		**$115/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Perennial veldt grass is extremely effective in stabilising sandy soils and can provide high quality stock feed.

Native Grasses

Rainfall: Native grasses grow in all rainfall zones.

Soil Types: Can grow on a wide range of soil types and aspects.

Main Productive Period: Spring/late autumn/early winter

Description

Native grasses are drought resistent perennials which can add value to grazing systems. Native grasses are dependant on such factors as soil texture, pH, rainfall, topography and susceptibility to waterlogging.

Native grass species can be categorised into either C_3 or C_4 plants. C_3 species are generally more productive during cooler months. whilst C_4 are generally most productive in hotter weather.

Native grasses that are common on Eyre Peninsula include members of the following genera;

- Wallaby grass (*Austrodanthonia sp.*)
- Spear Grass (*Austrostipa sp.*)

A wide range of other native grasses including; Windmill grass (*Chloris truncate*) and Brush-wire grass (*Aristida behriana*) may be found in native vegetation, roadsides, saline areas and in paddocks which are lightly or occasionally grazed such as large paddocks with limited water or steep non-arable country.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Provides perennial option for increasing ground cover in low rainfall environments.	Species can be selectively overgrazed reducing persistence.
	Able to seed in both spring and autumn depending on summer rainfall.	Generally adapted to soils with low phosphorus levels.
	Enhances biodiversity and provides food and habitat for native animals.	Spear grasses (*Austrostipa spp.*) is particularly susceptible to overgrazing.
	Drought and frost resistant in low rainfall environments. Will tolerate high temperatures. May respond to summer rainfall.	Thin pastures allow annual grasses to invade, reducing productivity and ground cover.
	Improve soil health (ground cover, nutrient cycling, organic matter and moisture retention).	Density and persistence of Spear grass (*Austrostipa spp.*) can decrease with application of agricultural fertilisers.
ECONOMIC	Low input grazing system for existing pastures. Highly palatable to stock.	Often cost prohibitive to establish from seed.
	Many Australian native grasses are quite tolerant of heavy grazing and recover well with a sufficiently periods of rest.	Generally do not produce the same amount of dry matter that introduced pasture species can.
	Consistent protein levels year round. Advantage in wool production enterprises as these grasses maintain strong wool fibre.	Skin and meat contamination from grass seeds (particularly *Austrostipa spp.*).

Establishing and Managing Native Grass Pasture

ESTABLISHMENT	**Natural Regeneration**
	Managing native grasses to encourage natural regeneration to increase plant density is the cheapest option to establishing a good native grass stand.
	To reduce costs, collect seed from native grasses on the property.
	Pre-sowing
	Ensure good control of grass and broadleaf weeds with a knockdown prior to sowing.
	Ensure adequate soil moisture before sowing. Cultivation may increase rainfall infiltration.
	Sowing
	Austrodanthonia (Wallaby grass) is susceptible to herbicides. Use of herbicides and fertilizers is not recommended at sowing or post sowing.
	Native grass seed can be purchased fluffy, cleaned or pelletised from selected outlets. Specialised seeders are needed to sow seed which is not pelletised.
	Pelletised seed is larger and heavier than the original seed and can be sown through conventional equipment.
	It is best sown in autumn. Ensure that there is adequate soil moisture for germination. Sow seed at a rate of 3 to 5 kg/ha cleaned/pelletised and 5 to 10 kg/ha for fluffy seed, just below surface at 5 to 8 mm. Seed placement can be critical. Can take 14 to 21 days to germinate.
POST ESTABLISHMENT MANAGEMENT	During establishment plants are very weak. Do not graze in the first year.
	Wallaby grass can respond to fertiliser however too much fertiliser promotes annual grasses and weeds to compete with native grasses (Sergeant *et al* 2009).
GRAZING MANAGEMENT	Responds well to short term high intensity rotational grazing regimes with long rest periods.
	Rest to allow native grasses and medics to establish before grazing in early spring. Once native grasses start to elongate stems, reduce stock density to allow seed set of native grasses and medics.
	Establishing a mix of winter active and summer active species can provide year-round feed, provided grazing is well managed.
	Grazing should be managed to reduce annual weed seed set in spring.
	Remove stock to allow seed set of native grasses if stand is thin. Germination of seed will occur following rains (Sergeant *et al* 2009).
ANIMAL HEALTH	Spear grass seeds can contaminate skins and meat of sheep.

Cost of Establishing Native Grass Pasture

NATIVE GRASSES			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	5 kg/ha pelletised seed at $100/kg	500
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) -1.7 L/ha @ $7/L	12
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	7
	Machinery	$8.50 sowing + $2.00 per additional pass	10.50
TOTAL ESTABLISHMENT COST		**$530/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Native grass pasture regenerating after rain.

Austrodanthonia spp. setting seed even after heavy grazing.

Under good conditions, native pasture can produce a high amount of dry matter.

Phalaris *(Phalaris aquatica)*

Rainfall: >400 mm

Soil Types: Broadly adapted to medium to high fertility light to medium soils with pH > 6. Particularly suited to soils that are wet in winter and dry in summer.

Main Productive Period: Late autumn, winter and spring to early summer depending on spring rainfall and cultivar summer dormancy.

Description

Phalaris is a broad leaved, deep-rooted perennial grass species. At the base of the leaf there is a large translucent ligule. New shoots on the crown below the surface are purple to light red in colour. A red sap is exuded from the base of the plant if squeezed.

Phalaris is well adapted to light textured, alkaline soil as its deep root system enables it to draw moisture from deep in the profile. In low rainfall years this enables it to persist better on light textured rather than heavier textured soil. Summer dormancy varies between different cultivars. Summer dormant cultivars are most suited to the low rainfall zones of Eyre Peninsula as they persist better in environments with moisture stress over summer.

