

# THE ROLE OF SALTLAND PASTURES IN THE FARMING SYSTEM - A WHOLE-FARM BIO-ECONOMIC ANALYSIS

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## ABSTRACT

In this study we use a whole-farm bio-economic model to assess the role of saltland pastures in a mixed crop and livestock farming system. Results of the analysis show that saltland pastures are likely to be profitable across a range of scenarios. However, the optimal area to establish will vary considerably according to site characteristics and market conditions. Key profit drivers for the saltland pasture system are identified and priorities for future R&D discussed.

## INTRODUCTION

The potential benefits of saltland pastures are well documented. They include reduced recharge of water tables, improved soil structure, and provision of feed for livestock during limiting periods of the year (e.g. Barrett-Lennard and Malcolm 1995; Bolt 2001; Lloyd 2001). However, in order for saltland pasture to be profitable these benefits must outweigh the cost of establishment, the risk of establishment failure and the cost of lost opportunities to undertake alternative practices.

Weighing up these benefits and costs is not straightforward. The profitability of a grazing system depends on a large number of factors including pasture growth rates and growth pattern, pasture quality and palatability, the class of livestock and pattern of grazing, and the cost of establishment and maintenance. In addition, profitability can be affected by interactions with other enterprises on the farm. Examples of important interactions include disease breaks, nitrogen fixation, weed control opportunities, grain feeding, stubble grazing and complementary or competitive machinery usage.

In this analysis we use a whole-farm bio-economic model to examine the role and profitability of saltland pastures in a mixed crop and livestock farming system. Our aims in doing so are twofold:

1. *To discuss how saltland pasture might best be integrated into current farming systems.* This provides a reference point for current extension efforts, thereby helping to ensure that appropriate messages are delivered to the farming community.
2. *To identify the key profit drivers of saltland pasture systems, and the sensitive areas for future research.* This should assist researchers to focus efforts in areas that are likely to deliver the greatest benefits to industry.

## METHOD OF ANALYSIS

### Description of the study area

The focus for this study was the medium rainfall broadacre agriculture districts within the Western South Coast and Lower Great Southern regions of Western Australia. Dryland salinity is widespread in these regions, and is forecast to expand considerably by 2050 (NLWRA, 2001).

Average farm size in the study area is approximately 1,500 - 2,000 hectares, of which about 50-60% is sown to crop (mostly wheat, barley and canola). The balance is pasture used to run sheep for wool and meat production. Cattle are also grazed and form an important part of some individual businesses. However, average cattle numbers per farm are very low (less than 50 head per farm), with the large cattle producers tending to concentrate closer to the coast and away from the main cropping zone (ABS 1997). In addition, many cattle are fed in feedlots. For these reasons cattle are not included in this analysis.

The study area receives between 400 and 500 mm average annual rainfall, of which approximately two thirds falls between May and October. The growing season is followed by a summer drought usually lasting from November to March. This highly seasonal pattern of rainfall has important implications for livestock feed supply. Availability of pasture is particularly tight in the late autumn and early winter. By contrast, the spring is typified by a 'flush' of pasture growth due to relatively warm weather and plentiful soil moisture. Consequently, supply of feed throughout the year is very uneven. This feature of the farming system has important implications for the profitability of alternative feed sources, and the *timing* of feed supply can be just as important as the *amount* of feed supply.

### Description of MIDAS (Model of an Integrated Dryland Agricultural System)

In this analysis we adapted the South Coast version of MIDAS (Bathgate 1999) to include saltland pasture. MIDAS is a whole-farm mathematical programming model that describes the physical, technical, biological and managerial aspects of broadacre cropping and livestock farming systems. The model includes components for crops, pastures, sheep, stubble, grain feeding, machinery and finance. It is strongly based on soil types and rotations, with different production figures for each rotation on each soil type. The model selects strategies that maximise profits in the medium term, i.e. the next 3-5 years.

