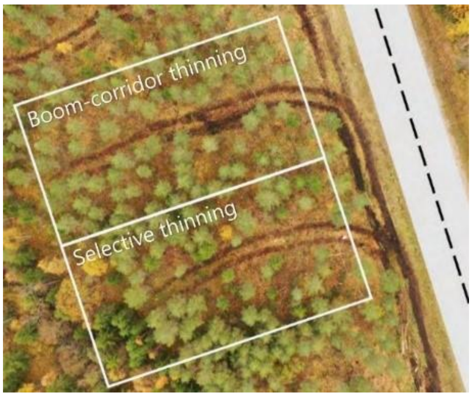
SMALL wood

February 2021

REPORT

Evaluation and Comparison of Fully Mechanized Thinning Techniques: Slovenian Case Study

In Slovenia, we tested the applicability of fully mechanized thinning in small diameter stands. The case study presents the course of field measurements and main results obtained in field measurements.



Aim of the study

The data captured in the field and its further analysis evaluates the productivity and cost-effectiveness of the technology and ergonomic workplace indicators and assesses damage to the soil and trees after the harvest. The aim of this study was to evaluate innovative technologies and operational models that can support a sustainable management and use of different types of small diameter wood.

Materials and methods

Study was carried out in Kočevje (Figure 1). The field trials included three different types of stands (younger small diameter beech stands, spruce stands, and younger small diameter stands in abandoned farmland comprised of mixed broadleaves). In each type of stand, we used two different thinning techniques: selective and boom corridor (Figure 1).

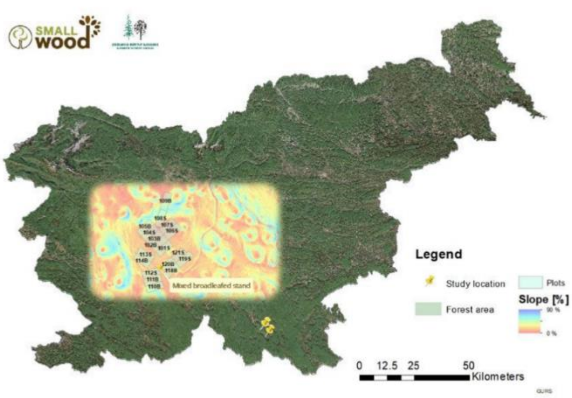


Figure 1: Location of study area with presentation of study units on diverse terrain.

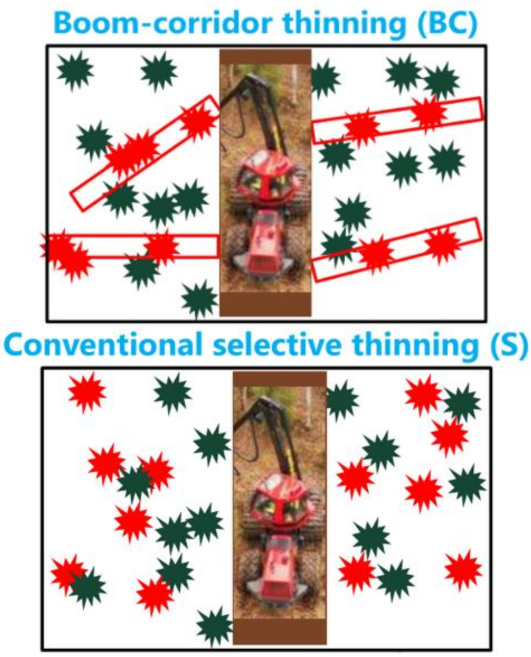


Figure 2: Comparison of boom corridor and selective thinning techniques (photo: Christian Höök)

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Individual study unit was 20 m x 50 m in size (Figure 3). Pre-inventories were performed on two transects for each unit, stand conditions were observed, dead biomass was sampled on the forest floor and main trees species were sampled in each stand (Table 1).

