OPPORTUNITIES AND CONSTRAINTS TO GRAZING SALINE PASTURES

Rob Kelly
CSIRO Livestock Industries
Centre for Environment and Life Sciences
Private bag 5, Wembley WA 6913
Tel: 08 9333 6000/Fax: 08 9383 7688/e-mail: rob.kelly@csiro.au

INTRODUCTION

Farming systems in Australia continue to evolve due to a number of significant economic and environmental pressures. In the last 40 years factors such as the declining terms of trade have seen the number of farms halve to the present number of about 100,000, and the area per farm increase to an average of 4100 hectares (Hooper *et al.* 2002). It is of interest that the major increases in farm size in the last 20 years have come from the livestock industries, with cropping farmers paying more attention to increasing productivity per hectare than expanding the size of their properties.

The environmental pressures of salinity, soil acidity, and climate change are becoming prime determinants of the productivity of the land. Salinity could possibly affect 17 million hectares of Australia. Reclamation is not a realistic option in many situations in the short to medium term, so the challenge is to find an alternative use for the land – economic and/or environmental. A responsible goal would be a productive use that improves the soil, water and biodiversity quality of the landscape, and it is for this reason that production from livestock grazing plants grown on saline land is attracting increasing attention. It is one of the founding cornerstones for this organisation "*Productive Use of Rehabilitated Saline Land*".

Finding a value for livestock is critical, since:

- most of the saline areas are or will be in the crop/livestock zones of Australia,
- most farmers in these regions already have pasture and animal management skills to allow rapid adoption and integration into the whole farm system,
- there is considerable complementarity between the livestock and cropping systems,
- potential to manage livestock in a way that improves the habitat value of the revegetated land, as well as the water quality and visual amenity, and
- pressure from the urban public to find a more friendly solution.

Livestock production from saline pastures has focused on the establishment, biomass production and survival of plants such as saltbush, bluebush, acacia, puccinellia and tall wheatgrass. Robust research into integration of livestock productivity from these plants into the whole farm system has been limited, but there have been two consistent findings – grazing animals do not grow as well on these salt tolerant species as expected from their dry matter production and *in vitro* analysis of nutritive value, and annual clovers and grasses growing in these areas are preferentially consumed by the grazing animals.

It appears that salt tolerant plants present a special challenge to grazing animals due to the wide variation in chemical and physical characteristics that enables them to survive and grow in this hostile environment. Yet the integration of the feeding value of these plants and new pastures at times of the year that are compatible with improved water and biodiversity value, utilising the whole farm feed supply, and optimising sward structure, offers considerable promise to livestock businesses. Masters *et al.* (2001) reviewed the opportunities and limitation for livestock production from saline land, and it is from this paper that much of the information to be presented below has been drawn.

