Economic feasibility of eucalyptus production

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This paper outlines the capital outlay needed to get into commercial eucalyptus production and the expected returns under several management regimes. Two possible markets are explored—firewood and biomass—and a break-even land price is calculated for each regime and market at varying price and yield levels.

Alternative management regimes

Three management regimes are evaluated. They differ in the number of trees per acre, irrigation, nitrogen application, length of each rotation, and number of rotations. In each case, the trees are replanted after 20 years. Regeneration of trees after harvest is from stump sprouts.

Regime 1 - high intensity, moderate nitrogen. The high-intensity program has a tree spacing of 6 by 6 feet for a total of 1,210 trees per producing acre. Trees are furrow-irrigated with 2 acre-feet of water in the first year and 3 acre-feet in subsequent years. Nitrogen is applied at 150 pounds per acre per year beginning in the second year. Weeds are controlled for the first 3 years.

The trees are cut every 5 years for a total of four rotations. The expected per acre yield is 60 dry tons per rotation or an average of 12 tons per year. This is equivalent to 30 cords per acre per rotation or an average of 6 cords per year if the trees are being grown for firewood.

Regime 2 - high intensity, high nitrogen. This is identical to regime 1 except that nitrogen is applied at 75 pounds per acre in the first year of each five-year rotation, but not in the year the trees are planted, at 200 pounds per acre in the second year, and at 300 pounds per acre in the third, fourth, and fifth years. These amounts are estimated to replace the nitrogen used by the trees. The expected production is 100 dry tons per acre per rotation or an average of 20 dry tons per acre per year (10 cords of firewood).

Regime 3 - low intensity. Trees are planted in a 7- by 7-foot spacing (889 trees per acre), and are irrigated only in the first year with a tank truck. No nitrogen is applied. Weeds are controlled in the first 3 years. Trees are harvested every 10 years.

The expected yield is only 40 tons per acre per rotation over the 10 years for an average of 4 tons per year. This is equivalent to 20 cords in a 10-year rotation or 2 cords per acre per year.

Comparison of regimes

As would be expected, the total cost per acre is highest for the high-intensity management regime with the high level of nitrogen (regime 2) at $679 per year, compared with $509 per acre for the high-intensity regime with moderate nitrogen (regime 1) and $229 per acre for the low-intensity regime (table 1, fig. 1). The only differences in costs for the two high-intensity strategies are for nitrogen and harvesting, because the higher level of nitrogen greatly increases the yield.

Net income from firewood

The net income per acre above cultural costs of producing eucalyptus for firewood has been calculated for a realistic range of prices received under each management regime (see examples, fig. 2). The prices received assume sale of stacked wood at the roadside, and therefore include harvesting costs but not transportation. Net income per acre in this case is the difference between gross income and the cost of cultural practices and trees. Cultural costs include fertilizer, herbicide, irrigation water, miscellaneous labor, overhead, and harvest cost.

For the high-intensity, moderate-nitrogen scheme, costs are covered if average annual growth is 5 cords per acre per year and price received reaches $100 per cord. At $70 per cord, costs are not covered for the range of growths evaluated. For the high-intensity, high-nitrogen scheme, production costs are covered if average growth is 6 cords per acre per year and the price is $100 per cord or more. Low-intensity management covers costs only with growth of 3 cords per acre per year and a price of $100 per cord, or a growth of 2

TABLE 1. Costs to produce eucalyptus for firewood under alternative management regimes

Item	Low intensity No N 2 cords/ac/yr		High intensity Mod N 6 cords/ac/yr		High N 10 cords/ac/yr	
	$/ac/yr	*%*	*$/ac/yr*	*%*	*$/ac/yr*	*%*
Cultural						
Herbicides: pre-emergent 1st 3 yr; spot treat 1st 2 yr	8	4	8	2	8	1
Fertilizer: 35¢/lb	0	0	41	8	79	11
Irrigation: $8/ac-ft	15	5	62	12	62	9
Misc. labor: $6.50/hr.	15	7	15	3	15	2
Harvest: $35/cord	58	25	194	38	323	48
Overhead: operating loan @ 10% p.a.; taxes; insurance, accountant; phone; office	53	23	63	12	66	10
Total cash costs	145	64	383	75	553	81
Cash costs/cord	73		64		55	
Trees: discing, smoothing, $50/acre; trees, 70¢ ea; layout, planting, 15 hr/ac (high-density) or 9 hr/ac (low-density); 5-yr loan @ 10%	64	28	86	17	86	13
Equipment: depreciation & interest on furrow irrig. system (high-density); backpack sprayer; rototiller; shovels	20	9	40	8	40	6
TOTAL COST	229	100	509	100	679	100
TOTAL COST/CORD	115		85		68	