Phalaris is particularly sensitive to acid soils where available aluminium is high.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Tolerates short periods of inundation and moderately saline soils.	Sensitive to acidic soils, especially where soil aluminium is high.
	Summer dormancy of underground buds is the key to the persistence of phalaris stands in low rainfall environments.	Summer dormant cultivars are unable to take advantage of isolated summer rainfall events.
	Deep root system can have a benefit in lowering water tables which can help reduce the effect of salinity.	Has potential to become an environmental weed if not managed effectively.
ECONOMIC	Very persistent with appropriate management.	Perennial pastures are slow to establish and provide little grazing value in the first year.
	Highly productive on soils with a high degree of fertility.	Feed quality declines rapidly if not grazed effectively.
	Can be sown with annual legume pasture species such as medic to balance feed quality.	Risk of phalaris “staggers” particularly if grazing with cattle.

Establishing and Managing Phalaris Pasture

ESTABLISHMENT	**Pre-sowing**
	Phalaris seedlings are not very vigorous. It is vital that good control of broadleaf and grass weeds is achieved prior to sowing.
	Sowing
	Sow shallow (<1.5 cm) into a moist seedbed at a rate of 2 to 4 kg/ha in late autumn.
	Ensure good seed to soil contact by using press wheels, harrows or a roller.
POST ESTABLISHMENT MANAGEMENT	Phalaris may be grazed intermittently in the spring of the first year but ensure that stock are removed when the soil dries out.
	Don't cut for hay or silage in the first year. If possible allow to set seed to ensure adequate development of the crown of the plants.
	Monitor for insect pests. Seek advice from your agronomist local chemical reseller or Primary Industries department consultant on pest thresholds and appropriate control measure.
GRAZING MANAGEMENT	Stand should not be grazed heavily in the first year. A light graze in early spring may encourage the stand to tiller (Reed 1999).
	Both production and persistence are improved by rotational grazing.
	Do not allow stock to damage new growth at the base of the plant. The red-purple basal buds are where new growth comes from. Stand life will be greatly reduced if these buds are damaged.
	Removing the stock in late spring on occasion and allowing plants to set seed can greatly improve the life of the stand.
ANIMAL HEALTH	All cultivars of phalaris contain toxic alkaloids which can cause animal health problems. Phalaris "staggers" (most common in cattle) and sudden death are two symptoms of phalaris toxicity (Reed 1999). These issues can be overcome with careful management.
	Phalaris staggers is often an indication of cobalt deficiency in a phalaris based diet. Topdressing stand with cobalt or drenching stock can help minimise the risk (Bickford 2004).
	Phalaris toxicity seems to be less of a problem in newer cultivars of phalaris.

Cost of Establishing Phalaris Pasture

PHALARIS			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	4 kg/ha of seed @ $14/kg	56
	Companion/Cover Crop	Medic (coated seed) - 6 kg/ha @ $7/kg	42
FERTILISER AND APPLICATION	At Sowing	DAP - 80 kg/ha @ $0.55/kg	44
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) -1.7 L/ha @ $7/L	12
INSECTICIDE APPLICATION	Bare earth at seeding	Chlorpyrifos (300 g/L a.c) - 0.3 L/ha @ $12/L	4
	Post Emergent	Omethoate (290 g/L a.c) - 0.1/ha @ $39.60/L	4
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	7.50
	Machinery	$8.50 sowing + $2.00 per additional pass	10.50
TOTAL ESTABLISHMENT COST		**$180/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Phalaris setting seed at Lock in spring of the year of establishment.

Medic regeneration between phalaris plants in the second year of establishment.

Cocksfoot *(Dactylis glomerata)*

Rainfall: > 425 mm

Soil Types: Grows well in shallow infertile soils but requires good drainage. Cocksfoot is well adapted across a range of soil texture and pH. It is tolerant of high levels of available aluminium on acid soils.

Main Productive Period: Autumn to early summer.

Description

Cocksfoot is a tussocky deep-rooted perennial grass, suited to medium to high rainfall areas. It has bluish-green leaves which are distinctly folded.

The seed head is dense and spike-like in appearance when it first emerges. With maturity, it becomes open and branched.

Cocksfoot is well adapted to well-drained, acidic to neutral soils. Its shallower root system enables it to be highly productive on medium to heavier textured soils in high rainfall years. There are two main forms of Cocksfoot, the European and the Mediterranean types. European cultivars tend to be more erect and more summer active than the Mediterranean. Mediterranean types are better suited to environments on Eyre Peninsula as their summer dormancy enables them to persist in areas with frequent prolonged periods of moisture stress.

Cocksfoot is tolerant of high levels of available aluminium on acid soils.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Moderately easy, but slow, to establish. Germination and seedling vigour are exceptionally good.	Cocksfoot can be very persistent and can become the dominant pasture if not managed carefully.
	Summer dormant types have good drought tolerance.	Summer dormancy cultivars not take advantage of isolated summer rainfall events.
	Will tolerate acidic soils and high levels of available aluminium.	Will not tolerate waterlogged or saline soils.
	Tolerant of most insect pests and diseases.	Can be affected by leaf rust.
ECONOMIC	Productive high quality feed source.	Perennial pastures are slow to establish and provide little grazing value in the first year.
	Good persistence under appropriate grazing management.	Requires fertiliser application to remain productive.
	Seed production during spring is high.	Productivity can be reduced by frost.
	Does not have any animal health risks associated with it.	

