CASE STUDY OF THE ECONOMIC FEASIBILITY OF A RED OAK SMALL-DIAMETER TIMBER SAWMILL AND PALLET-PART MILL

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Abstract. The economic feasibility of producing lumber, cants, pallet parts, and residues from hardwood small-diameter timber (SDT) has not been investigated. To assess the potential for utilization of this resource, an economic feasibility analysis was conducted based on the results of a related SDT yield study. The economic feasibility analyses used in this research included: break-even, net present value (NPV), and internal rate of return (IRR). These analyses were used to determine the economic viability of a sawmill and pallet-part mill that would utilize red oak small-diameter timber. Twelve scenarios were evaluated using these analyses: two processing levels (sawmill-only, and sawmill and pallet-part mill), two yield levels (actual and average), and three log costs ($33, 39, and 44/tonne). The break-even analysis indicated that in this case study the sawmill-only processing level would not be profitable for all log groups under current conditions. The NPV and IRR analyses illustrated that in this case study a new sawmill-only (scragg mill) processing level scenario is not economically feasible under any of the hypothetical conditions tested. The NPV and IRR analyses indicated that the actual-yield sawmill and pallet-part mill scenario was found to be economically feasible at a $74/m^3$ ($39/tonne) log cost. The NPV was calculated to be over $500,000, and the IRR was approximately 11%.

Keywords: Small-diameter timber, economic feasibility, red oak.

INTRODUCTION

Economic feasibility studies determine the practicality of a particular project. They often assess the economical viability of a given processing operation or potential business. McCay and Wisdom (1984) determined the economic feasibility of nine different sawmills that could utilize small-diameter timber (SDT) from Southwest Virginia. Their results showed that only two mills, a short log mill and a scragg mill, were economically feasible at an 80% operating capacity. Lin et al (1995) used net present value (NPV) and internal rate of return (IRR) analyses to establish the economic feasibility of producing red oak dimension parts directly from grade 2 and 3 logs. They concluded that it was economically feasible and that their theoretical plant had higher profitability than sawmills. The economic feasibility of producing lumber, cants, pallet parts, and residues from SDT hardwoods has not been investigated. Therefore, an economic feasibility analysis was initiated and based on the results of a related SDT yield study (in press FPJ)

According to Newnan and Lavelle (1998), there are three major methods of economic feasibility analyses: NPV, annual cash flow, and rate of return. These methods have not been used extensively in the sawmill and pallet segments of the forest products industry (Bush and Sinclair

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1987). The economic feasibility analyses used in this research included: break-even, NPV, and IRR. These analyses were used to determine the economic viability of a sawmill and pallet-part mill that would utilize red oak SDT. Actual yield data were obtained from a participating sawmill that utilized a scragg mill that had a shifting twin circular saw and rotating end-dogging setup, gang resaw, edger, and trimmer. The pallet-part operation consisted of a cut-off-saw, gang resaw, part salvager, and a double-head notcher. Break-even analysis was used to determine which log diameters (15–25 cm small-end dia) would be profitable if only that diameter group was utilized by a hypothetical sawmill and pallet-part mill. NPV and IRR analyses were used to determine the economic feasibility assuming equal utilization of all log diameters.

Both the break-even analysis and the NPV and IRR analyses were evaluated under 12 scenarios as shown below:

- Processing Level
  1. Sawmill
  2. Sawmill and Pallet-part Mill
- Yield
  1. Actual
  2. Average
- Log Cost ($/m^3)
  1. 85
  2. 74
  3. 64

The analysis of multiple scenarios enabled the determination of approximate maximum delivered log cost and the effect of yield variation and processing level on economic feasibility. Since yield data on cants and pallet parts were collected, the comparison of a sawmill producing lumber and cants vs a sawmill and pallet-part operation producing lumber and pallet parts was possible. This additional processing level could have an effect on feasibility. The actual yield and average yield were compared to determine if yield variations affect revenues and costs, and furthermore, economic feasibility. Log cost is the single largest cost component for sawmills and was therefore systematically varied to estimate the delivered log cost payable by a mill utilizing SDT.

METHODS

Overview

The determination of economic feasibility required the estimation of annual revenues, annual costs, and net incomes over the life of the processing facility. The yield of sawdust, bark, chips, lumber, cants, and pallet parts, which was determined in the yield analysis part of this research (submitted for review FPJ), was utilized in conjunction with the participating mill's capacity, and current market prices to generate annual revenues. The variable costs along with fixed costs were attained from the participating mill and were used to generate annual costs. These revenues and costs were used in the break-even analysis to determine which log diameter groups would be profitable if a hypothetical mill of the same design produced products using only that log diameter group. Revenues and costs based on an equal volume from each profitable log diameter group were used to calculate net income, which in turn was used for the determination of NPV and IRR.

A description of the methods used to estimate revenues, costs, and net incomes is contained in the following section. The assumptions were justified for the economic analyses, including discount rate, project life, initial investment, land cost, and working capital requirement. The methods and assumptions of break-even analysis, and the NPV and IRR analyses are also described in their respective sections.

Revenue calculation

Annual revenues were calculated for each financial analysis. The yield of sawdust, bark, chips, lumber, cants, and pallet parts was utilized in conjunction with mill capacity and then-current market prices (Table 1) to generate annual revenues. The product yields, except for pallet-part

TABLE 1. *Red oak market prices.*

Product	HMR[1] ($/m^3)	HRX[2] ($/m^3)	Avg. ($/m^3)
FAS	470	449	460
FIF	424	449	436
1C	265	254	259
2A	212	216	214
3A	180	184	182
Cants	136	129	132
Pallet parts ($ average/piece)			0.36
Chips ($/delivered green tonne)			24
Sawdust ($/delivered green tonne)			11
Bark ($/delivered green tonne)			15

[1] Hardwood Market Report. July 1, 2006.
[2] Hardwood Review Express. July 7, 2006

yield, were divided by each group's actual log volume resulting in yield-to-log volume ratios. The pallet-part yield was divided by each group's actual cant volume resulting in yield-to-cant volume ratios. These yield ratios are shown in Table 2.

