



Use of saltbush and other perennials on Eyre Peninsula



Government of South Australia
Eyre Peninsula Natural Resources
Management Board



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1 INTRODUCTION

Growing Saltbush on Eyre Peninsula

In order to address natural resource management issues such as soil erosion, dryland salinity and sustainable agriculture, landholders on Eyre Peninsula have been encouraged to establish saltbush and other perennials through a range of incentives. Outcomes sought from these incentive programs included remediation of soil erosion, lowering water tables to address waterlogging and salinity while at the same time providing landholders with some grazing benefits. Historically, support was provided largely by State Government agencies and funded through the Commonwealth Government's Natural Heritage Trust (NHT). More recently, support has been provided by the Eyre Peninsula Natural Resources Management (EPNRM) Board via incentives for on-ground works.

Saltbush has been promoted on Eyre Peninsula (Lamont 1996; Bartel 2000) for use in the following situations:

- to reduce erosion risk
- as a drought risk management tool
- to cover the autumn feed gap
- for deferred grazing
- to increase carrying capacity
- to provide shelter for stock
- to minimise groundwater recharge.

Early Primary Industries South Australia District Office Information Sheets promoted Old Man Saltbush (*Atriplex nummularia*) for fodder production on non-saline soils (Lamont 1996). Livestock could obtain maintenance rations for growth and productivity from Old Man Saltbush with supplementary feed. Other publications also have promoted saltbush for improving saline areas.

A decade has passed since the last state-wide review on the utilisation of saltbush by Bartel and Knight in 2000. Little is known about how landholders on the Eyre Peninsula utilised saltbush with the exception of a few case studies in the 2000 review.

In this publication we explore what experts in the literature say about saltbush and glean first hand experiences from Eyre Peninsula farmers who are using saltbush and other perennials in their farming enterprises.





2 TECHNICAL BACKGROUND

WHAT THE EXPERTS SAY

This section summarises the saltbush literature. In Appendix One a Saltbush Fact Sheet collates and concisely summarises this information.

Site Preferences

Saltbush is drought and frost tolerant, well adapted to low rainfall conditions, long lived, originating in arid and semi-arid areas of Australia. It grows in rainfall zones from 175 mm to 500 mm per annum (Phelan 2006).

Old Man Saltbush is generally recommended for use on marginal land where the summer active component of the pasture is often very poor quality. It is adaptable to most soil types, including saline ground, deep sands, granite upland slopes and rocky limestone. According to Bartel (2000) some practitioners are advocating its use on fertile land.



Figure 1 Saltbush (background) is remarkably salt tolerant but does not grow in waterlogged soils.

Nutrition Considerations / Feed Value

The high concentration of salt in the forage is said to be a major factor in limiting the value of salt land pastures for grazing animals. The salt concentration in the saltbush leaf is higher on saline sites, which can inhibit livestock performance if other inter-row feed is not available (Bartel op. cit). It is suggested that condition scores, rather than weight, needs to be used as a measure of sheep condition when grazing saltbush. This is because the body composition of sheep grazed on saltbush contains 10-15% more water in their bodies than sheep grazed on non-saline pastures (Bartel 2000). Saltbush contains up to 25% salt, so in an effort to dilute the toxic salt load, additional water is retained in the body tissues and intestinal tract. Other saline fodder such as Puccinellia (*Puccinellia ciliata*), Balansa Clover (*Trifolium michelianum*) and Tall Wheat Grass (*Lophopyrum ponticum*) are also used to improve saline sites in the region and the foliage of these species contains less salt than saltbush and provides better feed value.

Improved pasture quality and quantity is often noted between saltbush rows on saline sites. It is thought that saltbush rapidly uses water after summer rain and lowers the water table, allowing grasses, sedges and



Figure 2 Saltland site with Puccinellia and saltbush.



rushes to occupy the site. Saltbush is summer active, responding well to summer rain, and is not noticeably affected by competition from winter growing species such as Annual Rye Grass and Puccinellia. However, Tall Wheat Grass actively competes for water and nutrients with Old Man Saltbush as they are both summer active species.

Saltbush can also be established as an alley system with more productive grasses/legumes/cereals sown in between the rows. The protein contained in a pasture/cereal mix can be up to 15% higher than saltbush, and will provide better nutrition for livestock, while still addressing other natural resource management issues.

Saltbush may contain toxic compounds (e.g. Oxalates) which are dangerous to animals at high doses. 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).

Vitamin B12 deficiency in livestock grazing saltland pastures was identified in a trial in the South East of South Australia (Liddicoat 2007). This may or may not be a problem, depending on mineral levels in stock and the use of supplementary feed.

Meat from sheep grazing saltbush is high in Vitamin E in comparison to sheep grazing dry pasture (Pearce 2004). This could protect sheep from a muscle wasting disease known as nutritional myopathy. Vitamin E also preserves the red colour of the meat and prolongs its shelf life.

Digestibility	48-55%
Metabolic Energy ¹ (ME)	5.3-8.2
Protein	12-16%
Dry Matter	20-30%
Vitamins and Minerals	High in vitamins and minerals, especially Vitamin E High in oxalates and potassium, which can induce calcium deficiency
Salt	25%

Table 1 Nutrition Summary of Old Man Saltbush.

Stock Intake / Feed Budget

Sheep can only consume a maximum of 800 grams of saltbush dry matter per day as their intake of salt per day is voluntarily limited to just 150-200 grams. Sheep require 10 to 14 litres of good quality water and energy to flush salt from the system. If the salt intake is too high then the feed will be flushed through the system undigested.

When grazing stock in a saltbush stand feed budgets should be calculated on 500 g dry matter per day at 6 units of Metabolic Energy /kg of DM = 3 ME per day. One DSE (dry sheep equivalent) requires 8.5 ME per day. The importance of the inter-row understorey or supplementary feeding with grain or hay to provide additional energy is critical to allow sheep to maintain condition.

Saltbush is not high quality fodder and will not fatten sheep above forward store condition. A mixture of supplementary feeding (hay or grain) or good quality pasture between the bushes is required as part of the diet for sheep to maintain their condition score (Table 2).

Dry Matter per shrub per annum	1 kg
Dry Matter per ha	1,000 kg (1,000 plants/ha)
DSE/ha per month	33 DSE (plus hay/grass)

Table 2 Saltbush Production Summary ².

The optimum amount of saltbush in the diet appears to be about 30% of daily intake with the remainder being pasture, hay, grain or stubble.

Establishment

Site preparation is essential for success. This includes:

- weed control during spring and summer before planting
- mounding on poorly drained or seasonally waterlogged sites
- deep rip heavy, poorly drained or rocky sites to 30 to 50 cm depth up to 6 months before planting,
- scalp on well drained sandy sites
- establish cover crops on very sandy erosion prone soils.

¹ One Dry Sheep Equivalent requires 8.5 ME per day

² Based on 6 m inter row spacing and 1.8 m plant spacing, ~1,000 plants per ha





Climate Variability

While success of establishment is largely determined by the weather, it is also possible to optimise chances of success in poor seasons.

There needs to be sufficient soil moisture available and good weed control to optimise the success of planting saltbush. If soil moisture does not occur, or occurs too late in the season, establishment should be postponed until the following year.

Establishment Costs

It is important to carefully consider the area, layout and management requirements of your proposed saltbush stand i.e. alley vs. block plantings, stock water location; inter-row spacing; and fencing. Orientation of the rows is determined by knowing the most damaging wind directions and ensuring that rows are at right angles to these extreme wind events.

In lower rainfall areas, plant saltbush up to 6 metres apart to maximise growth of grass, legume and cereal feed between the rows. This will also reduce the cost of establishment and allow farm machinery access between rows. Costs of planting are highlighted in Table 3. These costs do not include:

- lost opportunity costs from 1-2 years of lost grazing (only on more productive sites);
- cover crop costs on very sandy erosion prone soils;
- ripping/scalping/mounding;
- fencing;
- repositioning or establishing water points;
- labour costs associated with watering plants over the first summer.

Higher planting densities with 3 m between rows maximises the leaf area and are recommended for saline or wetter sites to maximise the rate of water use.

One study in the use of cover crops in the Murray Mallee (Bolto 2008) showed variation in success. Cover crops provide protection but can compete for moisture. It is important that cover crops are sprayed out once saltbush plants are established.

Grazing Management

Saltbush can be grazed by either sheep or cattle. In regard to sheep, saltbush is more readily used by older sheep and wethers and is not considered suitable for young, pregnant or lactating animals (Warren 1995).

Plants should be lightly grazed 10 to 18 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. It is critical to carefully monitor grazing to ensure that plants are not overgrazed at this time.

In the year following establishment, grazing should be light to encourage lateral branching, however it is important not to overgraze and damage the growing tips. In following years plants can be grazed to remove most of the leaf. Established plants which are overgrazed will reshoot however recovery will be slow. Saltbush will start to reshoot within a couple of months but should be rested for 6 - 8 months to allow the plant to fully recover.

Manage Pests

Rabbits and kangaroos will damage new seedlings in the first 10 months and are best controlled to prevent plant loss.

Saltbush plantations can harbour foxes. It is best practice to minimise lambing losses by implementing a fox baiting program prior to lambing.

Distance between rows (m)	Spacing within rows (m)	Plants per ha	Herbicide Costs (2 m spray row width - 1.7 L/ha @ \$7/L)	Cost/ha ³ (25c/plant; 20c contract planting)	TOTAL COST/HA
3	1.8	2,000	0.6 ha - \$7.15	\$900	\$907
6	1.8	1,000	0.3 ha - \$3.57	\$450	\$454
12	1.8	500	0.15 ha - \$1.80	\$250	\$252

Table 3 Establishment Costs of Saltbush.

³ These costs do not include 1-2 years of lost grazing; cover crop costs; ripping, mounding or scalping; fencing; repositioning water points or labour costs associated with watering plants over the first summer.



Rotationally Graze

To achieve the best results, saltbush management requires rotational grazing. This grazing system is also called high density grazing, short duration grazing, block and strip grazing, planned grazing and cell grazing. A rotational grazing system:

- improves utilisation of all feed, including more even grazing of saltbush
- improves ground cover over summer/autumn
- reduces 'patch' grazing and livestock camps
- prevents 'leggy growth' of saltbush
- minimises broadleaf weed content
- decreases the proportion of annual grasses.

