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Revegetating salt-affected land with shrubs

By Ed Barrett-Lennard¹, Fionnuala Frost², Steve Vlahos³, and Norm Richards⁴

The establishment of salt-tolerant shrubs such as saltbush and bluebush on salt-affected land reduces the risk of soil erosion, and can also fit into farm programmes as a profitable enterprise.

Salt-tolerant shrubs can be used as forage for sheep in summer and autumn, when the availability of annual pastures is low or annual pastures are just beginning to emerge.

This article describes three methods for establishing shrubs on salt-affected land and what affects shrub establishment.



Weed competition. Annual ryegrass, in the foreground, has prevented establishment of wavy leaf saltbush and quailbrush.

TOP: Sheep grazing a good stand of wavy leaf saltbush.

WHAT AFFECTS ESTABLISHMENT OF SHRUBS

Many saltbush species have female and male flowers on separate plants, but seeds are only found in fruits on female plants. The fruits consist of two bracts, which may (or may not) enclose a seed.

The use of saltbush fruit with a high percentage seed fill does not necessarily ensure good establishment because a range of stresses influence germination and establishment. These stresses include:

Salinity. Saltbushes, like cereal crops, have a relatively low tolerance to salinity during germination.

Waterlogging. Waterlogging inhibits germination. It can damage roots of young seedlings and increase the rate of salt uptake into the shoots, which kills the plant.

Seed burial. Covering saltbush fruits with more than five millimetres of soil may stop seedlings emerging.

Dry weather. Saltbush seeds must be sown on the soil surface, where they are susceptible to dry conditions; even brief periods of dry weather can cause many deaths.

Insect attack. Immediately after germination, when saltbush seedlings are less than five millimetres high, they can be killed by redlegged earth mites. Seedlings up to 15 cm high can be killed by Rutherglen bugs, grubs and locusts eating the leaves.

Weed competition. Weeds can decrease establishment through competition for moisture and light.

Low temperatures. Temperatures below 10°C reduce germination, so establishment can be slow during the cooler months of May to September.

Other stresses. Frosts, hail and sand blasting can all reduce establishment. Moreover, salt, low temperature and waterlogging can interact to cause lower germination than these factors would when operating alone.

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THREE METHODS FOR REVEGETATING SALT LAND

There are three methods for establishing salt-tolerant shrubs on saltland.

Direct seeding techniques. The niche seeder is designed to establish saltbush and bluebush on salt-affected soils. It modifies the soil environment to create a favourable niche for germination and growth of the seedling.

Planting nursery-raised seedlings. The most sensitive stages of establishment (germination and early growth) occur in a nursery. Seedlings are transplanted into the field when they are more resistant to environmental stresses.

The low cost method. The area to be established is fenced, and grazing is restricted to allow regeneration of native salt-tolerant plants, such as bluebush and samphire.

The choice of establishment technique will depend on the species to be grown, the soil type, site characteristics, climate, and finance.

Niche seeding

Niche seeders deposit saltbush fruits and a covering of vermiculite at intervals of one to three metres on a raised M-shaped mound.

The shape of the mound promotes leaching by rain of salt from the soil around the fruits. The vermiculite acts as a mulch; it retains moisture around the fruits and reduces the upward movement of salt by evaporation into the seedbed. The raising of the seedbed above the surrounding soil reduces waterlogging.

Thousands of hectares of saltbush have been successfully established on salt-affected land using niche seeders. However, some establishment has failed because of the following:


High salinity. Seeding is frequently unreliable on bare, highly saline sites. Sites growing patchy to continuous barley grass generally have mild to moderate salt concentrations and give better establishment.

Sowing on inappropriate soil types. Establishment is less reliable on heavy clay or shallow sand (less than 10 cm) over clay soils where the soil in the niche may be dispersive and hardsetting.

Dispersive soils contain clay which does not stay stable when wetted. The dispersed clay can block soil pores and act as a cement that hardens the soil when it dries.



On duplex soils with more than 10 cm sand over clay and sandier soils, establishment is usually good.

 Cross section of mound made by a niche seeder.

Use of poor quality seed. Half of the river saltbush fruit samples tested by the Department of Agriculture's Seed Testing Laboratory over the past two years had a germination of less than 20 per cent. Many samples had a germination of less than 5 per cent. Good establishment can only be achieved with viable seeds.

Waterlogging. Saltbush rarely establishes on waterlogged soil. Soil mounding and drainage of surface water improves establishment and growth.

