Saltland Capability Assessment: Targeting Plants to Landscapes to Increase Profitability

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Abstract

Saltland varies in its capacity for productive and profitable use. For example, in the Central Wheatbelt of Western Australia it ranges from being highly productive and profitable ($40-80/ha/yr) to being of negligible productivity and profitability. To reduce the spread and impact of salinity, perennial plants need to be planted on saltland to lower the watertable, but annual under-storey plants are essential to increase productivity and profitability through increased grazing opportunities. Clear guidelines are required so that interventions on saltland match the optimal combinations of plant species to the landscapes of different capability.

Research conducted at four trial sites in the medium rainfall (350-550 mm/yr) zone of Western Australia, with river saltbush, small-leaf bluebush, samphire, Rhodes grass, saltwater couch, puccinellia, tall wheat grass and lucerne, led to the development of a saltland capability assessment tool based on the following assessments; 1) level of salinity in the subsoil (25–50 cm depth), 2) depth to the watertable, and 3) presence of plant "indicator species." Results from the field trials combined with economic analysis suggested that profitability of the grazing system will be highest if plantings are confined to land with average EC_e values less than 8 dS/m and watertables in summer deeper than ~1 m.

The featured saltland capability assessment tool is a first step. However, the decision support tool needs to be validated across a wider range of saline sites and expanded to incorporate a wider range of plants. Farmer participation and validation is an essential component of this process; this participation will be continued through the Future Farm Industries CRC "Saltland Knowledge Exchange" and "SALTCAP" Projects.

Keywords

Soil salinity, waterlogging, halophytes, legume pasture, salt tolerant plants, economics

Introduction

Dryland salinity, the salinisation of land as a result of rising watertables following the clearing of native perennial vegetation (Ghassemi *et al.*, 1995), is a major problem affecting agricultural production and natural resources in Australia. A total of 1.9 Mha are presently regarded as being at risk from salinity because of shallow water-tables and this could increase to 3.7 Mha before equilibrium is reached (ISF 2008, R. George, Pers. Comm.). Western Australia (WA) is the State with the greatest area of saltland, with a current estimate (probably an underestimate) of 1 Mha at risk. This is likely to increase to 2.8 Mha before equilibrium is achieved (ISF 2008, R. George, Pers. Comm.). Equilibrium is when the area affected by salinity is no longer increasing.

To reverse the trend of rising watertables across some parts of the country, perennials are required over much of the landscape. However farmers will only be encouraged to change their farming practice away from current annual plant-based industries (cereal crops and annual pastures) if new industries based on perennials can compete economically. For much of the low to medium rainfall (300 to 500 mm) zone of southern Australia there are currently no compelling financial advantages for conversion to broad-scale industries based on perennial plants. It is therefore unlikely that perennial plants will be adopted into agricultural systems in this zone on the scale required to reverse the rising watertables that are causing salinity. Farmers will therefore need strategies to live with salinity.

With a mediterranean climate, southern Australian farming systems, generally have a fodder deficiency in summer and autumn and small areas of deep-rooted perennial pasture plants have a premium value at this time of year. Salt-tolerant fodder plants can be used to help fill this feed gap. However, saltland is highly variable in its ability to grow such plants, and the factors affecting “what plants can be grown where” in the saline landscape have until recently been poorly understood. It is increasingly recognised that plant zonation on saltland is affected by levels of salinity and waterlogging (Barrett-Lennard, 2003, Barrett-Lennard *et al.*, 2003). This paper explores the development of a framework for saltland capability assessment and examines its use in discriminating between areas of saltland that will provide good economic returns to the farmer, and those that will provide poor economic returns and should be left to revegetate naturally.

Methods

The research behind the saltland capability assessment tool (called SALTCAP-1) is based on trials conducted at four sites in Western Australia. These included three transect experiments conducted as part of the WA component of the Sustainable Grazing on Saline Land (SGSL) initiative located near Wubin, Meckering and Pingaring (WA) where six species were grown; three halophytic shrubs – samphire (*Halosarcia* sp.), river saltbush (*Atriplex amnicola*) and small-leaf bluebush (*Maireana brevifolia*), one halophytic grass – saltwater couch (*Paspalum vaginatum*), one sub-tropical grass – Rhodes grass (*Chloris gayana*), and one perennial legume – lucerne (*Medicago sativa*), and one additional transect trial located near Kojonup, WA where two halophytic grasses were grown – puccinellia (*Puccinellia ciliata*) and tall wheatgrass (*Thinopyrum ponticum*)(Jenkins, 2007). Data were collected on the survival and best growth of the eight perennial species in relation to soil salinity and depth to watertable.