Saltbush fodder blocks need to be grazed heavily so that stock eat down the taller shoots and prevent the bushes from growing above grazing height (Figure 3) - this is particularly so for Old Man Saltbush. Sheep can only graze to a height of approximately 1.2 m. Bushes that grow above this height can be slashed back to 30-50 cm with a slasher or grazed by larger stock such as cattle. Slashing should be avoided in winter as saltbush is summer active and regrowth will be slow. If left unpruned bushes above grazing height become woody with new growth concentrated in the upper branches. Blocks must be small enough and flocks large enough so that all of the bushes are grazed down within 6-8 weeks or less. Although plants can re-foliate in six weeks, plants need to be rested for 6 to 8 months to avoid killing them. Saltbush can be grazed at any time of year as the feed value is similar across all seasons.



Figure 3 'Pom poms' developing on taller shoots above grazing height.

Acclimatise Stock to Saltbush

It is recommended to start rotations with mature dry stock. If stock are not used to saltbush, they will not immediately graze it. Stock will need to be acclimatised to eating saltbush over a period of several weeks. This acclimatisation time will allow the stomach flora of the stock to adapt to digesting the plant. However, monitor stock during this period to ensure they don't lose condition. Young stock will need to be trained to browse saltbush by older stock.

Use It or Lose It!

A study by Norman (2007) found that:

- grazed shrubs grow faster than ungrazed
- both grazed and ungrazed saltbush drop leaves
- there is little advantage in deferring grazing between years.

The Norman study demonstrated that heavy grazing of mature Old Man Saltbush has little detrimental impact on the amount of edible dry matter available at the start of the following autumn. It appears that over dry periods, if the leaf matter is not grazed, saltbush will lose leaves, presumably due to moisture stress. The message here is 'use it or lose it'!

Watering Tips

To compensate for the high salt content, stock require access to ample quantities of high quality water, preferably below 1000 parts per million (ppm), when grazing saltbush (Bartel 2000; Ashton 2009). Consumption of water can increase by up to two to three times the amount consumed on non-saline pastures.

Consumption of water by sheep is about 12 litres water per day on pure saltbush, and eight litres per day when there is an understorey of dry feed (Ashton 2009; Table 4). If sheep are only able to drink once a day on saltbush pasture, they will reduce the amount of saltbush they eat, lose weight and production will decline.

Develop a water plan and a reticulation scheme for your saltbush plantations.

Daily water requirements will vary depending on class of stock, quality of water, salinity, time of year, feed type, and walking distance to water. In developing a water budget consider spillage, evaporation, cleaning, leaks and seepage.





Utilisation of paddock feed will improve depending on the location of the trough within a saltbush plantation. Placing a 2.4 m to 3.6 m trough in the centre of a paddock encourages more even grazing.

It is critical to ensure there is adequate water flow to the trough so that sheep are not waiting for a drink, particularly with the high salt content in their feed. If stock have to travel too far to water, areas closest to the trough will be grazed out first whereas in areas furthest away from the watering point, feed is left untouched or underutilised.

Placing supplementary feed at the opposite end of the paddock to the water trough will encourage better feed utilisation and reduce camping around the water trough.

Animal	Litres per day (grassland)	Litres per day (saltbush)
SHEEP		
• Weaner	2-4	4-8
• Adult dry sheep grassland	2-7	4-14
• Ewes with lambs	4-10	8-20
CATTLE		
• Weaners	25-50	44-70
• Dry stock	35-80	60-112
• Lactating cow	40-100	70-140

Table 4 Stock Water Requirements.

When estimating how much water should be allowed, consider the following:

- Salinity of water
- Size of flock
- Type of stock ⁴
- Time of year
- Feed type
- Lactation
- Walking distance
- Flow rate and reliability.

Mob Size (DSE)	Flow rate (Litres per second)
1,000-2,000	1-1.5
2,000-3,000	1.5-2
3,000-5,000	2-3
Greater than 5,000	3

Table 5 Suggested Water Flow Rates.

Saltbush Species and Varieties

Other species and varieties of saltbush have been grown and are commercially available from specialist stockists in South Australia. These include River Saltbush (*Atriplex amnicola*), which is more palatable and produces more biomass (leaf matter) than Old Man Saltbush and does not grow as high (Saltbush species are summarised in Table 6). However, this species is not as hardy and has poorer nutritional value. When the two species are grown together, river saltbush can be overgrazed (Bartel 2000). Eyre's Green Saltbush is another variety being promoted in SA that is a selected clone cutting derived from an Old Man Saltbush on Eyre Peninsula that has good lateral growth (Topline Nurseries accessed on line at <http://www.toplinenurseries.com/index-3.html> 16 November 2009). It is claimed that this variety grows rapidly and recovers more quickly from grazing than other species.

Future Farm Industries Co-operative Research Centre (FFICRC)

FFI CRC's *Enrich* project is currently evaluating nearly 70 Australian perennial native shrubs for their forage potential. Plants are being assessed against a range of criteria, including conventional growth performance, nutritive value of edible material, and 'bioactive' properties, such as their effects on ruminant microbes or intestinal parasites. Short lists of plants with the most desirable attributes are subsequently being trialed across southern Australia over varying rainfall and soil types.

Three of these sites are located on Eyre Peninsula, at Elbow Hill, Minnipa and Streaky Bay. By monitoring biomass, yield and stock grazing habits, landholders hope that this research will produce a broader suite of economically viable perennials, suitable for a range of land conditions. This will provide more options for farmers to manage their high risk erosion prone cropping soils while still able to generate income.

Further information about *Enrich* and other FFICRC perennial research programs can be found at <http://www.futurefarmonline.com.au/>

⁴ British sheep breeds drink ~ 20% more water, and cattle drink more than sheep



Saltbush Species & Varieties	Rainfall	Advantages	Disadvantages
Old Man Saltbush (<i>Atriplex nummularia</i>)	175-400 mm	- Highly drought tolerant - Highly frost tolerant - Moderate tolerance to salinity - Long-lived perennial - Grows in a range of soil types - Equal or better nutritional value compared with other saltbush species.	- Growth can grow above grazing height of sheep and get woody - Less palatable than other saltbush species - Higher salt content in leaves compared to river saltbush.
'De Koch' variety	175-400 mm	More palatable than regular Old Man Saltbush.	
'Eyre's Green' variety	175-400 mm	- Good lateral growth - Recovers quickly from grazing - May get more grazing (up to 3 times per year).	- Management required to encourage lateral growth in first year following establishment (through grazing or slashing) - Slower to grow on saline sites.
River Saltbush (<i>Atriplex amnicola</i>)	250-550 mm	- Highly palatable - Moderate to high tolerance of salinity - Moderate to high tolerance of winter waterlogging - Does not grow as high as Old Man Saltbush - Produces more biomass (plant matter).	- Less hardy; - Lower digestibility - Lower concentration of crude protein - Higher fibre concentration - Poorer stock performance (liveweight, wool) (Norman 2008) compared to Old Man Saltbush - Difficult to establish from seed - direct seeding not recommended.
Creeping Saltbush (<i>Atriplex semibaccata</i>)	250-500 mm	- Very palatable, especially when young - Up to 40 cm high, prostrate sub-shrub.	- Short-lived - Easily overgrazed - Suitable for use in landscaping for fire protection.
Wavy Leaf Saltbush (<i>Atriplex undulata</i>)	250-500 mm	- Low growing - Moderate tolerance to salinity - Can be direct seeded.	- Native to Argentina - Less tolerant to waterlogging - Low biomass - Does not withstand heavy grazing.

Table 6 Comparison of Saltbush Species.





Weeds and Weediness

Many natural areas are threatened by the invasion of exotic (non-native or introduced) plant species. These exotic species invading natural areas are known as environmental weeds. Weediness issues are not just limited to introduced species. Some non-local native species planted outside of their natural range can be 'weedy' in new environments. Old Man Saltbush, River Saltbush and Creeping Saltbush are all native to Australia, and while their potential for weediness is unknown, they are not thought to be of concern as they are naturally widespread.

New plant species introduced for productive purposes are potentially significant environmental weeds. *Phalaris*, *Puccinellia*, Tall Wheat Grass and Perennial Veldt Grass are examples of environmental weeds invading natural ecosystems and roadsides. Grazing is an important part of minimising the spread of these species so that they do not set seed. Avoid planting upstream of wetlands and close to natural areas to minimise the potential for invasion and posing threats to biodiversity.

Biodiversity

Few studies have looked at investigating the conservation and biodiversity values of saltbush and saline pastures. However, it is thought that there are ecological benefits from improved water management, reduced salt export and improved ground cover as a result of the introduction of perennial pastures in saline areas. Perennial pastures reverse some, but not all, of the impact. Bare salt scalds have almost negligible biodiversity (King 2006). Salinity itself has a negative impact on biodiversity. Where vegetation is present in saline areas, microbial activity in the soil can be 10 times higher.



Figure 4 Orange Chat in saltbush stand.

Unless fenced off, saline sites are almost always excessively overgrazed. Sheep in particular often camp on these sites in summer, as the soils are moist and cool. Fencing off saline areas often produces a surprising amount of feed from volunteer species. Fencing and careful grazing can increase ground cover cost effectively (see also *Saltland Genie* website www.saltlandgenie.org.au).

A pilot study in the southern Murray-mallee region of South Australia demonstrated that saltbush provided partial habitat for birds (Collard 2009). Collard concluded that saltbush stands have a potential role to play in achieving multiple natural resource management outcomes for both biodiversity conservation and sustainable land management. Saltbush sites contained a diverse range of plant, bird and invertebrate (insect) species, including threatened bird species not found in adjacent pasture sites. Insects found in this study included a mix of species, some of which were beneficial to agriculture as well as some that are known pest species.

Knowledge Gaps

It is not known what contribution saltbush stands have on biodiversity in the Eyre Peninsula region and this is potentially an area for further investigation.

Other gaps in knowledge in all regions include:

- cost-benefit analysis
- fire response of saltbush
- how to manage recruitment of saltbush seedlings between the rows
- response of saltbush to a range of chemicals and fertilisers
- impacts of saltbush alleys on soil moisture and nutrients on adjacent crops and pastures
- impacts of saltbush on ground water use
- compatibility with, and management of, saltbush with other fodder species.



2.1 OTHER PERENNIALS ON EYRE PENINSULA

Other perennial species are, or have been, promoted for use on Eyre Peninsula in a variety of situations. Some are compatible with saltbush. A more comprehensive coverage of the application of these and other pasture species and costs of establishment are found in *Pasture Options for Eyre Peninsula*.