Inadequate site preparation. Cultivation before niche seeding is essential, to improve leaching of salt from the soil and help break up large clods.

Weed competition. Heavy infestations of barley grass, annual ryegrass or iceplant frequently cause failures in establishment.

Lack of insect control. There are many examples where no saltbush seedlings were seen until redlegged earth mites were controlled by mist-spraying of insecticide. The mites were probably killing the seedlings before they emerged from the vermiculite mulch.

Lack of follow-up rain. Late sowings have been unsuccessful because of the high risk of subsequent dry conditions.

Several contractors in Western Australia use niche seeders to establish forage shrubs on saltland. Their charges range from \$100 to \$300 per hectare, depending on the size of the area to be sown, the species to be sown and the



▲
Ian Walsh, a farmer in the North Stirlings Land Conservation District, and Clive Malcolm examine an excellent saltbush stand that was planted with a niche seeder.

planting density. Some contractors will negotiate a lower price in exchange for considerations, such as using the farmer's tractor.

One of the better results from direct seeding that we have recently seen came from a farmer with a saline deep sandy duplex soil in the North Stirlings catchment. This farmer, who is part-owner of a niche seeder, established an excellent stand of saltbush over 20 ha for \$155 per hectare. The sowing of the saltbush was only a small part of the total revegetation process. Forage production from this profitable stand required planning, site preparation, seeding, post-seeding monitoring and management, and exclusion of stock (Table 1).

Planting nursery-raised seedlings

We have now conducted seven trials with river saltbush (*Atriplex amnicola*) in which we compared niche seeding with the transplanting of nursery-raised seedlings. The seedlings were planted using a commercially available tree planter that had a grader blade that scrapes away the weeds and their seeds, and a heavy ripper that rips to a depth of 40 cm.

In all cases, planted seedlings established better than fruits sown with a niche seeder (Table 2).

Nursery-raised seedlings were less susceptible than germinating seeds to salinity, waterlogging, brief periods of dry weather, insect attack, cold weather and hail. Competition from weeds for light and water during the early stages of growth was reduced, since the planter blade removed most weeds.

Table 1. Sequence of events used to achieve a successful saltbush stand on sandy-textured saline soil in the North Stirlings Land Conservation District

Date	Activity
May 1989	Scarified soil to promote leaching of salt and germination of weeds and to improve tilth. This allowed areas with dense annual ryegrass to be identified.
June 1989	Site became flooded. Farmer marked lines for 'W' drains by observing and pegging flow of surface water.
September 1989	Areas covered with ryegrass were sown to tall wheat grass. Barley grass area was sprayed with a mixture of Spray.Seed® for weed control and Le-Mat® for redlegged earth mite control, then scarified, harrowed, and niche seeded with a mixture of: Wavy leaf saltbush at 150 g/km row River saltbush at 100 g/km row Grey saltbush at 30 g/km row Quailbrush at 50 g/km row Old man saltbush at 25 g/km row Wattle (<i>Acacia saligna</i>) at 25 g/km row
December 1989	Installed 'W' drains to drain excess water.
April 1991	Grazed stand at 21 sheep/ha for two months.

Our results and farmer experience have shown that plant establishment from nursery-raised seedlings is more reliable than establishment by other methods.

Unfortunately, nursery-raised seedlings are relatively costly. In 1991, saltbush seedlings from nurseries cost 25 cents to 50 cents each; a stand of 1000 plants per hectare would cost between \$250 and \$500 per hectare for plants. Further costs would include transporting seedlings to the site, preparing the site and planting.

Farmers can substantially lower the cost of revegetation by producing their own seedlings. A farmer in the Kalgan Land Conservation District produces saltbush plants from cuttings in a home nursery at an estimated cost of only 6 cents each.

There has been some interest in the use of bare-rooted seedlings (seedlings without soil around the roots) for saltland revegetation. Bare-rooted seedlings have given good results when planted into non-saline soils. However, in our experiments on seven highly saline soils,

Table 2. Establishment of river saltbush from transplanted nursery-raised seedlings and seed sown with a niche seeder at seven sites

Site	Description	Per cent establishment	
		Seedlings	Seed
<i>1988 season</i>			
North Baandee	'Morrel' soil	97	73
Katanning	Heavy clay - subject to flooding	90	18
Esperance	Severely saline, waterlogged clay	10	0
<i>1989 season</i>			
Tammin	Duplex (sand over clay) soil	90	39
Meckering	Duplex (sand over clay) soil	92	5
East Narembeen	Clay subsoil (eroded duplex soil)	65	0
Yealering	Varies from sand over clay to heavy gleyed (smears and seals when wetted) clay	92	76



