

Observations on the effects of rough-delimiting and load compression on harvesting system costs in fuel wood thinning

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First Thinning for fuel wood

Common Harvesting System in Sweden



Thinning harvester with accumulating harvester/felling head

■ 60% of system cost



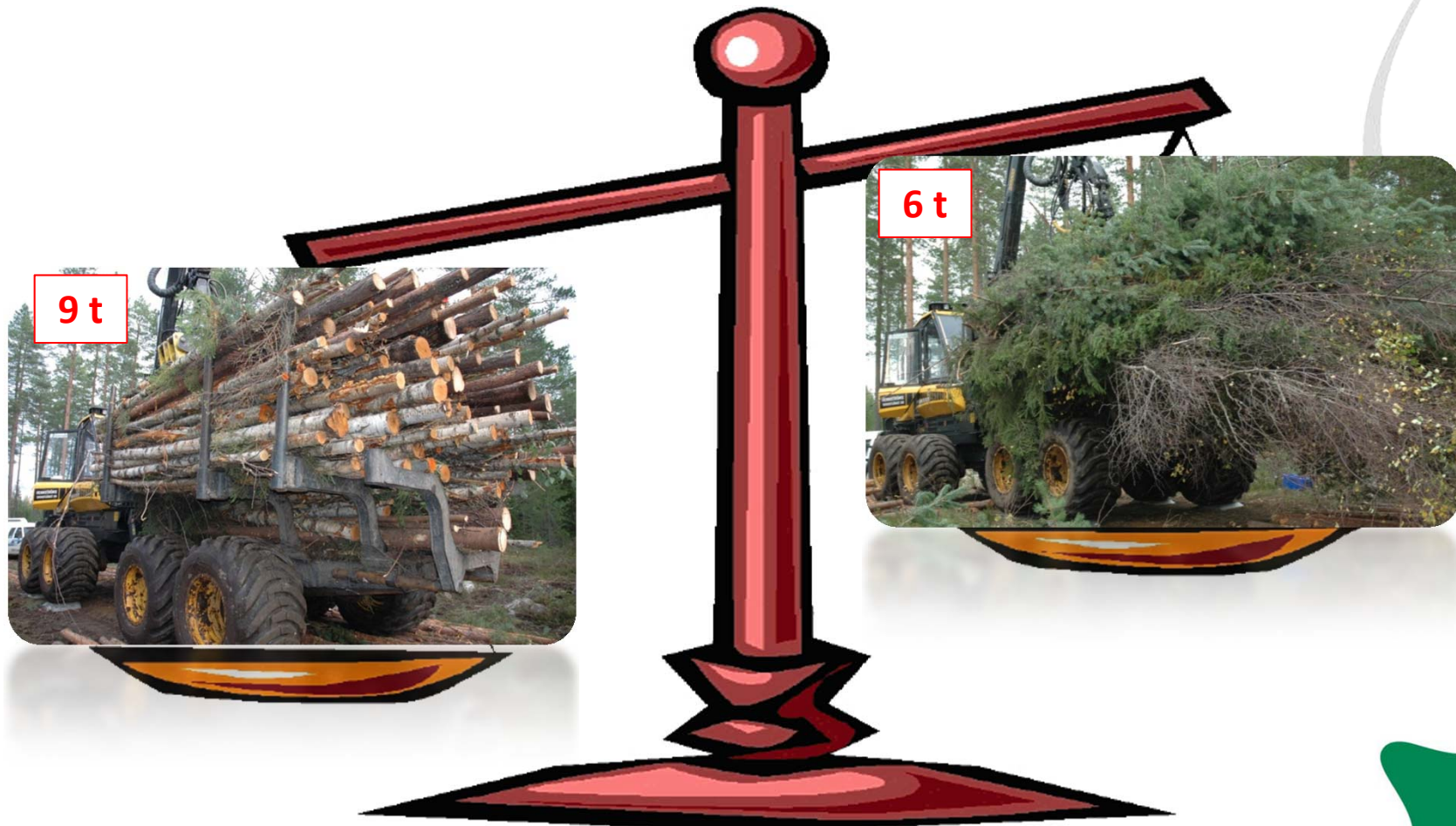
Medium Sized Forwarder

■ 40% of system cost (@ 200 m)
(it is only 15% in pulpwood)

Small trees are bulky

Harvesting whole trees with Dbh of 6-8 cm

- In piled small trees only 25-35% of the bulk volume is solid mass
- 30-60% of the forwarder's load capacity is normally used



Restrictions of the Work Environment



Strip roads should be kept narrow and damages on remaining trees avoided

- It is not possible to use a forwarder with a larger load space
- Loading is complicated if tree sections exceed 7-8 m
- With longer tree sections the forwarder is tail-heavy and difficult to maneuver

Aim of the study

Assess the technical and economic efficiency of systems including
“rough-delimiting” “load compression”



Compared to unprocessed/un-compacted
whole tree parts

- Field studies observations on time consumption and load densities
- Literature relations for bulk densities
- Follow-up data on system delays and costs

Field studies

System 1



Accumulating Felling Head
(No delimiting)



Medium sized forwarder
(No compaction)

System 2



Single Grip Harvester Head
(Rough delimiting)



