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## ABSTRACT

Comparisons of split-taper and no-taper sawing methods were based on the simulated sawing of 300 pruned logs of varying size, shape, and quality. Sawn timber conversions, Clears grade and Combined Clears grade conversions, and gross log value arising from each log were calculated for both methods and compared using paired *t*-test statistics.

In general, significant gains ($p < 0.01$) were provided by the split-taper method. Sawn timber conversions averaged 64% (range 52–70%) for the split-taper method and 62% (range 48–70%) for the no-taper method. Conversion to Clears and Combined Clears grades was significantly greater with split-taper sawing of well-pruned logs (PLI $\geq$ 6). Overall, conversion to Combined Clears yielded an average conversion of 36% (ranging from 18 to 54%) for split-taper sawing and an average of 34% (ranging from 16 to 51%) for the no-taper method. Gross log value, calculated as timber value per cubic metre of round log volume, was also significantly increased with split-taper sawing. On average the split-taper method yielded $246/m$^3$ whilst the no-taper method yielded $237/m$^3$. This equates to an average increase in conversion value of 4% (when measured relative to no-taper sawing). Conversion value increases ranged from nearly −14% to 27%, indicating that, although significant gains can be made with split-taper sawing, gains cannot be expected from all logs.

**Keywords**: split-taper; half-taper; sawing simulation; yield; AUTOSAW.

## INTRODUCTION

Over the years there has been much debate over the merits, or otherwise, of taper sawing methods. The implications of taper sawing are vast—from the type of log carriage that a mill should use to maximise timber yield from their log resource, to production rates, and clearwood conversions.

Past mill studies on batches of pruned *Pinus radiata* D. Don butt logs have indicated that, in comparison to other methods of log positioning, split-taper sawing produces greater conversions. Cown *et al.* (1988) reported conversion increases of 7.0% when split-taper was compared to no-taper sawing with a variable, rather than fixed, cant. When compared to full-taper sawing (again with a variable cant), the split-taper method showed a 9.6% increase. Lesser increases, ranging from 3.2% to 4.7%, were reported by Park (1995) from trials at three sawmills. Park also reported increased gross log values (ranging from 4.9% to 10.9%) with the split-taper/full-taper comparisons, estimated that mill production rates were lowered by 5–20% with the full-taper method, and found that conversion to clears grades was reduced by 2.2–6.5% with the full-taper approach. Although similar results were not reported by Cown *et al.*, the authors acknowledged that this may have been due to limitations of the batch sawing approach.

Some of the limitations of batch sawing can be overcome by the use of computer sawing simulation models such as SEESAW (Garcia 1987) and AUTOSAW (Todoroki 1990) that allow the same log to be repeatedly sawn under a range of processing scenarios. Park (1989a) used SEESAW, a user-driven interactive sawing simulator, to compare split-taper and no-taper cant-sawing methods. Although no significant differences were found in conversion rates, major differences were reported in the dimensions and number of pieces produced. Todoroki (1995) used AUTOSAW, an automated sawing simulator that also incorporates all SEESAW functionality, to compare the effect of log rotation on conversions. Split-taper sawing provided consistently better conversions than a no-taper alternative.

In addition to sawing methods, conversion of pruned logs to clears grades is influenced by the quality of pruning. Well-pruned logs have greater potential for clearwood production than poorly pruned logs. To predict pruning effectiveness, several indices have been developed. Two that are primarily used are those proposed by Whiteside & Manley (1987) and by Park (1989b). The former applies the relationship: $SED - DC$, where SED is small-end diameter and DC is the diameter of the defect core, a hypothetical cylinder that contains all branch stubs. The measure of pruned log quality, Pruned Log Index (PLI), proposed by Park combines DC with other log variables that combine log size, shape, and pruning quality into a single index. PLI is defined as:

$$PLI = \left[\frac{D1.3 - DC}{10}\right]^{0.5} \times \frac{D1.3}{DC} \times \left[\frac{CVOL}{LVOL}\right]^{1.6}; \qquad (\text{mm}/10)^{0.5}$$

where D1.3 is the under-bark log diameter measured 1.3 m from the butt end, and LVOL and CVOL represent woody volumes of the whole log and a smaller centrally contained mass comprising four quarter-cylinders respectively. Both volumes are calculated using sectional measurements. PLI enables prediction of pruning effectiveness (Table 1).