The yield ratios (Table 2) for each product (ie: lumber, cants, residues, and pallet parts) were then multiplied by the required annual log volume and required annual cant volume in the case of pallet parts, to get annual product volume. The actual yield analysis log volume, actual yield analysis cant volume, required annual log volumes, and required annual cant volumes are shown in Table 3.

The required annual log volume was calculated for use in the break-even analysis by dividing annual sawmill capacity, 47,200 m^3, by the cant and lumber yield (overrun) for each log group. The required annual cant volume for use in the break-even analysis was calculated by dividing annual pallet-part mill capacity, 18,878 m^3, by the pallet-part yield for each log group. For example, the required annual log volume for the 15-cm group is 47,200 divided by 1.54 (54% overrun for 15-cm group), which equals 30,683 m^3.

Since the NPV and IRR analyses assumed an equal volume from each log diameter group, the required annual log volume was calculated by dividing annual sawmill capacity by 5 for the five log groups. The quotient was then divided by the overrun for each log group as stated previously. The required annual cant volume for use in the NPV and IRR analyses was calculated by dividing the annual pallet-part mill capacity by 5, for the five log groups. The quotient was then divided by the pallet-part yield for each log group. The individual group volumes were then summed to get total annual volume (Table 3). These annual log and cant volumes were then used to generate annual product volume by multiplying them by the yield ratios.

The annual product volume was then multiplied by current market prices (Table 1) resulting in annual product revenue. The summation of revenues for all products resulted in annual revenues for that log group. The calculation of annual revenues is shown in Eq (1).

TABLE 2. *Yield ratios.*

Product	Log group (cm)				
	15	18	20	23	25
3A lumber	0.09	0.08	0.10	0.06	0.07
2A lumber	0.33	0.22	0.18	0.21	0.23
1C lumber	0.01	0.04	0.10	0.11	0.12
FAS lumber	0.00	0.00	0.00	0.00	0.02
1F lumber	0.00	0.00	0.00	0.01	0.01
Cants	1.10	0.88	0.71	0.62	0.53
Chips (kg/log m^3)	558.2	382.18	356.83	311.70	295.09
Sawdust (kg/log m^3)	496.2	368.66	311.47	273.32	245.75
Bark (kg/log m^3)	123.1	123.09	123.33	123.31	123.17
11 mm × 1.78 m pallet part (# parts/cant m^3)	315.5	562.02	619.38	582.95	622.48
11 mm × 1.30 m pallet part (# parts/cant m^3)	110.0	106.20	60.47	190.70	210.85
11 mm × 1.17 m pallet part (# parts/cant m^3)	51.16	56.59	86.82	89.15	114.73

TABLE 3. *Log and cant volumes.*

Log group (cm)	Actual log volume[1] (m^3)	Actual cant volume[1] (m^3)	Annual log volume[2] (m^3)	Annual cant volume[2] (m^3)	Annual log volume[3] (m^3)	Annual cant volume[3] (m^3)
15	2.34	1.29	30,683	29,236	6,137	5,847
18	4.70	2.06	38,830	29,557	7,766	5,911
20	6.00	1.18	42,941	28,623	8,588	5,725
23	7.80	2.41	46,536	29,972	9,307	5,994
25	9.93	2.63	48,338	30,058	9,678	6,012

[1] Total volume from yield analysis
[2] Total volume required for all x cm (ie: 15, 18, 20, 23, 25) group production used in break-even analysis
[3] Total volume required for equal group production used in NPV & IRR analyses

$$AR_j = \sum_{i-1}^{n} [(PY_{ij}/LV_j) * AV * MP_i] \quad (1)$$

where:

AR = annual revenue
PY = product yield
LV = log volume
AV = annual log volume
MP = market price
i = i^{th} product (ie: lumber grades, residues)
n = number of products
j = j^{th} log group

The annual revenues from each log group were then used in the break-even analysis to compare the profitability of individual log groups. The annual revenues were also used to determine net incomes for use in the NPV and IRR analyses. The annual revenues for different scenarios are shown in Table 4.

Cost calculation

The participating mill provided actual cost information based on its operations. Since this particular mill produces lumber from other species in addition to red oak, and the mill is also equipped with an additional primary breakdown (circular saw headrig) in addition to the scragg mill, its annual production is more than double the capacity modeled for this research. Therefore, adjustments were made to costs based on 47,200 m^3 capacity (annual scragg mill capacity), in lieu of 113,280 m^3 capacity, which is the total mill capacity. For example, the $\$/m^3$ were calculated by dividing the total 2005 cost by 113,280 m^3. The $\$/m^3$ were then multiplied by 47,200 m^3 to receive annual operating costs. The depreciation and taxes of the participating sawmill were used in calculating total annual operating costs.

The cost components used in this study, including a hypothetical $\$74/m^3$ log cost, adjusted fuel, marketing, and maintenance and repair costs are shown in Table 5. These cost components were held constant, except for fuel costs that varied with log diameter, and log costs that were systematically varied in the analysis.