The South Coast Model represents a farm of 2000 hectares in the medium rainfall zone of the South Coast (400 - 500 mm). This zone stretches from the Stirling Ranges in the west to Esperance in the east. Production parameters in the model for crops, pastures and livestock are representative of a typical, well managed, farm in the region. In this study we adapted the model to represent a farm in the North Stirlings area. A mix of soil types typical of the district was assumed (Overheu, personal communication 2002) and includes 200 ha of saline soil as outlined in Table 1.

**Table 1. Description of soil types used in the adapted version of the South Coast MIDAS.**

	Area (ha)		Area (ha)
Waterlogging prone duplex	630	Saline soils - high productivity	50
Medium depth sandplain duplex	250	Saline soils - mod productivity	50
Deep sands	70	Saline soils - low productivity	50
Grey loams and clays	850	Saline soils - bare scald	50

A feature of this study is that several classes of saline soil are represented. This is something that has been absent from previous studies. Inclusion of several classes of saline soils enables us to create a 'gradient' of salinity ranging from bare salt scalds not capable of supporting crop

or pasture through to highly productive saline country that is only mildly affected by salt. In doing so it becomes possible to assess the important trade-offs that farmers will face when deciding whether to establish a saltland pasture system or continue with annual crops and / or pasture.

### **Representation of the saltland pasture system**

The saltland pasture system represented in this analysis consists of alleys of saltbush species, with a mixed sward of annual species growing in the inter-row. Figures for pasture composition, production and quality were derived from measurements made on a mildly saline site near Lake Grace (Dynes and Norman, unpublished data), with some adjustments applied to reflect the higher rainfall and longer growing season of the North Stirlings study area.

The saltland pasture system could be grazed once per year, at any time during the year. The quantity of feed available for grazing depends on the month that it is grazed (Table 2). The feed available for grazing from the saltbush component on the moderate and low productivity saline soil types are 90% and 80% of those shown in Table 2 respectively. Likewise, the feed on offer figures for the annual pasture component on the moderate and low productivity saline soil types was assumed to be 75% and 50% of the figures shown here. The bare salt scald country is assumed to be ungrazed.

**Table 2. Feed available for grazing at different times of the year (kilograms of dry matter per hectare) for the highly productive saline soil type.**

	May kg DM/ha	August kg DM/ha	November kg DM/ha	February kg DM/ha
Saltbush	800	800	800	800
Volunteer grass	-	150	300	150
Volunteer legume	-	25	50	35
Improved legume	-	700	1500	975

Feed value also varies over the season - the highest quality feed is available during winter and spring, with a steady decline in quality over summer and autumn (Table 3). Further detail relating to feed available for grazing and feed value assumptions are available by request from the authors in a technical appendix.

**Table 3. Feed value of various pasture components at different times of the year (megajoules per kilogram of dry matter).**

	May MJ/kg DM	August MJ/kg DM	November MJ/kg DM	February MJ/kg DM
Saltbush	7.1	7.1	7.1	7.1
Volunteer grass	-	11.0	7.1	5.5
Volunteer legume	-	10.0	9.0	7.0
Improved legume	-	11.8	10.0	9.0

### **Cost of establishing and maintaining the saltland pasture system**

Following Ghauri and Westrup (2000) we assumed a contract charge of approximately \$170/ha to establish saltbush. A further \$55/ha was included to allow for establishment of an improved legume based pasture, bringing the total cost of establishment to \$225/ha (Table 4). An adjustment was made for the risk of establishment failure and the cost was amortised over 5 years at a real interest rate of 5%. The total cost per year was calculated by adding the cost of an annual application of fertiliser. The costs of establishment and the annual fertiliser on the moderate and low productivity saline soil were scaled back to reflect a decreased input level.

The costs we have calculated may be an underestimate because some farmers may also need to allow for the cost of new fencing, new water supplies, cleaning up of paddocks and earthworks for surface water management.