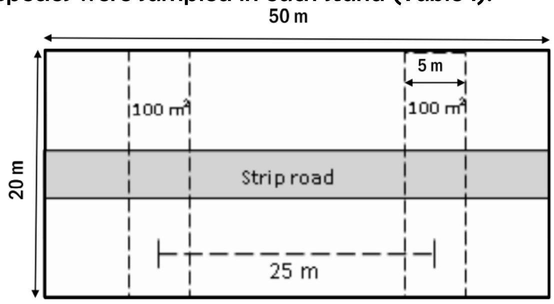

Figure 3: Study unit

Figure 4: Wooden protection for weighing scales.

Table 1: Characteristics of individual stands.

	Beech	Spruce	Mixed broadleaves
Number of study units	10	4	18
Age of the stand	20 years	40 years	30 years
Species	99 % *Fagus spp.* 1 % Other broadleaves	94 % *Picea spp.* 6 % Other broadleaves	38 % *Betula spp.* 25 % *Tilia spp.* 13 % *Corylus spp.* 9 % *Acer spp.* 15 % Other broadleaves
Mean DBH / BA-weighted	3,6 cm / 8,8 cm	8,7 cm / 14,8 cm	5,2 cm / 11,1 cm
Mean height / BA-weighted	6,2 m / 9,8 m	9,6 m / 13,9 m	7,8 m / 11,4 m
Mean density (trees ≥1 cm)	11 565 trees ha-1 (8 000–14 900)	4 475 trees ha-1 (2 650 – 7 400)	11 083 trees ha-1 (7 850–15 450)
Mean density (trees ≥4 cm)	3 430 trees ha-1 (2 000– 5 400)	2 838 trees ha-1 (1 950 – 3 600)	5 725 trees ha-1 (4 250 – 8 100)
Mean standing volume (stem+branches)	110 m^3 ha-1	255 m^3 ha-1	231 m^3 ha-1
Biomass removal (dry t ha-1)	**30**	**32**	**64**
Basal area removal (%)	**47**	**34**	**68**
Productivity BC (dry t PMh -1)	**3,8**	**5,6**	**6,1**

Time studies of mechanized thinning were performed. To assess harvesting emissions from a life cycle perspective, we also recorded machine fuel consumption. To collect productivity rates, we performed biomass scaling on the road during forwarding. In post-inventory, we recorded tree and soil damages along the strip road, in existing transects we remeasured remaining trees and stump heights.

Figure 5: Scaling of biomass on the road

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Results

During Slovenian field trials, we performed measurements on 32 study units, amounting to 3,1 hectares. In 31 productive machine hours, we harvested 153 dry tonnes of biomass. Large amounts of biomass were harvested in the thinning, often between 20-60 dry t × ha -1, and on average 45 dry t × ha -1 (108 m 3 × ha -1). In most stands, the novel boom corridor thinning method was more productive than the conventional selective method by 16 %, marginally statistically significant. Mean DBH and stand diversity explain the wide spread of productivity data. The productivity differences between working methods became more evident (and statistically significant) in the study units with a mean DBH above 10 cm. On average, the novel boom corridor thinning method was found to be faster in every work element.

