Effects of rough delimming of coniferous crowns on biomass and nutrient exports and the productivity of the forest wood chip production chain

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Introduction

- Rising demand for wood chips from forests
- Most important raw material are coniferous crowns/forest residues
- Increased biomass and nutrient export may lead to soil depletion on sites with low levels of available nutrients
- Bavaria: decision on degree of biomass utilisation in consideration of local site conditions
Rough delimbing of crowns

Whole crowns

Roughly delimbed spindles
Methods: Field trials

- Field trials
  - Motor-manual harvest, extraction by forwarder
  - Fully mechanised harvest, extraction by forwarder

- Time studies
  - Harvesting
  - Forwarding

- Sampling of wood chips
Methods: Biomass sampling

- 5-7 representative trees in each stand
- Weighing and sampling of different tree sections
- Further analysis in the laboratory (MC, nutrient concentrations)
Field trials

- Motor-manual harvest

- Fully mechanised harvest
Results: Motor-manual harvesting

- Felling and other work
- Rough deliming

Time consumption [min/tree]

Whole crowns  Delimbed spindles

Time consumption [min/ODT]

Whole crowns  Delimbed spindles
Results: Fully mechanised harvesting

- Felling and other work
- Rough delimming

Time consumption [min/tree]

Whole crowns | Delimbed spindles
---|---
1 | 1

Time consumption [min/OET]

Whole crowns | Delimbed spindles
---|---
3 | 7
Results: Forwarding

<table>
<thead>
<tr>
<th>Variant</th>
<th>Crown Distance [m]</th>
<th>Spindle Distance [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crowns</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Spindles</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Crowns</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Spindles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bar chart showing time consumption [min/ODT] for different variants and forwarding distances.

- Other
- Crane work
- Driving
## Results: Wood chip production cost

<table>
<thead>
<tr>
<th>Fully mechanised variant</th>
<th>Whole crowns</th>
<th>Roughly delimbed spindles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of felling and other costs</td>
<td>11.20 €/ODT</td>
<td>7.24 €/ODT</td>
</tr>
<tr>
<td>Rough delimbing of crowns</td>
<td>-</td>
<td>10.95 €/ODT</td>
</tr>
<tr>
<td>Forwarding</td>
<td>22.41 €/ODT</td>
<td>17.77 €/ODT</td>
</tr>
<tr>
<td>Chipping</td>
<td>18.16 €/ODT</td>
<td>14.53 €/ODT*</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>51.77 €/ODT</strong></td>
<td><strong>50.49 €/ODT</strong></td>
</tr>
</tbody>
</table>

Harvester: 155 €/PMH\textsubscript{15}; Forwarder: 90 €/PMH\textsubscript{15}; Chipper 245 €/PMH\textsubscript{15}
# Results: Wood chip quality

<table>
<thead>
<tr>
<th>Case study</th>
<th>Variant</th>
<th>Fine fraction (&lt; 3.15 mm) [w-%]</th>
<th>Ash content [w-%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor-manual</td>
<td>Whole crowns</td>
<td>25.6</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>Delimbed spindles</td>
<td>11.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Fully mechanised</td>
<td>Whole crowns</td>
<td>28.4</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>Delimbed spindles</td>
<td>5.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Wood chips from whole crowns

Wood chips from delimbed spindles
Results: Biomass exports - Site 1 (Selb forestry district)

- Export of sawlogs and roughly delimbed spindles
- Export of forest residues/whole crowns
- Harvest loss (20% of crown biomass)
Compared to conventional utilisation of forest residues/crowns, the method of rough delimbing leads to:

- Additional expenditure of time in harvesting
- Higher productivity in forwarding
- Higher wood chip quality
- Considerable reduction of biomass and nutrient exports

The method can be a suitable alternative on sites with relatively low levels of available nutrients.
Thank you for your attention!

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