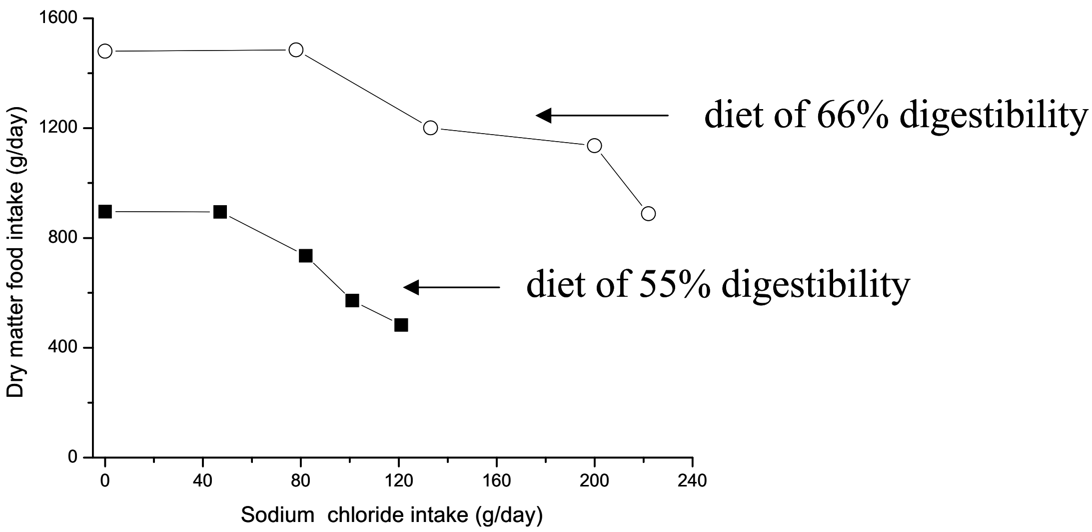
SALINE PASTURES AND ANIMAL PERFORMANCE

While there are many plants able to survive in saline environments (see papers by Craig, Thompson, Norman and Truong in this conference, Masters *et al.* 2001), their feeding value to a grazing animal is highly variable due to the amount of available edible material, its growth rate, nutritive value, and the animals' intake.

Estimates of intake of saline plants have ranged from less that 0.5 kg of dry matter (DM)/day to 1.9 kg DM/day for sheep. For medium quality forages (~55-60% digestibility) intakes generally below about 1 kg DM/day are not in themselves capable of maintaining sheep liveweight. Work conducted in 2001 on a number of saline areas across southern Australia by the *Animal Production from Saline Land Systems* initiative (Norman *et al.* 2002; Edwards *et al.* 2002; Lee *et al.* 2002; Thompson *et al.* 2002) has shown that it is only when there are significant amounts of "improved" pasture plants in the sward that sheep will be able to maintain or increase weight. This work continues to confirm the findings of the work undertaken by Warren and colleagues (see Masters *et al.* 2001) in the late 1980's and early 1990's, which provided a significant turning point in understanding and development of productive saline pastures.

Salt content is one of the factors influencing intake. Sheep can tolerate an intake of sodium chloride (NaCl) of about 100-150 g/head.day, provided there is a good supply of non-saline drinking water. However, work by Wilson (1966) shows that intake of salty feeds is influenced by both quality of the feed and its salt content, with intakes of a 55% digestible diet declining above salt intakes of 40 g/head.day, compared with intakes of a 66% digestible diet declining at salt intakes of above 80 g/head.day (see Figure 1). Quality of pastures varies considerably throughout the year, indicating effects on animal performance of ingestion of salt will also vary. There is also evidence in goats that high NaCl intake (3% of diet, supplying $<$15 g/head.day of NaCl) decreases food intake by about 30%, due to decreases in both the frequency (16%) and size (31%) of meals, with about one-third more time spent at each eating phase (Rossi *et al.* 1998). The weighting that can be put to these findings needs to be qualified by the observation that addition of NaCl to a diet may not result in the same effect on intake and animal performance as natural halophyte diets (Swingle *et al.* 1996; Pearce *et al.* 2002).

Figure 1. Effect of diet quality and salt content on dry matter intake by Merino wethers. (drawn from data published by Wilson, 1966)



Grazing management

Grazing management and intensity will affect both the amount and nutritive value of the feed on offer, and the growth habitat of both annual and perennial plants. Depending on whether or not the plants are continually or intermittently grazed influences the rate of regeneration of the plant and therefore its value to the grazing animal. It will also affect the rate of water use by the plant, since water use by a plant community is closely related to its year-round leaf area index (Hatton and Nulsen 1999).