Veldt Grass (*Ehrharta calycina*)

Originating from South Africa, veldt grass is an erect tufted perennial grass which grows from 30 to 80 cm high. This species will grow well on light textured, low pH and low fertility soils.

Veldt Grass requires an annual rainfall greater than 350 mm. The main productive period for this species is early spring. Veldt grass is effective in stabilising light textured soils, thereby reducing wind erosion risk.

Tagasaste (*Chamaecytisus proliferus*)

Tagasaste, also known as Tree Lucerne, is a perennial shrub or small tree used to increase productivity on deep sands and to prevent erosion on infertile deep sandy soils. It grows best in areas with an annual rainfall over 350 mm. Like Old Man Saltbush, Tagasaste requires management to keep the growth below the

grazing height of stock. It is suitable for a range of livestock (Figure 5). Cost of establishment is similar to that for establishing saltbush.

Lucerne (*Medicago sativa*)

Lucerne is a deep rooted perennial legume broadly adapted across a wide variety of neutral to alkaline soils, but intolerant of boron, waterlogging, salinity and high levels of available aluminium. Lucerne grows best in areas with rainfalls of >350 mm. The main productive period for lucerne is in spring, summer and early autumn depending on summer rainfall events and cultivar winter dormancy.

In his report (Bolto 2008) on lucerne and saltbush establishment in the Murray Mallee, Bolto cited failed establishment as one of the biggest issues with growing lucerne. The cost of establishment does not include the opportunity cost of production loss in the first year of establishment. When a failure occurs, not only are the input and opportunity costs lost, but also the cost of any topsoil and associated nutrients lost. The loss of topsoil through erosion is a significant environmental problem.



Figure 5 Tagasaste hedge made with boxed chicken wire provides fodder and shelter.





Puccinellia (*Puccinellia ciliata*)

Puccinellia is a perennial grass that is highly tolerant to salt and water logging. 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. Puccinellia grows with an annual rainfall of more than 350 mm and where the watertable is not too deep over summer. The main productive period is mid autumn through to spring then it hays off in November/December.

Tall Wheat Grass (*Lophopyrum ponticum*)

Tall Wheat Grass is a moderately salt-tolerant, deep rooted perennial plant growing to 1.3 m high, suitable for increasing production on slightly salty to moderately salty soil. Tall Wheat Grass will not persist in areas that are waterlogged over spring/summer. This species is best suited to areas receiving more than 350 mm of rainfall. This species is spring, summer and autumn active plant which is useful for supplementing the summer-autumn feed gap. It has not been recommended to plant with saltbush due to competition for moisture.

Evening Primrose (*Oenothera spp*)

Evening Primrose has been promoted for use for grazing and soil stabilisation on light sandy soils (Stanley, undated) on Eyre Peninsula. Evening Primrose grows and persists in rainfall greater than 250 mm per year. The most active growing period is in spring and summer, though in lower rainfall districts Evening Primrose will remain dormant in summer. Summer rains means it will remain active. Where rainfall is adequate, they do not compete well with other pasture species. Other pasture species are more productive in these areas.

Ryegrass (*Lolium spp*)

Perennial Ryegrass tolerates low pH soils and provides large quantities of high quality winter-spring feed. It does not persist as well as other deep rooted perennials under moisture stress and is suited to higher rainfall areas. It is not generally recommended on Eyre Peninsula.

Other ryegrass species such as Italian Ryegrass (*Lolium multiflorum*) is a short lived annual/biennial grass that will carry over summer if conditions are favourable. It is most commonly grown as an annual in order to best utilise dry matter production. Italian Ryegrass is suited to areas with annual rainfall above 450 mm on loam to light clay soils and does not perform well on heavy clays soils. Italian ryegrass is productive from early winter through to early summer if there is adequate rainfall and mild conditions. Rapid growth makes it highly competitive against weeds. Italian Ryegrass is moderately tolerant of salinity, waterlogging and frost.



3 WHAT YOU SAID

3.1 PHONE SURVEY - SALTBUSSH

Twenty landholders were contacted by phone between September and November 2009 and asked a series of questions relating to their saltbush and other perennials. The survey attempted to achieve geographical representation, a range of soils types, rainfall averages and conditions in the region (Appendix 2; Table 7). Rainfall ranged from 250 mm per annum to 500 mm per annum.

The survey targeted three main themes:

- Saltbush establishment, utilisation and management
- Utilisation of other perennial pastures
- Future directions.

Central Eyre Peninsula	Western Eyre Peninsula	Eastern Eyre Peninsula	Lower Eyre Peninsula	TOTAL
5	4	6	5	20

Table 7 Geographical Spread of Landholders Contacted.

Area Planted

Areas planted to saltbush ranged from 1 ha to 160 ha. Larger plantings tended to occur in the drier rainfall zones. Forty-five percent (9/20) of landholders had planted more than one stand of saltbush on their property.

Soil Type

Soil types on which saltbush was planted varied. Sandy rises and non-wetting sands, saline areas or magnesias patches were commonly planted to saltbush. Of the landholders surveyed, 35% (7/20) had stands that were planted on sandy rises and non-wetting sands, 45 % (9/20) on saline areas and 20% (4/20) landholders had stands planted on both sandy rises and saline areas on their properties.

Interest in Saltbush

Seventy-five percent of landholders (15/20) surveyed said they would plant saltbush again. Fifteen percent (3/20) said they were not interested in planting any more saltbush while 10% (2/20) were uncertain. Several landholders surveyed mentioned new plantings would be dependent on funding support to cover establishment costs, fencing and placement of

watering points. One landholder, (5%) said he was no longer using the saltbush as supplementary feed or planting on unproductive areas but would use saltbush plantings for wind protection.

Reasons for Establishment

All landholders surveyed established saltbush to either gain production from saline or unproductive areas; and/or to halt erosion; and/or to establish a green haystack to provide grazing in late summer-autumn.

Condition of Stands

All but one landholder reported the condition of their stands as either good or excellent. One reported the condition of his stand as poor, citing a lot of growth that requires management before it will be useful for his stock. Several landholders mentioned that saltbush seedlings were recruiting between the rows.

Benefits During Dry Times

Four landholders indicated that without the saltbush feed they would have sold stock in the drought. Others indicated that their stands were not of sufficient size to make a significant difference, but were of some use as stock feed and formed part of their grazing system.

Effect on Erosion

Good results were reported on the use of saltbush for controlling erosion or stabilising sandy rises. All those surveyed who had used saltbush to reduce erosion felt that it had been successful.

Effects on Salinity

All landholders who used the saltbush on their saline areas commented that they gained production from otherwise unproductive areas. Several commented that *Puccinellia* was probably a better option for feed on saline areas - or a combination of both *Puccinellia* and saltbush. No one commented on whether they thought the plantings had assisted with addressing salinity issues, but several mentioned they needed to expand their plantings as their saline areas were creeping out. Improved feed quality and quantity was noted between the saltbush rows including couch and barley grass.





Effects on Productivity

Saltbush helped with the late summer to autumn feed gap for most landholders and for some, at least, saltbush provided some productivity on land that would otherwise not be utilised at all. Preferences for *Puccinellia* (3) was mentioned for saline areas and others thought that clay spreading may provide better results on sandy rises. Three landholders expressed interest in establishing Lucerne as an alternative perennial for their sandy sites.

Livestock

The vast majority of Eyre Peninsula farmers surveyed grazed sheep. Only two landholders surveyed owned either cattle or cattle and sheep and grazed them on their saltbush. All other landholders exclusively grazed sheep in their saltbush. In addition to the autumn feed gap, other productive uses for the saltbush included using the sites as shelter for off-shears during inclement weather and providing shelter for lambing ewes.⁵

One landholder said he did not put lambing ewes into his saltbush as it was too difficult to visually check on them if they got into difficulty.

Several landholders on Lower Eyre reported difficulty in getting sheep to eat saltbush while other pasture grasses were present and better quality feed was available. This contrasted with experiences in low rainfall areas where saltbush was often the only feed available and sometimes the challenge was to keep the sheep out of these areas or not to remove too much of the foliage. Some of these difficulties also reflect where grazing management practices could be improved to get better utilisation of the saltbush (see also landholder capacity below).

Landholder Capacity

Some landholders indicated they learnt to manage their saltbush stands the hard way, (i.e. by trial and error); while others indicated they were still learning how to effectively utilise their stands. Capacity varied widely in terms of management. Many reported difficulty in managing growth in the early years following establishment to keep the feed within easy reach of sheep. Several commented that they needed to slash the saltbush and they had not managed the stands as well as they could. Others seemed to have a good understanding of monitoring the saltbush and determining the saltbush for grazing according to

the condition and growth of the plants. Some grazed their stands hard and then allowed it to regrow before putting the stock back in again.

Barriers to Establishment

Costs of establishing saltbush were reported as a significant barrier for 70% (14/20) of landholders. Cash flow and finances were cited frequently as issues, and most would not attempt to establish perennials without some sort of financial assistance. Water supply/quality issues was a factor for 20% (4/20) while 15% (3/20) felt that successfully establishing perennial plants was a major challenge, particularly with seasonal variation in rainfall. Seasonal variation was challenging for many when establishing saltbush. One landholder lost all of his 2008 plantings due to the poor season and low rainfall (see also effects of climate below).

Management Issues

Some growers had trouble with saltbush plants growing out of reach of stock. This was an issue as feed is effectively wasted. Keeping the growth down was a particular challenge for 40% (8/20). Mechanical pruning with a slasher was needed in several cases; however those with cattle did not experience this as an issue. Cattle were put into the stands prior to sheep to attain adequate pruning of plants. Attaining a balance between not grazing the saltbush hard enough and damaging or killing plants through overgrazing is especially difficult when saltbush stands comprise small areas of a landowner's overall enterprise.

Stock were either locked in paddocks or allowed access to saltbush and pasture paddocks at the same time.

Weed control difficulties were experienced by 20% (4/20) and included Onion weed, Ward's weed and Ice plant, while 10% (2/20) landholders reported rabbits as an issue.

Another landholder mentioned difficulty obtaining dry feed in drought years to supplement stock when they were grazing saltbush as an issue for him.

Seventy percent (14/20) of landholders had fenced their saltbush off from the remainder of the paddocks. Fencing was considered a major expense by landholders. Rotational grazing systems have been developed by farmers using saltbush (Bartel 2000), hence the need for fencing. Set stocking weakens the plants as they are unable to recover as any new growth is continually being grazed.

