Cutting Productivity of Windfalls in Finland

Kalle Kärhä¹, Tuomas Anttonen², Teijo Palander², Asko Poikela³, Sirkka Keskinen³, Ari Laurén⁴, Yrjö Nuutinen⁴ & Pekka T. Rajala¹
¹Stora Enso Wood Supply Finland, ²University of Eastern Finland, ³Metsäteho Oy & ⁴Natural Resources Institute Finland

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Photos: Tuomas Anttonen.
Reasons for Our Study

1) Damages caused by big storms for Finnish forests during the 2000’s

Sources: Finnish Forest Research Institute, Finnish Forest Centre.
1) Damages caused by big storms for Finnish forests during the 2000’s.

2) No studies of windfall salvaging in Finland.

Many windfall salvaging studies internationally, e.g.

*in Switzerland by Hagauer*
*in the Czech Republic by Dvořák*
*in Italy by Magagnotti et al.*
*in Poland by Szewczyk et al.*
*in Norway by Talbot et al.*
*in Sweden by Bergkvist and Sondell.*
Reasons for Our Study

1) Damages caused by big storms for Finnish forests during the 2000’s.

2) No studies of windfall salvaging in Finland.

3) The Trade Association of Finnish Forestry and Earth Moving Contractors: Wood harvesting costs of windfalls **typically 30–70% higher** than from normal loggings.
-Time-study data collecting in December 2013 after the Eino and Seija storms.
- **Comparative time study:**
  - Three harvesters (John Deere 1270D/H414, Logset 8H/TH 75X and Ponsse Ergo/H73), as well as three harvester operators.
  - The same harvesters/operators cut also normal standing trees of clear cuttings.
Cutting work was recorded on video, and the time study was carried out by analyzing the video material by a new tool developed by Ari Laurén.

Damage type was attached for all stems processed in the time study.

Final study material for stem processing modeling was 1,088 trees.

Stem processing time was modeled by applying non-linear regression analysis with the stem volume and windfall dummy as the independent variables.
Total Data (1,751 trees) by Operator, by Cutting Method and by Damage Type

(2) Felled whole tree without stump

(1C) Felled broken tree with separate butt and top sections

(1B) Hang-up whole tree

(0) Standing tree

(1A) Felled whole tree with stump

Tree drawings: Laura Noponen.
Total Data (1,751 trees) by Operator, by Cutting Method and by Damage Type

Modeling stem processing time in normal clear cuttings:

- (0) Standing tree
- (1A) Felled whole tree with stump
- (1B) Hang-up whole tree
- (1C) Felled broken tree with separate butt and top sections
- (2) Felled whole tree without stump

Number of stems

- Normal clear cutting
- Windfall clear cutting
- Windfall thinning
- Normal clear cutting
- Windfall clear cutting
- Windfall thinning
- Normal clear cutting
- Windfall clear cutting
- Windfall thinning

Total Data (1,751 trees) by Operator, by Cutting Method and by Damage Type

Tree drawings: Laura Noponen.
Total Data (1,751 trees) by Operator, by Cutting Method and by Damage Type

Modeling stem processing time in windfall clear cuttings:

<table>
<thead>
<tr>
<th>Operator</th>
<th>Normal clear cutting</th>
<th>Windfall clear cutting</th>
<th>Windfall thinning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator 1</td>
<td>2</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Operator 2</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Operator 3</td>
<td>2</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

- (0) Standing tree
- (1A) Felled whole tree with stump
- (1B) Hang-up whole tree
- (1C) Felled broken tree with separate butt and top sections
- (1D) Broken tree section
- (2) Felled whole tree without stump

Tree drawings: Laura Noponen.
Highlights of the Study
Time Consumption in Cutting of Windfalls

Modeling of moving time

Graph showing moving time in seconds per stem for different density of removal, stems/ha.

- Normal clear cutting
- Windfall clear cutting
- Windfall thinning
- Windfall cutting

Legend:

- Normal clear cutting
- Windfall clear cutting
- Windfall thinning
- Windfall cutting

Key points:

- 11.9 s/stem
- 5.6 s/stem
- → +114%
Time Consumption in Cutting of Windfalls

Modeling of stem processing time; Operator 1

![Graph showing stem processing time vs stem volume](image)

- Normal clear cutting
- Windfall clear cutting

Gap: 14.8 s/stem
Time Consumption in Cutting of Windfalls

Modeling of stem processing time; Operator 2

Cutting Productivity of Windfalls in Finland
Time Consumption in Cutting of Windfalls

Modeling of stem processing time; Operator 3

![Graph showing stem volume vs. stem processing time for normal clear cutting and windfall clear cutting. The graph indicates a gap of 10.1 s/stem between the two methods.](image-url)
Time Consumption in Cutting of Windfalls

Relative stem processing time by operator

100 = Cutting normal standing trees.
Time Consumption in Cutting of Windfalls

Relative stem processing time by operator

Cutting Productivity of Windfalls in Finland

100 = Cutting normal standing trees.
Moving time: +114%.

Stem processing time: +14–36%.

Miscellaneous time: +147%.
  with cutting windfall stems 3.7 s/stem,
  with normal standing trees 1.5 s/stem.

Total effective \((E_0)\) time:
  24–53\% higher compared to
  cutting normal standing trees (300–1,500 dm\(^3\)).
Time Consumption in Cutting of Windfalls

Relative total effective ($E_0$) time by operator

<table>
<thead>
<tr>
<th>Operator</th>
<th>Time Consumption in Cutting of Windfalls</th>
<th>Relative total effective (E₀) time by operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator 1</td>
<td>+24–53%</td>
<td></td>
</tr>
<tr>
<td>Operator 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operator 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
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</tr>
</tbody>
</table>

Cutting Productivity of Windfalls in Finland

100 = Cutting normal standing trees.
Cutting Productivity and Costs of Windfalls, as well as Harvesting Costs of Windfalls

- **Cutting productivity**: -20–35%.

- **Cutting costs**: +31–61%.
  (On the presumption that operating (E$_{15}$) hour costs of harvester in cutting windfalls are 5% higher than cutting normal final fellings).

- **Harvesting costs**: +11–34%.
  (On the presumption that no effect on forwarding productivity and costs in forest haulage of windfall timber).
Cutting Productivity of Windfalls by Operator

Cutting Productivity of Windfalls in Finland

100 = Cutting normal standing trees.
Cutting Costs* of Windfalls by Operator

*) On the presumption that operating (E_{15}) hour costs of harvester in cutting windfalls are 5% higher than cutting normal final fellings.
Harvesting Costs** of Windfalls

**) On the presumption that no effect on forwarding productivity and costs in forest haulage of windfall timber.
After the Eino and Seija storms cutting productivity of windfalls was, on the average, 20–35% lower than those of cutting normal standing trees.

Consequently, cutting costs were 31–61% higher and wood harvesting costs were 11–34% higher.

N.B. The Trade Association of Finnish Forestry and Earth Moving Contractors: Wood harvesting costs of windfalls are typically 30–70% higher.

More time studies with more operators/harvesters in different harvesting conditions are needed in the future.