Timing of grazing during the year is critical to its economic value, as in many parts of southern Australia the most demanding time is the summer/autumn period when annual based pastures are at their lowest in term of dry matter availability and quality. As a consequence, many farmers have recognised that their saline pastures could provide valuable feed reserves, and replace their high cost grain supplementation. It is of interest to note that in terms of productivity of saline pastures that there is evidence of variation in wool growth at this time. Lee *et al.* (2002) showed that clean wool growth in sheep grazing on a mixed pastures in southern New South Wales was about half that expected. Pearce *et al.* (2002) however found that sheep fed saltbush produced more wool, and did it more efficiently (~40%), than animals fed a non-saltbush diet of similar nutritive value (see Table 1). The variation in wool growth responses between studies requires needs to be resolved, since the factors that lead to increased wool production are likely to have important benefits for quality of fine wool, particularly staple strength.

It would also appear that utilisation of saline pastures in autumn may provide an opportunity to improve diversity of the ecosystem, since as most wheatbelt bird's nest between July and January, autumn grazed saltbush-based pastures could potentially serve a multipurpose role as habitat. Birds known to nest in saline shrublands include white-fronted chats and some wren species. Planned work will assess whether such dual purpose use occurs, or whether special purpose refugia with more dense and permanent cover need to be set aside as a component of saltland rehabilitation." (Lefroy, T., *pers. comm.*)

Table 1. Liveweight gain and wool production in Merino hoggets fed salty diets. (from Pearce *et al.* 2002)

	Diet		
	Control	Control + salt	Saltbush + barley
Liveweight gain (g/head.day)	62	90	62
Wool growth (g/100cm^2/day)	0.092	0.10	0.11
Wool growth/liveweight gain (g/g)	0.16	0.13	0.22

Feeding value of the plant material

Feeding value is the assessment of the worth of the herbage for the animal – it is determined by feed intake, and the value of that feed to the animal.

Feed intake is a function of the accessibility of the forage to the animal, the palatability of the forage, and rate of digestion and passage through the gastrointestinal tract. Two factors will affect the rate of passage of digesta in the animal – fibre and salt content. Generally speaking the higher the indigestible components in the diet, the slower the rate of passage and therefore intake is depressed. On the other hand high salt intakes from plant material (but not water) substantially increase water consumption, which in turn increases rate of passage of digesta through the rumen.

First let us understand the measurement of digestibility as it applies to saline pastures, since this will clarify some of the issues related to feeding value. Digestibility is the proportion of feed eaten that is not excreted in the faeces. Some is lost through such events as the conversion by rumen micro-organisms to gas during rumen fermentation, of which one of the most important in terms of environmental impact is methane, while the rest is generally converted to energy or protein substrates in the rumen. In some instances plant material may by pass the rumen digestion.

Digestibility is measured in the laboratory (*in vitro*) generally by digestion with enzymes, or indirectly by machines calibrated to such *in vitro* analyses (Near Infra Red spectrophotometers). If the plant material contains high levels of soluble materials that are not of value to the animal, such as the 20-30% salt found in many saltbushes, then this artificially inflates the digestibility value BUT NOT the feeding value of the material. Much of the information reported does not correct for this problem, and therefore I suspect that many have been mislead in concluding from laboratory analyses that plants grown on saline land can be good sources of nutrition. For example, saltbush leaf material with 24% soluble ash (mainly salt) and a *in vitro* digestibility of 60% would only provide 5.4 megajoules of metabolisable energy (MjME)/kg dry matter, not 8.4 MjME/kg dry matter if the digestibility was not corrected for soluble ash.

The other major component of feed that is important to the animal is its protein content. Again, considerable caution is needed with the interpretation of laboratory analyses of plants, as it is wrong to assume that all nitrogen measured in the feed is available to the animal. Many salt plants contain significant amounts of non-protein-nitrogen (betaines and nitrates), that can add >7% to the crude protein measurement. Further complications in the assessment of the feeding value arise from the combined effect that a lack of energy to the micro-organisms in the rumen will have on utilisation by these micro-organisms of nitrogen, and changes in rate of digesta flow which in some situations means a positive impact on the amino acids available to the animal in the intestinal tract.