⁵ Grazing pregnant and lactating ewes on saltbush is contrary to advice on saltbush utilisation



Inter-Row Feed Value

The feed value between rows of saltbush varied considerably in this survey. Due to poor or saline soils, 35% (7/20) stated they had negligible inter-row feed value, while others reported they had reasonable inter-row feed value with improved (e.g. sowed oats and lucerne) and non-improved pastures containing medics, clover, veldt grass and rye grass providing additional feed resources. Use of inter-row feed reduces the water requirements of sheep and assists in maintaining condition of stock (Ashton op. cit.) and needs to be considered. Growing feed between the saltbush rows increases the overall nutritional value and productivity if managed correctly (Bolto 2008).

In more reliable rainfall areas where pasture grasses were present, the better inter-row feed values meant that landholders had trouble getting sheep to eat the saltbush. Difficulties in achieving even grazing of the feed can be overcome with better grazing management strategies (see also landholder capacity and effects on productivity above).

Water Use and Quality

Stock had access to a watering point within the saltbush stands in 70% (14/20) of cases. Some landholders just kept the gates open so that stock could utilise troughs in adjacent paddocks. The risks with this practice are that production may suffer and damage to soils may occur with stock moving back and forth (Figure 6).

Effects of Climate

One landholder reported failed establishment due to poor rainfall in 2008. Others mentioned that watering the plants in the first year was a major labour intensive cost for them. Many reported seasonal variation as a concern to them in considering future plantings of saltbush and other perennial pastures.



Figure 6 Sheep have to travel to water and have bared out some areas as a result.





3.2 PHONE SURVEY - OTHER PERENNIALS

Use of Perennials

Seventy percent of landholders surveyed (15/20) reported planting other perennials on their property in addition to saltbush. Areas established with other perennials ranged from 5 ha to 283 ha. Seven landholders (35 %) reported failed establishment of other perennials plants on their property. Failures included lucerne, veldt grass and evening primrose establishment.

Of those landholders surveyed, lucerne was most commonly planted (40%), followed by Veldt Grass (25%), Puccinellia and Evening Primrose (15%) (Figure 7).

Reasons cited for establishing other perennials species in this survey included:

- To see if it would grow (experimental)
- To address salinity and/or erosion
- To get better returns
- To provide summer feed.

All landholders expressed an interest in planting more perennial pastures and shrubs on their properties (Figure 8).

Landholders surveyed identified saltbush (45%) and lucerne (40%) as the highest priority perennials of future interest.

Many landholders cited perceptions of, or had first hand experience in, the difficulty in establishment of perennials, and many mentioned the cost, uncertainty and issues associated with seasonal variability. Weed and insect control were concerns for some in establishing perennial species. Rabbits are also becoming a concern to landholders.

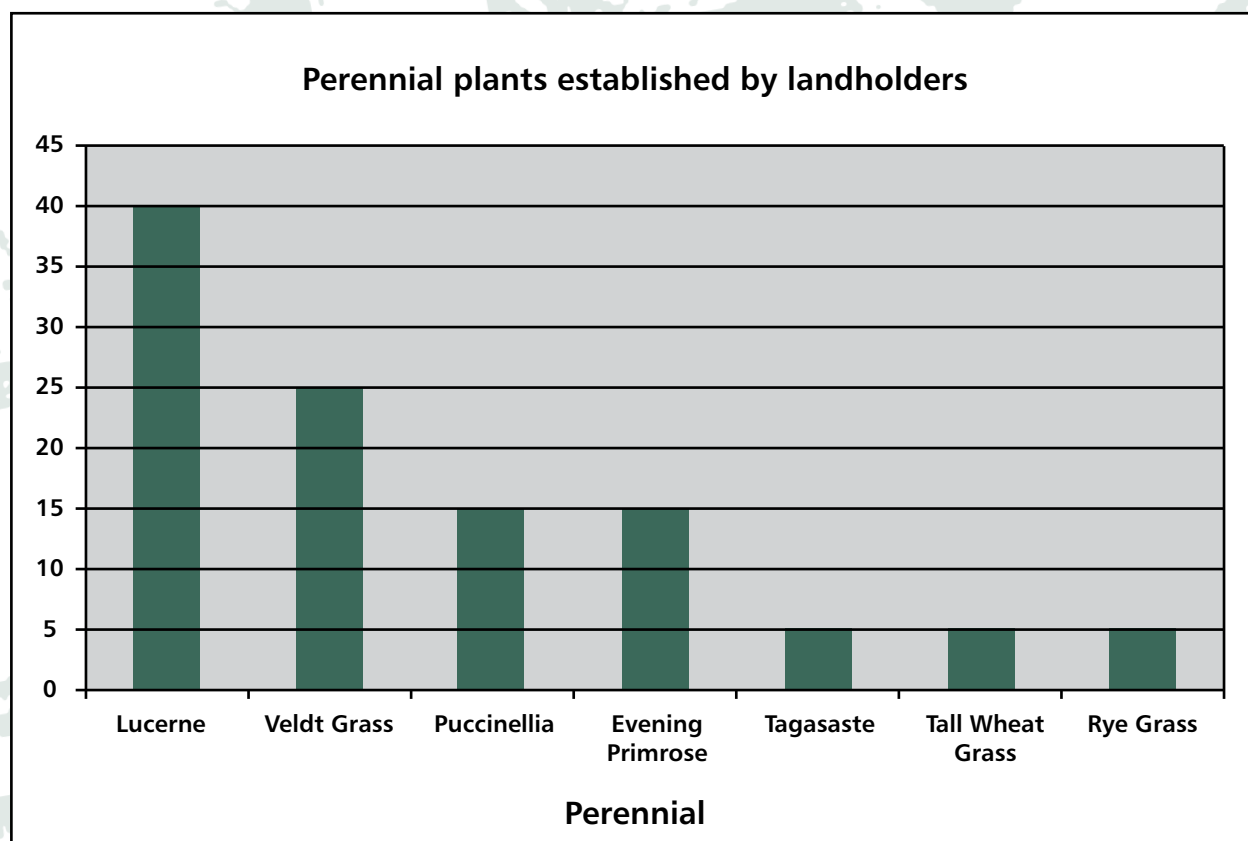


Figure 7 Perennial plants established by interviewed landholders.

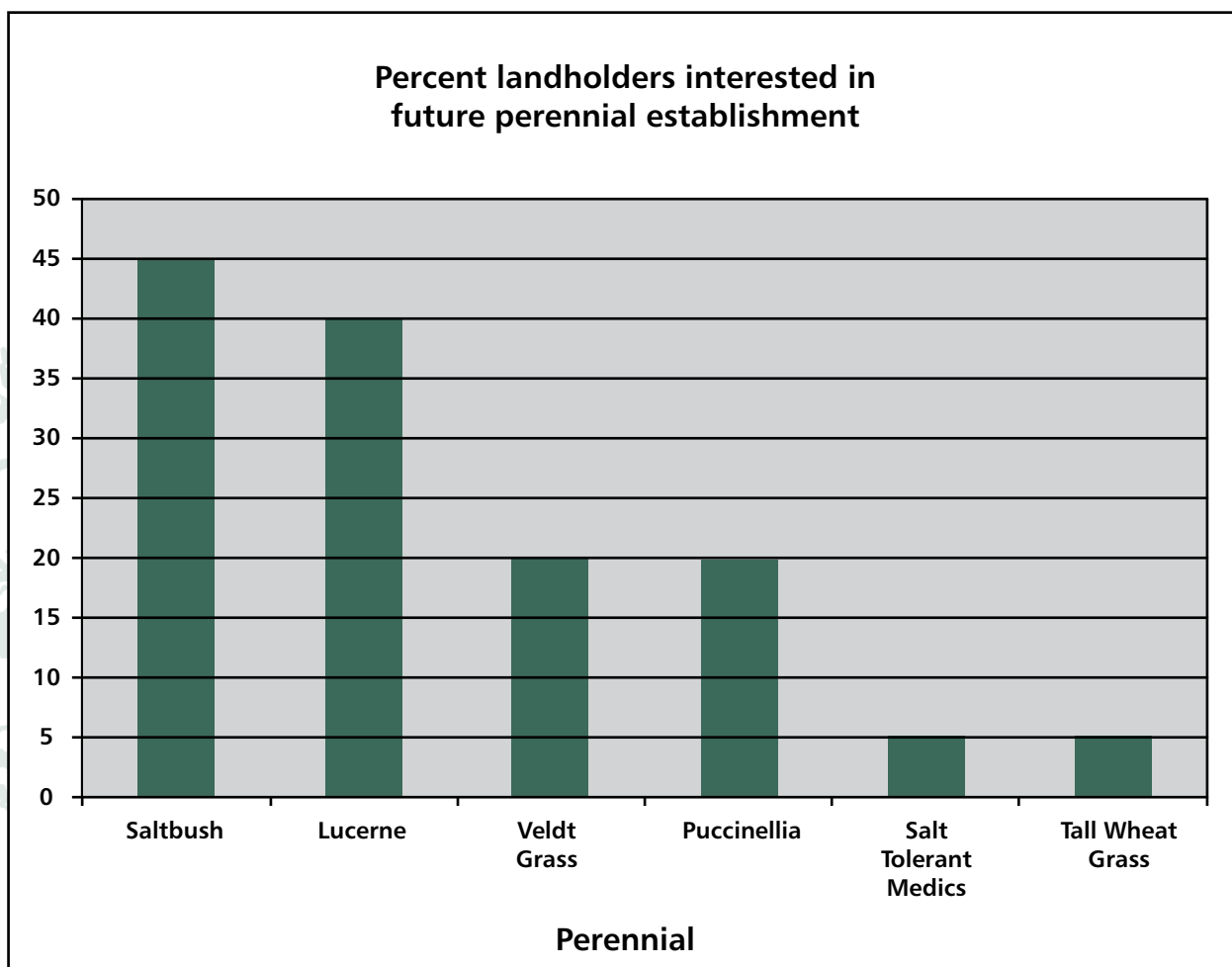


Figure 8 Percent landholders interested in future perennial establishment.





4 EYRE PENINSULA CASE STUDIES

4.1 PERENNIAL OPTIONS FOR NON-PRODUCTIVE AREAS

GAVIN REHN

Locations: Cleve & Arno Bay

Name of properties: Goonaeenya and Camborne

Rainfall: 300 mm



Success with saltbush has meant that it has been gradually planted over successive years on the Rehn's property near Cleve to improve the overall productivity of some of their more saline areas. Gavin has also successfully used a mix of Veldt Grass and Lucerne to cover his sandy rises on his cropping land at Arno Bay and gain higher production from these difficult to manage sites.

