Productivity of Forest Roadside Wood Chipping Operations in Bavaria

Fabian Schulmeyer, Karl Hüttl
Bavarian State Institute of Forestry (LWF)
Department 4 - Forest Technology, Business Management, Timber
Hans-Carl-von-Carlowitz-Platz 1; 85354 Freising; Germany
+49 8161 71 5119
fabian.schulmeyer@lwf.bayern.de
www.lwf.bayern.de

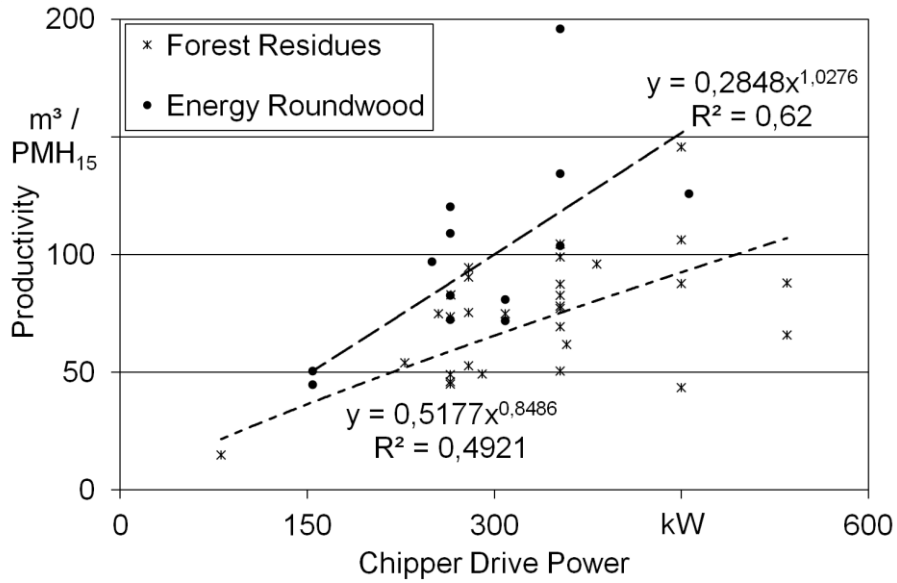
Summary
With growing demand for energy wood chips from forests, chipping operations are now an inherent part of forest production in Bavaria. Large, powerful chippers are used in a decoupled production step. During 38 chipping operations, an average productivity of 74.0 ± 25.3 m^3/PMH_{15} for forest residues and 99.1 ± 40.1 m^3/PMH_{15} for energy roundwood was recorded. Productivity increased with chipper drive power. The largest share of delays consisted of waiting for empty transport containers. Absolute waiting time was significantly higher for walking-floor dollies (median: 14 min 43 sec) than for container trucks (median: 9 min 21 sec). Considering the allowed payload, dollies performed better. Decisions for type and number of transport vehicles have to be made according to expected chipper productivity and site conditions.

Purpose and Methods
A research project funded by the Bavarian State Ministry of Food, Agriculture and Forestry was conducted between 2010 and 2013 to examine forest wood chip production in Bavaria. Aims were to analyse the current status quo and to identify options for optimisation. The outset were 36 expert interviews to determine typical settings during chipping operations. On this basis, time studies were conducted during 38 operations following the REFA method in cumulative timing at element level.

Results and Discussion
The growing demand for energy wood has led to profitable use of formerly loss-making assortments. Wood for chipping can be grouped in forest residues (includes whole trees from first thinnings) and energy roundwood (quality too low for other use, roughly delimbed), which plays an increasing role especially for the production of high quality wood chips for small scale combustion units. The most important tree species for wood chip production from forests in Bavaria is spruce (Picea abies).
Standard methods are used along the production chain. The raw material is extracted from the forest stand by forwarder and the assortments are stacked separately alongside the forest road. Chipping is organised as a decoupled production step and usually conducted at the roadside by specialised forest contractors. Drum chippers (truck-mounted or powered by agricultural tractors) are the most common machine types. Wood chips are blown directly into transport vehicles. The degree of mechanisation depends on land ownership and site conditions.
During 38 chipping operations, time studies were conducted with a total observation time of 47.5 hours (34.6 hours PMH_{15}). Productivity averaged at 74.0 ± 25.3 loose cubic metres per PMH_{15} (m^3/PMH_{15}) for forest residues and at 99.1 ± 40.1 m^3/PMH_{15} for energy roundwood.