Raw material costs are the single largest cost component for sawmills. Given the amount of yield variation between log groups, average yield (8.8% overrun) enabled comparisons of operating costs between log groups assuming an identical log cost. The required annual log volume was calculated for the average-yield scenarios by dividing annual sawmill capacity, 47,200 m^3, by the average yield. The required

TABLE 4. *Annual revenues ($) by log group and scenario.*

Scenarios		Log group (cm)				
Processing level	Analysis	15	18	20	23	25
Sawmill Only	Break-Even	4,272,078	4,238,335	4,471,441	4,569,220	4,804,957
Sawmill & Pallet-part Mill	Break-Even	6,991,241	6,919,565	7,379,456	7,627,938	8,065,811
Sawmill Only	NPV & IRR	854,416	847,667	894,288	913,844	960,991
Sawmill & Pallet-part Mill	NPV & IRR	1,398,248	1,383,913	1,475,891	1,525,588	1,613,162

TABLE 5. *Hypothetical sawmill cost components.*

Cost component	Fixed (F) or variable(V)	Cost \$/m^3
Log Cost	V	74.16
Wages	V	26.27
Residue Freight	V	15.68
Repairs & Maintenance	V	10.17
Fuel	V	7.63
Contract Labor	V	6.78
Health Insurance	V	2.97
Utilities	V	2.54
Supplies	V	2.12
Payroll Taxes	V	2.12
Equipment Rental	V	0.85
Retirement	V	0.42
Total Variable Cost (excluding log cost)		77.55
Marketing	F	8.48
Depreciation	F	6.78
Interest	F	4.66
Insurance	F	2.54
Taxes	F	1.70
Administration	F	0.42
Total Fixed Cost		24.58

annual cant volume was calculated for the average-yield scenarios by dividing annual pallet-part mill capacity, 18,878 m^3, by the average pallet-part yield.

One of the underlying assumptions in the calculation of annual revenues and the comparison between log groups is that the annual production capacity, 47,200 m^3, can be achieved using any of the log diameter groups in this study. The number of logs required for 15-cm group production is much greater than the number of logs required for 25-cm group production as shown in Fig 1.

The two estimates of the number of logs required to achieve annual production capacity are based on average yield and actual yield. The large variation in yield impacts the number of logs required and log cost. The exponential relationship between increasing volume per log as the log diameter increases has also been demonstrated by Huber and Vasiliou (1968) and Barbour (1999). The increased number of logs, required for a constant level of production, also affects the production rate and sawing costs. The general trend is that lower production rates occur and greater sawing costs accumulate as log diameter decreases (Howard 1987).

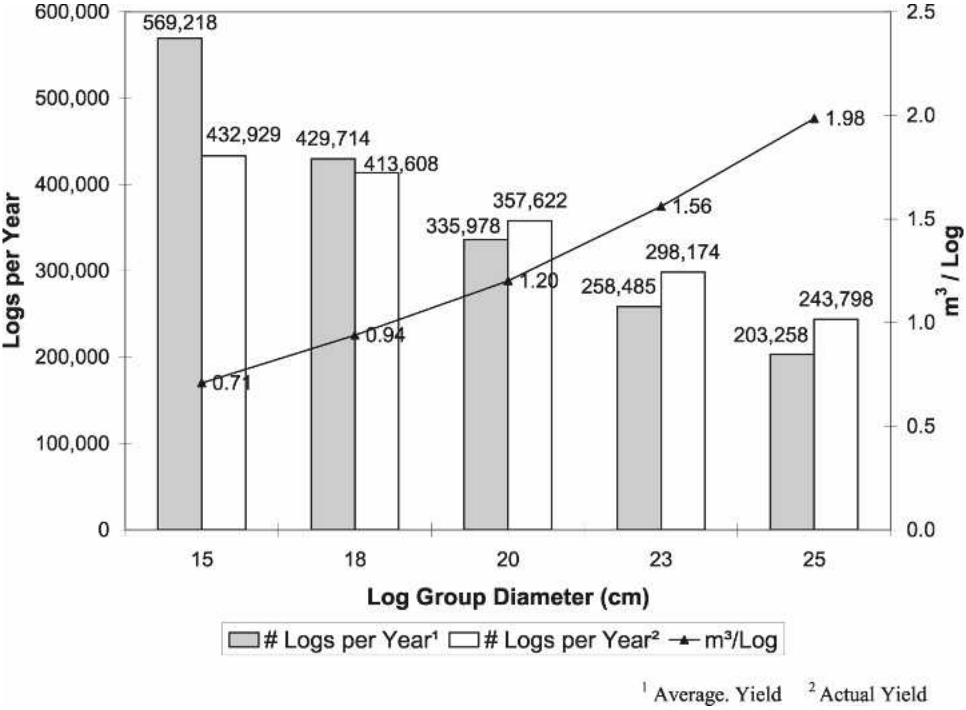

FIGURE 1. Log requirements and cubic meter per log ratios

To account for the additional material handling cost imposed by this empirical relationship, the fuel cost per cubic meter for each log group was adjusted according to the ratio of logs in that log group to logs in the 25-cm group. The ratios were calculated using the number of required logs per year (actual yield) from Fig 1. The original fuel cost for each log group was multiplied by these ratios (1.78 for 15 cm, 1.70 for 18 cm, 1.47 for 20 cm, and 1.22 for 23 cm) resulting in adjusted fuel cost for each log group. For example, the adjustment ratio for the 15-cm log group was 432,929 logs (Fig 1) divided by 243,798 logs, which is equal to 1.78. The variable operating costs for the sawmill-only after adjusting for fuel costs are \$91.11, \$86.03, \$82.21, \$79.69, and \$77.55/m^3 for the 15-, 18-, 20-, 23-, and 25-cm log groups, respectively.