Data were also collected on the percentage cover of native and naturalised (‘indicator’) species as predictors of salinity and waterlogging. The occurrence of these species was related to soil salinity and depth to the watertable on the transect trials at Wubin, Meckering and Pingaring . The species recorded at a frequency of greater than 40% cover and thus included in the assessment were capeweed (*Arctotheca calendula*), annual ryegrass (*Lolium rigidum*), cotula (*Cotula coronopifolia*), curly ryegrass (*Parapholis incurva*), rats tail fescue (*Vulpia myuros*), slender iceplant (*Mesembryanthum nodiflorum*), puccinellia (*Puccinellia ciliata*) and samphire (*Halosarcia* sp.).

Results

Survival of perennial plants on saltland declined most rapidly in the summer and autumn after the plants were established. Our data suggest that the zonation of these species on saltland can be predicted based on depths to the watertable in spring/summer and average EC_e values in the subsoil (25-50 cm). At three of the sites (Wubin, Meckering and Pingaring) plants were ranked for ‘good survival’ (60% survival or better in a local area). At the other site (Kojonup), plants were ranked for ‘occurrence’ at a local area.

At Wubin, Meckering and Pingaring, the depth to watertable associated with ‘good survival’ (95% confidence interval) was 0.7 to 1.0 m with samphire, 0.9 to 1.3 m with saltwater couch, 0.9 to 1.5 m with rhodes grass, 1.0 to 1.7 m with lucerne, and 1.4 to 1.8 m with river saltbush and small leaf bluebush. Watertables shallower than the optimal range decreased the survival of all species except samphire. Watertables deeper than the optimal range decreased the survival of all species except river saltbush and small leaf bluebush. The subsoil EC_e associated with ‘good survival’ (95% confidence interval) was ~3–9 dS/m for lucerne, ~5–15 dS/m for rhodes grass, saltwater couch, small leaf bluebush and river saltbush, and ~25–60 dS/m for samphire. EC_e values greater than these optima decreased the survival of all species except samphire (Barrett-Lennard *et al.*, 2008). At Kojonup, the depth to watertable in summer (95% confidence interval) associated with ‘occurrence’ was 0.9–1.0 m for puccinellia, and 1.1 to 1.2 m for tall wheatgrass. The EC_e in summer (95% confidence interval) associated with occurrence was 17–21 dS/m for puccinellia, and 10–11 dS/m for tall wheatgrass (Jenkins, 2008).

At Wubin, Meckering and Pingaring, the depth to watertable in spring associated with 40% or greater cover was 0.5 to 0.6 m for samphire and puccinellia, 0.8 to 0.9 m for rats tail fescue, 0.8 to 1 m for curly ryegrass, 0.9 to 1.3 m for cotula, 1.4 to 1.7 m for capeweed, 1.6 to 2 m for ice plant and 1.8 to 2.2 m for ryegrass. At these sites, the subsoil EC_e associated with 40% or greater cover was ~0.5-2 dS/m for rats tail fescue, ~4-6 dS/m for capeweed, ~7-12 dS/m for ryegrass, ~8-15 dS/m for cotula, ~9-22 dS/m for curly ryegrass, ~14-22 dS/m for ice plant, ~26-39 dS/m for puccinellia and ~57-85 dS/m for samphire (Bennett & Barrett-Lennard, 2008). Both depth to watertable and subsoil EC_e requirements appear very specific for each species, but this is likely to be related to the limited number of sites on which the current data are based.

Discussion

Some broad conclusions that can be made from the results presented above are that:

• Sites that grow samphire are likely to be too saline and waterlogged to grow useful saltland pastures.

• Puccinellia is adapted to, and should be grown on, severely saline waterlogged sites.

• Slender iceplant and annual ryegrass have excellent potential as indicators for the growth of river saltbush and small leaf bluebush.

• Curly ryegrass and cotula have potential as indicators for the growth of shallow rooted halophytic grasses like saltwater couch and tall wheatgrass.