As conversion to clears grades is influenced by pruning quality, and log conversions are influenced by log size, the quantification of taper sawing effectiveness by mill studies, whether by batch sawing or individual log sawing, is subject to uncertainty: variability between log samples can cause bias in results. To eliminate this area of uncertainty, this study used a computer sawing simulator, AUTOSAW. This allows the same logs to be "sawn"

TABLE 1–Prediction of pruning effectiveness by pruned log index (PLI)

| PLI values | Pruned log quality |
|---|---|
| 0–1.9 | Pruning has not been effective |
| 2–3.9 | Poor |
| 4–5.9 | Satisfactory |
| 6–7.9 | Good |
| 8–9.9 | Very good |
| 10+ | Excellent |

twice — once to a split-taper sawing method and once with no taper set. Further, it provides a paired sample (of logs) for analysis by statistical *t*-tests that test for the significance of the differences between the two sawing methods.

## METHOD

In this study split-taper sawing was compared to a no-taper sawing method with results derived from the simulated sawing of 300 pruned logs using AUTOSAW. All three-dimensional log models input to AUTOSAW were based on actual log measurements collected by either the grade-study method (Park & Leman 1983) or by the method of cross-sectional analysis (Somerville 1985). Comparisons of split- and no-taper sawing were based on the following factors:

(1) Sawn timber conversions (i.e., total sawn timber as a percentage of log volume).

(2) Clears and Combined Clears grade conversions (as a percentage of log volume); where Combined Clears grouped Clears and Select A grades, requiring that each board must have at least one defect-free face and edge.

(3) Gross log value. This was calculated as timber value per cubic metre of round log volume, i.e.—

$$\frac{\text{sawn timber (\$)}}{\text{round log volume (m}^3\text{)}}$$

This method of calculation was based on that of Park (1995). It did not include the cost of sawing, nor any value that might be obtained from residues such as chips and sawdust. It was used in place of the more usual calculation of "timber value per cubic metre sawn" to enable direct comparison of the effects of the two taper sawing methods. By using the first calculation, we removed the random variation between logs and compared variation between methods only.

Details of the log sample, sawing method, and statistical method of analysis follow.

### Log Sample

The sample consisted of pruned *P. radiata* butt logs of varying size, shape, and pruned quality. Log lengths ranged from 4.8 to 5.5 m; small-end diameters from 279 to 500 mm; sweep from 1 to 12 mm/m; and defect core size from 203 to 375 mm. The index for pruned log quality (PLI) ranged from 2.2 to 9.0 $mm^{0.5}$.

Because of the variability in log size, shape, and quality, the sample was divided into groups. For comparing sawn timber conversions, six groups were formed by segregating into three SED classes (SED < 350, 350≤SED<450, SED ≥ 450 mm) and two taper classes (≤10 and >10 mm/m). For further comparison of conversion to Clear and Combined Clears grade, PLI was used to segregate the logs into groups. Summary statistics of the log sample and sub-samples are given in Table 2.

### Sawing Simulation

Sawing simulations were based on a grade-sawing method that "boxed-in" the defect core. This was achieved by sawing on one face until defects were exposed, then rotating the log through 90° and sawing on the second face until once again defects were exposed. The