One additional adjustment was made to costs by transferring approximately one half of the maintenance and repair cost to marketing cost. This allocation was based on the assumption that a new sawmill using new equipment (as modeled in another section of this research) would have lower maintenance and repair costs as compared with the participating mill that had been in operation for 18 yr. Furthermore, in order for a new business to be successful, it would need to allocate relatively more money to marketing and make marketing an important function of the company (Gruber 2004).

Break-even analysis

In a typical business analysis, break-even analysis is used to determine the volume at which sales are equal to costs (Ingram et al 1999). The break-even analysis in this case study compared the ratio of annual revenues to annual costs (revenues/costs) for each log diameter group under a number of different scenarios to determine which groups would be profitable. This analysis found which log diameter groups were profitable given variable conditions such as processing level, yield, and log cost. The log groups that were calculated to be both profitable (ratio > 1) and practical within the defined scenarios were pooled and used in the NPV and IRR analyses.

Net present value and internal rate of return analyses

NPV analysis compares costs and revenues over the project life by discounting them to present values. The NPV is the summation of all cash flows occurring during the project life. A positive NPV means that the revenues over the project life are greater than the costs incurred during the project; a negative NPV means that the costs are greater than the revenues. An economically feasible project will have a positive NPV (Newnan and Lavelle 1998). IRR analysis determines the rate that the project will return to the capital required to finance the project. The greater the rate of return, the more desirable the project becomes for investors.

Assumptions regarding the characteristics and operation of a small-diameter timber sawmill and pallet-part mill were needed to assess its economic feasibility. The initial assumption was that the hypothetical facility would utilize an equal volume of red oak logs from each log diameter group (ie: 15–25 cm). The next major assumption was that the revenues and costs of the hypothetical facility would not increase from year to year. In other words, the variables that influence revenues (ie: capacity utilization, yield, market prices) and costs (ie: wages, health care costs, transportation) were held constant over the project life of 30 yr. This assumption was necessary so that the impact of log costs, yield, and processing level could be revealed.

The NPV and IRR were calculated in Microsoft Office Excel (Microsoft 2003) using net income from the various scenarios defined in the break-even analysis section. The net incomes were calculated by subtracting cost from revenues for each log group. The net incomes were assumed to occur every year for the project life. The net incomes are shown in Table 6.

TABLE 6. *Net income scenarios.*

Processing level	Yield	Log cost $/m^3$	Net income ($)
Sawmill Only	Actual	85	161,599
		74	381,279
		64	600,959
	Average	85	209,634
		74	423,310
		64	636,985
Sawmill & PP Mill	Actual	85	559,911
		74	779,590
		64	999,270
	Average	85	607,946
		74	821,621
		64	1,035,296

The project life was set at 30 yr based on two main factors: machinery useful life and depreciation. New sawmill machinery could last up to 30 yr with proper preventive maintenance in a single shift scenario. The depreciation method used in another part of this research allows for the depreciation of buildings for 30 yr.

The discount rate used in NPV calculations was set at 10%. This discount rate is similar to long-term industry averages reported by Hogaboam and Shook (2004). The discount rate reflects the cost of capital, whether it is sourced from creditors (debt) or investors (equity). Typically, investors require a greater return as compared with creditors. A method used to estimate discount rates is the weighted cost of capital. This technique enables firms to estimate a discount rate based on the proportion of debt and equity used to finance a given project and the respective required rates of return (Lang and Merino 1993). The estimated initial investment costs for the sawmill and pallet-part mill were $5.8 and $6.8 million, respectively.

The land and site preparation costs, including water, sewer, and roads, were budgeted at $800,000 (Loftus 2006). The initial costs of the buildings, machinery, and equipment for both the sawmill and pallet-part mill were calculated by appreciating the initial costs (supplied by the participating company) to 2005 dollars using a 4% discount rate. The working capital estimate was derived from the need to disburse payment for goods and services received during the first 4 mo of the first year when sales are considerably below normal.

The cash flows are discounted to the first year and summed (Lang and Merino 1993). The net incomes occurring in years 2 through 30 are discounted back to a year-1 value. The net income occurring in year 1 is then added to the other discounted net incomes, and the initial cost is then subtracted from the aggregate net income. This result is the NPV of the project. A positive value indicates that the project is feasible, and a negative one indicates that the project is not feasible given the assumptions and conditions set.

The IRR is the discount rate at which the NPV is equal to zero; at this level the discounted cash flow equals the initial investment cost. The IRR will be greater than the discount rate if the NPV is positive and less than the discount rate if the NPV is negative. The IRR is used by investors as a general indicator of project attractiveness (Lang and Merino 1993).

RESULTS AND DISCUSSION

The comparison of the actual-yield revenue-to-cost (R/C) ratios (Fig 2) with the average-yield R/C ratios (Fig 3) demonstrates the effect of yield on profitability assumed to occur in this case study. The 15-cm log group had an actual-yield R/C ratio > 1 in every log cost scenario, whereas, it had an average-yield R/C ratio < 1 in the $85 and $74/m^3 log cost scenarios. This is due to the high yield of the 15-cm group (54% overrun), which decreased the cost of logs required to operate the mill at a constant production volume.