**Table 4. Costs of establishment and maintenance of the saltbush pasture system on each soil type.**

	High productivity saline soil	Mod productivity saline soil	Low productivity saline soil
Cost of establishment (\$/ha)	225	200	175
Probability of success (%)	100	80	60
Investment Life of stand (years)	5	5	5
Real interest rate (%)	5	5	5
Amortised cost (\$/ha)	52	58	67
Annual fertiliser application (\$/ha)	20	17	14
Total annualised cost (\$/ha)	72	75	82

### Crop production on the saline soil types

An important consideration when assessing the value of a new enterprise is ‘opportunity cost’ - that is, the cost of lost opportunities to undertake alternative practices. In many situations it remains feasible to continue cropping saline land, especially that which is only mildly saline. Therefore the opportunity cost of cropping may be an important consideration when assessing saltland pasture. Indicative yields of wheat and barley on the three saline soil types are shown in Table 5. All yields are for a crop grown after a single year of manipulated pasture.

**Table 5. Yields of wheat and barley on the saline soil types (kilograms per hectare) when grown after a single year of manipulated pasture.**

	High productivity saline soil kg/ha	Mod productivity saline soil kg/ha	Low productivity saline soil kg/ha
Wheat	1700	1275	850
Barley	2000	1500	1000

### Commodity price and cost of production assumptions

Commodity prices assumed in the analysis are derived from medium-term estimates by the Australia Bureau of Agricultural and Resource Economics (ABARE, 2002). Adjustments were applied to some of the ABARE forecasts to reflect developments in domestic and global commodity markets since the release of the forecasts in March of this year. A summary of price assumptions for the major commodities is provided in Table 6.

**Table 6. Price assumptions for the major commodities.**

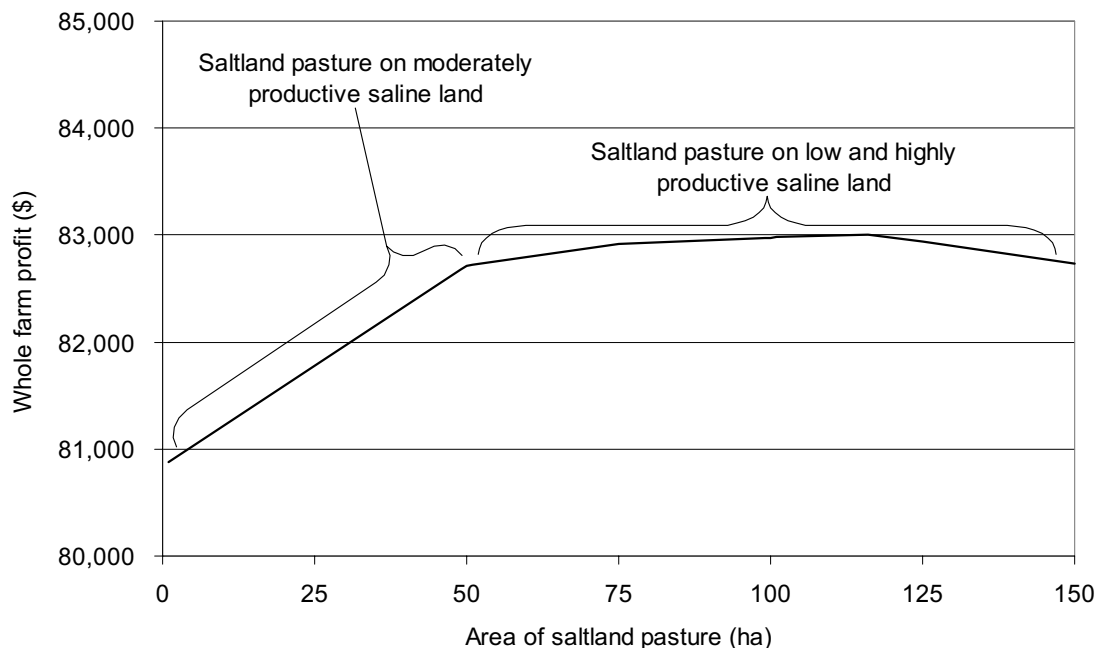
Commodity	Price	Commodity	Price
Wheat APW	210	Wool	370
Malting barley	210	Merino lambs	210
Feed barley	170	Shippers	40
Lupins	200	Merino hoggets	40
Canola	350	CFA ewes	25
*Grain prices are \$/t pool, GST exc.; wool price is c/kg greasy for 21 $\mu$ fleece wool; merino lambs are c/kg DW; shippers, hoggets & ewes are \$/hd at saleyard.			