TABLE 2–Log sample variables

| Log class | Length (m) | SED (mm) | D1.3 (mm) | LED (mm) | DC (mm) | Taper (mm/m) | Sweep (mm/m) | PLI ($mm^{0.5}$) | LVOL ($m^3$) |
|---|---|---|---|---|---|---|---|---|---|
| **All 300 logs** | | | | | | | | | |
| Mean ± std dev. | 5.3 ± 0.2 | 406 ± 51 | 449 ± 55 | 509 ± 64 | 269 ± 37 | 11 ± 4 | 6 ± 2 | 4.9 ± 1.4 | 0.80 ± 0.19 |
| Min, max | 4.8, 5.5 | 279, 500 | 301, 578 | 354, 675 | 203, 375 | 2, 28 | 1, 12 | 2.2, 9.0 | 0.38, 1.32 |
| **SED < 350, taper ≤ 10, 32 logs** | | | | | | | | | |
| Mean ± std dev. | 5.3 ± 0.2 | 324 ± 19 | 355 ± 19 | 403 ± 28 | 229 ± 19 | 8 ± 3 | 6 ± 2 | 3.6 ± 0.7 | 0.5 ± 0.1 |
| Min, max | 4.8, 5.5 | 279, 349 | 301, 386 | 354, 471 | 203, 272 | 2, 10 | 3, 12 | 2.2, 5.0 | 0.4, 0.6 |
| **SED < 350, taper > 10, 16 logs** | | | | | | | | | |
| Mean ± std dev. | 5.3 ± 0.1 | 331 ± 17 | 384 ± 22 | 453 ± 33 | 237 ± 23 | 13 ± 3 | 7 ± 2 | 3.8 ± 0.7 | 0.6 ± 0.1 |
| Min, max | 5.1, 5.5 | 279, 347 | 336, 424 | 386, 512 | 205, 268 | 11, 20 | 3, 10 | 2.7, 5.1 | 0.4, 0.7 |
| **350 ≤ SED < 450, taper ≤ 10, 98 logs** | | | | | | | | | |
| Mean ± std dev. | 5.3 ± 0.2 | 399 ± 25 | 430 ± 26 | 484 ± 34 | 265 ± 30 | 8 ± 2 | 6 ± 3 | 4.7 ± 1.2 | 0.7 ± 0.1 |
| Min, max | 4.8, 5.5 | 350, 448 | 379, 488 | 409, 570 | 207, 331 | 2, 10 | 1, 12 | 2.8, 7.7 | 0.5, 1.0 |
| **350 ≤ SED < 450, taper > 10, 85 logs** | | | | | | | | | |
| Mean ± std dev. | 5.3 ± 0.2 | 405 ± 26 | 461 ± 30 | 523 ± 41 | 273 ± 32 | 14 ± 3 | 6 ± 2 | 5.0 ± 1.3 | 0.8 ± 0.1 |
| Min, max | 4.8, 5.5 | 350, 448 | 397, 541 | 446, 655 | 205, 349 | 11, 28 | 3, 11 | 3.0, 8.5 | 0.6, 1.1 |
| **SED ≥ 450, taper ≤ 10, 29 logs** | | | | | | | | | |
| Mean ± std dev. | 5.2 ± 0.3 | 476 ± 15 | 506 ± 20 | 572 ± 41 | 293 ± 38 | 8 ± 2 | 6 ± 2 | 6.0 ± 1.3 | 1.0 ± 0.1 |
| Min, max | 4.8, 5.5 | 450, 500 | 470, 538 | 514, 675 | 214, 375 | 3, 10 | 3, 12 | 3.7, 8.8 | 0.9, 1.2 |
| **SED ≥ 450, taper > 10, 40 logs** | | | | | | | | | |
| Mean ± std dev. | 5.2 ± 0.2 | 471 ± 14 | 526 ± 20 | 589 ± 27 | 295 ± 40 | 14 ± 3 | 7 ± 2 | 6.0 ± 1.5 | 1.1 ± 0.1 |
| Min, max | 4.8, 5.4 | 451, 498 | 499, 578 | 543, 640 | 225, 362 | 11, 27 | 3, 11 | 3.6, 9.0 | 0.9, 1.3 |
| **PLI < 4, 84 logs** | | | | | | | | | |
| Mean ± std dev. | 5.3 ± 0.2 | 371 ± 46 | 409 ± 50 | 468 ± 62 | 276 ± 39 | 10 ± 4 | 8 ± 3 | 3.4 ± 0.3 | 0.7 ± 0.2 |
| Min, max | 4.8, 5.5 | 279, 469 | 301, 509 | 354, 655 | 203, 362 | 2, 24 | 1, 12 | 2.2, 3.9 | 0.4, 1.0 |
| **PLI 4 to < 6, 144 logs** | | | | | | | | | |
| Mean ± std dev. | 5.3 ± 0.2 | 408 ± 46 | 450 ± 49 | 510 ± 57 | 275 ± 36 | 11 ± 4 | 6 ± 2 | 4.8 ± 0.5 | 0.8 ± 0.2 |
| Min, max | 4.8, 5.5 | 307, 499 | 349, 558 | 379, 640 | 206, 375 | 2, 21 | 3, 12 | 4.0, 5.9 | 0.5, 1.2 |
| **PLI ≥ 6, 72 logs** | | | | | | | | | |
| Mean ± std dev. | 5.2 ± 0.2 | 444 ± 33 | 492 ± 38 | 553 ± 50 | 249 ± 27 | 12 ± 5 | 6 ± 2 | 7.0 ± 0.8 | 0.9 ± 0.1 |
| Min, max | 4.8, 5.5 | 386, 500 | 417, 578 | 455, 675 | 205, 315 | 3, 28 | 2, 10 | 6.0, 9.0 | 0.7, 1.3 |