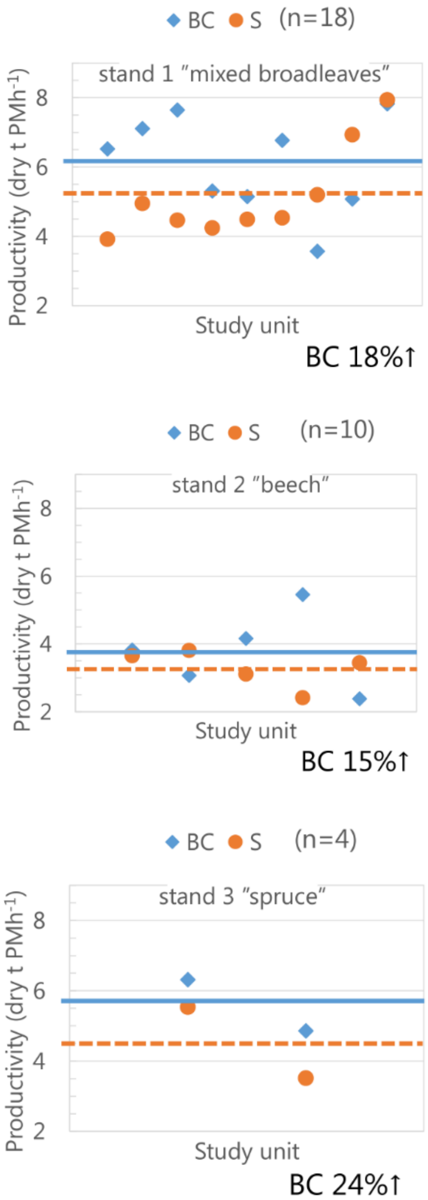

Figure 6: Productivity

Excessive height of the stand can be regarded as a bottleneck in the felling head's work (lacking feed rollers), leading to excessive top buckings and decreasing productivity (Figure 7).

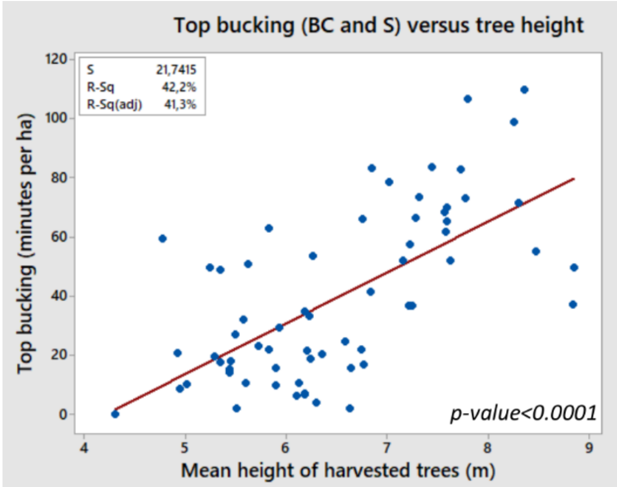

Figure 7: Relationship between mean tree height and time spent for top buckings.

Slovenia's difference between working methods was statistically significant (boom corridor thinning: 6,6 damaged trees/100 m strip road, selective thinning: 12,0 damaged trees/100 m strip road). In Slovenia, most of the stand damage consisted of "bark scratched" at stem height higher than 100 cm for both working methods and smaller than 50 cm2 in boom corridor thinning. Damage larger than 200 cm2 were the most abundant damage size in selective thinning. There was no statistical difference between the working methods in the variables analyzed, except for the number of damaged trees /100 m strip road after thinning. Damage on soil, the average stump height, the tree damage characteristics, and the main cause of tree damages were similar in both working methods. The destroyed tree number was very low for both working methods (between 0 and 0.3 trees per study unit). In the case of both working techniques, the main cause of damage was the harvester head movement.

Discussion and conclusion

The analysis of post-inventory data did not reveal significant differences in the majority of variables. On average, units thinned with BC technique were 23 % denser and there was 10 % less biomass removal in comparison with S technique. Yet, the BC proved to be more productive.

Biomass cost at roadside is about 48 € × dry t -1 (20 € × m -3). Even if these thinnings are on the edge of profitability, they should be regarded as an investment in the future production of high-quality roundwood and other ecosystem services in these stands, also enhancing forest's resilience against disturbances such as wildfires. The trials showed that the evaluated cutting technology can increase the cost-efficiency of thinning dense stands, especially when working with the novel boom-corridor thinning method.

The number of damaged trees observed after thinning was lower in boom corridor thinnings than in selective thinning. Although there was no statistical difference in emissions between the working methods, boom corridor thinning seems to be more energy-efficient than selective thinning due to lower time consumption, and therefore lower fuel consumption.

Authors:

Urban Žitko, Mirko Baša, Matevž Triplat, Slovenian Forestry Institute

Raul Fernandez Lacruz, Swedish University of Agricultural Sciences

Teresa de la Fuente, Universidad Politécnica de Madrid

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