Costs of production were based on current retail prices for agricultural inputs obtained by a phone survey of several suppliers in the district. In view of the large number of individual

inputs costs and their limited interest, they are not presented here but are available from the authors in a technical appendix.

## RESULTS AND DISCUSSION

### Economic value of the saltland pasture system



**Figure 1. Change in whole-farm profit with different areas of saltland pasture ('whole-farm profit' is profit at full equity before tax).**

Profit is maximised when saltland pasture is grown on 115ha of the total 200ha of salt affected land (Figure 1). The greatest increase in profit comes from establishing the first 50 ha of saltland pasture, which delivers an increase in whole-farm profit of about \$1,850 (or \$37/ha averaged over the 50 ha). Beyond that, there is little difference in profit between 50 and 150 ha of saltland pasture. The reason for this result is related to the fact that the first 50 ha are grown on the moderately productive saline land (as annotated in Figure 1). This soil type is capable of producing a reasonably good saltland pasture, yet does not support profitable annual crops and pasture. In other words, there is minimal opportunity cost associated with establishing saltland pasture on this soil type.

On the other hand, the highly productive saline soil type is capable of producing profitable annual crops and pastures. As such, there is a considerable opportunity cost associated with establishing saltland pasture on this soil type. Therefore the net increase in profit from establishing saltland pasture on this soil type is low, even though the sward is highly productive. The profitability of establishing saltland pasture on the low productivity saline land is also low - not because of opportunity cost, but because the quality and quantity of pasture provided only just offsets the cost of establishment and maintenance.

### How does the saltland pasture fit into the farming system?

The grazing strategy selected by the model involves utilising the saltland sward from late January through to early April. During this period feed available from annual pastures and stubbles is of low quality and quantity and without the saltland pasture large quantities of cereal grain and lupins are required to sustain the sheep. Including the saltland pasture system on the

farm reduces the quantity of supplement required and increases the number of sheep that can be run (Table 7).

**Table 7. Change in supplementary feeding requirements and sheep numbers with the inclusion of saltland pasture.**

Area of saltland pasture (ha)	Amount of supplementary grain (kg/DSE)	Total sheep numbers (DSE)
0	13	8,017
50	11	8,137
100	8	8,238
150	6	8,098

The extra stock can be carried on the farm because the saltland pasture is a lower cost source of feed than grain, i.e. there is a reduction in the cost of carrying stock through summer. This makes it profitable to increase the number of stock carried, which then allows better utilisation of the traditional pastures during winter and spring. The opportunity to profitably increase stocking rate is limited because the cost of carrying the extra stock through winter begins to outweigh the benefits of the extra stock (even though summer is still cheaper). The figures in Table 7 also show a slight decline in sheep numbers as the area of saltland pasture increases from 100 to 150 ha. This is because with a larger area of saltland pasture the model selected to increase crop production on the non-saline soil types.

#### **Where does the profit come from?**

The important factors that contribute to the profitability of a saltland pasture system are outlined in the profit and loss statements in Table 8. The total net benefit of \$1,835 is comprised of the savings related to reduced supplementary feeding (+\$3,441), the benefits of higher wool and sheep sales related to the higher stock numbers (+\$3,163), the husbandry costs, the extra depreciation and extra capital tied up by carrying the extra sheep (-\$1,323), a slight increase in interest earned (+\$64), a reduction in interest paid (+\$152) and an increase in costs associated with establishing and maintaining the saltland pasture system (-\$3,662).

