Economic evaluation of growing trees on saline discharge areas – preliminary findings

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Abstract

To date only limited examples exist of utilising agroforestry on salt-affected lands in Australia. However, saltland agroforestry has significant potential to make productive use of saline land contribute to site rehabilitation and reduce salt loads to streams. This paper reports the preliminary results of a desktop study into the productivity of trees on salt-affected land using two Western Australian case studies based on measured yield data.

The analyses evaluated the profitability of two prospective tree species for saline areas: *Eucalyptus occidentalis* (flat-topped yate) and *E. camaldulensis* (river red gum). The analyses combined measured growth rates from two specific sites with best estimates of other biological and economic factors to conduct the financial analysis. Two management strategies were investigated; planting the trees as a woodlot, and integration of trees with saltland pastures through an alley system. Sensitivity analysis was used to identify the productivity, market conditions and management strategies that may be required to make one or both of these examples a viable commercial option for growers and investors.

Key Words

dryland salinity, eucalypts, commercial production, agroforestry

Introduction

It is predicted that even with major intervention, land and water salinisation will continue to increase into the future (0). Therefore, there is good reason to attempt to turn saline land into a productive resource. Some farmers are already doing this through the use of salt-tolerant pastures for livestock production (e.g. 0, 0). Another option for salt-affected land is growing trees.

There are a number of Australian native species that have tolerance to both salinity and waterlogging (0). But, to date there are only limited examples of farm forestry on salt-affected land. Most likely this is due to uncertainty about growth rates, lack of established markets, high establishment costs, uncertain prices for products and long time lags between establishment and harvest. Barriers to adoption of farm forestry on productive agricultural land may include some of the above mentioned factors. An additional barrier on productive land is the lower than expected return compared to conventional agriculture, i.e. the opportunity cost of not using the land for cropping or grazing. Salt-affected land is of lower value for agricultural production therefore the opportunity cost of using that land for farm forestry is generally lower.

The project which underlies this paper seeks to evaluate the economics of growing salt-tolerant tree species for a matrix of salinity levels, climatic zones and layouts. Evaluation will be on the basis of the potential role of trees to improve the productivity and quality of salt-affected land, through both wood and non-wood value, and provide additional benefits (e.g. hydrological). The results of this project will form the basis of scoping further research opportunities for trees growing on salt-affected land. One such opportunity is evaluating the role of trees in improving productivity and species diversity of salt-tolerant pastures for improved animal production from saline land (e.g. via the Sustainable Grazing on Saline Land (SGSL) initiative).

As an initial outcome of this project, this paper presents economic analyses for two case studies of farm forestry on saline discharge sites in Western Australia; utilising *Eucalyptus occidentalis* (flat-topped yate) and *E.*

camaldulensis (river red gum). For each case study, sensitivity analysis was used to identify the productivity, market conditions and/or management strategies that may be required to make these species a viable commercial option for growers or investors.

Methods

An Excel spreadsheet model, *Imagine* (0), was used to conduct the financial analysis. This is a paddock-scale discounted cashflow model. It calculates a number of economic indicators that growers or investors would be interested in. The following indicators were used in the analysis:

- *Net Present Value (NPV)* - the value of the project expressed as the sum of annual net returns. A 7% percent discount rate was used in all of the case studies.
- *Annual Equivalent Return (AER)* - the annual equivalent of the Net Present Value.
- *Peak debt* - the highest cumulative cash deficit that occurs during the investment project.
- *Break-even period* - the period of time until a project yields a positive cashflow or 'breaks-even'.

As the economic analyses are based on uncertain parameters, sensitivity analysis was conducted. Sensitivity analysis is the investigation of potential parameter changes and their impact on the outcome. In this case, because many parameters are uncertain due to lack of trial data, sensitivity analysis is particularly useful for identifying break-even values of certain parameters. When conducting the break-even analysis only one variable was changed at any time and all other variables were held constant.

Case study One

Eucalyptus occidentalis

E. occidentalis is highly salt and water-logging tolerant (0) and produces timber suitable for structural applications and firewood (0). Assumptions used in this case study are shown in Table 1. Yield values were calculated using a mean annual increment (MAI) of wood volume estimated from a 25 year old planted woodlot of *E. occidentalis* growing at Dryandra (0), 175 kilometres south-east of Perth. Average annual rainfall at this site is around 500 mm. The trees were planted at a density of 816 stems/ha. Soil salinity (ECe) at the site ranged from 46 mS/m (non-saline) to 1113 mS/m (very saline) with the mean being 427 mS/m (moderately saline). No silvicultural management was conducted so yield estimates are likely to be lower than could be expected from a stand managed for commercial end use.