Establishing and Managing Cocksfoot Pasture

ESTABLISHMENT	**Pre-sowing**
	Ensure good weed control in the year prior to sowing.
	Use a knockdown spray prior to sowing to remove weed competition.
	Sowing
	Sow seed <1 cm deep into moist seed bed at a sowing rate of 2 to 4 kg/ha (1 to 2 kg/ha if in pasture mix) in late Autumn.
	Can be sown using a wide variety of sowing techniques.
	Ensure good seed to soil contact by using press wheels, harrows or rollers.
	Press wheels are of particular benefit in creating water harvesting furrow when sowing on non wetting sand.
	Can be sown with annual pasture legumes (i.e medic, clover) to provide a balance of feed.
POST ESTABLISHMENT MANAGEMENT	Cocksfoot will respond well to nitrogen fertiliser.
	Allow the stand to set seed in the first year to strengthen the crowns of the plants and to increase stand density.
	The quality of cocksfoot based pastures can be maintained by ensuring adequate fertiliser is applied to maintain a good balance of grasses and legumes in the pasture mix. Graze appropriately to ensure that cocksfoot does not become rank and unpalatable.
	Cocksfoot is reasonably tolerant of insect pests once established.
	It can occasionally be affected by rust (Lilicato 1998). Crash grazing the stand to remove infected material is the best way to manage this.
GRAZING MANAGEMENT	Cocksfoot based pastures should not be grazed intensively during the first year of establishment. Grazing should be delayed until plants have formed a strong root system and are well anchored in the soil.
	Feed quality and productivity rapidly declines if cocksfoot is allowed to grow too tall. If plants become rank the stand can be mown to a height of 6 cm to encourage new growth.
	Generally cocksfoot pastures will be more productive and persistent over the long term if they are rotationally grazed. Try to maintain 6 to 8 cm of top growth for maximum productivity.
	Prolonged heavy continuous grazing (especially with sheep) will quickly thin cocksfoot stands. Grazing needs to be closely monitored during summer to avoid plant loss through overgrazing.
	Low crown, prostrate varieties are less susceptible to over grazing by sheep as the buds from which new growth emerges are located closer to the ground.

Cost of Establishing Cocksfoot Pasture

COCKSFOOT			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	4 kg/ha of seed @ $14/kg	56
	Companion/Cover Crop	Medic (coated seed)- 6 kg/ha @ $7/kg	42
FERTILISER AND APPLICATION	At Sowing	DAP - 80 kg/ha @ $0.55/kg	44
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) - 1.7 L/ha @ $7/L	12
INSECTICIDE APPLICATION	Bare earth at seeding	Chlorpyrifos (300 g/L a.c) - 0.3 L/ha @ $12/L	4
	Post Emergent	Omethoate (290 g/L a.c) - 0.1/ha @ $39.60/L	4
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	7.50
	Machinery	$8.50 sowing + $2.00 per additional pass	10.50
TOTAL ESTABLISHMENT COST		**$180/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Annual legumes make excellent companion plants to cocksfoot pasture.

Puccinellia *(Puccinellia ciliata)*

Rainfall: >350 mm and where the watertable is not too deep over summer.

Soil Types: Will grow on slightly acidic to highly alkaline soils, highly saline areas (even where salinity levels have resulted in a bare salt scald) and areas exposed to periods of inundation.

Main Productive Period: mid autumn through to spring haying off in November/ December.

Description

Puccinellia is a highly salt tolerant perennial grass that will tolerate temporary waterlogging. Although a perennial species, it behaves like an annual dying off back to the base when the surface soil dries out during summer. It forms tussocks up to 40 cm high and wide and has long thin leaves.

Puccinellia is highly palatable and has a low salt concentration in the leaves. It is particularly productive where it is inundated periodically.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Salt and waterlogging tolerant. Will colonise bare saline scalds.	Potential to become an invasive weed. Seed spread through wind and water.
	Shades soil over summer reducing evaporation and the concentration of salts at the surface.	Will not tolerate long periods of inundation.
ECONOMIC	Can last up to 10 years.	Soil test and correct fertility deficiencies before sowing.
	Can be highly productive if well managed.	Overgrazing at any stage reduces production in the following season.
	Feed values greatest during winter and early spring.	Permanently waterlogged areas may require diversion drains where practical to run water off site.
	Can help fill the late summer/autumn feed gap as dry feed. Is a complementary feed source to saltbush.	

Establishing and Managing Puccinellia Pasture

ESTABLISHMENT	**Pre-sowing**
	Ensure good control of grass and broadleaf weeds prior to sowing.
	If waterlogging is a problem install shallow drains where practical.
	Cultivate site roughly to allow opening rains to leach salts, reduce sand blasting and surface sealing.
	Sowing
	Sow in autumn after opening rains. If area becomes un-trafficable after rains, dry sowing should be considered.
	Apply fertiliser based on soil test results.
	Broadcast seed over furrows at a rate of 6 - 10 kg/ha using a small seed box or broadcast seed mixed with sowing fertiliser.
	Do not use harrows, particularly on heavy soils or highly saline sites. A light roller may be used on light textured soils post seeding where site is not prone to waterlogging (Liddicoat and McFarlane 2007).
POST ESTABLISHMENT MANAGEMENT	Plants can take up to 2 months to emerge.
	Will take up to 18 months before plants sufficiently developed to withstand grazing.
	Will benefit from phosphorus applications.
	Monitor and control Red-Legged Earth Mite.
GRAZING MANAGEMENT	Will tolerate hard grazing, however overgrazing will reduce production in the following year.
	Allow plants to seed at least every two years.
	Highly digestible when actively growing.
	Has low salt content and makes a good complimentary feed.
	Can be rotationally grazed winter months. However do not graze plants too close to the soil surface if site is likely to be inundated (Smallcombe 2004).
	Feed quality declines as plants dry off over summer. However it still compares favourably with other dry feed (Smallcombe 2004).

Cost of Establishing Puccinellia Pasture

PUCCINELLIA			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	8 kg/ha seed @ $14/kg	112
FERTILISER AND APPLICATION	At Sowing	DAP - 60 kg/ha @ $0.55/kg	33
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) -1.7 L/ha @ $7/L	12
INSECTICIDE APPLICATION	Bare earth at seeding	Chlorpyrifos (300 g/L a.c) - 0.3 L/ha @ $12/L	4
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	8.50
	Machinery	$8.50 sowing + $2.00 per additional pass	10.50
TOTAL ESTABLISHMENT COST		**$180/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Tall Wheat Grass *(Lophopyrum ponticum)*

Rainfall: >350 mm

Soil Types: Broad adaptation to soil texture and pH.

Main Productive Period: Spring, summer, and autumn active plant useful for supplementary summer- autumn feed gap.

Description

Tall Wheat Grass is a tussocky perennial grass with blue green leaves growing to 1.5 m tall.