Together with the added complication that to excrete salt has an energy cost to the animal, it is prudent from the foregoing that we conduct studies on breeding and evaluation of saltland pastures using the grazing animal (e.g. sheep or cattle), rather than rely on laboratory analyses alone.

There are, however, situations where it is more appropriate to place greater weighting on laboratory analyses, as some plants that grow on saline land that do not accumulate salts. Norman (2002) reveals in a following paper that there is a considerable range in the nutritive value of plants growing on saline land – and this must represent an opportunity that requires exploitation. They include tall wheat grass, annual clovers, and the promising melilotus species (see paper by Thompson in this conference). But, one needs to be also alert to the possibility that they may contain secondary compounds that adversely affect animal performance.

Secondary compounds

Betaines, tannins, coumarins, oxalates, nitrates, triterpenoids, steroids, glycosides, saponins and alkaloids all have been found in saline plants, and all may affect animal performance. There are two though that warrant elucidation – oxalates and tannins. Oxalates cause precipitation of insoluble calcium oxalate in the rumen and kidney, and ultimately death. Saltbush can contain significant quantities of oxalates, oxalates can cause calcium deficiency, and so supplementary feeding with cereal grains needs to include a calcium supplement such as limestone. Tannins are polyphenolic compounds found in many plants (e.g. acacia and lotus species), and while from 2-4% in the diet protects protein from rumen degradation and increases the absorption of essential amino acids, 4-10% depresses voluntary feed intake. There is also some evidence of tannins providing some protective effects against gastrointestinal parasites.

Complementarity of salt tolerant plants

In many grazing experiments sheep and cattle consume a wide variety of plant species, with intake of saline plants forming only a minor part of the diet. Recent studies (Norman *et al.* 2002; Edwards *et al.* 2002) indicate that when given a choice sheep preferentially graze the higher nutritive components of the sward, with a low but perhaps important consumption of the plants containing higher amounts of salt. The importance of a mixture in the diet could be due to two factors. Firstly, a number of controlled experiments with sheep have shown that mixing of hay and saltbush often results in increase in total feed intake – and therefore animal performance. Secondly, long-term grazing experiments indicate that the animals can adapt over time to saltbush and double their intake of this plant material (Le Houerou 1992).

Concluding remarks

The information presented provides a snapshot of some of the opportunities and constraints that exist for establishment and expansion of grazing systems by utilising pastures grown on saline land, and plants that contain salts and other compounds in all their forms – sodium, potassium, calcium, magnesium, chloride, sulphate, carbonate and bicarbonate. It is well established that some saltbush and bluebush species can contain amounts of salt well in excess of the 5% content, which has been shown to depress animal intake.

There is also evidence that there may be a change in carcass composition as a result of ingestion of salt – sheep produced carcasses of higher protein (18.3% v. 16.8%), less fat (16.4% v. 24.0%) and trend towards higher proportion of unsaturated fats (1-2% higher) following drinking of water containing 1.3% sodium chloride (Walker *et al.* 1971). The work of K. Pearce in our laboratory is now testing this effect in young sheep fed saltbush.

In evaluating options, given the plethora of interactions that may occur, it is important to define the actual impact on the animal as soon as possible in any development program. Simple issues such as those of high salt intake leading to water retention, so measurements of liveweight can incorrectly overestimate the feeding value of the plants. The fact that cattle consume considerably more water than sheep when grazing saltbush, as well as eat lower quality feed (Wilson and Graetz, 1980), and the potential for salt and secondary compounds to dramatically change the feeding value of the plant or the pasture sward, should serve as cautionary signposts.

And, the benefits of the pastures to water quality and the ecosystem cannot be underestimated, and need to be evaluated if the wider benefits are to be counted.

This is the foundation for the work currently being planned and undertaken by the CRC for Management of Dryland Salinity, including CSIRO, state Departments of Agriculture, the University of Adelaide, Meat and Livestock Australia, Land and Water Australia and Australian Wool Innovations.

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