Increasing Pasture Production on Drained Saltland

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Abstract. The Upper South East of South Australia has been identified as being at risk of extensive soil degradation, with large areas already affected by dryland salinity and waterlogging. To mitigate this, an extensive network of drains has been installed. In 2009, 19 soil surveys were conducted on land adjacent to a number of deep drains (>1.0 m) in order to determine soil salinity and pH. The surveys indicated low levels of topsoil salinity (0-10 cm) in the southern part of the region, while 66% of soil sampling sites in the northern zone had salinity levels (ECe) below 4 dS/m. These results suggest that important changes in soil salinity have occurred, which are likely to impact on pasture species adaptation. To identify suitable pasture options for these drained areas, four pasture evaluation trials were established in 2009. These trials were established on four different soil types, with each sown to 32 species including annual and perennial legumes, annual and perennial grasses and perennial herbs. Results show that an array of productive pasture species could potentially be suited to these environments, with species performance often site specific. This contrasts to the limited range of previously sown saltland species, principally puccinellia (*Puccinellia ciliata*) and tall wheat grass (*Thinopyrum ponticum*). The results demonstrate that pasture productivity can be substantially improved by the resowing of new pasture species in these areas.

Keywords: Salinity, pasture production.

Introduction

Salinity became widespread in South East South Australia following a series of events in the late 1970's and 1980's. Prior to the onset of broad scale salinity, much of the region's productive flats and sandy rises were sown to lucerne, a deep-rooted perennial, However these stands were decimated by aphid infestations in 1978 (Government of South Australia: Department for Water 2011). This was followed by broad scale flooding in 1981, with 1.0 m of water covering much of the inter-dunal flats (Munday 2005). To excerabate the problem a severe drought in 1982 prohibited the removal of salt removal (flushing) from the topsoil, brought to the surface by the proceeding floods (Munday 2006). Existing pasture species were poorly adapted to the increased salinity, resulting in low water usage. Some year's later graziers introduced the salt-tolerant grass *puccinelli*a, which saw an increase in pasture cover (Munday 2006).

The landscape changed again in the 1990's and 2000's, due to a series below average rainfall and/or the establishment of an extensive network of drainage networks constructed to address productivity and environmental concerns in this region (Government of South Australia: Department for Water 2011). These factors contributed to lower the watertable levels, thereby reducing the extent of waterlogging and assisting the movement of salts deeper into the subsoil. As a result salt tolerant species, particularly *puccinellia*, are failing. This created a need to understand the changes in soil characteristics in areas influenced by the drains, and to identify pasture species suited to these altered areas.

Methods

Soil Surveys

Surveys were conducted on 19 properties in the Upper South East of South Australia. Surveys were conducted on flat land adjacent to deep drains (minimum depth of 1 m) between January and March 2009, when salinity level are expected to be highest. A minimum of 8 topsoil samples (0-10 cm) were collected along each transect, up to 3 km from the drain. Ten soil cores were collected at each sampling point. Sampling was only undertaken on dry topsoil. Each sample was assessed for salinity (EC_e (dS/m)), $pH_{(water)}$ and texture.

Transects were grouped into three geographical areas based on rainfall and soil type differences, and referred to as the northern, southern and western zones.

Pasture Production

Four pasture evaluation sites were established adjacent to deep drains in winter 2009 (see Table 1). At each site, 32 commercial pasture species were sown on differing soil types.. Three germplasm groups were represented: annual and perennial grasses, annual legumes, and perennial legumes and herbs (Table 2). More than one variety of species was sown (66 varieties) in a randomised block design with 3 replicates. Pasture availability was visually assessed seasonally and calibrated using dry matter cuts. Pasture availability was analysed within each germplasm group using analysis of variance. Plots were intermittently cut or grazed after dry matter assessments. Fertiliser was applied annually, with insect and weeds controlled when required.

Table 1. Soil characteristics of the pasture evaluation sites at establishment (0-10 cm, 26th March 2009).

Site	Location	Drain	Soil Type	$pH_{(water)}$	EC_e (dS/m)
1	Taunta Hut	Mt Charles	Loamy sand	8.4	1.3
2	Mt Charles	Bunbury	Loamy sand	6.3	1.0
3	Woolumbool	Fairview	Loamy sand	6.0	1.0
4	Taratap	Taratap	Light medium clay	8.8	3.4

Table 2. Pasture species sown within each germplasm group at the pasture evaluation sites.