In the yield case study, the logs were two-sided and then sawn into 7.6-cm-thick cants and 2.5-cm-thick lumber. The larger-diameter logs (ie: 23 and 25 cm) yielded greater volume of higher grade lumber, compared with the small-diameter logs, which is more valuable than the cants that account for the majority of the volume of the latter. The market price for cants is lower than

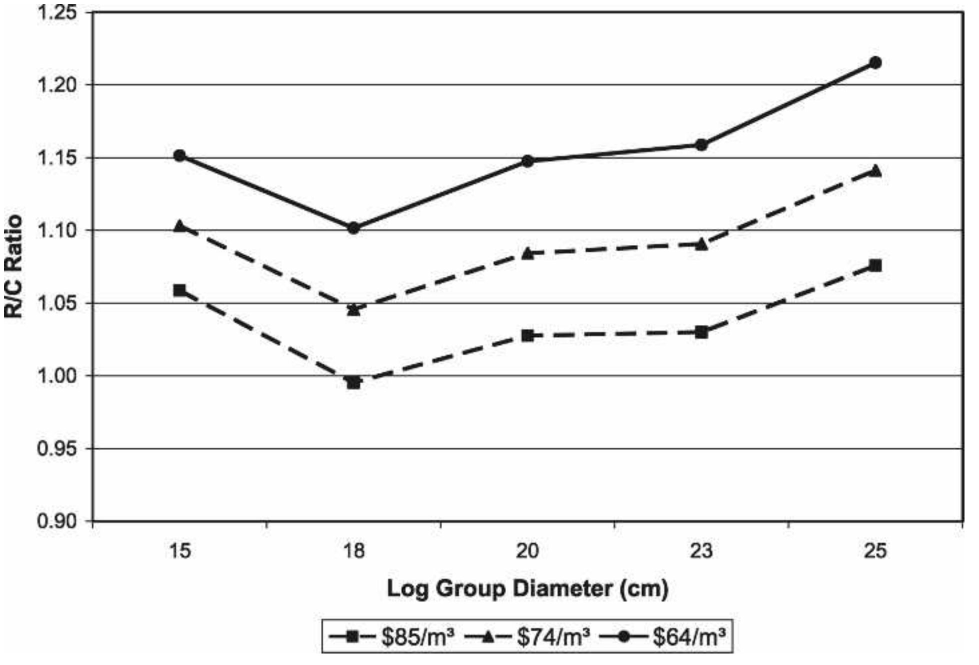

FIGURE 2. Sawmill R/C ratios (actual-yield)

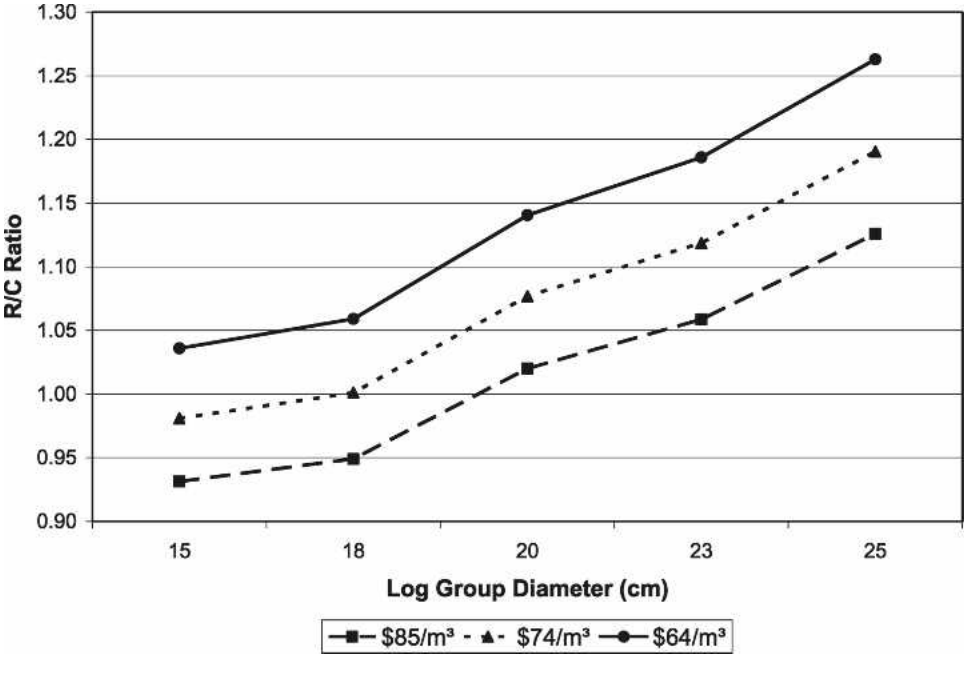

FIGURE 3. Sawmill R/C ratios (average-yield)

lumber, and given the operating costs, the overall result is that profitability decreases with decreasing log diameter.

The costs for the 15- and 18-cm log groups exceed the revenues for the \$85 and \$74/m^3 log cost scenario as shown in Fig 3. Therefore, the hypothetical sawmill described in this study would not be profitable utilizing only 15- and 18-cm dia logs in these scenarios. The trend was increasing profitability with increasing log diameter.

The effect of yield variation on profitability was evident at a greater processing level as indicated when comparing the trends shown in Figs 4 and 5. The 15-cm log group, due to its high yield, exhibited a greater R/C ratio than the other groups. However, no common trend between diameter and profitability was found to be evident as illustrated in Fig 4. For example, the 15-cm log group had R/C ratios of 1.18, 1.15, and 1.12 for the \$85, \$74, and \$64/m^3 log costs, whereas the 25-cm log group had R/C ratios of 1.18, 1.14, and 1.10 for the same set of log costs. However, all log diameters were profitable at the sawmill and pallet-part mill processing level.

The pallet-part size yield is apparent in both Figs 4 and 5. The 20-cm log group had a total pallet-part yield of 66%, which was the greatest of all the log groups. In addition, the pallet-part length yield was 75% 178-cm-long parts, which was the highest of all the log groups. The 178-cm parts sell for more than the other parts in the marketplace. These yield and market conditions result in comparatively larger revenues, which is evident in the deviation of the general linear trend (Fig 5).

Any conclusive relationship between profitability and log diameter at the sawmill-pallet-part mill processing level is obscured due to the actual-yield variation. Given the annual capacity of the pallet-part mill, 18,878 m^3, and the pallet-part yield, some cants must be purchased on the market (Table 7).