Establishment

Gavin and his father Peter have planted both Old Man Saltbush and Eyre's Green Saltbush. Gavin believes that Old Man Saltbush does better on saline ground than the Eyre's Green variety. The oldest saltbush stands have been grazed regularly since being established 3 and 5 years ago. The Envirofund program made it possible for Gavin and his father to establish saltbush.

The site was ripped prior to saltbush 'speedlings' being planted into a low lying saline area. Timing varied for planting and occurred only when the soil held sufficient moisture. Little weed control was required due to the saline conditions of the sites. Grazing of stands occurred within two years of planting.

The most recent saltbush stand of Eyre's Green was planted in August 2008 and has already had been lightly grazed for the first time. This first graze has allowed the development of lateral shoots, which is preferred for easier management of saltbush growth in the longer term (Figure 9).

Every year Gavin and his father have steadily increased the area planted out to saltbush, so that now over 100 hectares have been established. This gradual practice of planting manageable 'chunks' makes it a less onerous process to build up reasonable areas of saltbush.

Management

Managing the leggy growth of Old Man Saltbush has been done in the past by borrowing some of the neighbour's cattle, however, other options are now being considered by the Rehns. The challenge for them now is to keep the Old Man Saltbush growth down



Figure 9 Lateral growth following first grazing of Eyre's Green.



to grazing height by maintaining the right amount of grazing pressure on the stands. As for paddock size - Gavin believes smaller areas provide better grazing, however, getting the right grazing pressure is still being refined. In one paddock, for example, in which both Eyre's Green and Old Man Saltbush were planted together, the stock have concentrated on the Eyre's Green over the Old Man, thus leaving the stand unevenly grazed.

Gavin prefers to keep his lambing ewes out of the saltbush so that he can keep an eye on them (it is difficult to see them amongst the saltbush if they are having trouble lambing). Sheep are also crutched prior to being put into the saltbush, thereby reducing the risk of blowfly strike and the need to check them as often.

With some natural saltbush on his property, training stock to eat saltbush was not that difficult. Usually he puts hoggets and ewes in together over summer.

Water

The Rehns are fortunate that they have access to good quality water with mains water being less than 1000 ppm, with sufficient pressure to keep troughs full when sheep are watering - ideal for sheep grazing saltbush. Troughs are not located in all saltbush blocks so the stock need to move between stands to access water, which has created some bare areas.

Gavin views saltbush as a tool to increase productivity on his more marginal country rather than the answer. The increase in growth of grasses between the rows with supplementary feeding of hay enables him to keep stock off other paddocks at critical times of the year. He says he gets more production from his marginal land by using perennial plants such as saltbush.

If he had to put a figure on the grazing value of his saltbush Gavin believes the estimated value may be \$50-\$100 per acre.

Biodiversity

Not only is the saltbush helping improve productivity on saline ground, but they may be benefiting local wildlife. Gavin reports that after the Wangary bushfire of 2005, he observed large numbers of Ringnecks (Port Lincoln Parrots) in the saltbush, presumably feeding on the saltbush seeds.

Perennial Veldt Grass and Lucerne

Despite continued below average rainfall, Veldt Grass and Lucerne mix were successfully established on a sandy rise at Gavin's Arno Bay property in 2009 (Figure 10). The benefits of this combination include:

- the Veldt Grass holds the light soils together
- the Lucerne provides high quality feed
- summer rains produce valuable green feed.



Figure 10 Lucerne and Veldt Grass established on sandy rise.





4.2 PRODUCTION GAINED FROM SALINE SITES

ALAN MCNAMARA

Location: Tumby Bay

Property: Alandra

Rainfall: 300 mm



Alan began experimenting with saltbush in 1997 by trialling several species through direct seeding and planting out 2,000 De Koch seedlings. The De Koch tubestock did well, and Alan could see the potential of improving his large area of salt affected land (over 135 ha of his 2,500 ha property is salt affected).

Today Alan has over 100 ha of saltbush planted in his salt affected areas (Figure 11) and is getting good grazing from these otherwise unproductive areas. Over successive years Allan progressively increased the area planted to saltbush. Poor seasons have posed a challenge when establishing plants in recent years. However, once established, the plants provide Alan with long term fodder options. Even in the worst years he has been able to hold onto his core breeding stock (45 large-framed beef cattle and 300 ewes) due to the feed provided within his saltbush stands.

Salinity Control

The saltbush plantings are assisting in lowering the water table and as a consequence saline areas are now becoming productive again with rye and barley grass recruiting between the saltbush rows (Figure 12). Alan believes that this is protecting the adjacent productive cropping land from encroaching salinity.

Establishment

Alan banded (mounded) the saline areas using a Grizzly plough and then ripped prior to the contractor planting out in May and early August 1997. Seedlings were planted on top of the one metre wide mounds with 1.5 m spacing between individual plants and 2.5 m spacing between the rows running in an E-W orientation. In 1998, 71,000 tubestock were planted

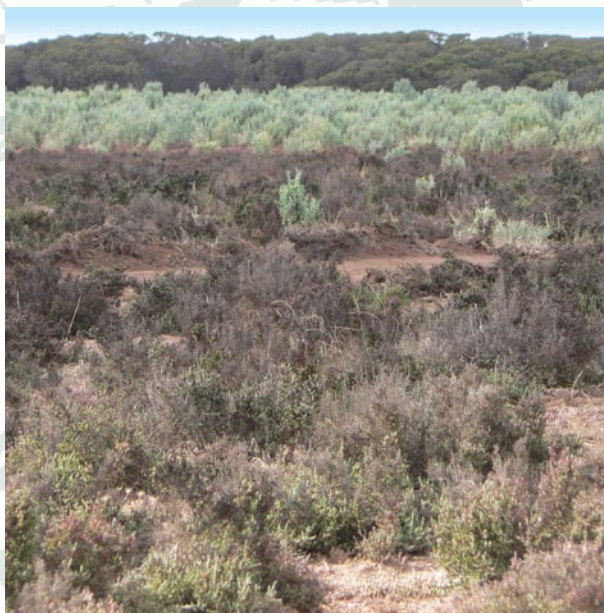


Figure 11 Saltbush growing well and recruiting in saline areas.



Figure 12 Rye and barley grass recruiting between saltbush rows.

out with 95% survival due to the good seasonal rainfall. In good or average seasons establishing Old Man Saltbush has proved straightforward and only in very dry years has Alan found it a challenge. Some of the plantings even in the very highly saline areas are surviving. Areas are fenced off using cyclone fencing and one hot wire for the cattle. He has tried planting Eyre's Green and Puccinellia but neither species survived the poor season. Ideally, planting should happen after the first rains and in Alan's experience, August is often too late especially in poor years.

Urea was aerially applied with success and plants appeared to green up and respond within 6 weeks of application. Alan is considering trying this again.

Grazing Management

Alan is currently dividing up one stand into two smaller paddocks to achieve more even grazing pressure. He has found that placement of water troughs has been critical in achieving even grazing.

Alan first grazed the saltbush lightly about 12 months after establishment. He then rested the saltbush for about 9 months. Subsequent grazing is heavier, until mostly sticks with minimal foliage remains. He has not needed to manually lop the growth off the Old Man Saltbush as a combination of heavy grazing and using cattle have kept the stands to a manageable height (Figure 13). Sheep are usually put into the stand first followed by the cattle.



Figure 13 Large-framed cattle graze saltbush at Tumby Bay.



Sheep are usually drenched prior to being put into the saltbush to prevent scouring. Alan notes that the older stock tend to do better on the saltbush than his younger animals. Supplementary feed includes hay and crushed grain put into a centrally located cradle. This prevents animals being disturbed with daily feeding and reduces bare areas by tracking to and from supplementary feed sources.

Water

Alan has a good supply of mains water connected to troughs placed at intervals in both sides of the stands to encourage even grazing.

Costs

Overall, Alan estimates that he has spent \$70,000 (including time and labour) to establish his saltbush but believes the value of the stands to be in excess of \$100,000. He has a green haystack that also is addressing salinity on his property (Figure 14) and providing some production from an otherwise unproductive site. Overall, saltbush has made his property more viable.



Figure 14 Saltbush has made highly saline areas productive.



4.3 IMPROVING PRODUCTION, ENVIRONMENT AND AMENITY ON SALINE AND SANDY SITES

BEN RANFORD

Location: Cleve

Property: Bronte's Block

Rainfall: 330 mm



Despite four successive years of below average rainfall, Ben has succeeded in establishing lucerne and saltbush on a block that 20 years ago, had bare saline scalds and sandy blowouts. When the block was purchased in 1996 he fenced off the degraded sites and began remediation works. Ben could see the possibilities of turning around these degraded sites, though some in the district were not so convinced. He regrets he did not take photos before he commenced work on the block, so that he can demonstrate the success of his work with a before and after comparison.

His results have been very encouraging. Through protecting these areas from further erosion he has also managed to gain increased production, addressed ground water recharge and improved amenity of his property.

Ben has established perennial species consisting of 45 ha of saltbush and 70 ha of lucerne on areas of deep siliceous sands and heavy saline soils on his 880 ha property known as Bronte's Block. On the home property he has also established 70 ha of veldt grass.



Figure 15 Lucerne growing between saltbush rows on deep sands.

Establishment

In 1996 after several failed attempts to establish cereal rye on a dune, Ben planted his first area with Old Man Saltbush. Twenty ha was planted out by a contractor, comprising three rows planted 2.5 m apart followed by one row 5-6 m apart (to allow for vehicle access) with saltbush 'speedlings'. Ben divided this stand into three paddocks, each with its own supply of water centrally located in each block. The site is still productive today, with rye grass, barley grass and medic coming up between the rows, even during the recent poor seasonal conditions. The dune no longer shifts and his South African Meat Merino (SAMMs) cross sheep are doing well.

The dune is a high recharge area and establishing saltbush on the site assisted in reducing this recharge into the low lying areas which were already showing signs of dryland salinity.

Minimal loss of saltbush plants occurred during establishment, however plants did do poorly on the sodic soils. The success of "speedlings" on deep sands was due to a reasonable season.

On another sand dune Ben established three rows of saltbush 1.5 m apart, interspersed with an inter row

width of two widths of his airseeder where lucerne has been established (Figure 15). On this site he has allowed the saltbush to get 'leggy' and grow as it provides an important windbreak for the lucerne inter-row alleys.