Annual and Perennial Grasses		Annual Legumes	Perennial Legumes and Herbs	
Italian ryegrass	Perennial ryegrass	Balansa clover	Lucerne	Chicory
Annual ryegrass	Phalaris	Arrowleaf clover	White clover	Plantain
	Prairie grass	Persian clover	Strawberry clover	
	Grazing brome	Gland clover	Sulla	
	Cocksfoot	Subclover		
	Veldt grass	Berseem clover		
	Tall wheat grass	Woolly pod vetch		
	Tall fescue	Gama medic		
	Puccinellia	Burr medic		
	Wallaby grass	Barrel medic		
	Rhodes grass	French serradella		
	Forest blue grass	Yellow serradella		

Results and Discussion

Soils

The southern soil survey's generally identified low levels (EC_e < 4 dS/m) of topsoil salinity (Fig. 1), suggesting that these areas could potentially be re-established with less salt tolerant pastures. The highest salinity levels found in the southern area were adjacent to the 1 m deep East Avenue drain. Similarly, in the Northern and Taratap drain survey's, higher topsoil salinity was associated with transects adjacent to shallower drains (Fig. 1). This difference is consistent with the expectation that deeper drains have a greater effect on lowering the watertable, and therefore having a larger mitigation effect on salinity.

Northern soil survey's showed that approximately two thirds of sample sites contained low levels of topsoil salinity (Fig. 1). The remaining soil samples were impacted by localised salt scalding, with associated high salinity readings. Salt scalding was generally associated with depressions in the landscape. This result is not unexpected given the historically higher incidence and severity of salinity in the northern zone.

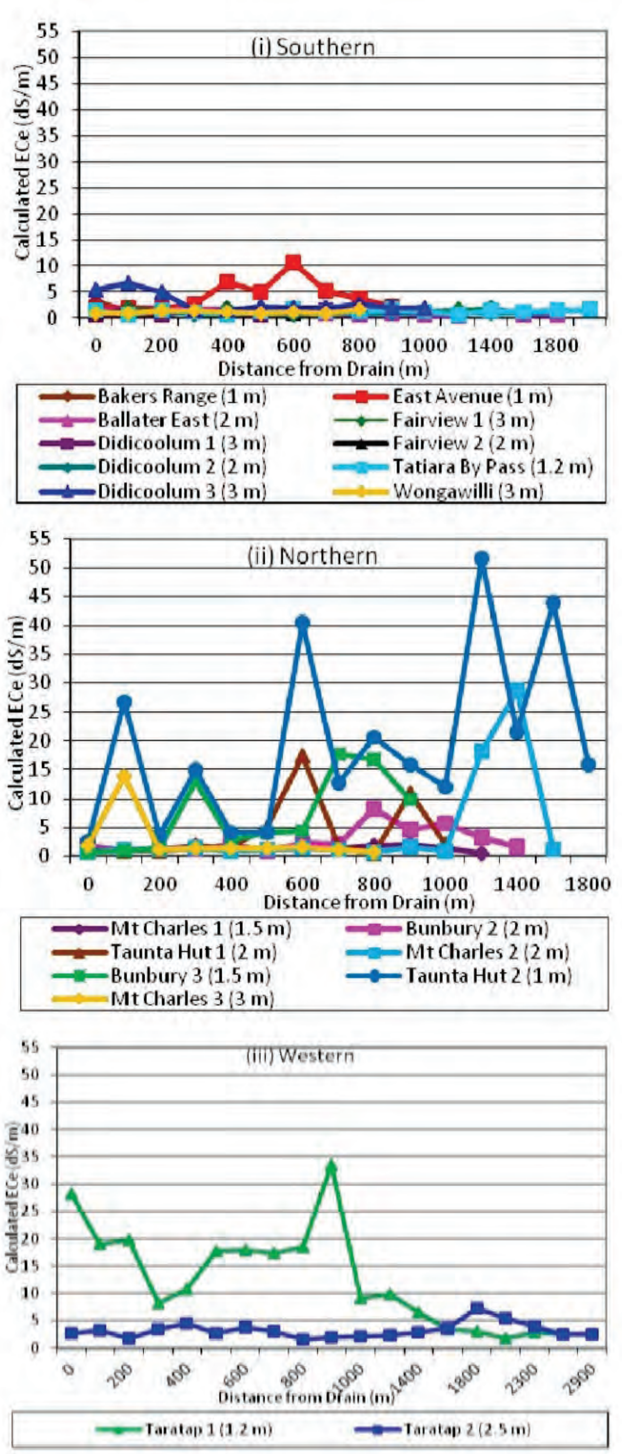

Figure 1. Topsoil salinity (0-10 cm) along the soil survey transects at varying distances from drains in January-March 2009. Drain depth shown in brackets.