The volume of cants that must be purchased increases as the log diameter increases due to the

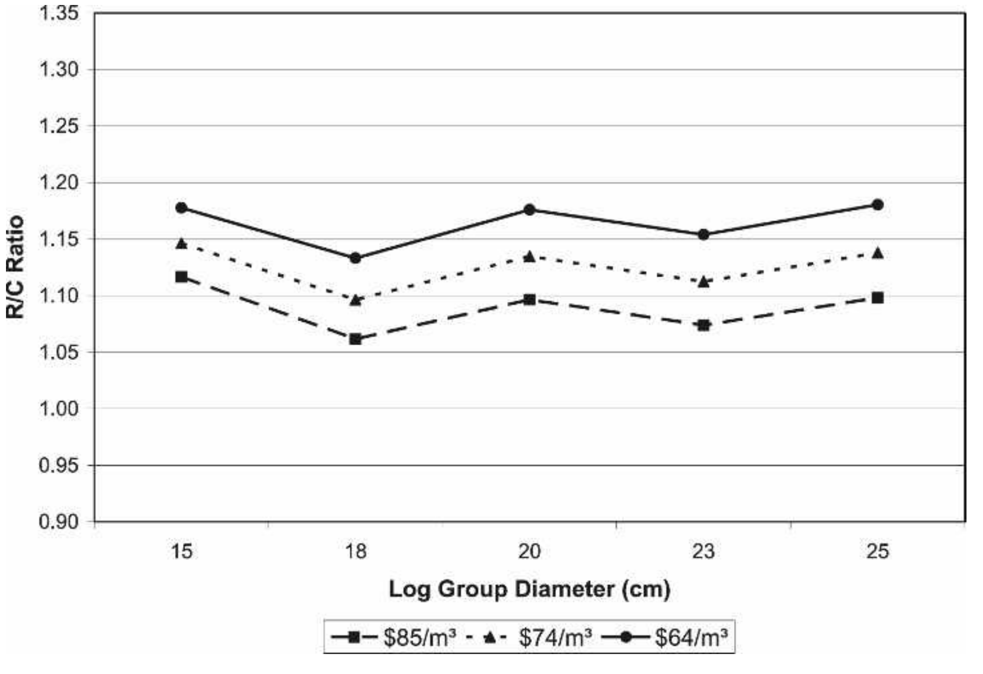

FIGURE 4. Sawmill and pallet-part mill R/C ratios (actual-yield)

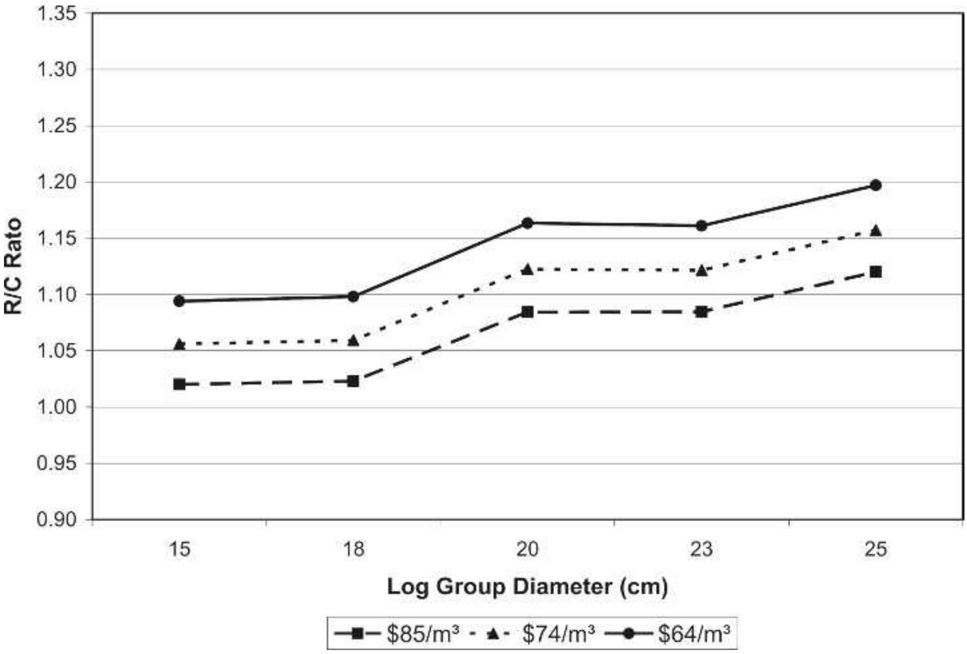

FIGURE 5. Sawmill and pallet-part mill R/C ratios (average-yield)

TABLE 7. *Cant volume and costs.*

Log diameter group (cm)	Cant volume (m^3)	Cant cost ($)
15	12,294	1,628,260
18	12,537	1,660,440
20	13,448	1,780,944
23	15,621	2,068,630
25	17,219	2,280,300

initial log yield and therefore increases the raw material costs of the cants. In turn, the total pallet-part mill costs increased as log diameter increased and this affects the R/C ratios. The average-yield R/C ratios (Fig 5) had a positive linear trend between log diameter and profitability, which is a factor of constant log costs and increasing revenues. The break-even analysis results indicated that all log diameter groups could be profitable given the sawmill and pallet-part mill processing level (Figs 4 and 5).