In 2006 Ben planted out his bare saline areas to Old Man Saltbush and in just a few years, cover between the saltbush rows is occurring. He hopes that as the organic matter builds up between the rows it will produce better quality feed for the future. He plans to expand his saltbush area as another paddock is also developing areas of dryland salinity.

Twelve years ago Ben planted trees along a saline creek line (blue gums and red gums) and later added saltbush and also lucerne (Figure 16). Already sea barley grass and young saltbush plants are emerging. Ben may fence off the trees as the sheep tend to camp under them leaving the soil bare and exposing the roots. He may consider using sheep for just a few days to graze the lucerne and saltbush in this area.

Ben has established lucerne on sandy rises within paddocks. His first attempt in 2002 failed as he did not use a cover crop. His second attempt, using cereal rye and barley as a cover crop was successfully direct drilled with the lucerne at a 1:1 ratio (Figure 17).



Figure 16 Saltbush recruitment in saline creekbed.



Ben grazed this site last summer and got good grazing from the lucerne. Ben is looking for another good season in 2010 to maintain the lucerne; otherwise he believes he may need to over sow some areas. His property has missed out on valuable summer rainfall to help sustain the lucerne, especially following several dry seasons, leaving very little or no sub-soil moisture.

Grazing Management

Ben believes that the grazing management for saltbush is much easier than lucerne. Lucerne is more fragile and has a much shorter grazing period (days) whereas sheep can remain in a saltbush stand for several weeks.

In the saltbush stand Ben puts out hay and grain as supplementary feed. Large round bales are set in a cradle so that feed is always there, rather than disturbing grazing animals with daily feeding. Often the feed is placed at the opposite end of the saltbush stand to the water point to minimise sheep milling in one area and baring it out and aiding soil erosion.

Ben baits for foxes prior to lambing and has a short lambing period. Lambing ewes are placed in the saltbush for protection. His lambing percentages are close to 100%.

Ben has had no trouble training his sheep to graze saltbush and suspects that lambing in the saltbush may help give the lambs a taste for the salty diet.

Management Issues

Ben emphasises that weed control in his perennial vegetation is always a problem as chemical control options are limited. Broad scale weed control is not possible, therefore, spot spraying of boxthorns and other weeds is very time consuming.

Wind erosion is occurring at the sides and ends of one of the saltbush stands on a sand dune, so Ben is allowing these to grow taller. His worst winds are from the NW and W so that he has ensured that rows do not align to these wind directions. The problem comes with the wind deflecting around the dune and where the sheep walk to water. One option he is considering is to have rows evenly spaced but without straight rows, or putting down gravel or other less erodible material to reduce the soil loss on these areas of concern.

The 20 year old saltbush has been slashed once with a slasher at 1.5 m in height to reduce the leggy growth. In an experiment two years ago some bushes were knocked over (very gently!) with a bucket of a front end loader. This did not kill the plants and encouraged lateral shoots (Figure 18) however, slashing is less destructive and is his preferred method for managing the 'leggy' growth.



Figure 17 Lucerne growing in sandy rises.

Water

Fresh water is in ample supply as Ben relies on mains water. Some sites have water located in adjacent paddocks so that sheep have to move out to access drinking water, however, in the long term Ben plans to put in additional troughs to overcome this issue.

Managing Problem Areas

Ben has demonstrated how important it is to fence off problem areas and then create the right environment to establish perennials (Figure 19). He has succeeded to reverse degradation and improve production on his block even with a run of below average seasons. Ben intends to establish more saltbush on his other saline affected areas.



Figure 18 Vertical shooting from knocked over stems.



Figure 19 Saltbush has improved the environment, production and amenity.



4.4 GETTING THE BEST OUT OF MAGNESIA PATCHES

SHAUN FREEMAN

Location: Penong

Property: Bagster

Rainfall: 300 mm



Shaun manages 3,500 hectares near Penong in the far west. He runs 1500 cross bred merinos. Two years ago Shaun planted out saltbush into an alley system on his saline magnesia patches in an attempt to get some production from these areas. He planted saltbush in 5-6 rows, 3 m apart with an alley in between of 3-4 boom spray widths where Shaun could sow stock feed. In just two years, despite poor seasons, he has managed to get good grazing value by successfully growing feed oats in the saltbush alleys. His hard work in getting the saltbush established is now paying off.

Establishment

Shaun established Eyre's Green saltbush two years ago after trialling Old Man Saltbush in an 8 ha holding paddock near his shearing shed and along a raceway (Figure 20). He was impressed by the rapid growth of saltbush, how it responded well after summer rains,

the food and shelter it provides for his rams, and his off shears and crutched sheep. This area was ripped prior to establishing with 19,000 plants using the Ripper Saltbush Seeder borrowed from the Eyre Peninsula Natural Resources Management Board (EPNRM) in Streaky Bay. Despite some hard grazing, this year the site supports a good germination of spear grass between the saltbush aided by good rains in 2009. He is waiting for the seed to drop before putting the stock back in to allow ongoing germination of these native grasses. Previously there was little inter-row feed and what did grow was of poor quality (Ward's Weed and Ice Plant).

Once Shaun saw the potential of saltbush he established Eyre's Green into his magnesia patches in 2008 and again in 2009. He chose Eyre's Green for its palatability and growth characteristics. The Ripper



Figure 20 Holding paddock where Old Man Saltbush was trialled.



Saltbush Planter borrowed from EPNRM, was an efficient way to plant with 800 - 1,000 seedlings per hour. In 2009 he planted 10,000 plants (Figure 21). In 2010 he intends to replace the plants lost and fill in the gaps (Figure 22). He suspects that the 3 m row spacing may be too wide for the Eyre's Green variety.

Management Issues

Mice caused considerable damage in 2009, and Shaun lost many saltbush seedlings and also suffered damage to the oats. He has previously dry sowed oats, however, Shaun is concerned that mice numbers are rising again and he may have to consider sowing the oats after the opening rains.

Snails are posing a problem over summer as numbers tend to build up along the highway and then move into the adjacent paddocks. Shaun plans to apply snail bait to try and reduce the numbers.

Grazing Management

Shaun plans to eventually rotate his stock through the six paddocks of saltbush and with sown oats in the alleys. Mobs of 200-300 will get roughly 2-3 weeks grazing in each 24 ha paddock once the oats have germinated and are firmly established.

Shaun has found that saltbush provides good shelter for his sheep in bad weather, as there is no scrub on his property to provide protection, Shaun has welcomed this extra benefit.

Trial and error has been used to manage his saltbush. Shaun believes it is important not to overgraze the saltbush, and to only graze it lightly in the first 12-18 months following establishment. Shaun's tip for grazing saltbush is not to graze it too hard and some leaves should remain on the bushes as plants should not be completely defoliated.

Water Supply

Part of Shaun's property where his saltbush stands are located is watered by mains. Underground tanks from roadside runoff also supplement his property's water supply. The other part of his property is not fed by mains water and is closer to Penong. This area has groundwater that is only suitable for adult stock. He cannot plant saltbush there for grazing purposes due to the water quality (good quality water is a major requirement for livestock production when grazing saltbush).

For watering stock in his saltbush paddocks Shaun uses mains water connected to a header tank, which is fed by an electric water pump to his troughs to ensure good flow rates into troughs. He is considering putting in another tank and trough to assist in increasing water availability and flow rates and to achieve more even grazing across his paddocks.



Figure 21 Saltbush alleys.



Figure 22 Plants less than twelve months old.





4.5 REDUCING Paddock SIZE INCREASES GRAZING PRODUCTION

PETER KUHLMANN

Location: Mudamuckla, east of Ceduna

Property: Mudabie

Rainfall: 290 mm



Peter was an early innovator when it came to establishing saltbush on his 8,800 hectare property near Ceduna. He established 40 hectares of Old Man Saltbush 17-20 years ago into alleys when it was first promoted in the region. He was involved in the Soil Board at the time and tried saltbush on some of his poorer sandy and stony soils. Last summer he planted sorghum in the alleys. He still grazes the stand regularly when adjoining paddocks are not in crop. He has also successfully established lucerne in another paddock (65

ha) and is now considering establishing lucerne within the saltbush alleys. Both paddocks are now the most productive on his property. However, he believes that in the case of his saltbush alleys, reducing the paddock size has been the major reason for the increase in production, as stock are utilising all the feed in the paddock more evenly.



Figure 23 Saltbush alleys were established prior to GPS technology.



Establishment

Saltbush alleys separated by 2-3 rows of Old Man Saltbush were established using the EPNRM Ripper Saltbush Seeder from Streaky Bay. As the worst winds are from the north-west and south-west, Peter ripped prior to planting the rows in a north-south orientation to avoid the prevailing winds from tunnelling up between the rows. 16,000 plants were planted with at least 80% surviving to date.

The alleys are 26-30 m wide and the spaces between saltbush rows are 3 m. Distance between plants within rows is 1.5 m.

Peter's lucerne paddock of 65 ha was planted 3 years ago using SARDI10 variety and was sown with a precision disc seeder. He used a cover crop of barley which was then sprayed out once the lucerne was established.

Management Issues

Approximately 5 years ago Peter slashed his saltbush to reduce the 'leggy' growth. Peter has planted sorghum in the alleys previously and some recruitment of sorghum was noted this year.

Peter has found that ester sprays used in cropping have not lead to any off-target chemical issues in his saltbush.

Peter believes that paddocks must be small to get most grazing days from the saltbush. Peter is keen to continue with lucerne as it provides him with better grazing production whatever time of year it rains.

Peter is not going to remove the saltbush, as it has provided some benefits to his property. He is considering planting lucerne between the alleys in the future as that paddock rarely covers the cost of cropping and is more suited to grazing.

Grazing Management

Peter's lack of fencing has made grazing and stock management difficult on those areas of his property, however, where he has reduced paddock size, he has increased his livestock production. His 500 cross bred sheep spend a couple of weeks in both the smaller paddocks in rotation.

Peter has noticed that his lambs aren't too keen on staying in the lucerne paddock and has trouble keeping them in the smaller paddocks.

The timing of grazing and grazing value of the inter-row vegetation varies depends on whether the alleys are cropped or not. Crops, medics and later sorghum have all been used as inter-row plantings. Peter has found the alley system hard to manage, particularly as the saltbush alleys were established prior to GPS technology and lacks the precision he requires. Onion weed is becoming problem in the alleys.