NOTE: All costs and returns are pretax. Some growers may be eligible for investment tax credits and amortization for planting expenses under federal Reforestation Tax Incentive programs. Costs were calculated for each management regime for each year for 20 years, discounted to current dollars and put on an equivalent annual annuity basis.

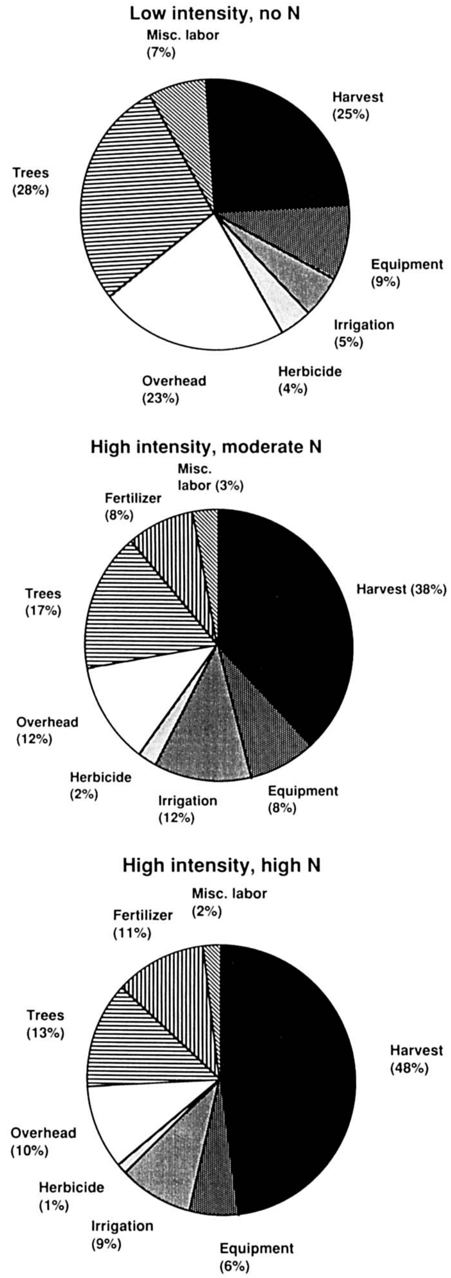

Fig. 1. Cost breakdown for alternative regimes.