Tall Wheat Grass is broadly adapted to slight to moderately saline soils. It can be highly productive if well managed on soils that have adequate moisture stored in the subsoil.

It is moderately water logging tolerant but will not persist in areas that are that are water logged over the summer.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Drought tolerant.	Weak seedling but persists once well established.
	Grows well in moderately saline and waterlogged areas.	Is an aggressive coloniser. Will establish easily in non saline areas. Can be considered an environmental weed risk.
	Grows in acid and alkaline soils.	Should not be grown next to primary saline areas.
ECONOMIC	Can carry increased stocking rates if well managed.	
	Supplementary feed during the summer/autumn feed gap.	

Establishing and Managing Tall Wheat Grass

ESTABLISHMENT	**Pre-sowing**
	Ensure good control of grass and broadleaf weeds with a knockdown prior to sowing.
	Lightly cultivate the soil prior to break of season to help leach salts. However the length of time without vegetative cover should be minimised to reduce capillary rise of salts to surface.
	Sowing
	Seed germination tests are strongly recommended, as seed viability decreases rapidly after 2 years.
	Sow in autumn <1 cm deep at a rate of 15 kg/ha. Tall wheat grass is more easily managed if it is sown as a single species pasture option.
POST ESTABLISHMENT MANAGEMENT	Tall Wheat Grass is not very vigorous during establishment. Careful grazing is essential in the first year to maintain leafiness and allow seed set.
	Plants will respond to nitrogen and phosphorus if seasonal conditions are good in spring.
	When poorly managed, tall wheat grass reverts to an unproductive monoculture.
RECLAIMING TALL WHEAT GRASS STAND WHICH ARE UNPRODUCTIVE	Mow plants to a height of 10 cm as the plants send up flowering stems.
	Slashing can result in a dense mat which takes longer to break down and tends to smother the pasture regrowth. By mulching this material it maximises trash removal and protects the crown. Stands can also be burnt to remove dead material and encourage new growth.
	Monitor and control Red-Legged Earth Mite.
GRAZING MANAGEMENT	Pasture height is a major factor in determining feed quality. If plants are allowed to become rank, feed quality declines rapidly. The maximum recommended height of tall wheat grass pasture is 20 cm.
	Rotationally graze plants down to 10 cm in spring to promote good root development and water use (Borg *et al* 2007). This also prevents the spread of tall wheat grass seed and off-site weed issues. (Liddicoat *et al* 2007).
	Graze hard at the autumn break to remove excess trash.
	When grazed correctly, tall wheat grass has the potential cut high quality silage or hay (Nichols 2002).
	Do not graze pasture over winter or spring if the site is waterlogged.
	If stock start to selectively graze, increase the stocking rate or use temporary electric fence to force grazing.

Cost of Establishing Tall Wheat Grass

TALL WHEAT GRASS			
VARIABLE COSTS*			COST ($/HA)
SEED AND INOCULATION	Seed	15kg/ha @ $15/kg	225
FERTILISER AND APPLICATION	At Sowing	DAP - 40 kg/ha @ $0.55/kg	22
	Post Emergent	Urea 50 kg/ha @ $0.50/kg	25
HERBICIDE	Knockdown	Glyphosate (540 g/L a.c) -1.7 L/ha @ $7/L	12
INSECTICIDE APPLICATION	Bare earth at seeding	Chlorpyrifos (300 g/L a.c) - 0.3 L/ha @ $12/L	4
OPERATIONS COST	Labour @ $15/hour	25 min sowing + 5 mins per additional pass	9
	Machinery	$8.50 sowing + $2.00 per additional pass	12.50
TOTAL ESTABLISHMENT COST		**$310/ha**	

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Saltbush *(Atriplex spp.)*

Rainfall: >300 mm

Soil Types: Broadly adapted across soil types and rainfall zones although production is poor on heavy clays and acidic soils.

Main Productive Period: Year round.

Description

Saltbush is a deep-rooted perennial shrub with blue grey foliage. It is hardy and drought tolerant persisting in environments with very low rainfall.

Some species of saltbush, such as Old Man Saltbush (*Atriplex nummalaria*), are able to grow to a height and diameter of three metres.

There are more than 40 species of saltbush (including introduced species) which are well adapted to low rainfall or saline conditions.

	ADVANTAGES	DISADVANTAGES
ENVIRONMENTAL	Can be used as a block planting on saline ground or as alleys where lower salinity levels allow more productive species to grow between saltbush rows.	Does not tolerate excess waterlogging.
	Suitable for a wide range of soil types. Can be used on those areas of the farm that are unprofitable and cause management problems.	Dormant in cool temperatures.
	Long lived and deep rooted perennial, with the ability to reduce recharge and lower the salinity risk.	May harbour vertebrate pests i.e. rabbits.
	Drought resistant. Productive in warmer climates.	Intolerant of acid soils.
	Can be used on light textured soils as a stabilising plant against wind erosion.	Land tied up by saltbush cannot be used for other purposes.
ECONOMIC	Produces high protein forage.	Stock requires ample fresh water.
	Provide year round reliable feed that is not wasted or fouled, "green haystack".	Animals need to be trained to graze. It is not suitable for certain livestock classes e.g. young, pregnant or lactating animals.
	Does not generally require high amounts of fertiliser.	May contain toxic compounds (e.g. Oxalates) which are dangerous for animals at high doses.
	Can be established in alleys with more productive grasses/legumes sown as understorey. Protein of pasture mix can be high (up to 15%).	By itself feed value is low-moderate. Digestibility is low.