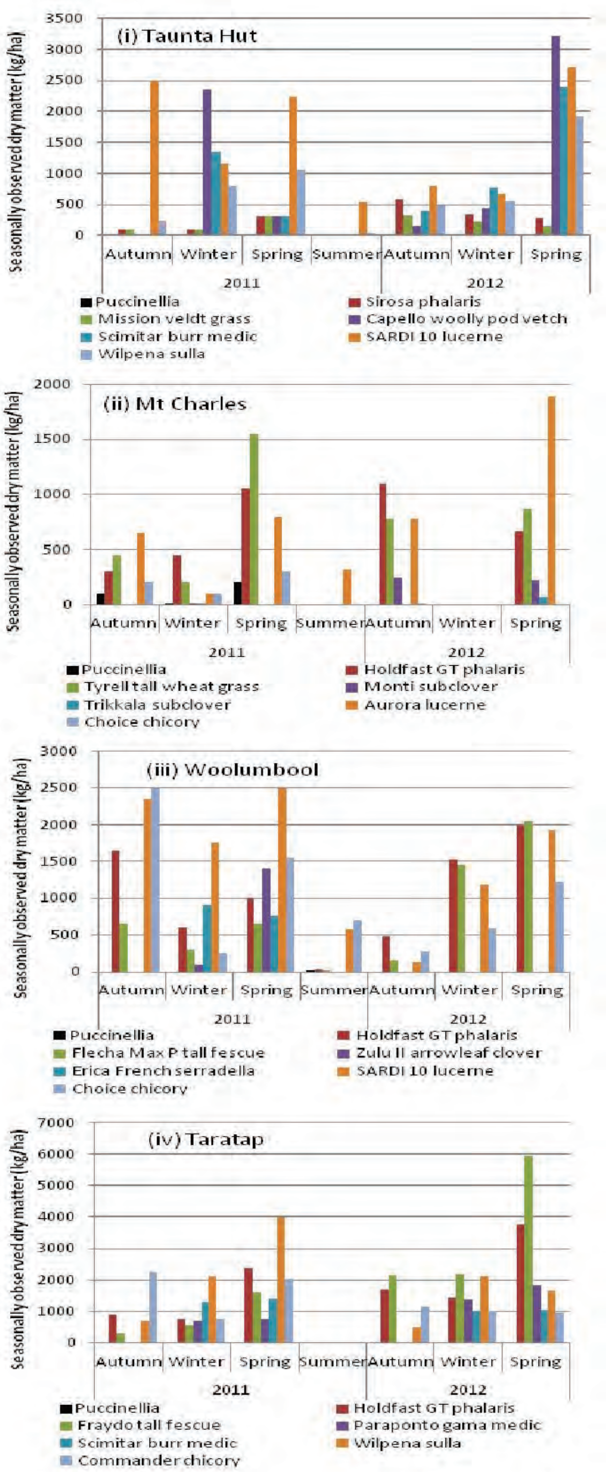

Figure 2. Seasonal dry matter production (kg/ha) for the two most productive species in each of the three germplasm groups, compared to puccinellia at each site, for 2011 and 2012.

Pastures

There was large variation in species performance across the four evaluation sites. Phalaris, tall wheat grass, lucerne and chicory demonstrated adaptation across a range of sites; however in many cases the best performing species were different at each site (Fig. 2).

The annual and perennial grasses performed poorly at Taunta Hut (Fig. 2). The annual grasses failed to persist after the establishment year, and the best performing perennial grasses (phalaris and perennial veldt grass) had very low levels of production. However, there were a number of well suited annual legumes including clovers, medics and serradella (Fig. 2). Lucerne, sulla and chicory also performed well at this site. A number of grasses performed well at Mt Charles including tall wheat grass, phalaris, tall fescue and prairie grass (Fig. 2). Mt Charles was the only site where puccinellia persisted, although at low levels. The dominance of balansa clover from an earlier farmer sowing demonstrates its excellent adaptation to this soil type. Subclover and lucerne also performed well at this site.

Many species and varieties of annual and perennial grasses, perennial legumes and herbs performed well at Woolumbool in 2012 including phalaris, tall fescue, lucerne and chicory (Fig. 2). This result contrasts with the poor performance of the annual legumes that failed to survive the dry autumn of 2012.

Species from all germplasm groups grew well at Taratap including phalaris, tall fescue, annual medics, sulla and chicory (Fig. 2). Scimitar burr medic and Paraponto gama medic performed exceptionally well.

Conclusion

The trial results indicate that there has been a large reduction in the incidence and severity of salinity across the Upper South East landscape. This assessment is based on local knowledge of the study area prior to the establishment of the drains. It is uncertain if this change can solely be attributed to the influence of the drains, or the recent years of below average rainfall, or both. More than 75% of the soil sites surveyed had low levels of topsoil salinity. At these locations pasture establishment should not be inhibited by salinity, confirmed by the high levels of production of certain pasture species (*e.g.* x, y, z) at the four trial sites. Salinity deeper in the profile has the potential to affect the growth of perennial species however was unexplored in this study. However considering, the good performance of many perennial species suggests that subsoil salinity was not a major limiting factor. These results seem to confirm an excellent opportunity to improve the land productivity across a broad geographical area previously deemed saline.

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