A new device for reducing crew size and operator workload during log winching operations

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Introduction

Intermediate harvesting technology
Tractor and winches
Winching

heavy physical work
low productivity

Is it possible to increase winching performance and reduce winch operator workload?
Introduction

Yes!

With an auxiliary double-drum winch for automatically returning the winch cable to the load site

Piccino
Goals

1) Verify the improvement of winching productivity
2) Determine the reduction of winching cost
3) Measure the operator workload
Materials and methods

30-year-old Turkey oak coppice
Whole tree extraction
Comparative test
6 different loggers
Work sessions randomly distributed
Parallel winching corridor
Materials and methods

Productivity - classic time-motion study
Winching distance and load size
Fuel consumption
Physiological workload - heart rate measurements
Polar RC3 GPS sport heart rate monitors
# Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Team</th>
<th>Distance</th>
<th>Tree size</th>
<th>Load size</th>
<th>Cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(m)</td>
<td>(m³)</td>
<td>(m³)</td>
<td>(s)</td>
</tr>
<tr>
<td><strong>Manual</strong></td>
<td>A</td>
<td>35&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.169&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.549&lt;sup&gt;a&lt;/sup&gt;</td>
<td>524&lt;sup&gt;ac&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>24&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.298&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.441&lt;sup&gt;a&lt;/sup&gt;</td>
<td>324&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>35&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.330&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.659&lt;sup&gt;a&lt;/sup&gt;</td>
<td>301&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Auxiliary winch</strong></td>
<td>A</td>
<td>38&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.286&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.481&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td></td>
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<td>0.586&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>C</td>
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<td>0.375&lt;sup&gt;a&lt;/sup&gt;</td>
<td>289&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Notes: Different superscript letters on the same column denote statistically significant differences between treatments, checked with Scheffe's test at the 5% level.
Results - winching cost

The graph shows the winching cost (€/m³) plotted against the winching distance (m) for different teams:

- Team A
- Team B
- Team A - AW
- Team B - AW
- Team C
- Team C - AW
# Results - Operator Workload

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Auxiliary winch</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td>bpm</td>
<td>bpm</td>
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<tr>
<td>1</td>
<td>106A&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>2</td>
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<td>5</td>
<td>141B&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>6</td>
<td>105A&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16</td>
</tr>
</tbody>
</table>

Notes: Different capital letters on the same row, indicate statistically significant differences between treatments, after testing with a pair t-test at the 10% level. Different superscript letters on the same column denote statistically significant differences between workers, checked with the Kruskal-Wallis test at the 10% level.
Results – operator workload

Percent work time within HRR class

- >80% HRR
- 60-80% HRR
- 40-59% HRR
- <40% HRR

Subjects (n) and treatments:

- Auxiliary winch
- Manual

1 2 3 4 5 6
Conclusion

Productivity increased

Workload decreased for most operators

- reduction in manpower to achieve the same job
- sped up the winching cycle by returning the cable faster
- the winching assistant had more time to prepare the loads
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