Water Supply

The property is has mains water, and in Peter's smaller saltbush paddocks, he is using a header tank to feed the troughs. Peter is still experimenting with his water supply and believes that the flow rate could still be improved. He is considering replacing the pipe with a larger diameter to improve the flow rate to the troughs to increase his livestock production.





4.6 SALTBUSSH A SAVIOUR IN DROUGHT

TIM & TRECINA HOLLITT

Location: Streaky Bay

Property: Mulgunyah, Micha Well & leased land

Rainfall: 350 mm



The Hollitts run both merinos and prime lambs (Poll Dorsets) as part of their farming enterprise. The saltbush has been used to address salinity issues, protection for sheep off-shears and lambs. The added benefit of providing a 'green haystack' during the recent drought has convinced the Hollitts of the value of saltbush. Without saltbush they would have to have sold their sheep during the last drought. The saltbush kept the animals in store condition and saved them from having to make that hard decision.

Establishment

A 5 ha lamb holding paddock at the Mulgunyah property is used at shearing time and was established with saltbush in 1997 using the EPNRM Ripper Saltbush Seeder from Streaky Bay achieving a 99% strike rate. The seedlings were watered in and superphosphate was added at planting time. The rows were planted 6 m apart and run in a north to south direction. Three years later extra super was applied; however, this made no difference to growth or foliage. Initial grazing was withheld for two years and now the stand is grazed twice a year at shearing and crutching time.



Figure 24 Trees and shrubs were established on the edge of one saltbush stand in a saline area.



On a nearby leased property, a 3 ha and 1 ha salt affected area of the paddock was planted with saltbush by the owner, in 2003. Plants were watered in and then grazed two years after planting. The owner successfully sought funding to use saltbush to minimise the impact of the salt into surrounding cropping land. Considerable recruitment of grasses between the bushes is evident at these sites. Trees were also established along the edges of the saltbush stand and protected from the sheep with guards, however, not all the trees survived (Figure 24).

On the home property of Micha Well, a Poll Dorset stud, the 0.5 ha ram paddock was planted with saltbush in 1993. The site was sprayed out first, ripped into lines and seedlings planted with an initial watering. This stand was also left for two years before grazing and was a self funded project.

Management Issues

Rabbits are an issue at one of the sites (the lamb holding paddock). Trecina states that the main issues with saltbush are the time and cost of establishing stands. The Hollitts see a place for saltbush in their overall enterprise but are also interested in establishing lucerne in the future.

Grazing Management

Hay is used as supplementary feed in the saltbush stands; however considerable feed value is obtained from grasses and medics between the rows. The stands are primarily used in summer when feed is in short supply and in dry years for their merino ewes and lambs. The value of the saltbush during drought however was particularly noteworthy.

Water

Mains water was provided within one saltbush site but the other sites relied on the groundwater supplies which varied in quality. Sheep had to travel to water at the two sites on the leased land. However, testing the water showed that the groundwater had increased in salinity following the drought. This may be a result of the dry years and little infiltration but the Hollitts want to investigate this further. Water quality may be an issue for the Hollitts in the future in regard to sheep being able to effectively utilise their saltbush.





4.7 BUYING INTO PERENNIAL PROBLEMS

MARK SIVIOUR

Location: Lock

Property: Chaylmah

Rainfall: 270 mm



Mark manages a 1400 ha property near Lock which he purchased six years ago. The property already had existing stands of both Old Man Saltbush and Tagasaste (Lucerne Tree) requiring management, having grown beyond the grazing height of his SAMMs (South African Meat Merinos) and Dohne's sheep. The fences around these areas are falling down and/or are in disrepair, so he is pulling them out while he grapples with how he is going to manage these sites into the future. He can see that with some active management the sites will provide good perennial feed over summer for his sheep while at the same time these sites will stabilise the deep sands and reduce erosion risks.

Management Issues

In a 40 ha paddock, erosion along the fenceline is one of the issues Mark has on 4 ha of his deep sand planted to saltbush (Figure 25). The Old Man Saltbush

has also grown so tall that he is now considering purchasing specialised equipment to reduce the height of the saltbush; this will allow the plants to regenerate and be a valuable feed source again. There may be an opportunity for Mark to use this equipment for contract work in the local area.

The timing and intensity of grazing saltbush has not been controlled since the fencing has been removed and Mark has found the inter-rows have been bared out. However, the saltbush has still provided a buffer to the native vegetation and is still holding the soil together.

Two hectares of saltbush have been planted in a north-south orientation in another 40 ha paddock. When the plants grew above grazing height, he knocked down the saltbush and lateral shoots are already visible (Figure 26).



Figure 25 Erosion along the fenceline.



The third, 8 ha perennial stand on Mark's property has been established on a sandy rise with both Tagasaste and Old Man Saltbush. Mark believes that he may have overgrazed the saltbush, subsequently suffering some shrub losses, however, the remaining plants are now responding and reshooting (Figure 27).

Unfortunately the Tagasaste stand on the same sandy rise is well beyond the browsing height of sheep and can only be reinvigorated with manual lopping (Figure 28).

Grazing Management

Mark has some challenges to get the best value from his perennial shrubs including manual lopping, fencing and getting water into the sites. However, he does see the value of these areas for the autumn feed gap and retaining cover of sandy areas of his paddock.

He has observed that his Dohne's sheep appear to do better on the saltbush than the SAMMs. He feeds hay (oats and vetch) when the sheep are grazing the saltbush. Usually 400 sheep are put into the 40 ha paddock and can access the saltbush on an "as needs" basis. Fencing off the stands and providing water will provide him with better feed utilisation and management when grazing his perennials.

Water

At present, both 40 ha paddocks are supplied with mains water. Mark is considering placing troughs within the 10 ha stands to gain better grazing production once he has manually slashed the saltbush. Water from a 2,000 litre header tank connected to the mains will then gravitate to those troughs.



Figure 27 Hard grazing of this saltbush stand has encouraged reshooting.



Figure 26 Lateral shoot development on Old Man Saltbush.



Figure 28 Tagasaste which has grown beyond the browsing height of sheep.





5 DISCUSSION AND CONCLUSIONS

This review of saltbush usage on Eyre Peninsula has highlighted the versatility of the shrub for a number of soil types and its utilisation in farming enterprises in the region.

Among the key findings are:

- Most landholders who planted saltbush were assisted with establishment grants
- Costs of establishment was cited as a barrier for many landholders
- Availability of planting machinery assisted in saltbush establishment in some areas of EP
- Many farmers with saltbush rely on mains water for stock
- Of those landholders who rely on groundwater, declining water quality (usually increasing salinity) and supply has become an issue for many
- Many are learning through 'trial and error' due to lack of extension services and support in managing their stands
- The most prevalent management issue experienced by landholders was keeping the growth within the grazing height of their stock
- Most of those with saltbush stands have inter-row feeding benefits and most did not regret establishing saltbush
- In addition to saltbush addressing land management, shelter and feed gap issues, there are also some potential biodiversity benefits
- Of those landholders interested in planting other perennials, most indicated an interest in establishing lucerne.

It appears that many landholders may welcome and benefit from opportunities to discuss perennial management with their peers. It appears that many of the management issues experienced are common to most landholders. Individually, landholders are using trial and error to learn how to manage their stands to gain the best production outcomes.

Getting the best from grazing saltbush and other perennial plants comes from rotational grazing practices. On much of Eyre Peninsula set stocking is still widely practiced. Changes in livestock grazing practices will also provide benefits when managing these perennials.

Most landholders were interested in establishing lucerne. Some landholders had already demonstrated success in establishing lucerne, but dry years have reduced success rates. Lack of success may have resulted in a decline in landholder confidence and reluctance to try again. Again, opportunities to learn first hand from peers may be required to improve success rates.

A cost-benefit analysis to demonstrate the economics of the cost of establishment versus the long term benefits and gains in stabilising soils, reducing salinity and providing perennial pasture/fodder is needed to assist landholder decision making.

Biodiversity benefits from establishing perennial shrubs such as saltbush requires further investigation on Eyre Peninsula. The results of this investigation may then also require funding organisations to reconsider the funding incentives to landholders for such activities on private land.

Other areas for further investigation include: fire, competition of saltbush with cropping (alley farming - roots taking moisture from crops) and compatibility with other perennial pastures.

When watering points are some distance away there are other issues such as soil degradation, grazing patterns and efficiencies to consider. (Distance travelled to water versus efficiencies in grazing/feed utilisation).

One of the difficulties of undertaking this review was finding good information on who had saltbush and other perennials on their properties. If not for the goodwill of landholders and a willingness to share information and contacts, this review would have been made more difficult. Databases were incomplete and in many instances the original extension staff no longer worked in the region. Keeping good landholder relationships and records is vital if utilisation of new perennial options is to be reviewed again, especially after long periods of time between the promotion of perennial plantings, its adoption and future reviews.



6 APPENDICES

6.1 APPENDIX ONE

Saltbush Facts ⁶

Saltbush is a hardy, deep rooted, long lived, perennial shrub, which is tolerant of drought, low rainfall and saline environments. There are 40 species, some of which live up to 100 years. Saltbush is suitable for a wide range of soil types and is productive year round.



	Advantages	Disadvantages
Environmental	• Grows on saline ground • Range of soil types • Summer active • Utilises out of season rainfall • Acts as a sub-soil water pump • Suitable for magnesia patches • Suitable for sandy sites • Has biodiversity value • Buffer between agriculture and native vegetation • Can be used in fire planning - low flammability.	• Doesn't tolerate excess waterlogging • Intolerant of acid soils • Dormant in cooler temperature • May harbour pests • Limits other land uses • Eyre's Green is not frost tolerant.
Economic	• High protein forage • Feed is not wasted or fouled • Low fertiliser requirements • Combine saltbush with other productive grasses and legumes in inter-row plantings • Saltbush can provide valuable shelter for lambs and off shears.	• Requires 10-14 litres of water/day/head at <1000ppm • Stock need to be trained to graze saltbush • Need inter-row grazing for young, pregnant or lactating stock • Some species need active management to keep plants below 1.2 m.

