Eucalypt SRC - sensitivity analysis of growing costs in New Zealand

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1. ABSTRACT

The growing costs of a bioenergy crop has been evaluated. Using a spread sheet costing model, the sensitivity to changes in growing costs were assessed by changing individual inputs from those used in a base case. Factors tested were; wood density, land value, annual changes, establishment costs, initial tree stocking, yields, discount rates and rotation length. Increases in yields and wood density made considerable reductions in growing costs. Project management costs such as land price, cost of seedlings, establishment costs and interest rate increased the growing costs compared to the base case.

2. INTRODUCTION

Dedicated bioenergy crops are not part of the New Zealand forestry or bioenergy scene as they are regarded as an expensive crop if grown solely for bioenergy. Horgan and Cox (1986) reported that, for the firewood scenario they evaluated, an Internal Rate of Return (IRR) of 5.9% could be expected. To improve this they suggested that increased revenues and reduced costs could make a more attractive investment.

To provide a clearer understanding of what has the most influence on the growing costs of a bioenergy crop, this paper has evaluated the sensitivity of a range of input values on growing costs. The objective of the evaluation was to assist bioenergy managers and researchers on the important aspects that could improve profitability.

An excel spread sheet has been developed to assess the growing costs of a bioenergy plantation.

Growing costs are based on ODT (Oven Dry Tonnes), a product which should be the ultimate bioenergy fuel unit. The analysis includes a base crop and three coppice rotations.

3. BASE CASE

The base case uses the following inputs and values (Table 1). Included in this table is the range of variables tested:

Table 1. Base case and range of variables tested

	Base case	Values tested
Biomass Basic Density; kg/m^3	410	452 & 550
Land Value $/ha	3000	0, 2000, 5000
Annual charges $/ha/yr	70	0 & 150
Pre-plant spraying $/ha	150	-
Other Land Prep $/ha	0	-
Planting costs $/tree	0.24	-
Fert ($/ha) -after each harvest	250	0 & 500
Planting density stems/ha	3000	2,500, 5,000 & 10,000
Tree Cost $ per 000	550	1- 1,000
Yield increases %	0	10, 20, 30, 40,50
Discount rates	7%	8% & 10%
Rotation length yrs	7	5, 6, 8, & 9

Calculations with the base case include a number of assumptions, which must be considered in analysing the result. In particular while some of the variables have changed, base yield has not changed with the variable. This means that when tree stocking has changed yields have not been adjusted from the base case.

Base case calculations are based on 7% discount rate and a seven year rotation, as these are considered as a middle-of-the-road scenario. Growing costs are calculated on an oven dry tonne basis. Yields for the base case were 235 m^3/ha at age seven years. Under bark stem volume was converted to oven dry matter using a whole tree density value. Other biomass components (foliage, branches and bark) were not included in the calculations as the data is less certain for these variables as a time series. The model is based on a single hectare calculation. **The growing cost of the base case was $48.10/ODT.**

4. SENSITIVITY ANALYSIS

The base model was run with changes to a single variable. The changes in growing costs/ODT were converted to a percentage of the base case value.

4.1 Seedling Cost (base - $550/000)

If the seedling cost is nearly doubled to $1 per plant, the growing costs increase by approximately 20%, if the seedlings have zero value, the growing cost reduces by approximately 25%.

4.2 Wood density (base - 410 kg/m^3)

A range of wood density values were tested. As the yield is calculated as m^3/ha, actual fibre is the critical element to assess. Accordingly wood density can be very important. Average values for a range of eucalypts species were taken for young material as 452 kg/m^3, and the values for one of the denser species, *E. maidenii* (a sub species *of E. globulus)*, for the other extreme at 550 kg/ m^3 (Shelbourne *et al*. 2000).

It is apparent that wood density makes a considerable difference to the growing costs. The average wood density (an increase of 41 kg/ m^3 gives nearly a 10% reduction in growing costs, while selecting a dense species with 140 kg/ m^3 higher wood density gives just over 25% improvement.