All of the NPVs were calculated to be negative, and the internal rates of return were below the 10% discount rate for the sawmill-only (scragg mill) actual-yield scenario at all log costs as shown in Fig 6. The general trend is increasing economic feasibility with decreasing log cost. From this case study, it was found that a new SDT sawmill that solely produced lumber and cants would not be economically feasible given the assumptions and conditions in this scenario. The sawmill-only is not economically feasible under the average-yield scenario at any log cost as shown in Fig 7. These results contrast with those by McCay and Wisdom (1984), who reported a positive NPV and a 23% IRR for a scragg mill using low-quality small-diameter hardwoods, assuming a 10-yr project life and 15% discount rate.

The effect of processing level (ie: more value added processing) on economic feasibility is evident as the NPV are positive for the $74 and $64/m^3 log cost scenarios (Fig 8). The NPV was calculated to be over $500,000 and the IRR was approximately 11% at the $74/m^3 log-cost scenario. The transformation of cants into pallet parts increases the value of the material, which in turn increases revenues and profitability. This

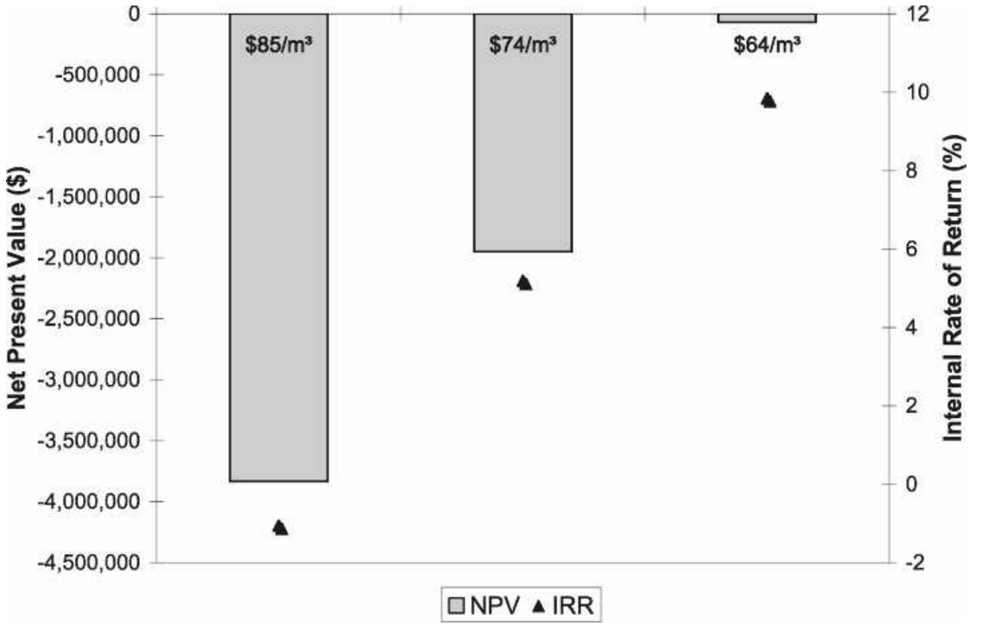

FIGURE 6. Sawmill NPV and IRR (actual-yield)

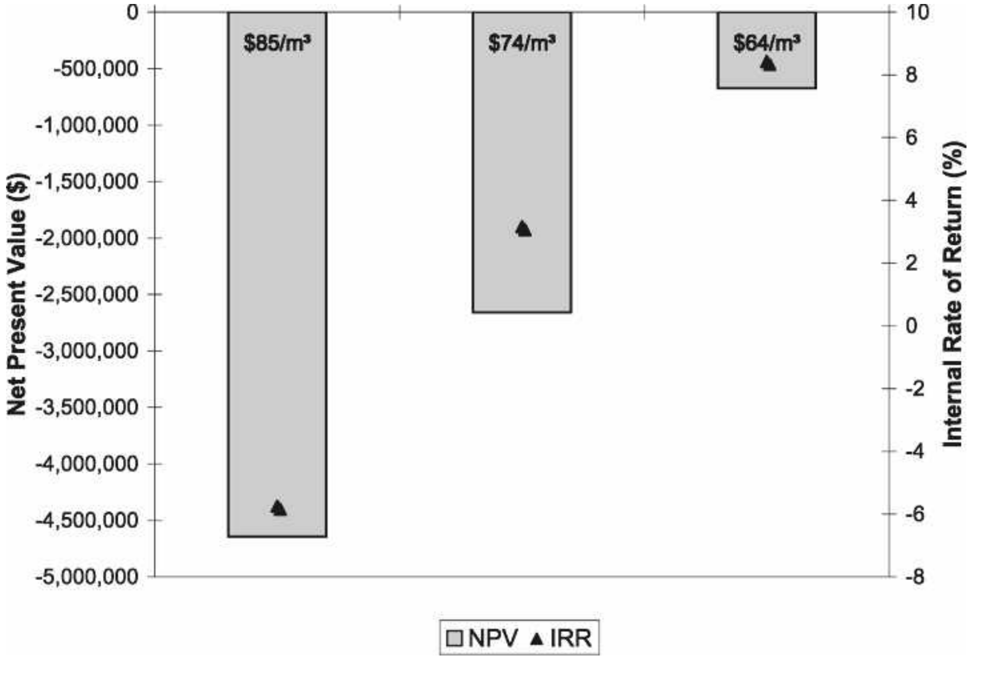

FIGURE 7. Sawmill NPV and IRR (average-yield)

increased profitability at a greater level of processing increases the economic viability given these conditions. The $74/m^3$ delivered log cost is approximately equivalent to $39/tonne, and this price competes favorably with pulpwood prices. The sawmill and pallet-part mill average-

