A simulation approach to determine multi-tree felling and processing efficiency

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What is the technical / theoretical potential efficiency?
Which head size would you prefer?
Accumulation capacity?
Restriction of accumulation capacity
Capacity utilization in accumulation

Max accumulation, equal diameter
Max accumulation, random diameter
Single stem

Mass (green) of stem and bark, kg

Percent of mass of largest stem

$d_{\text{stump}}$ 5 10 15 20 25 30

$\text{dbh}$ 4.3 8.5 12.8 17 21.3 25.5
Simulation approach

> Eliasson 1999:
  > Model for selective thinning with regular harvester head
  > Modelled by crane speed, delimming speed, cutting pace,
    machine movement speed, tree size, tree positions etc

> Now: adapted for multi-tree handling
Stand properties and work method

$BA = 35 m^2 \text{ ha}^{-1}$; $dbh = 7.9 \text{ cm}$; $\rho = 5775 \text{ trees ha}^{-1}$
Varying factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean tree size, dbh (cm)</td>
<td>6, 8, ..., 14</td>
</tr>
<tr>
<td>Average density, m² ha⁻¹</td>
<td>25, 30, 35</td>
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<tr>
<td>Head max Ø, cm</td>
<td>1, 10, 20, ..., 50</td>
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Results: Boom movement distance

Boom movement, m ha$^{-1}$

dbh

HH
AHH$_{30}$

(6.1) (3.8) (2.5) (1.8) (1.3)
Results: Time consumption per tree

HH = Single tree Harvester Head
AHH = Acc. Harvester Head Ø = 30 cm
Time saving by accumulation

Relative time consumption, %

Harvester head diameter / Stump diameter
Main findings

a) Head size – important for efficiency
b) Head Ø 4-5 times average stump Ø

Further research

I. Verify model and parameters (empirical tests)
II. Extend the model to cope for selective and intermediate approaches
III. Break-even analysis of increasing harvester head and base machine size in first thinning
Thank you
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