4.3 Initial tree stocking (base – 3,000 stems/ha)

Initial tree stocking can have a large bearing on establishment costs. It can also have a significant bearing on productivity, while more trees can mean more wood, too many trees can result in significant mortality (Nicholas and Kimberley, 2002). Because of the need to keep other values the same as the base case, this particular analysis assumes constant yield irrespective of stocking, these results are indicative only of changes in initial costs. Reducing the initial stocking causes a 6% reduction in growing costs, while increasing to 5,000 stems/ha sees a 25% increase and going to the extreme of 10,000 stems/ha (note no yield changes) results in a cost increase of 85%.

4.4 Land cost (base - $3,000/ha)

Land cost is also a key part of any venture. A zero land cost, assuming the land is already in ownership, makes a large difference to the growing costs, resulting in an improvement of 42%, a reduction in land price to $2,000/ha, a 14% reduction and increasing land values to $5,000/ha results in a 28 % increase.

4.5 Management Fee (base case - $70/year)

The sensitivity of a reduction in management fee, which is an annual cost, shows that it can move from nearly 15% reduction in costs for no management fee, to just over 15% for nearly doubling the management fee.

4.6 Post harvesting costs (base case - $250/ha at each harvest)

Costs after each rotation for inputs such as fertilisation or stump thinning were tested as zero cost, this gave a reduction of about 4%. Increasing costs to $500 increased costs by about 4%.

4.7 Yields (base - 235 m^3/ha)

Changes in yield from improved genetic stock or from increased productivity from waste water application were tested in 10 % increments from 10% to 50%, Reduction in growing costs from 10, 20, 30, 40 and 50% resulted in 9, 17, 23, 29 and 33 % reduction in growing costs respectively).

4.8 Interest rate (base - 7%)

Increasing the interest rate from 7% to 8% and 10% resulted in a 14% increase to a 44% increase respectively.

4.9 Rotation length (base - 7 year rotation)

As shown in Figure 1, growing costs are highest for the shorter rotation of five years and fall with each year longer rotation to age 8 years, before climbing back up at age nine years.

