Efficient chip supply systems improve chipper utilisation

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Abstract

In Sweden forwarder mounted chippers with an integrated bin dominates chipping on, or close to landings. Farm tractor towed chippers which blow chips into a container shunted by a second tractor to a reloading point is an option enabling higher chipper utilisation. These machines have limited off road capacity which seriously impairs their usability. To get the higher chipper utilisation of the two-machine system while maintaining the traditional systems terrain capability, contractors use forwarder mounted chippers and hook-loader equipped forwarders to shunt containers. Skogforsk studied the performance of this system during 2 days. The chipper spent 4% of the time waiting for the forwarder, due to restricted space at the chipping site, and 31% waiting for trucks. Results were used as input in a simulation of effects on trucking capacity and forwarding distance on system efficiency. The forwarder can supply the chipper with enough containers on transport distances shorter than 170 m off road or 320 m on dirt roads. At 75 km distance to customer at least 3 trucks, each carrying 3 containers, are needed to avoid waiting time for the chipper system. The need for trucking capacity depends on transport distance and truck scheduling. A regular interval between truck arrivals minimizes waiting times for both trucks and chipper. The studied system has a higher potential chipper utilisation than a traditional system, but is sensitive to disturbances in container logistics. To fully utilise its potential it is imperative to adapt truck scheduling and an adequate number of trucks to transport distances.

Introduction

In Sweden forwarder mounted chippers with an integrated bin dominates chipping on, or close to landings. As the efficiency of the chipper unit has increased during last years, the relative time spent on transporting chips to the nearest reloading point has increased to around 30 per cent (Lombardini m.fl. 2013). This decrease in utilisation of the chipping unit dilutes the positive gain received by the higher chipper productivity. Farm tractor towed chippers which blow chips into a container shunted by a second tractor to a reloading point is an option where chipping and transport are less dependent on each other, thus enabling higher chipper utilisation. These machines have limited off road capacity which seriously impairs their usability. To get the higher chipper utilisation of the two-machine system while maintaining the terrain capability of the traditional systems, contractors have started to experiment with forwarder mounted chippers and hook-loader equipped forwarders to shunt containers.

To evaluate the new systems time studies of the chipper and hook loader equipped forwarder were made in 2013 and Results were used as input in a simulation of effects on trucking capacity on system efficiency. Supply systems for chipped biomass is complex and

difficult to study in the field and are therefore better studied using simulation models, as shown by e.g. Bradley et. al. (1976), Asikainen (1995), and Eriksson et. al. (2014).

Materials

Skogforsk time studied the performance of the chipper and the hook lift equipped forwarder on 3 sites during 2 days in 2013. Thereafter the supply system from chipping to chip delivery at heating plant were simulated using the Extend sim software.

Simulation scenarios using 2,3, and 4 trucks and 2 different shift schedules for the trucks were analysed. The simulation was run for a total of six independent weeks (30 work days) for each scenario. In the simulation of the complete supply chain it was assumed that the machines worked one eight hour shift per day and that this was divided into two four hour parts by a lunch break. The chipper was forced to stop for a maintenance break of on average 45 minutes, e.g. refuelling and knife changes, on after an average of work 7 hours. Two shift schedules for the trucks were analysed; simultaneous start where all trucks leave the garage at 7:00 a.m. and separated start where truck shifts were started one hour apart starting from 6:00 a.m. Furthermore, trucks were forced to return to the garage at end of the day. They could do so either without or with load.

Results

In the field study the chipper spent 4% of the time waiting for the forwarder, mainly due to restricted space at the chipping site, and 31% waiting for trucks when all available containers were filled. Simulations show that given an infinite supply of containers the forwarder can supply the chipper with enough containers to hold waiting times close to zero on transport distances shorter than 170 m off road or 320 m on dirt roads.

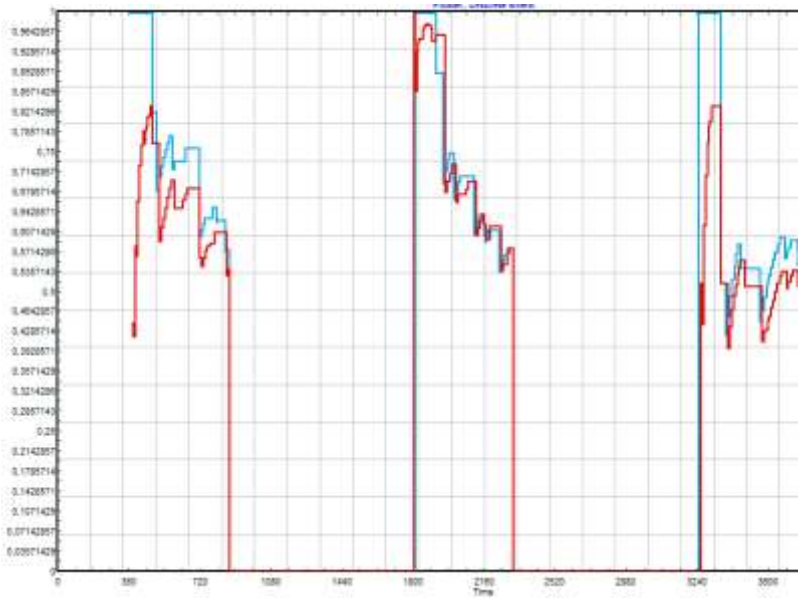
At 75 km distance to customer 3 trucks, each carrying 3 containers, are needed to avoid excess waiting time for the chipper system (table 1). Utilisation of the chipper is often close to 100 per cent in the morning and decreasing during the day, see the example in figure 1. Although an increase to four trucks increase chipper utilisation, but not significantly so, the gain of only 0.85 loads per day cannot motivate the cost of one additional truck. The need for trucking capacity depends on transport distance and truck scheduling. A regular interval between truck arrivals minimizes waiting times for both trucks and chipper. However, this does not necessarily mean that trucks should have different starting times in the morning. If the trucks start at the same time there will be excessive queuing at the landing the first day when all trucks are unloaded, subsequent days the queuing will not be as bad as some trucks will start from the garage with a chip load and some will start unloaded. If the start of the trucks shifts are separated with one hour from each other there will be less variability in the number of delivered loads and in chipper utilisation during the 30 work days than if all shifts start at the same time, but the averages of these parameters will not differ.

Table 1. Chipper and forwarder utilisation during the simulated 30 day period and the average number of loads delivered per day.

No. of trucks	Chipper utilisation	Chipper starved	Forwarder utilisation	Loads delivered per day
2	60.5	21.5	40.4	4.92
3	80.1	3.5	53.6	7.20
4	81.9	0.1	54.2	8.05

The studied system has a higher potential chipper utilisation than a traditional system, but is sensitive to disturbances in container logistics. To be able to do the transport work with an 80 € per hour forwarder and free the 200€ an hour chipper to continue chipping decrease the total cost for chipping and transport to the reloading point. This is true irrespectively of the utilisation on the forwarder as long as more than 3/4 of the 30 per cent of time a conventional forwarder mounted chipper spend on transport is spent chipping instead. To fully utilise the potential of the studied system it is of uttermost importance to adapt truck scheduling and number of trucks to transport distances.

Figure 1. Chipper utilisation (blue line) and Forwarder utilisation (red line) for 3 days during the simulation for 3 trucks with a staggered shift schedule.



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