Establishing and Managing Saltbush for Grazing

ESTABLISHMENT	**Pre-sowing**
	Carefully consider the area, layout and management requirements of your proposed saltbush stand i.e. alley vs. block plantings, stock water location.
	Control summer active perennial weeds In the spring and summer before planting.
	Deep rip poorly drained or compacted sites to 30 to 50 cm up to 6 months before planting.
	Sowing
	Saltbush can be direct seeded or planted as nursery-grown seedlings
	Use a cover crop on very sandy erosion prone soils.
	Aim for rows approximately 3 m apart. Plants seedlings 1.8 m apart along rows. This will give a total length of rows ~ 3 km/ha and plant density of around 2000 plants/ha.
	On poorly drained or seasonally waterlogged soils plant saltbush on mounded rows.
POST ESTABLISHMENT MANAGEMENT	Plants should be lightly grazed 10 to 12 months following establishment. This will encourage plants to develop the desired shrub form. If plants are not grazed within 18 months they may become woody at the base which results in less fodder available to the sheep. Carefully monitor grazing to ensure that plants are not overgrazed at this time (Liddicoat and McFarlane 2007).
	Although plants can re-shoot within a couple of months, they should not be grazed again for 6 to 8 months to avoid damaging the growing tips.
GRAZING MANAGEMENT	The optimum amount of saltbush in the diet appears to be about 30% of daily intake with remainder being pasture, hay or stubble (Liddicoat and McFarlane 2007).
	Stock need to be acclimatised to eating saltbush over a period of several weeks. This to allow the stomach flora of the stock to adapt to digesting the plant. Stock should be monitored during this period to ensure they don't lose condition (Honeysett *et al* 2004).
	Plants should be grazed heavily enough that stock eat down the taller shoots and prevent the bushes from growing above grazing height (max 1.2 m for sheep).
	Rotationally grazing stock though several blocks of saltbush over a long period of time gives the best results.
	Isolated short term grazing often gives poor production responses as the livestock's digestive systems are not equipped to handle the feed.
	Young stock need to be trained to browse salt bush by older stock (Honeysett *et al* 2004).
	Supplementing feed with hay and /or grain in the final weeks of grazing is sometimes done to allow the stock to fully graze down the saltbush. Stock in poor condition are less likely to do well unless supplementary feed is supplied.
	Ensure there is adequate supply of good quality water (below 1000 ppm) available. Sheep will drink up to 12 L per day on pure saltbush and 8 L per day when other feed is available (Liddicoat and McFarlane 2007).
	Supplementary feed such as hay should be placed at the opposite end of the paddock to water supply to encourage stock to graze saltbush.
	Bushes can be pruned back to about 30 to 50 cm with a farm slasher to improve feed quality and to rejuvenate plants into production. Mechanical topping should not be done in winter as plant growth is slow.
	Most landholders find it valuable to utilise their saltbush stands when other feed sources are scarce, e.g. in times of drought and during the autumn feed gap. Having access to a saltbush stand can reduce the amount of hand feeding required.
	Saltbush maintains its feed value year round and is often referred to as a "green haystack".
ANIMAL HEALTH	An issue with grazing saltbush is oversupply of salt and proteins so restrict intake. Feed should be supplemented with hay or grain if not meeting stock requirements.
	Nitrate poisoning is suspected to occur in young hungry stock grazing on saltbush and may cause death (Honeysett *et al* 2004).
	Oxalates may cause precipitation of calcium in the rumen and kidneys causing kidney damage, calcium deficiencies and gastroenteritis, although this is rare. Sheep voluntarily reduce their feed intake when oxalate levels are high (Honeysett *et al* 2004).

Cost of Establishing Saltbush for Grazing

SALTBUSH				
VARIABLE COSTS*			COST ($/HA)	
			BLOCK 3 m inter-row x 1.8 m plant spacing (total 3 km of rows ~ 2000 plants/ha)	ALLEY 12 m inter-row x 1.8 m plant spacing (total 850 m of row ~ 500 plants/ha)
SEED	Seedlings	$0.25 each	500	125
HERBICIDE	Knockdown	2 m spray width along saltbush row - 1.7 L/ha @ $7/L	0.6 ha - $7.15	0.6 ha - $1.80
OPERATIONS COST	Contractor	$0.20 per plant	400	100
TOTAL ESTABLISHMENT COST			**$907/ha**	**$227/ha**

* Establishment cost is indicative only and intended as a comparison to other pasture species. Costs current as of December 2009.

Growing annual pastures between saltbush rows increases the feed value of saltbush stands.

Rotational Grazing

What is it?

Livestock are rotated through a number of paddocks at high stocking rates to utilise maximum feed in one paddock while other paddocks recover from grazing. The length of time stock remain in a paddock is determined by the available feed and the rate of pasture growth. Rotational grazing is also referred to as high density grazing, strip grazing and cell grazing.

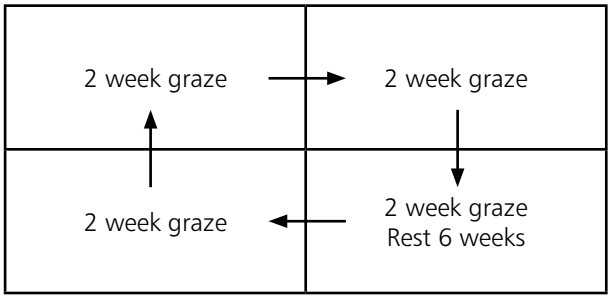
Why use a rotational grazing system?

- To improve pasture utilisation
- To improve ground cover over summer/autumn
- To reduce 'patch' grazing and livestock camps
- Minimise broadleaf weed content
- Decreases the proportion of annual grasses

How is it done?

Large paddocks can be split into smaller grazing units using temporary electric fencing or permanent fencing can be used to create small adjoining paddocks.

A simple rotational grazing system can be created by combining stock from four small paddocks into one large mob/herd and rotating the entire mob through the paddocks one by one. This program aims to graze each paddock for a period of around two weeks grazing with six weeks rest between grazings (see diagram).