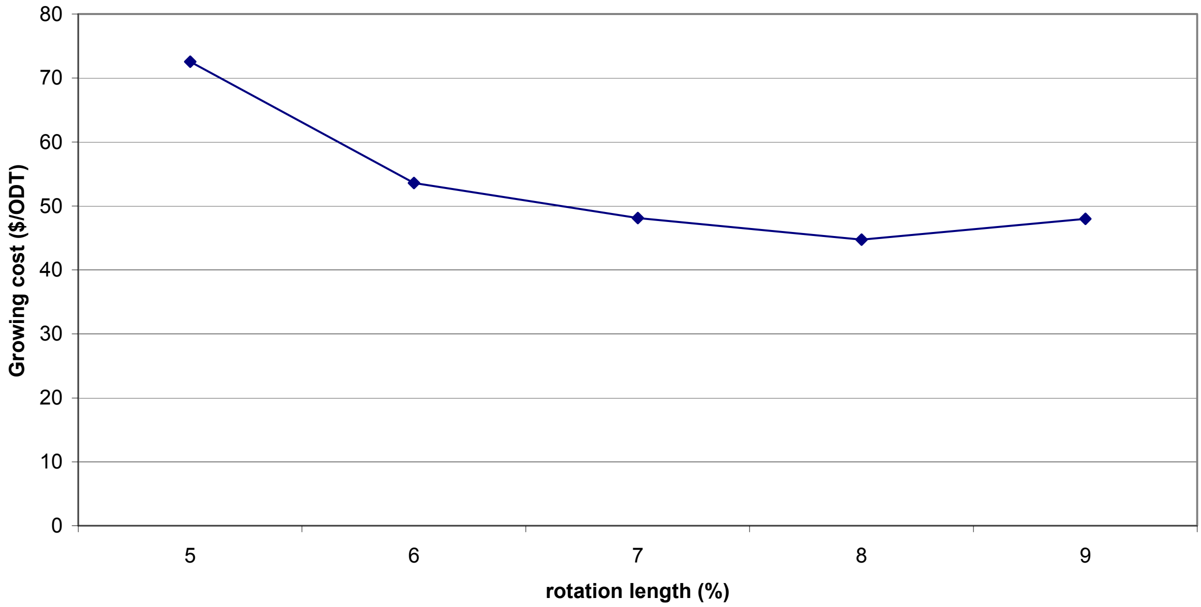

Figure 1. Influence of rotation length on growing costs for base case

5. DISCUSSION

5.1 Growing cost reductions

The series of sensitivity analysis have shown that the most influential reductions (Figure 2), in growing costs have been:

- Zero land value
- 50% increase in yields
- 40% increase in yields
- high wood density
- minimum seedling cost
- 30% increase in yields
- 20% increase in yields
- reduction in land value of $1,000/ha
- 10% increase in yields
- medium wood density
- reduction in initial stocking of 500 stems/ha (assumes same yield as base case)
- no post harvest costs
- zero management fees

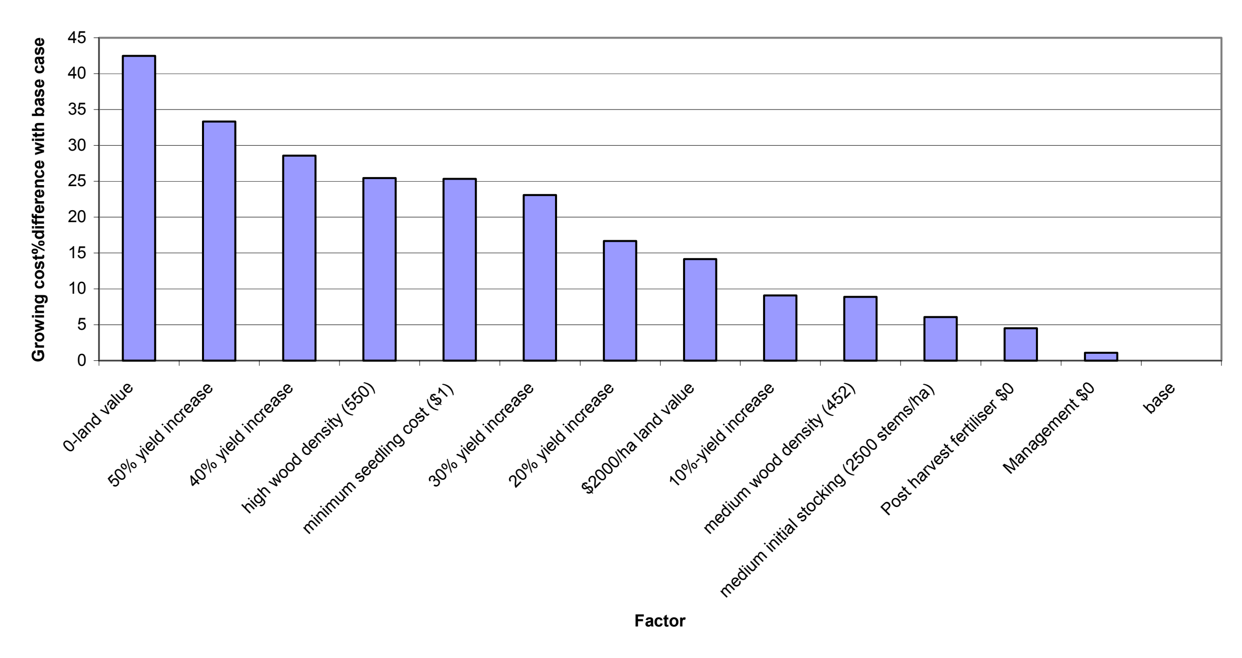

Figure 2. Factors that reduced growing costs compared with base case

5.2 Growing cost increases

For some of the cases evaluated, there was an increase in growing costs. The largest increases in growing costs (Figure 3) have come from:

