Productivity of a single-grip TimberPro 620 harvester with a LogMax 7000 harvesting head in a beech dominated stand

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FORMEC 2016 – From theory to Practice: Challenges for Forest Engineering
Warsaw, Poland - 07.09.2016
Outline

- Introduction
- Methods
- Results / Trends
- Summary
Introduction

- Close-to-nature forestry can entail a higher species composition
- Hardwood trees exhibit complex tree and crown architecture that can complicate the processing phase
- Increased use of single-grip harvesters

Objective of pilot study

- Determine the productivity of a TimberPro 620 harvester in beech and in spruce following two silvicultural treatment; clear-cut and selective-cut.
Methods

- Study location / stand description
- Experimental layout
- Pre-harvest inventory
- Time and motion
Study location and stand description

Stand description

- 4.5 ha in size
- 65% Beech
  30% Norway spruce
  5% Scots Pine
- Avg. 90 years old
- Avg. standing volume pre-harvest 280 m³/ha
- Two silvicultural treatments
  - Selective-cut
  - Clear-cut
Experimental layout

- Selective-cut
- Clear-cut
TimberPro 620

- 23.1 metric tons*
- 9.6 m long boom
- LogMax 7000 head
# LogMax 7000C

<table>
<thead>
<tr>
<th>DIMENSIONS</th>
<th>METRIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>1742 mm</td>
</tr>
<tr>
<td>Weight (incl. feed rollers and damped protection plate)</td>
<td>1619 kg</td>
</tr>
<tr>
<td>Sound effect*</td>
<td>110 dB</td>
</tr>
</tbody>
</table>

### FEEDING

- Two feed rollers with variable displacement axial piston motors
- Optional: Two feed rollers with fixed displacement motors
- Feed force std/opt: 42,1/36,3 kN
- Feed speed std/opt: 5,2/3,9 m/sec
- Maximum roller opening: 713 mm

### CUTTING / DELIMBING

- Bar length / Maximum cut capacity: up to 90 cm / cut up to 75 cm
- Maximum full coverage delimming diameter: 560 mm
- Minimum hydraulics requirements for acceptable performance: 165 l/min

www.logmax.com
Time and motion

Elements of CTL with single-grip harvester

- Moving
- Boom-out
- Felling
- Processing
- Manipulation

Work cycle

- Op delay
- Non-op delay
Results

- Inventory
- Work cycle elements (distribution and duration)
- Harvesting productivity
## Pre-harvest inventory

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Species</th>
<th>Number of trees</th>
<th>Average DBH of harvested trees (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear-cut (Plot A)</td>
<td>Spruce</td>
<td>15</td>
<td>34.3&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Beech</td>
<td>15</td>
<td>29.7&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Selective-cut (Plot B)</td>
<td>Spruce</td>
<td>22</td>
<td>43.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Beech</td>
<td>30</td>
<td>38.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total</td>
<td>All</td>
<td>82</td>
<td>37.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>Average estimated merchantable volume (m&lt;sup&gt;3&lt;/sup&gt;/tree) †</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear-cut (Plot A)</td>
<td></td>
<td></td>
<td>1.18&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Beech</td>
<td></td>
<td></td>
<td>1.13&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Selective-cut (Plot B)</td>
<td></td>
<td></td>
<td>2.03&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Beech</td>
<td></td>
<td></td>
<td>2.11&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1.74</td>
</tr>
</tbody>
</table>

† estimated merchantable volume derived from species dependent biomass expansion factors
Distribution of work cycle elements

Beech, Clear-cut
- Beech, Clear-cut: 11.2%
- Spruce, Clear-cut: 8.0%
- Clear-cut Spruce: 11.2%
- Selective-cut Beech: 14.3%
- Selective-cut Spruce: 2.7%
- N = 30

Beech, Selective-cut
- Beech, Selective-cut: 5.9%
- Spruce, Selective-cut: 3.8%
- Clear-cut Spruce: 12.6%
- Selective-cut Beech: 50.2%
- Clear-cut Beech: 27.5%
- N = 15

N = 15

Cycle element
- Boom-out
- Felling
- Moving
- Processing
- Manipulation
Duration of work cycle elements

Average duration (seconds/m³) ± 20% difference

Clear-cut

Selective-cut

Work cycle elements

Average duration (seconds)

Species
Beech
Spruce

Eric R. Labelle
## Harvesting productivity

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Species</th>
<th>Number of trees</th>
<th>Harvesting productivity [m³/PMH]</th>
<th>Average</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear-cut (Plot A)</td>
<td>Spruce</td>
<td>15</td>
<td>34.5ᵃ</td>
<td>2.68</td>
<td>17 % higher</td>
</tr>
<tr>
<td></td>
<td>Beech</td>
<td>15</td>
<td>29.5ᵃ</td>
<td>1.69</td>
<td></td>
</tr>
<tr>
<td>Selective-cut</td>
<td>Spruce</td>
<td>22</td>
<td>29.9ᵃ</td>
<td>2.19</td>
<td>6 % higher</td>
</tr>
<tr>
<td>(Plot B)</td>
<td>Beech</td>
<td>30</td>
<td>28.2ᵃ</td>
<td>1.69</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>All</td>
<td>82</td>
<td>30.0</td>
<td>1.04</td>
<td></td>
</tr>
</tbody>
</table>

Logmax.com
Harvesting productivity

A

**Clear-cut**

<table>
<thead>
<tr>
<th>Species</th>
<th>Beech</th>
<th>Spruce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equation</td>
<td>$y = -12.73 + 3.027x - 0.05033x^2$</td>
<td>$y = -68.77 + 5.263x - 0.06182x^2$</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.296</td>
<td>0.805</td>
</tr>
</tbody>
</table>

**Selective-cut**

<table>
<thead>
<tr>
<th>Species</th>
<th>Beech</th>
<th>Spruce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equation</td>
<td>$y = 3.601 + 15.80x - 1.713x^2$</td>
<td>$y = 4.927 + 15.14x - 1.172x^2$</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.486</td>
<td>0.802</td>
</tr>
</tbody>
</table>

B

<table>
<thead>
<tr>
<th>Beech</th>
<th>Equation</th>
<th>$r^2$</th>
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<tbody>
<tr>
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<table>
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<tr>
<th>Beech</th>
<th>Equation</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y = 16.88 + 25.77x - 10.15x^2$</td>
<td>0.262</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spruce</th>
<th>Equation</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y = 3.899 + 44.08x - 11.65x^2$</td>
<td>0.793</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Beech</th>
<th>Equation</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y = 13.60 + 0.339x + 0.00096x^2$</td>
<td>0.119</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- Average of 17% higher harvesting productivity for spruce compared to beech in clear-cut treatment.

- Expand study to determine which tree related characteristics influence the most harvesting productivity in mixed wood and hardwood stands.

- Develop GPG‘s to assist operators in processing trees with complex crown architecture.
Acknowledgements

- Norbert Harrer and Wolfgang Mayer (Forstservice Harrer & Mayer GbR)
- Ernst Geyer (BaySF)
- Philipp Gloning and Michael Miesl (TU München)
- Hartwig Storath (TU München)
- Dr. Herbert Borchert (LWF)
- Moritz Bergen and Kevin Lemmer (TU München)
Questions

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Forest Operations / Forstliche Verfahrenstechnik

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