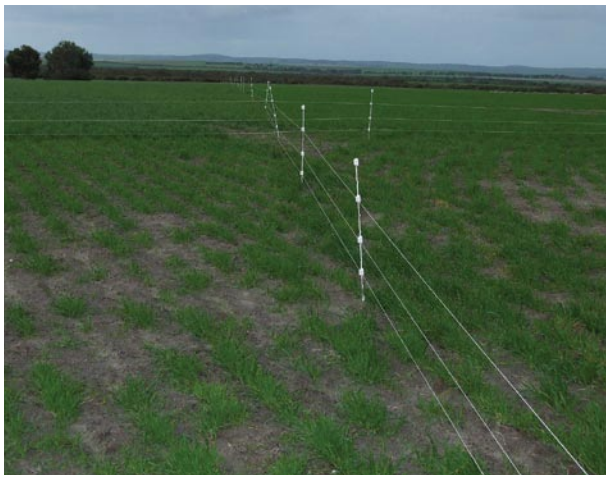
(Meat and Livestock Australia 2007).

Grazing periods in each paddock may be lengthened or shortened depending on pasture response to stocking pressure and seasonal conditions. In periods of high production, rotations may be sped up by reducing the grazing and rest period to one week grazing with three weeks rest. This will help to both utilise feed grown and ensure that pastures remain at their most productive.

Where paddock feed is limited in summer/autumn and in poor seasons, confine stock to area of low inherent wind erosion risk before critical surface cover levels are reached.

Management

Monitor stock condition and pasture feed on offer regularly when using this type of grazing system. Ensure stock have access to a reliable supply of clean water with adequate flow rate so that stock do not hang around water points and baring out the area. An effective strategy for supplying water to stock in this grazing system is to set up a central watering point which is shared between the four paddocks or through the use of portable troughs.



Temporary electric fencing used to split paddock into four grazing "cells".

Central watering point with access from all four cells.

Surface Cover for Wind Erosion Protection

How much surface cover is enough?

Over-grazing paddocks has a number of impacts including;

- Deterioration of stock health where pasture is low.
- Poor regeneration of perennial pastures in following years.
- Colonisation of bare areas by weeds.

However the major impact of over grazing paddocks is the increased risk and severity of wind erosion. Many of the soils on Eyre Peninsula are at a high risk of wind erosion.

Maintaining adequate cover on a paddock in dry season can be a challenge. However once a paddock is bare there are very few options for managing the risk of wind erosion until rains produce some growth.

	MINIMUM COVER		DESIRABLE COVER	
	%	tonnes/ ha	%	tonnes/ ha
Loam	15	0.5	35	1
Sandy loam	20	0.6	50	1.5
Sand	50	1.5	70	2.5

Source: Gale, 2008

Dry matter (t/ha) should only be used as a guide to potential amount of grazing days. It can be difficult to make a visual estimate of dry matter (t/ha). Surface cover to minimise wind erosion risk is a function of cover height and % of ground covered by vegetation.

Assessing dry matter (t/ha) is particularly difficult when the pasture is in various stages of drying off. Whilst the pasture may appear to have a more bulk when it is green, it may contain up to 75% moisture.

Cereals/grasses sown using machinery on wide row spacings (>25 cm) do not generally have as high surface cover percentage over summer as pastures broadcasted or sown with narrow row spacings.

In order to maintain adequate cover and manage wind erosion on susceptible soils stock must be removed from paddocks prone to erosion.

Options for removing stock from erosion prone areas include;

- Selling stock before there is a shortage of cover.
- Agisting stock.
- Confined feeding of stock in areas at less risk of wind erosion - i.e. feedlot in paddock with a heavier soil.

Pasture 2.3 t/ha 90% surface cover (2 to 10 cm height)

Pasture 3.7 t/ha 95% surface cover (2 to 10 cm height)

Pasture 4.3 t/ha 95% surface cover (10 to 40 cm height)

Cereal residue 1.1 t/ha, 30 cm row spacing (2 cm to 10 cm height, 35% surface cover)

Cereal residue 2.3 t/ha, 18 cm row spacing (10 to 40 cm height, 65% surface cover)

Cereal residue 2.3 t/ha, 30 cm row spacing (2 cm to 10 cm height, 40% surface cover)

Glossary

Annual	a plant that completes its entire lifecycle within the space of one year.
Arable	land that is capable of being farmed productively.
Active Constituent (a.c)	the concentration of the ingredient within a pesticide product which is active in controlling the pest.
ARGT (Annual Ryegrass Toxicity)	powerful toxin formed in annual (Wimmera) ryegrass by a combination of a nematode (eelworm) and a bacterium which can be lethal to livestock.
Biodiversity	the number and variety of living organisms in the ecological complexes in which they naturally occur.
Buds	growing points in the crown of perennial plants from which new growth emerges.
Companion Species	plants grown in association with each other to complement e.g. legumes fixing nitrogen to be used by grass pastures.
Competition (weed)	plants that compete against desirable pasture species for moisture and nutrients.
Continuous grazing/Set stocking	grazing by stocking at a consistent density or rate throughout the year, whether or not by the same animals.
Crown	base of stem of perennial plants containing buds from where new growth emerges. Often below the soil surface.
Cultivar	abbreviated from cultivated variety. A plant variety specifically selected for commercial use due to its desirable attributes.
Digestibility	the percentage of the feed eaten which can be used by the animal.
Diploid	a cell having two sets of similar chromosomes.
Dry weight	weight of any plant part after removal of moisture, usually by drying.
DSE	dry sheep equivalents. One DSE is the amount of energy required to feed a 50kg wether in fat score 2.5.
Forb	a herbaceous flowering plant, not a grass.
Feed quality	a measure of the percentage of protein, digestibility, metabolisable energy and fibre in a particular feed source.
Genus (Genera)	a plant or animal taxonomic classification. Subdivision of family. Each genus is made up of many species.
Germination	the start of growth of a seed or other reproductive cell after a period of dormancy.
Grass-freeing	using a grass selective herbicide in legume pasture to remove competition from grass weeds.
Hard-seed	seed which is dormant for an extended period (>1 year) because of the impermeability of the seedcoat to water. Is important in the self regeneration of annual pastures.
Holistic	taking into account all things.
Improved pastures	pastures sown with introduced species of grasses and or legumes.
Inoculate	the addition of the appropriate bacteria (rhizobia) to legume seed to promote the development of nitrogen fixing nodules on the plants roots.