Survival and growth of the halophytic species included in the trials discussed above have shown that these species can be used for the reclamation of saltland. But how can we persuade farmers to grow these species on their saltland – what industries can be developed around the sowing of salt tolerant halophytic shrubs and grasses? Several researchers have proposed a range of services or products using salt tolerant plants (Barrett-Lennard, 2000), but the most extensive use of saltland has been for the grazing of sheep. Farmers who wish to become involved already understand the industry, have facilities for handling sheep and the industry has well-developed markets (meat and wool) and marketing processes.

However, there are three practical problems facing sheep grazing halophytic plants (Masters *et al.*, 2001);

- halophytes, and in particular *Atriplex* species, produce relatively low leaf yields,
- the material has a relatively low digestibility, resulting in a low net energy yield for the grazing animal from the feed, and
- the plants can accumulate high concentrations of salt in their leaves (20-30% of leaf dry weight), so that grazing animals limit their feed intake.

There is now some evidence that the growth of halophytes can provide some environmental benefits to saltland by drawing down the watertable and thus starting to restore the productivity of saltland (E. Barrett-Lennard, Pers. Comm.). This recognition has led to the development of an alternative "model" for the design of saltland pasture: using halophytes primarily to lower watertables, so that less salt and waterlogging under-storey species (especially annual legumes) can be grown, with sheep predominantly grazing these other species (Barrett-Lennard & Ewing, 1998). This is becoming one of the most frequent uses of saltland today. In the 300 to 500 mm rainfall zone of southern Australia, saltbushes (*Atriplex* species) are grown on saltland to lower the watertable, but the stands also incorporate an under-storey of annual legumes, in particular balansa clover (*Trifolium michelianum*) and burr medic (*Medicago polymorpha*), to improve the nutritive value of the feed on offer. Economic analyses show that these systems can deliver benefits to farmers of $AUS 40-80/ha/yr (Bathgate *et al.*, 2008).

Research based on four sites in WA suggests that a reasonably robust saltland capability assessment tool can be developed using assessment of the levels of soil salinity (average EC_e values at 0-25 and 25-50 cm depth in the soil profile), the average depth to the watertable in spring/ summer and the presence of native and naturalised 'indicator' species (Barrett-Lennard *et al.*, 2008, Bennett & Barrett-Lennard, 2008). Greatest profitability will be achieved from the grazing system where plantings are restricted to land with an average EC_e of less than 8 dS/m and a watertable in summer that is deeper than ~ 1 m (depending on soil type). These sites are indicated by the frequent occurrence of annual species such as capeweed and annual ryegrass (Bennett & Barrett-Lennard, 2008). Saltbushes will also grow on land affected by higher levels of salinity (EC_e values of 8 to 16 dS/m), which are indicated by the frequent occurrence of cotula, slender iceplant and annual ryegrass (Barrett-Lennard *et al.*, 2008, Bennett & Barrett-Lennard, 2008). However, these pastures are likely to be energy deficient for grazing animals and will therefore require additional supplements of hay or grain.

The current saltland capability assessment tool (known as SALTCAP-1) is an initial step in the prediction of 'what to grow where' on saltland and what saltland can be economically productive if sown with the right saltland pasture system. However, the current key needs to be validated across a wider range of saltland sites and expanded to incorporate a wider range of perennial and annual plants. Further focussed work is planned on the following issues;

- Increasing sites and species, with the aim of separating the causes of zonation and increasing the number of pasture and indicator species in the matrix. Our present key has a number of obvious omissions, including sea barley grass (*Hordeum marinum*), balansa clover and woolly clover (*Trifolium tomentosum*).
- Measuring average EC_e values to determine the relationship between average EC_e at the soil surface and EC_e values at depth.
- Measuring depths to the watertable in all seasons to establish the relationship between average watertable depths in spring/ summer and at other times of year, so that the saltland capability assessment can be used throughout the year.
- Conducting glasshouse experiments to test the assumptions that winter waterlogging causes damage to roots, or prevents root growth occurring at depth, which subsequently prevents them from obtaining moisture at greater soil depths in the summer.

Conclusion

Saltland varies in its capacity for productive use. Some mildly affected land is capable of supporting highly productive and commercially valuable plants, some more affected land will support less commercially valued plants, and some land will be so severely affected that it will be of no commercial use. Farmers, advisors and catchment managers need clear guidelines so that investments on saltland can be targeted to landscapes of greatest value. A preliminary saltland capability assessment tool, SALTCAP-1, is available through the Future Farm Industries CRC and research is planned over the coming years to improve its potential.

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