In this analysis it was assumed that *E. occidentalis* was grown either in block formation, as a woodlot, or in belts with pasture in the alleys. It was also assumed that trees will help to lower the saline watertable (0) allowing pasture to grow between the belts. For both strategies it was assumed that trees were thinned after 10 years, with 70% of the thinnings sold as firewood. The trees were harvested at 25 years with 60% of the final harvested volume sold as sawlogs and 15% of the final harvested volume sold as firewood.

Table 1: Assumptions for *E. occidentalis* on moderately saline land

Parameter	Woodlot	Belt	Parameter	Woodlot	Belt
Establishment cost ($/ha)	688[1]	838[1]	MAI (m^3/ha/yr)	2.5[2]	2.5
Maintenance cost ($/ha)	358[1]	358[1]	Firewood price ($/$m^3$)	25	25
Pruning and thinning cost ($/ha)[1]	630	793	Sawlog price ($/$m^3$)	60	60
Harvest age (years)	25	25	Stocking rate of pasture (DSE)	n/a	3

1: Net present value of discounted costs; 2: From Archibald *et al* (2002)

It was assumed that there were spatial interactions between the trees and pasture. Due to lack of information on tree and pasture interactions on saline land, the level of interactions were assumed to be similar to alleys on non-saline land; i.e. a 20% yield competition penalty for two tree heights, and a 2% yield shelter benefit for twenty tree heights (0). However, the yield penalty may be higher on saline soil than non-saline soils because tree roots may be closer to the surface, thus increasing competition (0). Additionally, Woodall and Bruce (0) observed that pasture growth under *E. occidentalis* decreased by up to 40% on mildly saline land. Therefore, the competition penalty may be underestimated in this analysis.

Results and Discussion
The results of this case study (Table 2) show a negative return when *E. occidentalis* is grown as a woodlot on this site.
Table 3, below, shows large changes (close to 100%) in the value of either MAI or prices are necessary for this investment to break even.

Table 2: Financial results of *E. occidentalis* grown as a woodlot or in belts compared with saltbush grown in belts

Financial indicator	Woodlot	Belts with pasture	Saltbush belts with pasture
Net Present Value ($/ha)	-661.30	38.50	229.50
Annual Equivalent Return ($/ha)	-56.75	3.30	19.70
Peak debt ($/ha)	-1238	-227	-91
Break-even period (years)	Never	24	5

Table 3: Parameter values necessary for *E. occidentalis* (woodlot) to break even

Parameter	Break-even value	Change (%)
MAI (m^3/ha/yr)	5.4	+ 116%
Prices ($/$m^3$)	Firewood: 48, Sawlogs: 114	+ 90%

When *E. occidentalis* is grown in belts with pasture in the alleys the investment just breaks even over 25 years. The NPV is $38/ha, with an AER of $3.30/ha (Table 2). However, as the results show, a system of saltbush in belts with pasture in the alleys, has an AER of $19.70/ha. Additionally, the saltbush system has a lower peak debt and a shorter break-even period. This indicates that the time lag until the investment starts generating positive income will be much shorter. Therefore, from a financial perspective, a land manager would prefer the saltbush alley system over the *E. occidentalis* alley system.
Increases of more than 100% in either MAI or product prices are required for the *E. occidentalis* alley system to be as profitable as the saltbush alley system (
Table 4). A 40% increase in the stocking rate of pasture would also make the *E. occidentalis* alley system as profitable as the saltbush alley system. A change in any of these parameters to the level shown will mean the *E. occidentalis* alley system will generate the same NPV over the life of the investment. However, the *E. occidentalis* system will still have a higher peak debt and long break-even period than the saltbush system because the trees do not produce income until years 10 and 25, while there is some income generated through grazing of the saltbush from year one. Changing the yield or prices of *E. occidentalis* does not alter the peak debt and break-even period at all, because the bulk of income from the trees is not received until the final year. Improving the pasture in the alleys (therefore allowing for an increase in the stocking rate), brings the break-even period back to 12 years but the peak debt remains the same. Although the levels of interaction between trees and pasture were not investigated explicitly, the effect of interactions is implied in the stocking rate.