**Table 8. Comparison of profit and loss statements with and without saltland pasture.**

	Without saltland pasture (\$/farm)	With 50 ha of saltland pasture (\$/farm)	Difference (\$/farm)
Grain sales	294,121	294,121	0
Wool sales	115,454	117,184	1,730
Sheep sales	95,634	97,067	1,433
Interest received on working acc.	1,452	1,516	64
Total revenue	506,661	509,888	3,227
Crop & pasture costs	171,884	175,546	3,662
Sheep husbandry & replacements	64,394	65,359	965
Supplementary feeding	13,074	9,633	-3,441
Overheads	93,500	93,500	0
Interest charged on working acc.	1,020	868	-152
Total cash operating costs	343,872	344,906	1,034
Cash flow	162,789	164,982	2,193
<i>minus</i> Depreciation	28,918	28,990	72
<i>minus</i> Opportunity cost of capital	52,989	53,275	286
Profit at full equity before tax	80,882	82,717	1,835

Further analysis of the numbers in Table 8 allows us to attribute the total benefits of the saltland pasture system into several categories. This is shown in Table 9 below.

**Table 9. Attribution of the total benefits of the saltland pasture.**

	Amount (\$)	Percentage of total benefit
Benefit from reduced supplementary feeding	3,441	63%
Benefit from increased sheep numbers	1,840*	33%
Benefit from reduced financing costs	216**	4%
<b>Total</b>	<b>5,497</b>	<b>100%</b>

\*  $1,730 + 1,433 - 965 - 72 - 286 = 1,840$

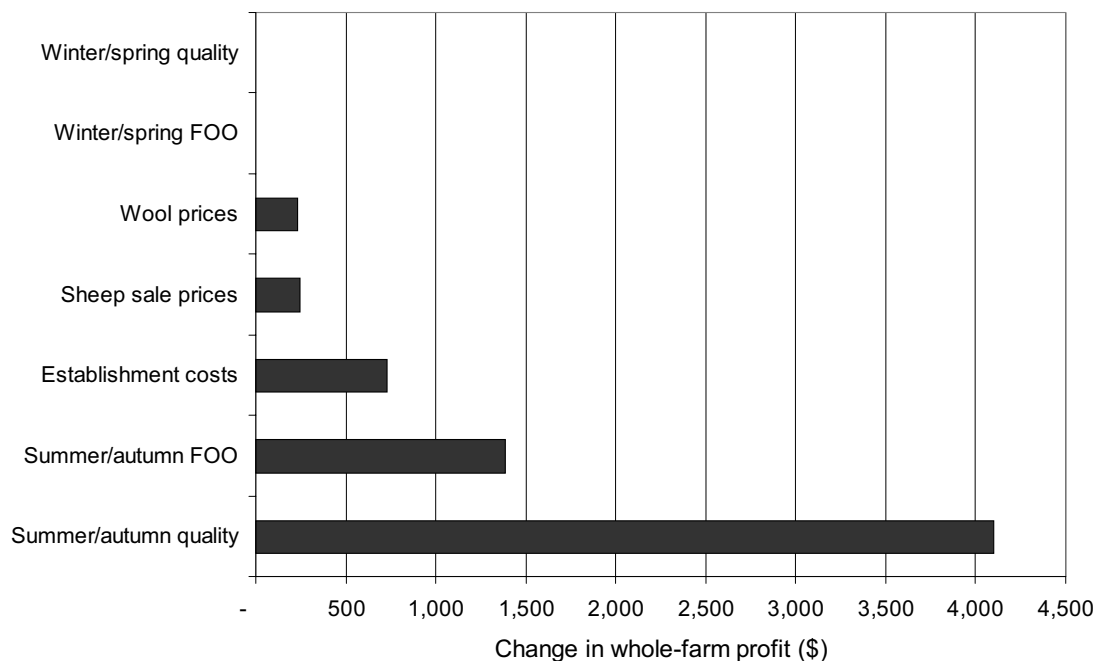
\*\*  $64 + 152 = 216$

The reduced supplementary feeding provides about 63% of the total benefit, increased sheep numbers provide about 33% and the reduction in financing costs represents the remaining 4%. So, farmers adopting saltland pasture can get the majority of the benefits without having to increase sheep numbers.