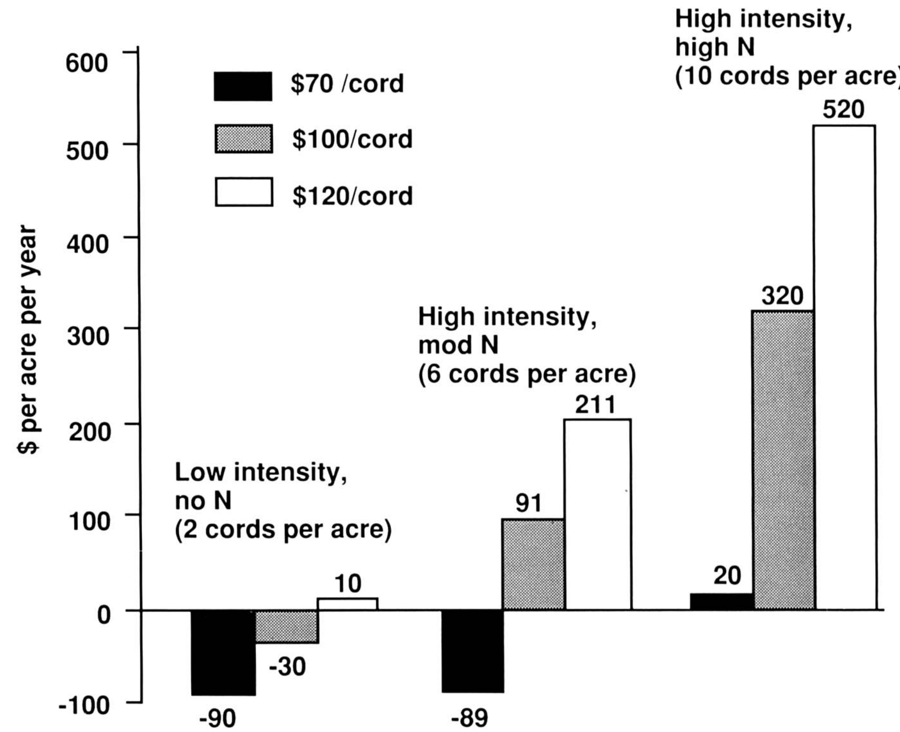

Fig. 2. Net annual return to land under three regimes.

cords per acre per year and a price of $120 per cord.

The studies reported by Donaldson et al. and Hasey et al. would correspond to the high-intensity, moderate-nitrogen regime. The Napa Valley study reports an average annual growth of 10 cords per acre per year for *Eucalyptus camaldulensis* (river red gum) and 6 cords per acre per year for *E. dalrympleana* (mountain gum), which would cover all costs at prices of $100 per cord or higher. Although the Sierra foothill study is only 43 months old, the *E. globulus* (blue gum) and C-2 clone already exceed growth rates of 6 cords per acre per year and would cover costs at $100 per cord.

Break-even land prices for firewood production

The net income per acre above all costs except land can be viewed as money available for land payments. Break-even land prices for each management regime at various prices for firewood are shown in table 2. At $70 per cord, only the high-nitrogen regime results in a positive net income. If the price increases to $80 per cord, it is possible to buy land for up to $912 per acre under the high-intensity, high-nitrogen strategy. At $90 per cord, the price of affordable land is only $233 per acre for the high-intensity, moderate-nitrogen strategy but goes up to $1,673 per acre for the high-nitrogen alternative. At $100 per cord, low-intensity management can support land payments of $311 per acre.

Table 2 demonstrates that higher priced land requires the more intensive management strategies if land payments are going to be made from the firewood enterprise.

Biomass production

The same analysis has been carried out for biomass as for firewood production, except that harvest costs are not paid directly by the grower. Eucalyptus for biomass is usually sold on the stump, and the processor arranges for the chipping and hauling.

Yields for biomass production are measured on a tonnage basis. The dry tons per acre produced are approximately twice the number of cords produced. Moisture content at the time of cutting is between 50% and 60%. Thus, 20 dry tons equal 40 wet tons at 50% moisture. Hauling and chipping charges are made on a wet ton basis.

The hauling cost is about 20¢ per wet ton per mile. In the analysis, a hauling distance of 20 miles was used, resulting in a cost of $8 per dry ton at 50% moisture.

The cost of hauling and chipping reduces the price received for the wood by $38 ($30 for chipping and $8 for hauling). Gross prices received for biomass are currently about $30 to $45 per dry ton. Deducting the cost of chipping and hauling from the price received results in a net income ranging from a loss of $8 per ton ($30 - $38) to a gain of $7 per ton ($45 - $38).

At the present time, it is unlikely that more than $20 per dry ton could be obtained after the cost of chipping and hauling have been deducted, but higher prices have been used in this study in anticipation of higher real prices in the future due to increased competition for biomass chips. They also demonstrate the price needed to make biomass production profitable.

For the high-intensity, moderate-nitrogen strategy, a price of $26 per dry ton is needed to cover all costs except land; for the high-intensity, high-nitrogen strategy, $18 per dry ton is needed. For the low-intensity option, the break-even price is $40 per ton. If tree growth could be increased to 6 tons per acre under low-intensity management for the same production

TABLE 2. Break-even land prices for firewood production

Firewood price	Low intensity No N 2*	High intensity* Mod N 6*	High intensity* High N 10*
$/cord		$/acre	
70	0	0	152
80	0	0	912
90	82	233	1,673
100	311	689	2,433
110	539	1,146	3,194
120	767	1,602	3,955

* Cords per acre per year.