third face was opened by counting back from the cant (i.e., after allowing for an appropriate cant size based on SED, and fitting the remaining fibre with boards). A schematic example of the sawpattern is given in Fig. 1 (note that the log shown is simplified for clarity and is NOT representative of the log models used in the simulations).

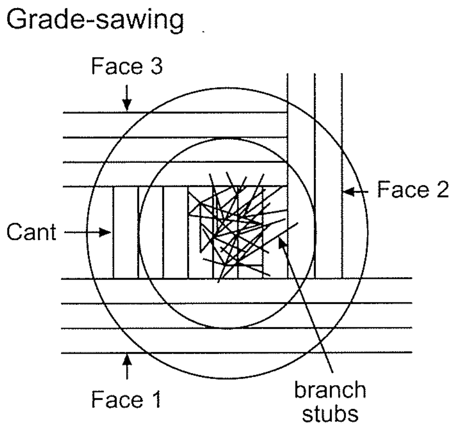


FIG. 1–Example of sawpattern used in simulations

For simplicity all sawkerfs were assumed to be 3 mm and all pieces 40 mm thick. A minimum board length of 1.8 m was specified. Board widths ranged from 50 to 300 mm (50, 75, 100, 150, 250, 300). Cant size was set according to SED: a 150-mm cant was cut from those logs with a SED of less than 350 mm, and a 200-mm cant from larger logs. To remove variability caused by other factors, neither wane nor overcutting was allowed on any boards in these simulations.

Each log model was subject to two simulated sawings: one with the log positioned for split-taper sawing, and the other with no taper. An example showing the effect of the two log positions is given in Fig. 2.

A shape and grade scanning optimising 3-saw edger, integrated with an optimising trimmer, was simulated. The grade-optimising edger was chosen in preference to a volume-

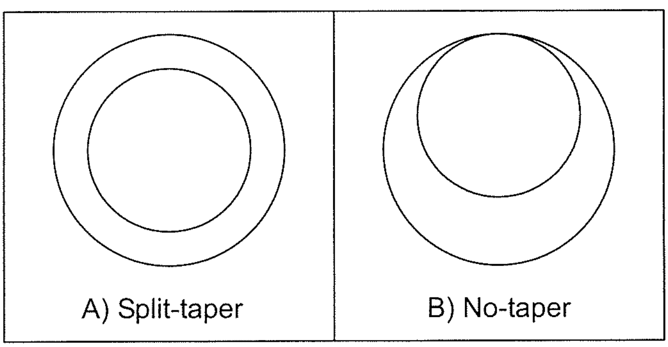


FIG. 2–Example of a log positioned for (a) split-taper and (b) no-taper sawing.

optimising edger based on recent research findings (Todoroki 2001) that showed that the effect of opening cut and variation in value yield was greatly reduced with grade scanning and optimised edging. Resultant boards were graded according to seven grade categories. The categories were based on New Zealand cuttings and appearance grades (SANZ 1988) but extended to accommodate a third cuttings grade as commonly extracted by New Zealand sawmills (Table 3). The first category, Clears, required boards to be defect-free and the second, Select A, allowed defects on the reverse face and edge. The other categories comprised three cuttings grades and two lower-valued grades.