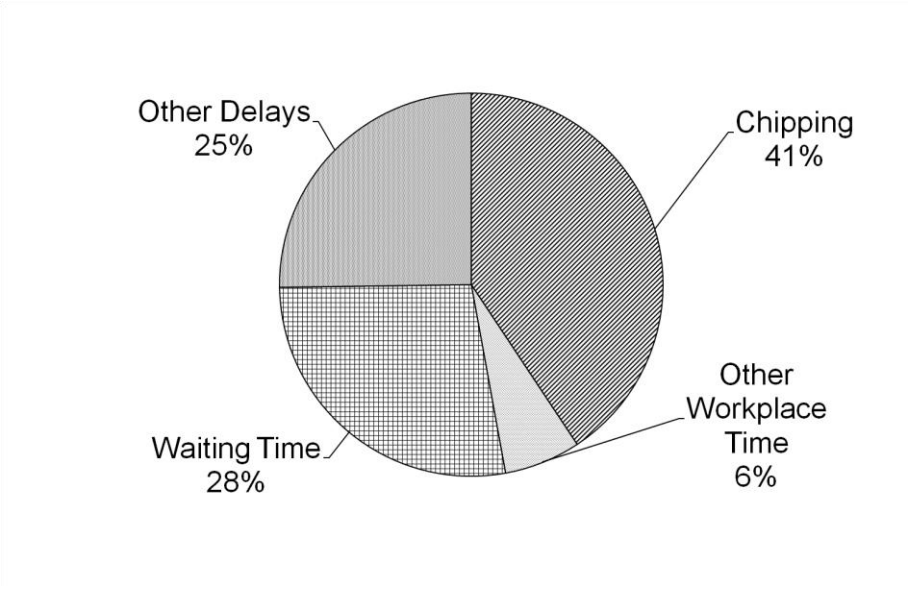
Productivity increased with chipper drive power (Fig. 1). Type of raw material (logging residues or energy roundwood) and chipper drive power were identified as the main influencing variables on productivity. Variables tested that showed only little or no influence were tree species, chipper construction type, screen size and knife sharpness.

Fig. 1: Chipper productivity subject to raw material (forest residues or energy roundwood) and chipper drive power.



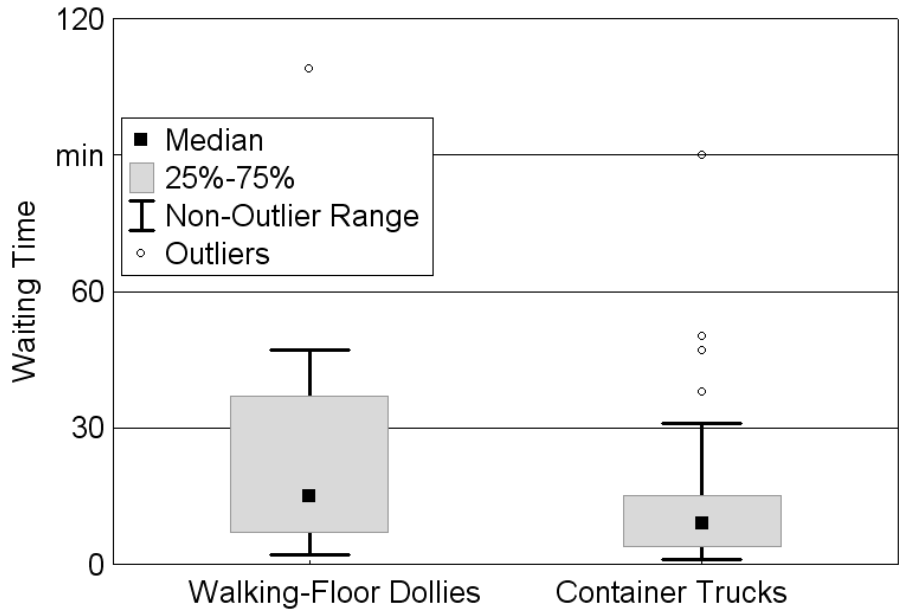
Overall utilisation of the chipper constituted 47 % of total observation time. Waiting time for a new, empty transport medium (container, dolly) was the main delay factor (28 %, Fig. 2). Other delays, especially relocation time and mechanical delays, were significantly higher for forest residues than for energy roundwood. Higher relocation time results from lower bulk density of the forest residues. Higher mechanical delays indicate a stronger strain on the machine parts.

Fig. 2: Workplace time and delays during the observed chipping operations.



The observed waiting time (Fig. 3) was significantly higher when waiting on walking-floor dollies (median: 14 min 43 sec; 0.75-Quantile: 37 min 26 sec) than on container trucks (median: 9 min 21 sec; 0.75-Quantile: 15 min 10 sec). In order to reduce costly waiting periods, it is necessary to hold available enough transport vehicles. However, a certain minimum waiting time is unavoidable in forest conditions. The container or dolly has to be placed in a convenient position. After loading, the cargo needs to be evened out and secured. Often, the width of forest roads does not allow transport vehicles to pass alongside the chipper, resulting in manoeuvring time. From the observed operations, a waiting time of up to 15 min for container trucks and 37 min for walking floor dollies was considered acceptable even with precise planning and favourable traffic conditions. Longer delays could usually be explained by too few transport vehicles available, above-average traffic disturbances or delays when unloading at the transport destination.

Fig. 3: Chipper waiting time subject to type of transport vehicle (walking-floor dolly or container truck).



As walking-floor dollies are more difficult to manoeuvre and take more time to be set up at the chipper, higher waiting times were to be expected. Considering the fresh weight of the produced wood chips of 340 kg/m³, the observed dollies had an average loading capacity of 69 m³ to keep to the legal gross vehicle weight of 40 t. This is 2.38 times the loading capacity per container (29 m³). Thus, the effective waiting time per m³ wood chips is 51.7 % higher for container trucks.

Conclusion

Professional utilisation of large, powerful chippers is widespread in Bavarian forests. High productivity can be reached with high drive power. To reduce waiting time for the chipper, transport capacities have to be matched with chipper output. Beyond that, the decision for type and number of transport vehicles has to take the site conditions in the forest into account, particularly road width and curve ratings.