⁶ Prepared by Daniel Schuppan, Mary Crawford and Di De Laine, Senior Consultants, Rural Solutions SA





Saltbush Nutritional Value

- Plants have 48-55% digestibility with Metabolic Energy (ME) 5.3-8.2
- Tests show protein of 12-16% with leaves having 20-30% Dry Matter (DM) and 25% salt
- High in vitamins and minerals especially Vitamin E
- Saltbush is high in oxalates and potassium, both of which can induce a deficiency in calcium

Animal Intake

- Sheep maximum voluntary salt intake 150-200 grams per day
- Eat less than 800 grams saltbush dry matter per day
- Requires energy and 10-14 litres of water per day to flush salt

- If too much salt is consumed by livestock, the feed is flushed through undigested
- Budget on 500 g DM per day at 6 ME/kg DM = 3 ME per day. 1 DSE requires 8.5 ME per day
- Additional energy required needs to come from the understory or a high energy supplement.

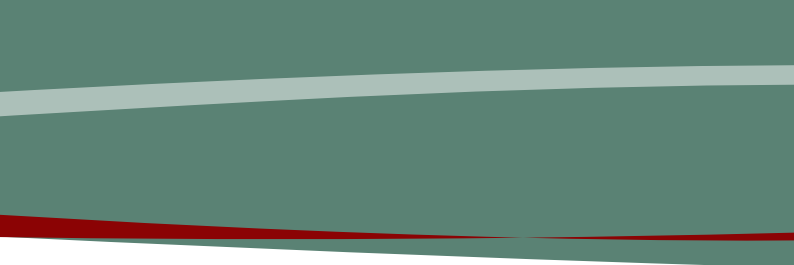
Saltbush Production

- 0.5-1 kg of edible dry matter per shrub per year
- May be 1 t DM per ha. Example stocking rate - 33 DSE/ha for 1 month plus hay/grain
- Saltbush will drop leaves, so, if you don't graze it you lose it.

Cost of Establishing Saltbush for Grazing

SALTBUSSH			COST (\$/ha)	
VARIABLE COSTS			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	0.15 ha - \$1.80
OPERATIONS COST	Contractor	\$0.20 per plant	400	100
	TOTAL ESTABLISHMENT COST		\$907	\$227

NB. Alignment of saltbush rows needs to take into account prevailing wind direction to avoid wind tunnelling and soil erosion.



Species

- Old Man (less palatable but equal or better nutritional value)
- Eyre's Green - more lateral growth, less management (does not like frosts)
- River Saltbush - more palatable but less nutritious. Not compatible with other species of saltbush as it will be grazed out more quickly
- Suitable perennial inter-row species include Puccinellia in saline sites, Veldt Grass on sandy rises. Oats and other cereals can be grown if inter-row spacing is wide enough
- Important to consider what inter-row species are established and utilised when planning saltbush layout and grazing management of both species.

Plant and Stock Management

- Plants should be lightly grazed in the first 12 months
- Can be grazed any time of the year however many landholders utilise saltbush during autumn feed gap
- Supplementary feeding with hay and or grain is recommended to maintain condition
- Suggested that sheep be off shears or crutched prior to putting into saltbush to reduce flystrike being undetected amongst the shrubs
- Wool production not lamb production or for lactating animals
- Critical to keep plants to 1.2 m grazing height by rotational grazing
- Rest phase between grazing needs to be at least six months
- If plants get too leggy mechanical topping will rejuvenate plants into production
- Mechanical topping should not be done in winter as plant growth is slow
- Paddock needs to have a water point within the saltbush stand with an adequate flow rate to ensure stock have sufficient water for their needs
- Limit paddock size to get even grazing across the stand.

Three Year Trial into Saltbush

A three year project funded by the SA Sheep Industry Fund and managed by the SA Sheep Advisory Group will investigate the impact of different feed supplements when combined with saltbush. More information can be found at www.productivenutrition.com.au





6.2 APPENDIX TWO

EPNRM REVIEW OF SALTBUSH PLANTINGS ON EYRE PENINSULA

PHONE SURVEY

Project aims.

Review use and utilisation of established saltbush stands on Eyre Peninsula

PART 1. Background Details

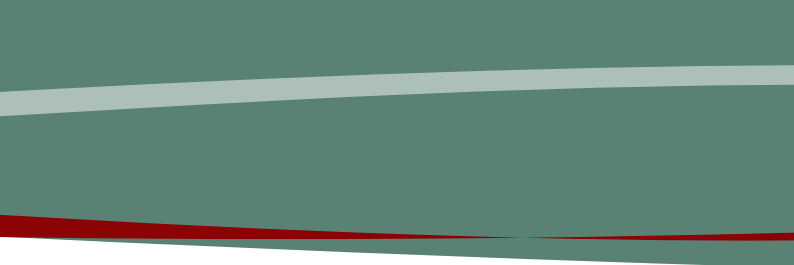
Is it okay if I ask you a couple of background questions about your property?

1. Where is your property located? _____ Hundred _____
2. What is the size of your property? _____ Acres or _____ Hectares
3. What is your annual rainfall? _____ Inches or _____ mm

PART 2. SALTBUSH Questions

4. What area of saltbush was planted? _____ Acres or _____ Hectares
5. What soil type was the saltbush planted on? _____
6. Do you have any saltbush remaining on the property? ☐ Yes ☐ No
Remaining area: _____ Acres or _____ Hectares
7. Is the stand fenced off from the remainder of the paddock? ☐ Yes ☐ No
8. Is there a watering point located within the stand/fenced area? ☐ Yes ☐ No
What is the condition of the stand? ☐ Excellent ☐ Good ☐ Poor ☐ Very Poor
9. What were the reasons for establishing the stand? _____

10. Is the stand grazed regularly? ☐ Yes ☐ No
11. If not, why not (i.e. too difficult to manage/palatability)? _____



12. What stock do you use to utilise saltbush on your property? _____

13. What grazing value do the plants in the inter-row have? _____

14. When do you normally graze the stand? _____

15. How does saltbush fit into your grazing rotation over the whole property? _____

16. Would you plant saltbush again? If not why? _____

17. What are the potential alternative land uses for the area on which saltbush is sown? _____





PART 2: OTHER PERENNIAL PASTURES

18. Have any other perennial plants been sown or planted on your property? ☐ Yes ☐ No
(if no go to PART 3)

19. What perennial fodder/pasture plants have been sown or planted?

Lucerne	Veldt Grass	Puccinellia	Saltbush	Tagasaste	Tall Wheat Grass	Other (please specify)

20. What area (size and location eg around saline area) and how long ago were the perennial fodder/pasture plants established?

21. What were the reasons for establishing the perennial fodder/pasture plants? e.g. Production benefits, soil erosion control, salinity etc.

22. How do you feel the perennial plants have benefited your farming system? _____



PART 3: SUMMARY AND FUTURE DIRECTIONS

23. Would you plant more perennial fodder/pasture species on your property? ☐ Yes ☐ No

24. If Yes, what type of perennial fodder/pasture species would you like to establish? _____

25. If No, what is preventing you from establishing more perennial fodder/pasture plants? _____

26. What, if any, are the biggest challenges to managing perennial fodder species on your property? _____

27. We are putting together some case studies on the use of saltbush for grazing on Eyre Peninsula. Can we visit your property and ask you some further questions about how you use your stand? ☐ Yes ☐ No

28. Preferred property visit date/time: _____

29. Do you know of anyone else in the area that has saltbush on their property? _____





GLOSSARY

Alley farming	where crops or pastures are grown between widely spaced rows of trees or shrubs, presents a means of potentially increasing water use and protecting soils.
Annual	a plant that completes its entire lifecycle within the space of one year.
Arable	land that is capable of being farmed productively.
Biodiversity	the number and variety of living organisms in the ecological complexes in which they naturally occur. The term biodiversity includes genetic diversity, species diversity and ecosystem diversity.
Biomass	plant matter grown.
Block plantings	rows of perennial plantings in a paddock.
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	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 commercial 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.
Dry weight	weight of any plant part after removal of moisture usually by drying.
Feed quality	a measure of the percentage of protein, digestibility, metabolisable energy and fibre in a particular feed source.
Forbs	are herbaceous flowering plants that are not graminoids (grasses, sedges and rushes).
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.
Improved pastures	pastures sown with introduced species of grasses and or legumes.
Indigenous species	species native to an area.
Lateral growth	sideways growth of a plant.
Legumes	are plants that have the ability to take nitrogen from the atmosphere and convert it to a form that can be used by the plants.
Microbial activity	microorganisms and soil bacteria living in the soil assisting in nutrient recycling.
Mounding	creating a raised, friable soil bed. This technique improves drainage and control of weeds
Native species	organism e.g. plant, that is found naturally in Australia. Not introduced from overseas. An endemic species is a native species that is found naturally in a specific area.
Non-arable	land that is unable to be cultivated or farmed.
Non-wetting	soil, often light textured, on which water does not easily infiltrate due to organic wax coatings on the soil particles.



Nutritional Myopathy	muscle wasting or dystrophy in livestock due to nutritional deficiencies in the diet.
Oxalates	naturally-occurring substances found in plants and animals which belong to a group of molecules called organic acids.
Pasture	grasses and legumes planted for grazing.
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.
Prostrate	growth habit that is flat against the ground.
Rank	pasture growth (commonly perennial) which is 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.
Ripping	breaking up the soil surface into shallow furrows to create a friable soil so that roots of seedlings can easily penetrate. Ripping is usually done with a tractor or bulldozer fitted with single or multiple-tined ripper prior to planting out.
Rotational grazing	a paddock that is not set-stocked continuously; rather it is grazed and rested regularly, either on a set time schedule or intermittently as required. Rotational grazing allows a high stocking density to be applied to each paddock for a suitably short period. Grazing and rest periods are determined according to available herbage and estimated rate of recovery of desired pasture species.
Scalping	removing weeds with a small amount of topsoil.
Seed Bank	amount of seed set by pasture and lying dormant on the soil surface which may germinate under suitable conditions.
Set stocking	grazing systems in which stock remain in one field or paddock for a long period.
spp	abbreviation for species. Often used when referring to more than one species within the same genus.
Spelling	the planned absence of stocking or cropping to rest the area from agricultural stress.
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 of dry sheep equivalents (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.
Store condition	refers to the old fat score of 2 or the current condition score of 2 to 3 (store to forward store). These scores estimate the condition or 'nutritional well-being' of sheep.
Summer active	species giving production during summer.
Summer dormant	perennial plant where buds remain dormant until autumn rains.
Tussock	a compact, densely tufted growth form of some grasses and sedges.
Water table	the depth at which soil pore spaces or fractures and voids in rock become completely saturated with water.
Winter active	species giving production during winter.





8 FURTHER READING

General

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