TABLE 3–Grades and prices (per cubic metre) by width

| Grade | Price ($/m³) by width class (mm) | | |
|---|---|---|---|
| | 50, 75, 100 | 150, 200 | 250, 300 |
| Clears | 500 | 550 | 650 |
| Select A | 400 | 450 | 520 |
| # 1 Cutting (70% in 1000 mm or longer) | 350 | 360 | 375 |
| # 2 Cutting (70% in 600 mm or longer) | 300 | 320 | 340 |
| # 3 Cutting (60% in 300 mm or longer) | 220 | 250 | NA |
| Pith-free | 200 | 230 | 275 |
| Box/Merch (incl. pith) | 170 | 180 | 210 |

Total timber conversions, conversion to Clears grade, Combined Clears (Clear and Select A grades), and total timber value per cubic metre were calculated for each log under both sawing methods. A statistical procedure, TTEST (SAS 1994), was used to test the significance of the differences between the paired sample (split- and no-taper sawing methods). With this approach, variability among logs is ignored, and the test concentrates on the difference in the outputs from the two sawing methods.

## RESULTS

### Sawn Timber Conversions (total sawn timber as a percentage of log volume)

Overall, conversions were greater for the split-taper method than for no-taper sawing. Mean sawn timber conversions and other statistics are given in Table 4 for each log group and the sawing method. An average conversion of 62% (range 48–70%) was found for the no-taper sawing method. For the split-taper method the average was 64% (range 52–70%). Of the 300 logs, 243 (i.e., 81%) recorded higher conversions with split-taper sawing. The greatest percentage increase relative to no-taper sawing amounted to about 13% (arising from a split-taper conversion of 62% and a no-taper conversion of 55%). The lowest percentage increase was about –7% (split-taper 56%, no-taper 60%) where the negative sign indicates that no-taper sawing produced a better result).

*P*-values obtained from paired *t*-tests that compare split-taper and no-taper sawing methods are shown in Table 5. Those log classes with statistically significant differences at the 1% test level are given in bold. A significant difference in sawn timber conversion was noted for each of the log groups, with split-taper sawing attaining significantly greater conversions.

TABLE 4—Sawn timber conversion percentage statistics by log class

| Small-end diameter (mm) | Taper (mm) | Sawing method | N | Mean | Std dev. | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| SED < 350 | ≤10 | No-taper | 32 | 57 | 4 | 48 | 63 |
| | | Split-taper | 32 | 59 | 3 | 52 | 65 |
| | >10 | No-taper | 16 | 57 | 2 | 53 | 62 |
| | | Split-taper | 16 | 59 | 3 | 53 | 63 |
| 350 ≤ SED < 450 | ≤10 | No-taper | 98 | 63 | 3 | 57 | 68 |
| | | Split-taper | 98 | 64 | 3 | 56 | 69 |
| | >10 | No-taper | 85 | 62 | 3 | 55 | 67 |
| | | Split-taper | 85 | 64 | 2 | 59 | 69 |
| SED ≥ 450 | ≤10 | No-taper | 29 | 66 | 2 | 61 | 70 |
| | | Split-taper | 29 | 67 | 2 | 62 | 70 |
| | >10 | No-taper | 40 | 64 | 2 | 57 | 67 |
| | | Split-taper | 40 | 66 | 2 | 62 | 69 |
| All logs | | No-taper | 300 | 62 | 4 | 48 | 70 |
| | | Split-taper | 300 | 64 | 3 | 52 | 70 |

TABLE 5—*P*-values arising from *t*-test analysis of split-taper and no-taper sawing methods. Values in bold type are significantly different at $p<0.01$.