Knockdown	non selective herbicide used to control weeds prior to sowing (usually based on glyphosate or paraquat/diquat).
Leaf blade	in a grass the part of the leaf that folds away from stem.
Leaf area index	the percentage of the ground covered if the green leaf matter of a pasture plant was laid out as a single layer. Important for estimating photosynthesis and the rate of plant growth.
Legumes	plants that have the ability to take nitrogen from the atmosphere and convert it to a form that can be used by the plants.
Ligule	a projection at the junctions of the leaf blade and leaf sheath in grasses.
Native species	organism e.g. plant, that is found naturally in Australia. Not introduced from overseas. An endemic species is a native species naturally occuring in a specific area.
Node	growing point of a plant after a period of stem elongation.
Non-arable	land that cannot be cultivated.
Non-wetting	soil, often light textured, on which water does not easily infiltrate due to organic wax coatings on the soil particles.
Pasture	grasses and legumes planted for grazing.
Pelletised/ Coated seed	seed coated with a protein covering and sometimes other additives to protect the seed, enhance germination and in some cases provide a uniform size to improve sowing.
Perennial	plant with a life span extending over more than two growing seasons.
Persistence	continues to grow and survive in an area under adverse conditions.
Plant back periods	the length of time after which a chemical is applied to a paddock before plants that are sensitive to that chemical can be sown.
Press wheel	a wheel attached to seeding machine to apply pressure in seed row to increase soil to seed contact and create a firm furrow.
Prostrate	growth habit that is flat against the ground.
Rank	pasture growth (commonly perennial) under utilised by stock allowing it to grow tall with a high amount of poor quality dry material.
Recharge	the replenishment of water in the ground, e.g. through injection or infiltration from surface water into groundwater aquifers.
Rhizomes	A creeping stem, usually below ground from which new shoots arise.
Rotational grazing/ Cell grazing	a grazing system which involves rotating stock through a series of small grazing areas (either paddocks or "cells" created by temporary electric fencing) to allow maximum feed utilisation and time for the pasture to recover.
Seed bank	amount of seed set by pasture and lying dormant on the soil surface which may germinate under suitable conditions.
Seed dormancy	the resting or inactive phase of plants or seeds. Dormancy of shoots is usually in response to unfavourable environmental conditions.
Senescence	point at which a plant begins to die.
Spp.	abbreviation for species. Often used when referring to more than one species within the same genus.

Spray-topping	spring herbicide treatment of pasture to restrict the development of seed heads, particularly grasses.
Stand (pasture)	area of pasture. Particularly when referring to perennial pastures.
Stocking density	the number of animals per unit area of land at a point in time; the number (DSE) in a paddock at any one instant.
Stocking rate	the number of animals per unit area over a given period; the total number of dry sheep equivalents run per hectare (DSE/ha) on a farm or paddock averaged over a calendar year.
Summer active	species giving production during summer.
Summer dormant	perennial plant where buds remain dormant until autumn rains.
Tetraploid	a cell having three sets of similar chromosomes.
Tiller	a stem produced at the base of grass plants. Tillers are segmented, each segment possessing its own two-part leaf. They are involved in vegetative reproduction.
Top dress	application of fertiliser to crop or pasture post-establishment.
Trifoliate	having three leaflets.
Tussock	a compact, densely tufted growth form of some grasses and sedges.
Winter active	species giving production during winter.

Further Reading

General Pasture Information

A Guide to Better Pastures in Temperate Climates - Brouwer, D (ed.) (2002), NSW Agriculture.

Pasture Management - Bickford, R. (2004) Inkata Press.

Improving Feed Utilisation, Producer Success Stories - (2009) Eyre Peninsula Natural Resources Management Board.

Perennial Pastures for areas receiving less than 800 mm annual rainfall - Studmeyer, R., Saunders, C., Maling, I., and Clark, T (1994), Ag Victoria.

Pasture Assessment and Livestock Production - Bell, A. (2006) Primefacts Fact Sheet.

Inoculating and Lime Pelleting Pasture Legumes - Brown, S. and Revell, C., (2005) AgDex 137/23, Department of Agriculture, Western Australia.

Grasses of South Australia. An illustrated guide to the native and naturalised species - Jessop, I, Dashort, G. and James, F. (2006), Wakefield Press.

Use of Saltbush and other Perennials on Eyre Peninsula - (2010) Eyre Peninsula Natural Resources Management Board.

Annual Pastures

Pasture Legumes for Temperate Farming Systems - The Ute Guide - Wurst, M. (2004) Primary Industries and Resources SA.

Short Lived Ryegrasses - Reed, K. (2000). AG0709 (Jan 2000). AgVic.

Tetrone Italian Ryegrass - Seed Distributors (2008) Information sheet.

2006 Forage Sorghum Guide. South Australia - Etherton, A (2006). Pacific Seeds Pty Ltd.

The Forage Book - Stuart, P.N (Ed) (1993) - Pacific Seeds.

Sheep infertility from pasture legumes - Croker, K., Nichols, N., Barbetti, M., Adams, T. (2005) Farmnote 41/2005. Department of Agriculture, Western Australia.

Perennial Pastures

Prospects for Profitable Perennials in Mixed Farming Systems - S. Bennett (2009). Future Farm Industries CRC and School of Biology, UWA.

Lucerne

Success with Lucerne - Stanley, M., Britton, R., Cristinat, R. (2002) Primary Industries and Resources SA.

The Lucerne Management Handbook - Bullen, K. (ed.) (2002), 4th Edition DPI Queensland.

Lucerne in Pasture and Crop Rotations, Establishment and Management - Latta, R., Devenish, K. and. Bailey, T. L. (2003). Farmnote No 26/2003, Department of Agriculture, WA.

Lucerne for Pasture and Fodder - McDonald, T., Nikandrow, A., Bishop, A., Lattimore, M., Gardner. P., Williams. R. and Hyson, L (2005). Agfact P2.2.25, third edition NSW Agriculture.

Grazing sheep and cattle on dryland lucerne - Devenish, K., Lacey, T., and Latta, R (2003). Farmnote 27/2003. Department of Agriculture, Western Australia.