### What are the key profit drivers of saltland pasture systems?

The numbers in Tables 8 and 9 highlight clearly where the differences in returns are occurring with and without saltland pasture. However, they still leave us guessing as to exactly what factors are driving the profit and, more importantly, what areas farmers and researchers could do well to focus on so as to bring about further improvements in profitability, i.e. it is difficult to isolate cause and effect from Tables 8 and 9.

Sensitivity analysis provides a valuable tool for better isolating key profit drivers. A summary of key profit drivers based on the assumptions used in this study is provided in Figure 2. Each horizontal bar represents the effect on profit of a favourable 10% change in the listed factor.

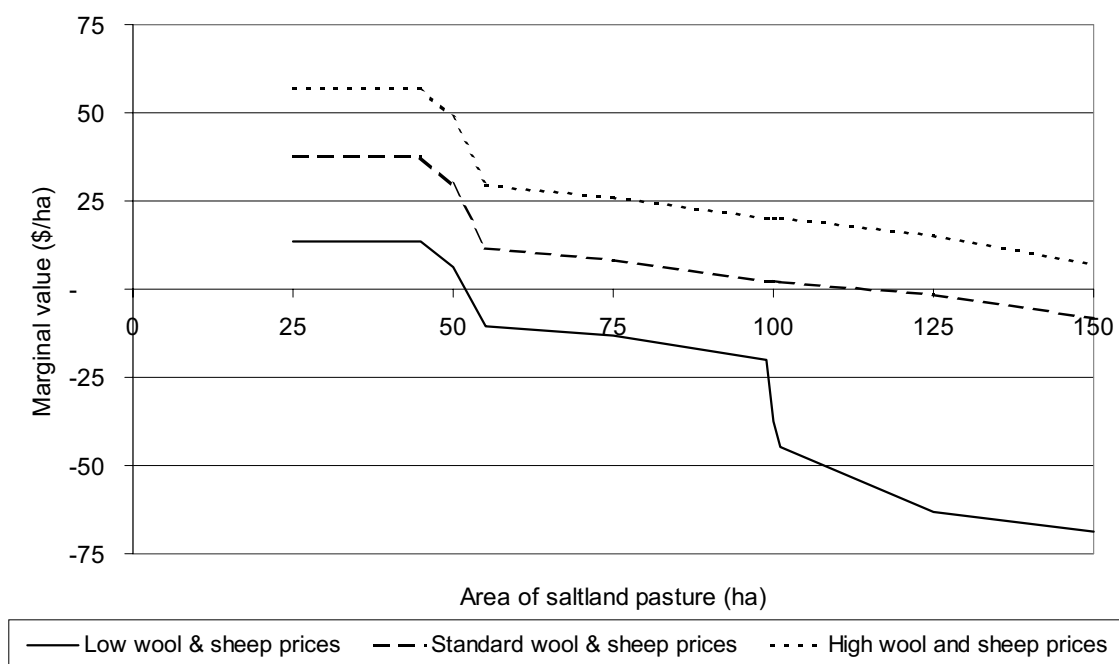


**Figure 2. Key profit drivers for the saltland pasture system in this study ('FOO' is feed on offer).**

This approach provides a valuable guide for prioritising action, either managerial on the part of a farmer or research on the part of a scientist. The results show that increased feed quality or feed available for grazing in summer/autumn is likely to be very valuable and could warrant further investigation if increases are likely to be achieved. By contrast, having extra feed available for grazing in winter and spring is of low value because the saltland pasture is not grazed at this time. However, this is not the same as saying that extra production in winter and spring has no value, i.e. extra production from winter or spring could be deferred and then grazed in summer and autumn, in which case it would have moderate value.

When using the information in Figure 2 it is important to realistically assess the scale of change that is possible for each parameter. For example, at first glance it appears that reducing establishment costs has relatively minor scope for improving profit. However if it were possible to surpass 10% and achieve a 50% reduction in establishment costs then profits would improve considerably. In fact, Ghauri and Westrup (2000) present a farmer case study where cost savings in excess of 50% (compared to contractor rates) have been achieved.

Wool and sheep prices are relatively minor profit drivers for the profitability of adopting saltland pastures. This is explored further in Figure 3, which charts the ‘marginal’, or additional, value of extra hectares of saltland pasture under different combinations of wool and sheep prices.