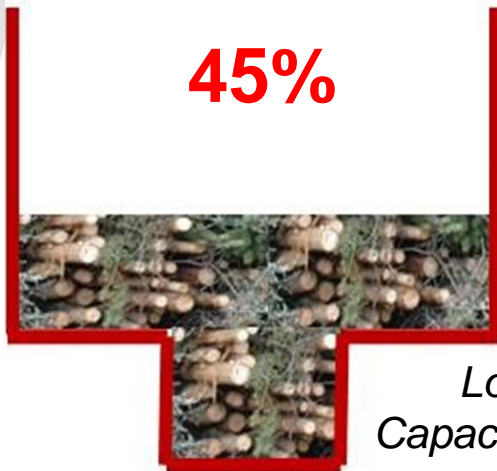
Medium sized forwarder
(No compaction)

Results

System 1 [No compress/process] (18 loads)

Load Bulk Density = 207 kg/m³
Load Fresh Mass = 5.39 t (2.86 OD t)

45%



*Load
Capacity (12 t)*

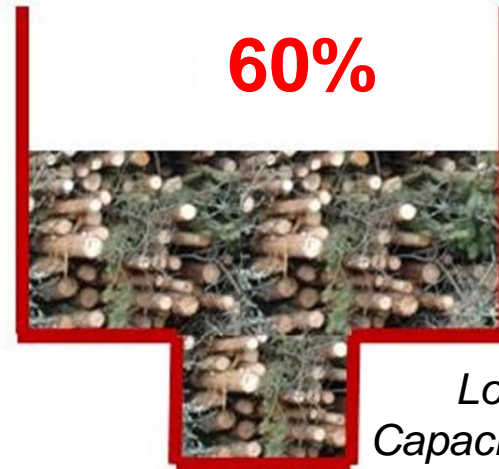
Factors

- Dbh = 6.7 cm
- Pile size = 151 kg
- Bucking length = 5.8 m

System 2 [Rough delimiting] (17 loads)

Load Bulk Density = 296 kg/m³
Load Fresh Mass = 7.19 t (3.81 OD t)

60%



*Load
Capacity (12 t)*

Factors

- Dbh = 7.6 cm
- Pile size = 365 kg
- Bucking length = 5.4 m

System Economy

-Reference systems based on bulk density curves from the literature (Bergström et al. 2010)

	S 1 field study	S1 + load compaction		S 2 field study	S2 - rough delimiting
Harvester productivity [od t/PW hour]	2.84	2.84	Harvester productivity [od t/PW hour]	2.94	3.23
Forwarder productivity [od t/PW hour]	4.86	5.61	Forwarder productivity [od t/PW hour]	6.45	3.72
Harvesting cost [€/od t]	33.53	33.53	Harvesting cost [€/od t]	32.39	29.45
Forwarding cost [€/od t]	16.83	14.51	Forwarding cost [€/od t]	12.63	21.89
Toal cost [€/od t]	50.36	48.04	Toal cost [€/od t]	45.02	51.33

Load Compaction
- 5% of total cost

Rough Delimiting
- 12% of total cost

Some Considerations

The single-grip harvester in S2 had limited capacity for accumulating small trees :

- an accumulating function should be used

If the harvested Dbh exceeds 8 cm:

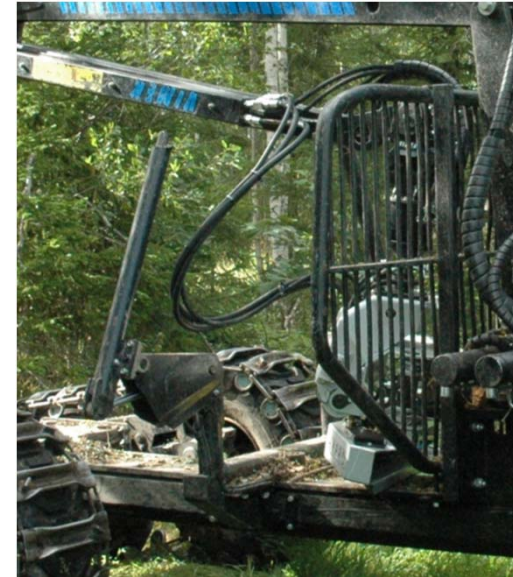
- Feed-rollers can double the compaction effect

Bucking length affects the payload and productivity

- tree parts should be as long as possible

Grapple-saw on the forwarder ?

- Productivity of the forwarder while loading ↓
- Productivity of the harvester while felling-bunching ↑



*To reduce system costs by 10%
We can use a 45% increase in
bulk density by load compaction*



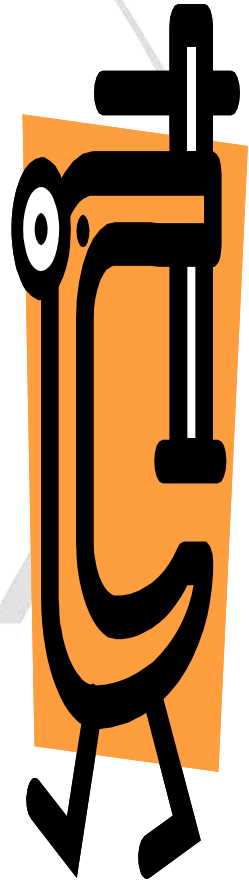
*Compressing devices should cost
max. 7% of a 15 t forwarder
purchase price
(e.g. €16,000 on €230,000)*

The alternative could be bundling...but...



It should be based on simple solutions to remain cost efficient!

Conclusions



- Rough-delimiting and load compression can increase the harvesting efficiency in fuel-wood thinnings.
- The compressing solutions should be simple in order to remain “*cheap*”.
- Future development and **optimization** of cost-effective compressing and bundling equipment could allow early thinnings to be more profitable than present.

Thanks for your attention!



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