Larger loads and decreased damage – the potentials of a new forwarding concept

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Abstract:
In ground based transport of products from the forest to roadside the impact on the soil should be minimized, which implies small (i.e. light) loads and careful driving. However, economical rationality implies large loads and high speed. Recently, the concept of adding a trailer to a conventional forwarder has revived, with the objective to comply with both concerns and to fit into the current mechanized CTL system. Here we present the analysis of the theoretical potential of the forwarder trailer concept compared to conventional forwarding at final felling operations. The analysis addresses the trailer's "sweet spots" in terms of break-even forwarding distances under different scenarios, and the amount of sweet spots (% of final felling volume) in Swedish final fellings is estimated. The results show that the forwarder trailer concept has substantial potentials of reducing soil impact without increasing costs. However, the level of increased purchase costs and work element time consumption are crucial for the trailer concept's viability, since even rather small alterations in these levels resulted in large changes in viability. According from the scenarios tested here, the time consumption increase was more influential than the purchase cost. It can be concluded that there are environmental and economical potentials that warrant a further investigation of the forwarder trailer concept, which currently is tested in practice on several places in Sweden.

Keywords: Forwarder, ground pressure, productivity, cost-efficiency, fuel consumption, theoretical potentials, comparative study

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1 Introduction

In mechanized forestry, machines operate on rough soils that, ideally, should remain unaffected by the operation. However, large masses are handles (trees or logs) and, thus, the machines are often heavy. Machine masses are especially high in the work of transporting trees or logs from the terrain to roadside landing points, as it generally is time and cost efficient to maximize payloads as well as transport speed. Thus, there is generally a conflict between minimized soil disturbance and maximized operational efficiency. Lately there have been increased concerns about the soil damage at harvesting operations, resulting in restrictions on where machines can travel and their ground pressure (Horn et al. 2004). Reduction in ground pressure can be achieved by decreasing the mass (lighter machines and/or reduced payload) and/or increase the supportive area.

An alternative to modification of currently used machines is to introduce new machine concepts. For instance, it has previously been suggested and tested that forwarders could be equipped with a trailer to increase the total payload transported (Eriksson 1998). Such tests has indicated that use of a trailer is cost-efficient if transport distances are long, but the viability is very sensitive to the extra cost implied for using the trailer compared to only using a conventional forwarder. Thus, cost-wise it does not appear economically viable to use a trailer when competing with a conventional forwarder that uses its maximum payload capacity. However, in the light of potential restrictions on maximum ground pressure during

forwarding, the use of trailers could be reconsidered. First, with restrictions on ground pressure, the conventional forwarders might not be able to fully use their load capacity and, thus, increases the costs per transported unit for the conventional system. Second, trailers enable larger payloads that can be distributed on additional axle(s) and larger supportive areas compared to conventional forwarders. Moreover, some of the limitations in previous trials on forwarder trailers were limitations in crane torque, resulting in decreased efficiency when operating on full crane reach during trailer loading and unloading (Eriksson 1998). However, technical development has resulted in more powerful cranes (Nordfjell et al. 2010). Moreover, new inventions also circumvent the need to work on long crane reaches in combination with a self-driven trailer, powered by the forwarder's engine (Volungholen 2008). Thus, there are both environmentally and technical reasons to re-evaluate the forwarder-trailer concept.

The objective of the study was to analyse the potentials of forwarder trailers in terms of time consumption, cost-efficiency and fuel consumption compared to conventional forwarders, both with and without ground pressure restrictions. This was conducted by use of theoretical modelling to identify conditions in which trailer use may be viable compared to conventional forwarders in final felling. Moreover, the abundance of Swedish final fellings with favourable conditions for forwarder-trailers was assessed.

2 Material and Methods

In the comparisons, we assumed that the forwarder trailer was combined with a Medium forwarder with reduced payload. The performance of that constellation was contrasted to the performance of Medium and Large forwarders with full payload and with reduced payload, resulting in having five different machine constellations in our comparisons. Full payload was 14 and 18 kN for the Medium and Large forwarder, respectively, whereas their payloads were reduced 15 with and 27%, respectively when aiming for a maximum ground pressure (axle loads) of 70 kPa. Under the same ground pressure restriction, the payload of the trailer constellation was 21.4 kN (11.9 on the forwarder and 9.5 on the trailer). All forwarders were 8-wheelers, with bands on all 4 bogies. The trailer was 4 wheeled, with bands on both bogies.

The computations for forwarding time consumptions were based on Nurminen et al. (2006). To cover the uncertainties of costs and performance of a forwarder trailer, four scenarios were tested. For time consumption, the fast scenario was that the use of a trailer only added 5% of time required for all work elements, whereas it in the slow scenario was assumed to require 10% extra time plus an additional extra productive minute per load. In the cheap trailer cost scenario it was assumed that a trailer cost 30 000€ (10% of the cost for a Medium forwarder), whereas a trailer in the expensive scenario was assumed to cost 70 000€ (23.3% of a Medium forwarder). Altogether, the scenarios were: fast-cheap, fast-expensive, slow-cheap and slow-expensive. The purchase cost for a Large forwarder was assumed to be 500 000€.

To identify the abundance of favourable conditions for forwarder-trailers, work outcome of the five machine constellations and the four trailer scenarios were modeled on data from more than 1000 Swedish final felling stands (containing in total 1.6 million m^3).

3 Results and Discussion

As expected, the forwarder-trailer constellation was most viable at long forwarding distances. However, the break-even distance compared to the conventional forwarder varied greatly for the different scenarios. A fast and cheap trailer constellation was cheaper to use than both the fully loaded Medium and Large forwarders at single-way distances of more than ca. 200 m. A slow and expensive trailer was cheaper than the Medium forwarder at distances over ca. 600 m, but not cheaper than the fully loaded large forwarder at any of the tested distances (0-1000 m).

When comparing the trailer constellation with the conventional but reduced payload forwarders, a fast and cheap trailer constellation was cheaper at distances over ca. 150 and 50 m compared to the Medium

and Large forwarder, respectively. The corresponding break-even distances for a slow and expensive trailer constellation were ca. 250 and 350 m.

Compared to the fully loaded conventional forwarders, the amounts of stands that could be forwarded cheaper with the trailer constellation were heavily dependent on the cost-speed scenarios. In fact, 79 and 98% of the total volume would be forwarded cheaper with a cheap and fast trailer than with a Medium and a Large forwarder, respectively. The corresponding proportions for an expensive and slow trailer were 10 and 0%, respectively. However, when doing the same comparison with conventional but reduced payload forwarders, a cheap and fast trailer was cheaper for at least 97% of the volume. An expensive and slow trailer was cheaper on 52 and 78% of the volume, compared to the Medium and Large forwarders with reduced payload, respectively.

All together, there seems to be a substantial potential for the forwarder trailer concept, and especially so when restricting conventional forwarders' ground pressure (i.e. reducing payloads). However, under certain trailer cost-speed scenarios there were also considerable amounts of volumes that could be forwarded cheaper with the trailer concept even compared to conventional forwarders with full payloads. Moreover, when competing with conventional full payload forwarders, the level of increased purchase costs and work element time consumption are crucial for the trailer concept's viability. Apparently, even rather small alterations in these levels result in large changes in the level of viability. According from the scenarios tested here, the time consumption increase (fast versus slow) was more influential than the purchase cost (cheap versus expensive).

Based on the results it can be concluded that there are environmental and economical potentials that warrant a further investigation of the forwarder trailer concept. Prototypes have already been manufactured and are tested in practice, which will contribute to the evaluation in terms of information on practical limitations and actual costs and time consumptions.

4 References

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