Nursery-raised saltbush seedlings planted with a tree planter establish well.

establishment of bare-rooted river saltbush seedlings was very poor. We attribute these failures to:

- Root damage during the removal of seedlings from soil in the nursery and during planting. Broken roots allow excessive levels of salt to move into and kill the plant.
- Lack of salt hardening, which causes plants to experience a severe osmotic shock when transplanted into saline soils. (See 'Small scale tree and shrub nurseries' Farmnote 94/89, for an explanation of how to harden seedlings. Seedlings transplanted straight from a nursery into saline soils can have up to half their water content sucked into the soil.)

We believe that bare-rooted seedlings have considerable potential because the lack of soil makes them cheap to transport. Some nurseries are developing production systems to overcome the above problems. Experiments with bare-rooted seedlings are continuing.



The low cost method

The low cost method entails fencing the salt-affected area to restrict grazing, and allowing the site to regenerate naturally. This method is particularly appropriate for bare valley floor areas affected by severe salinity, and for morrel soils of the eastern and northern agricultural areas and the Upper Great Southern. Once grazing is reduced, samphire (*Halosarcia* species) and bluebush (*Maireana brevifolia*) will establish, provided there are sources of seed close by.

Revegetation can be helped by roughening the soil surface with harrows or a cultivator bar to help catch seed.



Seedlings in the Banchi Tree Nursery operated by students of Dalwallinu District High School. The school won the students section in the 1989 John Tonkin Tree Awards. Photo: GREENING AUSTRALIA.

Fencing and restricting grazing is a low cost method for establishing samphire and bluebush. Note the better growth where grazing is controlled.

Recommendations for establishment

Saltland revegetation is part of total catchment management. Your planning must also take account of the whole catchment.

Planning: Catchment management

Off-site

You should plan to:

- reduce surface and subsurface water flow on to saltland by using interceptor drains and grade banks;
- reduce erosion of soils by cultivating on the contour, installing grade banks, and retaining more stubble; and
- reduce water recharge by using wheat-lupin rotations or establishing perennial pastures, and tree or shrub plantations.

On-site

You should plan to:

- increase the movement of flood water off saltland by using surface drains;
- reduce waterlogging by using mounds, bedding systems or deep drains; and
- confine floodwaters to watercourses by building levee banks.

Planning: Revegetation

Identify soil types

Site assessment is essential. Important soil characteristics are soil texture, degree of salinity (as indicated by the amount and type of 'indicator' grasses), and degree of waterlogging.

Some natural indicators and colonizers of saltland include Mediterranean barley grass (*Hordeum geniculatum*), ice plant (*Mesembryanthemum* spp.), mallee lovegrass (*Eragrostis dielsii*), saltspurry (*Spergularia* spp.), curly ryegrass (*Parapholis incurva*) and beard grass (*Polypogon monspeliensis*). See "Forage shrubs and grasses for revegetating saltland", Bulletin 4153.

Choose an establishment method

- Niche seeding

Direct seeding, using a niche seeder, is suitable for sandy textured and sand over clay soils with an upper sandy horizon more than 10 cm deep.

Timing is critical for niche seeding. In the eastern and northern agricultural areas, plant saltbush seeds in June and July to ensure there is maximum winter rainfall for soil leaching and seedling growth. Bluebush can be sown in May to June.

In wetter areas, seed as soon as the risk of waterlogging has decreased.

- Nursery-raised seedlings

Nursery-raised seedlings are suitable for sandy textured, duplex, and heavier clays.

The time of transplanting for nursery-raised seedlings is less critical than that with the niche seeder; however, plant seedlings early enough to develop deep roots before their first summer.

Seedlings should be vigorous, hardened to wind, and be 10 to 15 mm high. If seedlings are to be planted in peat pots, peel off the bottom of the pot before transplanting and tease the roots apart. Peat pots must be planted so that the lip is covered by soil.

Deep ripping can improve the growth of seedlings in sandy soils having a traffic pan.

- Low-cost method

A low cost technique is suitable for highly saline, bare soils subject to waterlogging, morrel soils, and heavy grey clays.

