STUDIES OF AN INNOVATIVE HARVESTING SYSTEM IN DENSE EARLY THINNINGS

The objectives of this study were to evaluate the productivity and operative cost of a harvester with a prototype of harvester head featuring feed-rollers for compression and rough delimbing of small trees and a standard forwarder in dense early thinnings. The aim was to identify the developments that will be required to improve the effectiveness of the system based on the prototype head. Some conclusions:

- *The feed-roller system improves the efficiency of the bucking process and also increases the harvested biomass bulk density when bunched at the strip-road side by 47-70%.*
- *Compression-processing reduces the harvesting yield by 10-23% and the magnitude of the improvement increases with the processed tree size.*
- *The head increases the size of the forwarder pay-loads by 17-24% due to the compression of the biomass, and increases forwarding productivity by up to 12% at a forwarding distance of 300 m.*

Even though the head is an early prototype that has not been optimized in terms of mass and functionality, its operating costs are already comparable to those of conventional alternatives. If the head is further developed, and optimized, it can be expected to reduce the operating costs of harvesting from stand to road-side significantly.

INTRODUCTION

Extensive efforts have been made to increase the efficiency and productivity of forest fuel supply chains in the Nordic countries over the last few decades. Harvesting operations have been identified as the key factor in determining the productivity of early thinnings, with felling operations being particularly important due to the productivity losses associated with handling small diameter trees. Dense early thinning stands are very diverse in terms of species compositions and tree size distributions. The adoption of two distinct harvesting systems has been suggested. The first of these systems would combine existing accumulating felling heads (AFHs) with technologies for compression-processing and cut-to length large tree bunches in stands with tree heights above ca. 8-9 m. The second system would require the development of new heads that can continuously cut and accumulate trees during linear crane movement (boom-corridor thinning) and then bunch full trees at the strip-road sides in stands with tree heights below ca. 6-7 m.

Bracke Forest AB has recently developed a prototype head (MAMA) for the felling, compression-processing and bucking of small diameter trees from dense early thinnings (Fig. 1). The objectives were therefore to measure, and compare to a conventional system based on AFH, the productivity and cost of a harvester with the MAMA head featuring a feed-roller system for compression-processing and a standard forwarder in early thinning.

CONCLUSIONS

The time required for the felling, accumulation, compression-processing and bunching of tree-parts at the strip-road side using the MAMA head is no greater than that needed for the felling and bunching of whole trees with an conventional AFH. The feed-roller system enables effective bucking work and simultaneously increases the bulk density of the harvested biomass when bunched at the strip-road side by 47-70 %.Compression-processing reduces the harvesting yield by 10-23 % and this effect becomes more pronounced as the size of the processed trees increases. This factor is primarily responsible for the harvester productivity with the MAMA head being 12-14 % lower than that for the Conv. AFH (Table 1).The MAMA head increases the size of the forwarder pay-loads by 17-24 % due to the compression of the biomass, and as consequence it increases forwarding productivity by up to 12 % for a forwarding distance of 300 m.

Figure 1. The prototype MAMA head developed by Bracke Forest AB.

Table 1. Productivities and costs for the MAMA and a conventional system (Conv.) in a "typical" early thinning stand (removal stem volume ca. 35 dm^3) for various forwarding distances.

	Conv.	MAMA	Difference (%)		
	(300 m forw. dist.)		100 m	300 m	500 m
Harvester productivity (m^3/SMH)	9.5	8.2	-13	-13	-13
Forwarder productivity (m^3/SMH)	13.2	18.7	+50	+42	+38
Total system cost (€/m^3)	*22.2*	*22.5*	*+3*	*+1*	*0*

Although the MAMA head is a prototype that has to be optimized in terms of mass and functionality, it already achieves costs that are comparable to those of conventional systems. With further development of the MAMA head, it can be expected to reduce costs by up to 12% under the studied conditions.

LITERATURE

Bergström, D. & Di Fulvio, F. Studies on the use of a novel prototype harvester head in early fuel wood thinnings. (Manuscript submitted to the International Journal of Forest Engineering 2013-11)

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10.12.2013

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