| Small-end diameter (mm) | Taper (mm) | *P*-values | | | |
|---|---|---|---|---|---|
| | | Conversion | Clears conversion | Combined Clears conversion | Value per cubic metre |
| SED < 350 | ≤ 10 | **1.5E-07** | 1.8E-01 | 1.7E-01 | **3.1E-03** |
| | >10 | **9.4E-04** | 1.4E-01 | 6.1E-02 | **8.4E-03** |
| 350 ≤ SED < 450 | ≤ 10 | **1.4E-06** | 6.6E-01 | 1.1E-01 | **1.0E-04** |
| | >10 | **6.7E-12** | **5.1E-04** | **2.0E-04** | **6.9E-09** |
| SED ≥ 450 | ≤ 10 | **2.4E-05** | 6.9E-01 | 2.4E-02 | **8.9E-03** |
| | >10 | **3.8E-10** | **4.5E-05** | **1.9E-05** | **1.1E-08** |
| All logs | | **3.9E-36** | **1.6E-06** | **7.6E-10** | **5.2E-23** |

No significant difference in conversion to either Clears grade or the Combined Clears grades was noted for the small logs (SED < 350 mm) nor for logs with taper ≤ 10 mm/m. However, the larger tapered logs (i.e., SED ≥ 350 mm and taper > 10 mm/m) recorded significantly greater Clears and Combined Clears conversions when split-taper sawn. Value per cubic metre was also significantly greater for the split-taper sawing method.

## Clears and Combined Clears Conversions (as a percentage of log volume)

Summary statistics, including those for conversion percentage, for logs regrouped by PLI, are given in Table 6. *P*-values from paired *t*-tests are also given. Again, a significant increase in sawn timber conversion percentage was noted for each of the log classes. Clears grade conversions were significant for logs with PLI less than 4 but not for those with PLI between 4 and 6. The converse was found with conversions to Combined Clears. The reason for this is not clear, although it could be speculated that, as logs with PLI <4 were generally smaller, the size of the cant (which was set according to s.e.d.) influenced the result. For logs with PLI ≥ 6, split-taper sawing yielded significantly greater conversion to both Clears and Combined Clears grades.

TABLE 6–Conversion percentage statistics for logs grouped by PLI

| Pruned log index | Sawing method | N | Mean | Std dev. | Min. | Max. | *P*-value |
|---|---|---|---|---|---|---|---|
| **Sawn timber conversion percentage** | | | | | | | |
| PLI < 4 | No-taper | 84 | 59 | 4 | 48 | 66 | ** |
| | Split-taper | 84 | 61 | 3 | 52 | 68 | |
| 4 ≤ PLI < 6 | No-taper | 144 | 63 | 3 | 54 | 70 | ** |
| | Split-taper | 144 | 64 | 3 | 56 | 69 | |
| PLI ≥ 6 | No-taper | 72 | 65 | 2 | 56 | 68 | ** |
| | Split-taper | 72 | 66 | 2 | 61 | 70 | |
| All logs | No-taper | 300 | 62 | 4 | 48 | 70 | ** |
| | Split-taper | 300 | 64 | 3 | 52 | 70 | |
| **Clears grade conversion percentage** | | | | | | | |
| PLI < 4 | No-taper | 84 | 11 | 5 | 1 | 26 | ** |
| | Split-taper | 84 | 12 | 5 | 2 | 24 | |
| 4 ≤ PLI < 6 | No-taper | 144 | 17 | 5 | 4 | 35 | ns |
| | Split-taper | 144 | 18 | 6 | 8 | 41 | |
| PLI ≥ 6 | No-taper | 72 | 26 | 6 | 12 | 38 | ** |
| | Split-taper | 72 | 29 | 5 | 16 | 40 | |
| All logs | No-taper | 300 | 18 | 8 | 1 | 38 | ** |
| | Split-taper | 300 | 19 | 8 | 2 | 41 | |
| **Combined Clears conversion percentage** | | | | | | | |
| PLI < 4 | No-taper | 84 | 27 | 5 | 16 | 39 | ns |
| | Split-taper | 84 | 28 | 5 | 18 | 39 | |
| 4 ≤ PLI < 6 | No-taper | 144 | 34 | 5 | 22 | 47 | ** |
| | Split-taper | 144 | 36 | 5 | 23 | 50 | |
| PLI ≥ 6 | No-taper | 72 | 42 | 4 | 32 | 51 | ** |
| | Split-taper | 72 | 45 | 4 | 36 | 54 | |
| All logs | No-taper | 300 | 34 | 7 | 16 | 51 | ** |
| | Split-taper | 300 | 36 | 8 | 18 | 54 | |

ns = not significant ($p > 0.05$)
** = highly significant ($p < 0.01$)

