The impact of mechanical log surface damage on fibre loss and chip quality when processing *Eucalyptus* pulpwood using a single-grip harvester

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Mondi (Forest Re-Engineering Manager)
Contents

- Objectives, Research Problem and Question
- Background
- Experimental design and Methodology
- Results
- Discussion and Conclusion
Research problem & Question

- Influence of mechanized debarking, log dryness class and log size on:
  - Wood chip size distribution
  - Wood chip bark content values
  - Fibre loss

How does mechanised debarking of *eucalyptus* roundwood logs influence wood chip quality and fibre loss in pulp and paper manufacturing?
Mill value chain
Log surface damage
Typical wood chip size specifications

<table>
<thead>
<tr>
<th></th>
<th>Fines</th>
<th>Pins</th>
<th>Accepts</th>
<th>Over-thick</th>
<th>Oversize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawdust</td>
<td>&lt; 1/8 &quot; rh</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td>&lt; 1/4 &quot; rh</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pins</td>
<td>&lt; 1/2 &quot; rh</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overs</td>
<td>&gt; 11/4&quot; rh</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 8mm slot</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accepts</td>
<td></td>
<td></td>
<td>&lt; 8mm slot</td>
<td>&gt; 1/2 &quot; rh</td>
<td></td>
</tr>
<tr>
<td>Relative pulp yield values</td>
<td>0.25</td>
<td>0.50</td>
<td>1.00</td>
<td>0.94</td>
<td>0.92</td>
</tr>
<tr>
<td>Pulp Yield % for <em>E. grandis × urophylla</em> (9 years)</td>
<td>12.85</td>
<td>25.70</td>
<td>51.40</td>
<td>48.32</td>
<td>47.29</td>
</tr>
</tbody>
</table>

(True, 2006; McEwan, 2004)
Site information
Experimental design

- 180 Trees harvested (540 logs)
- Harvesting treatments (18 with 30 logs per treatment)
- Three debarking treatments
  - Mech 1 (3 processor head passes)
  - Mech 2 (5 processor head passes)
  - Motor-manual (control)
- Two drying periods
  - One week
  - Two weeks
- Three log section classes
  - Base section
  - Middle section
  - Top section
- 3 × 2 × 3 Factorial design
- Degree of confidence 95%
Harvesting
Marking & Fibre collection—log level

- Logs marked after felling (5.5m logs)
  - Use of timber tags
  - Numerically sequenced
- Complementary data
  - Tree – DBH, height
  - Log position – Base, middle, top
  - Debarking treatment
Fibre collection
Secondary transport
Chipping
Wood chip sampling

- Wood chip samples
  - Non bias (12 litres) per log – thoroughly mixed wood chips
    - Chip screening and classification
      - Oversize chips
      - Over-thick chips
      - Accept chips
      - Pins
      - Fines
  - Wood chip moisture content calculated
  - Wood chip purity
    - Bark and knots removed
    - Expressed as a weight fraction of sampled chips
Harvesting residues: Micro CT scanning
Physical log properties
Wood chip moisture Content %

- Log drying rates higher with decreasing log size
- No significant difference in log MC across debarking treatments
Wood Chip Purity
Bark content %: Treatment

- Manually and Five pass mechanically debarked logs produced wood chips with a significantly lower bark content.
- Wood chip bark contents of 0.3% - 0.5% allowed (Biermann, 1996)
Wood Chip Uniformity
Accepted chips %

Debarking treatment:
- Manual
- Mech. (3 pass)
- Mech. (5 pass)

Accepted chips %
- 2.06%
- 0.59%
• Logs dried for a one week period produced significantly less accept chips
• Accept chip content decreased with decreasing log size
Over-thick chips: Treatment × Drying period

- Logs dried for a one week period produced significantly less over-thick wood chips.
Over-thick chips:
Treatment × Log section

- Feed roller induced log surface damage had a significant effect on over-thick chip production.
Pins:
Treatment × Drying period × Log section

- Logs dried for a one week period produced wood chips with significantly more pins.
- Wood chip pin content increased with decreasing log size.
- Log surface damage caused greater increases in pin chip production after a one week drying period.
Fines: Treatment × Log section

- Manually debarked logs produced wood chips with significantly less fines
- Wood chip fines content increased with decreasing log size
Fines: Drying period × Log section

- Logs dried for a one week period produced significantly more wood chip fines
- Wood chip fines content increased with decreasing log size
Feed roller induced fibre loss
Wood fibre loss volume:
Per setting (10 trees)

<table>
<thead>
<tr>
<th>Debarking treatment:</th>
<th>Wood volume loss (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mech. debarked (two pass)</td>
<td>0.010</td>
</tr>
<tr>
<td>Mech. debarked (four pass)</td>
<td>0.020</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>%</th>
<th>Treatment</th>
<th>%</th>
<th>Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mech. debarked (two pass)</td>
<td>0.83</td>
<td>Mech. debarked (four pass)</td>
<td>1.58</td>
<td>0.75</td>
</tr>
</tbody>
</table>
Wood fibre loss volume: Per ha

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<thead>
<tr>
<th>Debarking treatment:</th>
<th>Treatment</th>
<th>m3</th>
<th>Treatment</th>
<th>m3</th>
<th>Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mech. debarked (two pass)</td>
<td>2.64</td>
<td>Mech. debarked (four pass)</td>
<td>5.09</td>
<td>2.45</td>
</tr>
</tbody>
</table>
Economic Evaluation
Value of recoverable pulp: Debarking Treatment

**Debarking treatment:**

- **Manual**
  - Value of recoverable pulp yield (R/tonne): R 50.90

- **Mech. (3 pass)**
  - Value of recoverable pulp yield (R/tonne): R 9.64

- **Mech. (5 pass)**
  - Value of recoverable pulp yield (R/tonne):

<table>
<thead>
<tr>
<th>Product</th>
<th>Pulp price (August 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>US Dollar/tonne</strong></td>
<td><strong>Rand/tonne</strong></td>
</tr>
<tr>
<td>Bleached Eucalyptus Kraft pulp (BEKP)</td>
<td>$ 792.00</td>
</tr>
</tbody>
</table>

*(KSH Consulting, 2013)*
Value of recoverable pulp: Drying Period

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</table>

(KSH Consulting, 2013)
Value of wood fibre lost: Debarking Treatment (10 trees)

<table>
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<tr>
<th>Debarking treatment:</th>
<th>Value of harvesting residue fibre lost (Rand/ten trees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mech. (two pass)</td>
<td>R 3.32</td>
</tr>
<tr>
<td>Mech. (four pass)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>Rand/tonne</th>
<th>Reference</th>
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<tbody>
<tr>
<td>Eucalyptus pulpwood (green state)</td>
<td>R 299.28</td>
<td>FES, 2012</td>
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</tbody>
</table>
Value of wood fibre lost: Debarking treatment (1600 trees)

Value of harvesting residue fibre lost (R/ha)

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<th>Reference</th>
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Results summary

- Wood chip uniformity and fibre loss is related to feed roller induced log surface damage
- Log drying period influence wood chip uniformity and pulp recovery
- Wood chip uniformity and pulp recovery decreases with decreasing log/tree size
Discussion and Conclusion

- Fewer feed roller passes
- Residual bark
- Harvesting head calibration
- Research into optimum log moisture content
- Optimum debarking break point
References