**Figure 3. Marginal value of saltland pasture with different wool and sheep sale prices ('standard' prices are those provided in Table 6; 'low' & 'high' prices for wool are 70% and 130% of the standard prices respectively; 'low' & 'high' sheep sale prices are 60% and 140% of the standard prices respectively).**

In the low price scenario it is still profitable to include saltland pasture on the moderately productive saline land. However, additional area on top of the first 50 ha leads to reductions in profit of between \$10 and \$70/ha. These results highlight that saltland pasture on moderately productive saline land will likely be the most ‘robust’ in terms of profitability under a wide range of scenarios. Growing saltland pasture on the highly productive saline soil increases profit slightly in some price scenarios and reduces profit slightly in other price scenarios.

## CONCLUSIONS

The results of this analysis show that saltland pastures are likely to be profitable across a range of scenarios, with the optimal area varying considerably according to site characteristics and market conditions. The largest increase in profit consistently came from establishing saltland pasture on 'moderately' productive saline soil types, i.e. land that is too saline to produce profitable annual crops and pastures, but not so saline as to severely impact on production from the saltland pasture system. By contrast, establishing saltland pastures on 'highly' productive saline land is unlikely to deliver large profits due to the opportunity cost of annual crops and pastures. Likewise, saline soils of 'low' productivity delivered only modest gains in profit at best.

These results suggest that farmers will be best off by starting to establish saltland pasture on moderately saline country. At current high wool and sheep prices there might also be some gains from expanding saltland pasture into saline country of low and high productive capacity. However, growers contemplating such a move need to be aware that this strategy could backfire should there be a synchronised downturn in wool and sheep prices. Under this market scenario, saltland pasture is only likely to be profitable on moderately productive saline soil types.

Sensitivity analysis shows that the profitability of saltland pastures is highly sensitive to several key factors such as summer/autumn feed value, amount of feed available for grazing in summer/autumn and establishment costs. Methods to bring about improvements in these areas could warrant further investigation.

In addition, further analyses of the type undertaken here are required to address important questions that remain unanswered. For example:

- When should saltbush be planted? Should it be planted on an area that is in the process of going saline, but can still be cropped?
- Would it be profitable to grow annual crops in between alleys of saltbush?
- What other options do we have for saltland pastures, and how do they compare to the saltbush alley / annual inter-row system studied here?
- What role is there for saltland pasture in specialist prime lamb production?
- How would the presence of another perennial in the landscape (e.g. lucerne) impact on the relative profitability of saltland pasture systems and vice versa?

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## REFERENCES

- ABARE, 2002, Outlook to 2002-07: *Australian Commodities*, 9(1), 23-164
- ABS, 1997, Agricultural Census & Agricultural Commodity Survey, Australian Bureau of Statistics, Canberra.
- Barrett-Lennard, E.G. and Malcolm, C.V., 1995, Saltland pastures in Australia - a practical guide, Department of Agriculture, Western Australia, South Perth.
- Bathgate, A.D., 1999, Whole farm model to optimise profit on South Coast farms, Final Report for the Grains Research & Development Corporation, Department of Agriculture, WA.
- Bolt, S., 2001, Salinised resources - a necessity and an opportunity. In: Proceedings of the 7<sup>th</sup> National PURSL Conference, Launceston Tasmania, 20-23 March 2001, pages 24-34, Conference Design, Sandy Bay.
- Ghuri, S. and Westrup, T., 2000, Saltland pastures: changing attitudes toward saline land, Farmnote No 47/2000, Department of Agriculture, WA.
- Lloyd, M.J., 2001, Changing attitudes to saltland - a farmer's perspective, In: Proceedings of the 7<sup>th</sup> National PURSL Conference, Launceston Tasmania, 20-23 March 2001, pages 35-43, Conference Design, Sandy Bay.
- NLWRA, 2001, Australian Dryland Salinity Assessment 2000: extent, impacts, processes, monitoring and management options, National Land & Water Resources Audit, Canberra.