If bluebush or samphire plants are present, a reduction in grazing pressure will allow the paddock to revegetate. If the area lacks plants, revegetation will be promoted by:

- scratching the soil surface with either harrows or a cultivator bar and scattering seed onto the surface; and
- niche seeding or planting nursery-raised bluebush seedlings in rows 20 m apart, and allowing the stand to thicken up over subsequent years.

Choose the species carefully

The species planted will depend on the salinity of the site, shown by indicator grasses, and its susceptibility to waterlogging (Table 3).

With niche seeding, many farmers and contractors sow a mixture of shrub species. Seed mixtures should be dominated by one or more of:

- wavy leaf saltbush (*Atriplex undulata*);
- river saltbush (*A. amnicola*); and
- bluebush (*Maireana brevifolia*), provided the site is not subject to waterlogging.

Other useful species:

- Quailbrush (*A. lentiformis*), a tall growing shrub that establishes easily. It may not persist on saltland in the long term.

Table 3. Shrub selection and establishment method for saline soils

Winter waterlogging	Cover			
	Annual rye grass	Complete barley grass	Patchy barley grass	Bare
1-3 months per year	Acacias <i>Niche seeder or tree planter</i>	River saltbush <i>Niche seeder or tree planter</i>	River saltbush <i>Niche seeder or tree planter</i>	Samphire <i>Low cost method</i>
1-3 weeks per year	Acacias <i>Niche seeder or tree planter</i> Old man saltbush <i>Tree planter</i>	River saltbush Wavy leaf saltbush Quailbrush Grey saltbush <i>All niche seeder or tree planter</i>	River saltbush Wavy leaf saltbush Quail brush <i>All niche seeder or tree planter</i>	Samphire <i>Low cost method</i>
Less than one week per year	Old man saltbush <i>Tree planter</i>	Acacias Old man saltbush <i>Both niche seeder or tree planter</i>	Small-leaved bluebush <i>Niche seeder or low cost method</i>	Small-leaved bluebush <i>Niche seeder or low cost method</i>

- Old man saltbush (*A. nummularia*), which is not as palatable as other species. It may grow out of reach of sheep and is not tolerant of waterlogging.
- Grey saltbush (*A. cinerea*), a shrub that ranges from erect to prostrate forms over 8 m in diameter. Its palatability ranges from poor to good.
- Wattle (*Acacia saligna*), a useful windbreak and fodder shrub, especially on mildly saline soils.

Test the seed

Seed for niche seeding must be tested for germination so you can calculate seeding rates. See 'Variable quality of saltbush seed influences establishment' on page 130.

Prepare the site

Site preparation may be time consuming, but is essential.

Fence the site and remove dead trees and stumps. Cultivate soil one or more times several months before planting to leach out salt and develop soil tilth. On some sites cultivation followed by rain will cause boggy conditions. In this case, cultivate immediately before niche seeding.

Control weeds by heavy grazing in the season before sowing, burning, tillage, or use of a knock-down herbicide. Do not use residual herbicides.

Control surface water

Establishment of salt tolerant plants improves if waterlogging is reduced. Surface water flow must be managed to prevent seed from being buried and seed or seedlings from being washed away. Some tree planters have modifications that allow the seedlings to be planted in mounds.

If the site has a surface drainage system, the line of tree planter and niche seeder mounds should follow the direction of the drainage system, to promote the run-off of excess water. The maxi-

mum gradient of mounds should be as for grade banks (0.3-0.5 per cent). If the site has no surface drainage system, mounds should be on the contour.

Control insects

Attack by insects, including redlegged earth mites and lucerne flea, can be disastrous for establishment. You must have insecticide on hand, and spray equipment available for use.

Monitor germination at one to two week intervals. Redlegged earth mite must be controlled during germination. If insects are present, spray two to three weeks after seeding, even if no seedlings are visible. Mites can be controlled with Le-Mat® at 50 mL/ha on grassy areas or 150 mL/ha on bare soil.

Rutherglen bugs and aphids may also attack establishing plants. These pests can be controlled by spraying maldison and metasystox respectively.

Grazing

Uncontrolled long-term grazing by sheep kills most saltland plants. Grazing should be restricted to about two months of the year to allow plants to recover. Vigorous saltbush stands may be lightly grazed in the first autumn after planting. A full grazing should be possible in the second autumn after planting.

Saltbush is a maintenance feed for sheep. It is best used in conjunction with non-saline forages such as grasses, stubbles and hay.

Sheep grazing saltbush in summer can drink as much as 10 L/day. They should have access to drinking water with an electrical conductivity less than 1000 mS/m. □

Further reading

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