Table 4: Parameters values where AER of the *E. occidentalis* belt system is equivalent to AER of the saltbush belt system

Parameter	AER equivalent to saltbush	Change
MAI (m^3/ha/yr)	5.7[1]	+ 128%
Prices ($/$m^3$)	Firewood: 58, Sawlogs: 138	+ 135%
Stocking rate (DSE/ha)	4.3	+ 40%

[1]: Height of trees was not adjusted, therefore interactions were not adjusted. In practice higher MAI may mean increased interactions

Case study Two

Eucalyptus camaldulensis
E. camaldulensis will grow in moderately saline (ECe 400-800 mS/m) and waterlogged sites (0) and there are significant differences in growth potential amongst provenances. *E. camaldulensis* is a widely used plantation species around the world and its timber is used for pulp, particle board, firewood and structural timber (0).
Assumptions for this case study are shown in Table 5. Yield estimates for *E. camaldulensis* were taken from a 14 year old stand growing at Bowelling, 80 kilometres east of Bunbury, in the south west of Western Australia (0).

Annual average rainfall for this site is 670 mm. The trees were growing on a moderately saline site with an average ECa of 112 mS/m (equivalent to approximately 600 mS/m ECe) and were planted at 600 stems per hectare. Again these trees did not receive any silvicultural management. For this analysis it was assumed that trees were grown as a woodlot for pulpwood and harvested after 14 years.

Table 5: Assumptions for E. *camaldulensis* on moderately saline land

Parameter	Value	Parameter	Value
Establishment cost ($/ha)	692[1]	MAI (m^3/ha/yr)	8.5[2]
Maintenance cost ($/ha)	280[1]	Pulpwood price ($/$m^3$)	25
Harvest age (years)	14		

1: NPV of discounted costs; 2: From Bennett and George (1996)

Results and discussion

Table 6 shows the results for this case-study. Under this set of assumptions the investment yields a positive return after 14 years, as indicated by the NPV of more than zero. Therefore, growing *E. camaldulensis* for pulpwood may provide a productive and profitable use of moderately saline land at this site.
Table 7 shows the minimum values (for MAI and price) and maximum values (for costs) which result in the investment just breaking even.

Table 6: Financial results of *E. camaldulensis* when grown for pulpwood

Financial indicator	Base-case scenario
Net Present Value ($/ha)	252
Annual Equivalent Return ($/ha)	29
Peak debt ($/ha)	-932
Break-even period (years)	14

Table 7: Parameter values necessary for *E. camaldulensis* to break even

Parameter	Break-even value	Change (%)
MAI (m^3/ha/yr)	6.7	- 21%
Pulpwood prices ($/$m^3$)	20	- 20%
Establishment costs ($/ha)[1]	948[1]	+ 37%
Maintenance costs ($/ha)[1]	526[1]	+ 88%

1: NPV of discounted costs

Concluding comments

Results from case study One (*E. occidentalis)* indicate that timber production from this species on this site is not a viable alternative, unless growth rates are substantially more than has been measured. Integrating the trees with pasture for sheep production may result in the investment breaking-even, but is less financially rewarding than the potential return from saltbush belts integrated with pasture. Again, the land manager would need to be confident of a substantial increase in growth rate to choose this land-use system. The uncertainty of interactions between *E. occidentalis* and pasture further detracts from this alternative. The break-even values indicate the values that researchers should be considering and aiming for when conducting further research into *E. occidentalis* on saline land. Currently, improved germplasm and management has already made in-roads into improving yield for this species (0). Therefore, growth rates for improved seed sources may be already closer to the break-even value.
Results from case study Two (*E. camaldulensis*) show that this may be a viable alternative at this site, providing the land holder is capable of incurring a level of debt close to $100/ha for 14 years until the trees are harvested. In addition, there may be hydrological and environmental benefits of the trees which have not been accounted for here. This may further increase the value of the trees to the land holder. Sensitivity analysis shows that some decrease in yields and prices and an increase in costs is possible for the investment to still break-even and is therefore a better option than doing nothing with the land. Again, these values should be considered by those

researching this species. This land-use system was not compared with saltland pastures, so it is possible that it may still be a more profitable land use than *E. camaldulensis* for pulpwood.
The analyses presented here relate to specific case studies. Productivity is likely to vary according to regional factors, and depending on site salinity. Therefore, these analyses do not provide a definitive evaluation of the potential of each species; rather they provide an example of the application of the methodology, based on observed data. Further analysis as part of this project will examine the potential viability of improved seed sources, other salt-tolerant species, such as *Casuarina obesa*, and salt-tolerant hybrids for a matrix of salinity levels, climatic zones and paddock layouts. In addition to commercial viability the potential role of trees to provide additional benefits (e.g. hydrological value, biodiversity value) will be evaluated.

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