## Gross Log Value

With split-taper sawing, a significant increase in value, over and above no-taper sawing, was recorded for all PLI classes (Table 7). The $p$-value column in Table 7 indicates that the difference between the two sawing methods was significant at all reasonable test levels ($p$ is much less than 0.01). On average the no-taper method yielded \$237/m$^3$ (round) whilst the split-taper method yielded \$246/m$^3$ (round), equating to an average increase in gross log value of 4% (when measured relative to no-taper sawing). Percentage increases in value (split-taper relative to no-taper), calculated as

$$\frac{\$(\text{split-taper})/\text{m}^3 - \$(\text{no-taper})/\text{m}^3}{\$(\text{no-taper})/\text{m}^3} \times 100\%$$

are given in Table 8. They ranged from nearly –14% to 27% indicating that, although significant gains can be made with split-taper sawing, gains can not be expected from all logs.

TABLE 7–Statistics with variable value per cubic metre ($/m$^3$)

| Pruned log index | Sawing method | N | Mean | Std dev. | Min. | Max. | *P*-value |
|---|---|---|---|---|---|---|---|
| PLI < 4 | No-taper | 84 | 203 | 22 | 155 | 256 | 2.3E-04 |
| | Split-taper | 84 | 209 | 22 | 146 | 260 | |
| 4 ≤ PLI < 6 | No-taper | 144 | 237 | 23 | 178 | 298 | 6.6E-12 |
| | Split-taper | 144 | 246 | 22 | 196 | 319 | |
| PLI ≥ 6 | No-taper | 72 | 276 | 20 | 216 | 308 | 2.6E-10 |
| | Split-taper | 72 | 289 | 18 | 250 | 330 | |
| All logs | No-taper | 300 | 237 | 34 | 155 | 307 | 5.2E-23 |
| | Split-taper | 300 | 246 | 36 | 146 | 330 | |

TABLE 8–Percentage increase in value per cubic metre from split-taper relative to no-taper sawing

| Pruned log index | N | Mean | Std dev. | Min. | Max. | Percentage of logs recording increase with split-taper sawing |
|---|---|---|---|---|---|---|
| PLI < 4 | 84 | 3.3 | 7.4 | –13.8 | 26.6 | 69 |
| 4 ≤ PLI < 6 | 144 | 4.0 | 6.4 | –11.8 | 23.4 | 69 |
| PLI ≥ 6 | 72 | 5.2 | 6.2 | –7.3 | 22.4 | 78 |
| All logs | 300 | 4.1 | 6.7 | –13.8 | 26.6 | 71 |

## DISCUSSION

The above results indicate that split-taper sawing may improve timber conversions and Clears grade conversions from pruned logs over and above that which could be expected for logs sawn with no-taper set. Substantial increases in value may also be obtained. These results are consistent with findings from actual sawmill studies (Park 1995) which indicated that, with split-taper sawing, benefits in both volume and value (as measured by conversion to Clears grades) yields could be derived.

While this study compared timber conversions and value, there is scope for further evaluation of the two taper sawing methods. Piece counts, dimensions, and production rates are influenced by the methods. Differences will also result if different saw systems or optimisation criteria are applied. In the work presented here, the objective was to extract as much value as possible from the pieces. This was achieved through simulating a grade scanning optimiser, and allowed direct comparison of timber grades from the two methods. Grade optimisation assumed open market conditions. Incorporation of customer demands for green sawn timber, i.e., timber order books, is planned as an extension to the current AUTOSAW system.

Further, in the work presented here, and in actual practice, the "value" of green sawn timber and in particular the value of clear or defect-free wood was determined by a pricelist for green products. This does not take into account effects of drying (e.g., distortion—bow, warp, and cup) that influence the market value of the timber product. Incorporation of grain orientation, wood density, and other wood properties that influence drying distortion, into sawing simulation tools, is seen as a necessary step for derivation of market value. This is a complex problem and will require a long-term research commitment of both staff and resources.

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