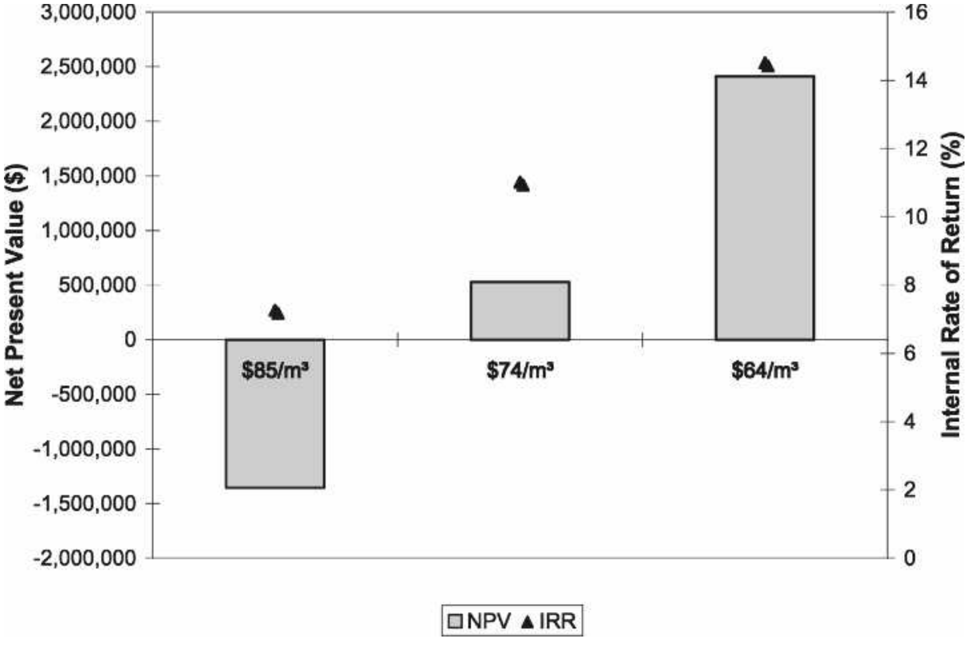

FIGURE 8. Sawmill and pallet-part mill NPV and IRR (actual-yield)

yield scenario is not economically feasible given our conditions and assumptions. The IRR is less than the discount rate and the NPV is slightly negative at $39/tonne (Fig 9).

SUMMARY

The break-even analysis indicated that in this case study the sawmill-only processing level would not be profitable for all logs group under

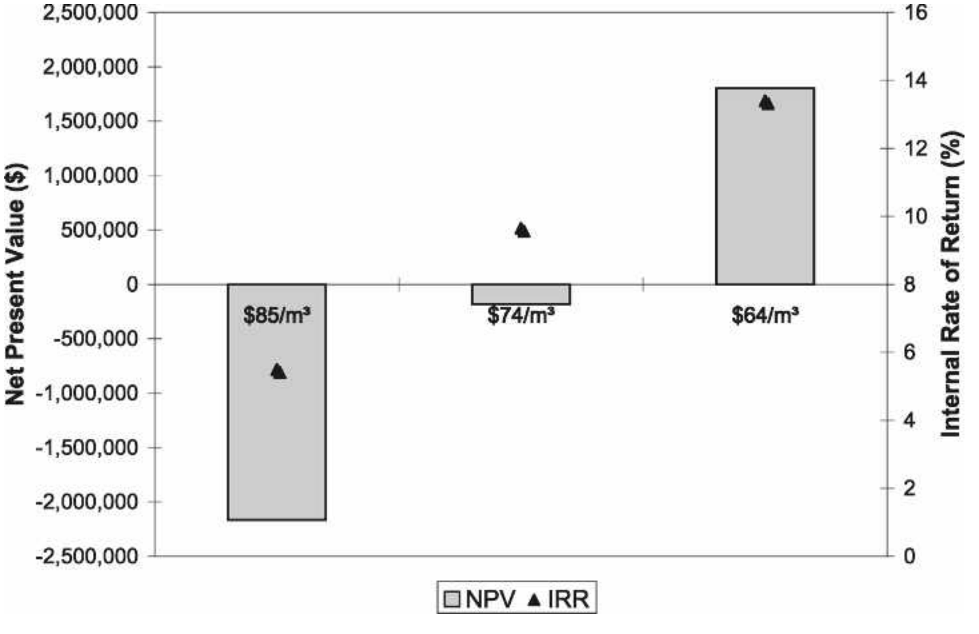

FIGURE 9. Sawmill and pallet-part mill NPV and IRR (average-yield)

current conditions. The NPV and IRR analyses illustrated that in this case study a new sawmill-only (scragg mill) processing level scenario is not economically feasible under any of the hypothetical conditions tested. This research has found that a sawmill and pallet-part mill could utilize red oak small-diameter timber given the $74/m^3 log cost, actual-yield scenario. The yield of various products affected profitability and subsequently economic feasibility in two distinct ways. First, the yield variation between log groups, as measured by mill over- or under-run, affected the volume of logs required for a constant production level. In this case, it dramatically decreased log costs in the case of the 15- and 18-cm log groups, which increased their profitability. Second, the sawing configuration was held constant for each log group, which led to a high proportion of cants in the smaller diameter groups. To maintain a constant production in the pallet-part mill, additional cants were purchased instead of produced for the larger diameter groups (23 and 25 cm). This in turn increased costs for those log groups affecting their profitability.

The results of this case study are limited by the mill configuration, market prices, product yields, cost scenarios, and assumptions described herein. Mills should be encouraged to investigate their yield from SDT and attempt multiple product configurations and sawing patterns to determine their own potential for utilizing SDT. Further research into this area could take the form of different species, different sawing patterns, different mill types, and more cost scenarios. The additional processing level represented by converting cants into pallet parts adds value to the cants and captures more of the value chain. This additional processing adds enough value to enable the economic feasibility of utilizing red oak small-diameter timber.

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