TABLE 3. Break-even land prices at various biomass prices

Biomass price	Low intensity No N 4*	High intensity Mod N 12*	High intensity High N 20*
$/dry ton		$/acre	
15	0	0	0
20	0	0	327
25	0	0	1,088
30	0	338	1,848

* Production of dry tons per acre per year.

costs, the break-even point would be $29 per ton.

Break-even land prices for biomass production

The low-intensity management strategy is not appropriate for biomass production, unless growth rates of 6 tons per acre per year can be obtained or the price of fuelwood increases from the current level.

For the high-intensity, moderate-nitrogen strategy, the break-even land price is only $338 per acre at a price of $30 per dry ton and a growth of 12 tons per acre per year (table 3). If yield could be increased to 14 tons per acre and $30 per ton were received for wood on the stump, the operation could support a land purchase price of $795 per acre.

For the high-intensity, high-nitrogen regime, the break-even land price is $327 per acre at $20 per ton and jumps to $1,088 per acre at $25 per ton.

Conclusion

The potential for growing eucalyptus for firewood or biomass appears to be economically promising. As with any agricultural enterprise, there are several alternatives for production practices. More intensive management increases yield per acre, which spreads costs over a larger number of cords or tons and thus decreases the cost per unit produced.

In the three alternative management regimes analyzed—high-intensity, moderate nitrogen; high-intensity, high nitrogen; and low intensity—expected yields were 6, 10, and 2 cords per acre per year for firewood production and 12, 20, and 4 dry tons per acre per year for biomass. The break-even prices for firewood at the farm gate were estimated to be $85, $68, and $115 per cord. Break-even biomass prices were $26, $18, and $40 per dry ton on the stump.

This analysis shows that low-intensity production would not be profitable, unless production could be increased to 6 dry tons (3 cords) per acre per year without increasing costs or the price received increased from current levels.

The high use of nitrogen seems to be justified. The greater revenue from the projected increase in yield far outweighs the added fertilizer cost between the moderate and the high rate of nitrogen application.

At $100 per cord and $35 for harvest for firewood production, the increased revenue per acre per year is estimated to be $260. The increase in cost is $17 per year for a net increase in profit of $243.

Biomass production is not profitable for low-intensity or the moderate nitrogen regimes at a price of $20 per ton. At present, more than $20 per dry ton is a high price to expect for wood on the stump. It seems that the high-intensity, high-nitrogen alternative is the most suitable for biomass production.

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Selection and clonal propagation of eucalyptus

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Most eucalyptus plantations are started with seedlings that are highly variable in growth rate and form. Although breeding programs are under way to improve the quality of eucalyptus seed, the improvements are not expected to come soon.

Development of clones (genetically identical plants) from selected superior seedlings offers a possible means of rapidly increasing productivity and uniformity of eucalyptus plantations. Although eucalyptus has a reputation of being difficult to propagate vegetatively, research in France, New Zealand, Brazil, and India has demonstrated that clonal propagation of some species is feasible. Clonal plantations of *Eucalyptus grandis* (rose gum) and *E. camaldulensis* (river red gum) have been established in India, Brazil, regions of Africa, and California. A report on clonal propagation of species well adapted to several areas of California appeared in *California Agriculture*, May-June 1983 (pp. 20-22). This article adds information on selection criteria, methods of propagation, and problems encountered.

Clonal propagation for biomass has two basic objectives: (1) to capture desirable genetic traits, such as fast growth, straight trunk, minimum lateral branch development, thin bark, and tolerance of low temperature and other stress; and (2) to produce large numbers of uniform trees at a cost competitive with seedlings.

Selection of seedlings

We selected seedlings mainly from short-rotation intensively cultured plantations. We also planted seedlings in beds at a 2- by 2-foot spacing and, after 4 to 6 months, selected the most vigorous for further study. For salinity and cold hardiness screening, we grew seedlings in 1-gallon containers, subjected them to salt or cold stress, and then evaluated vigor and form of the surviving individuals. In other cases, screening for stress tolerances began after selection for form and vigor.