- very high initial stocking (assumes same yield as base case)
- 10% interest rate
- Increase in land value by $2,000/ha
- high initial stocking (assumes same yield as base case)
- high seedling cost
- other site preparation costs increasing by $1,000/ha
- 8% interest rate
- other site preparation costs increasing by $500/ha
- post harvest costs of $500/ha
- other site preparation costs increasing by $250/ha
- management costs increasing to $150/ha/yr

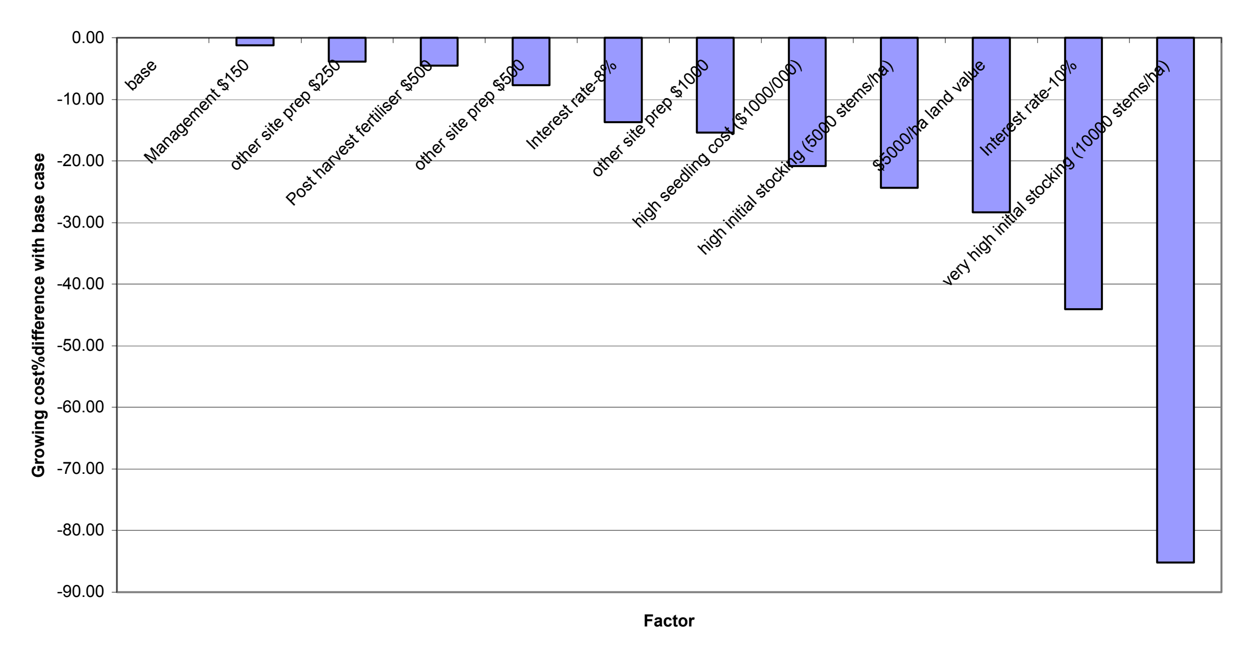

Figure 3. Factors that increased growing costs compared with base case

This study has evaluated growing costs, the bioenergy manager should also take into account harvesting and transport costs, which can increase raw material costs by as much again. Using harvesting costs from the base case increases Harvesting costs from the base case result in a gate cost of $97/ODT. The sensitivity of this to cost changes could be the subject of a future evaluation.

6. CONCLUSION

This analysis of the sensitivity of growing costs has shown where a bioenergy manager can make a significant reduction in the growing costs of the operation. In the growing side improvements in yields and high wood density provide substantial reductions in growing costs. Project management costs such as land price, cost of seedlings, establishment costs and the interest rate used can also make significant cost increases to a project.

8. ACKNOWLEDGMENTS

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9. REFERENCE

Horgan, G.P.; Cox, O. 1986. The Economics of Growing Firewood. In Shula, R.G., Hay, A.E., and Tarlton,G.L. (Eds), The Firewood Venture. NZFRI Bulletin No.137.