Perennial Veldt Grass and Native Grasses

Perennial Veldt Grass - Freebairn, R (1989). Agfact P.2.5.27. Department of Agriculture and Fisheries NSW.

Managing Sandy Soils on Eastern Eyre Peninsula - Honan, I (2003) Envirofund Project Booklet.

Perennial Veldt Grass in the River Dutton Catchment - Marshall, N (2005) Fact Sheet. River Dutton Catchment Project. Eyre Peninsula Natural Resources Management Board.

Grazing management of Danthonia and Microlaena based native pasture - Garden, D., Dowling, P (1999) Tips and Tools for Sustainable Grazing Systems No 6/99. Meat and Livestock Australia.

The key ingredients in the successful broad-scale sowing of native grasses - Chivers, I. (2006), Native Seeds Pty Ltd.

Phalaris and Cocksfoot

Phalaris - Reed. K., AG0712 Fact sheet (December 1999) DPI Victoria.

Cocksfoot - Lilicato, S., AG0715 Fact sheet (January 1998) DPI, Victoria.

Saltland Pastures (Saltbush, Puccinellia and Tall wheat grass)

Saltland Pastures in Australia: a practical guide - Barrett-Lennard, E.G., Malcolm, C.V. and Bathgate, A. (2003) 2nd edition.

Saltland Pastures for South Australia - Liddicoat, C. and McFarlane, J, (2007) Department of Water, Land and Biodiversity Conservation Report No 2007/08.

Sheep production on puccinellia-based pastures in South Australia - Edwards, N.J., Hocking Edwards, J.E., Sanders, D. and Revell, D.K (2002) in Animal Production in Australia 24: 293.

Urea applied to puccinellia pastures increases sheep production. Fenton, M.L., Edwards, N.J., McFarlane, J.D., Craig, A.D., Abraham, E.A. and Hocking Edwards, J.E. (2004) in Animal Production in Australia 25: 241.

Puccinellia cilata for the Wimmera - Smallcombe, A (2004). Ag 1161, Dept of Primary Industries Victoria.

Getting the Best from Old Man Saltbush - B. Honeysett, P. Milthorpe, M. Wynne. (2004) Agfact P.2.5.43 (first edition) Department of Agriculture NSW.

Oldman Saltbush - Farmer Experiences in Low Rainfall Farming Systems - B. Bartel and A. Knight (2000). Primary Industries and Resources SA.

Management of Tall Wheat Grass - Borg, D (2007) - Agnote Ag1287. Dept of Primary Industries, Victoria.

Establishing and managing tall wheat grass in saline soils for productivity - Nichols, C (2002) - Agnote Ag0707, Dept of Primary Industries, Victoria.

Useful Websites

Future Farm Industries CRC - profitable perennials. www.futurefarmcrc.com.au

EverGraze - Perennial pastures including native grasses. www.evergraze.com.au

Saltland genie - Pasture options for salinised land including decision making tools. www.saltgenie.org.au

South Australian Resource and Development (SARDI) pastures group. www.sardi.sa.gov.au/pastures

Meat and Livestock Australia - information, tips and tool on pastures and grazing management. www.mla.com.au

References

Ashton, B. (2009) *Livestock water quality and consumption.*

Borg, D. (2007) *Management of Tall Wheat Grass* - Agnote Ag1287, Dept of Primary Industries Victoria.

Bickford, R. (2004) *Pasture management. Practical farming series*. Inkata Press.

Brouwer, D. (ed.) (2002) *A Guide to Better Pastures in Temperate Climates*, NSW Agriculture.

Brown, S. and Revell, C. (2005) *Inoculating and Lime Pelleting Pasture Legumes* (2005) AgDex 137/23, Department of Agriculture, Western Australia.

Croker, K., Nichols, N., Barbetti, M. and Adams, N. (2005) *Sheep infertility from pasture legumes* - Farmnote 41/2005. Department of Agriculture, Western Australia.

Gale, G. (ed.) (2008) *Surface cover for wind and water erosion protection*, Fact Sheet 89, August 2008. DWLBC.

Devenish, K., Lacey, T., and Latta, R. (2003) *Grazing sheep and cattle on dryland lucerne Farmnote* 27/2003 - Department of Agriculture, Western Australia.

Etherton, A. (2006) *Forage Sorghum Guide - South Australia*, Pacific Seeds Pty Ltd.

Freebairn, R. (1989) *Perennial Veldt Grass* - Agfact P.2.5.27. Department of Agriculture and Fisheries NSW.

Fuller, B. (2007) *Pasture Solutions* - Wrightson Seeds.

Honeysett, B., Milthorpe, P. and Wynne, M. (2004) *Getting the Best From Old Man Saltbush* Agfact P.2.5.43 (first edition) Department of Agriculture NSW.

Liddicoat, C. and McFarland, J. (2007) *Saltland Pasture for South Australia* - DWLBC.

Lilicato, S. (1998) *Cocksfoot*, AG0715 Fact sheet - DPI Victoria.

Matic, R., Nagel, S. and Saunders, R. (2009) *Vetch variety sowing guide*, FS80/01/09, Primary Industries and Resources SA.

Meat and Livestock Australia. (2007) *Getting started with simple time-based rotational grazing*, MLA Tips and Tools information sheet, April 2007.

Nichols, C. (2002) *Establishing and managing tall wheat grass in saline soils for productivity* - Agnotes Ag0707. Dept of Primary Industries, Victoria.

Reed, K. (1999) *Phalaris*, AG0712 Fact sheet, DPI Victoria.

Smallcombe, A. (2004) *Puccinellia cilata for the Wimmera* - Ag 1161 ISSN 1329 -8062 Dept of Primary Industries, Victoria.

Sargent, K., Mitchell, M., Nie, Z., Hirth, J. and Virgona, J. (2009) *Management of Native Pastures in Victoria*, Evergraze.

Trengove, C. (2004) *Redgut and how to prevent it in SA Lamb*. Vol. 30, August 2004, pg 4.

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