Alexander Höldrich and Hans Hartmann, Straubing, and Markus Schardt, Freising

Work Time Requirements for Wood Log Production

The demand for wood logs is growing. In some cases, they are even beginning to become scarce. More efficient techniques of wood log production could solve this problem. In this contribution, results of work time measurements for the most important process steps (wood harvest, cutting, splitting, piling) are presented. In model process chains, the work time required for the individual steps is added up. From the forest to the final consumer, added work time requirements thus vary between 0.3 (professional wood log supplier) and 3.6 (free-time production for domestic purposes) labour hours per stacked cubic metre.

Dr. Hans Hartmann is director of the department "Biogenous Solid Fuels" of the Technology- and Promotional Centre (TFZ) in the Competence Centre for Renewable Raw Materials, where Alexander Höldrich is employed as well. Address: Schulgasse 18, D-94315 Straubing; e-mail: *Hans.Hartmann@tfz.bayern.de*
Markus Schardt is a scientist working at the Bavarian State Institute of Forestry, Am Hochanger 11, D-85354 Freising.

Keywords

Wood logs, labour requirement, firewood preparation

Work time was measured based on the method for forestry time studies according to REFA (Association for Work Studies and Operational Organization). For the actual measurement of the time required for individual process steps, a hand-held computer ("palm") with special time study software was used (*Fig. 1*). In order to be able to correlate the time required for the process steps, which was aggregated into total work time after data evaluation, with the material flow, the wood volumes produced over the period under consideration had to be registered as well. Based on the time- and quantity data, the technical work productivity of manpower- and machinery use during the considered process was calculated. Potential time requirements for rides to the forest, set-up times, tank filling, saw sharpening, repairs, or longer waits were not taken into account.

A total of 40 time studies were carried out. Among these, eight studies examined the wood harvest in the forest (young thinning), while 32 studies considered subsequent processing and supply (splitting with the axe or the splitting hammer, small and large vertical splitter, small and large horizontal splitter, small and large combined sawing-splitting machines, circular log saw, feeding, stacking, piling). For this purpose, locations and assortments were chosen which came as close as possible to the conditions encountered in practice along with skilled test persons at different levels of professionalism. Of course, this also resulted in a relatively large variability of the wood characteristics, and it was accepted that mean wood diameters increased like under practical conditions (here from 12 to a maximum of 26 cm) with the growing degree of mechanization.

Time Requirements for the Log Harvest

Especially during the wood harvesting process (here: young thinning), measured technical work productivity shows a particularly high degree of variation. Depending on the working conditions, it ranges between 0.18 and 1.42 m^3 (solid measure of timber in m^3) per labour hour. Here, the different initial conditions (mass per piece, tree density and -species, terrain, development, technical equipment, capabilities and skills of the test persons) had a particularly great effect. The average of all individual studies showed time requirements of 0.56 m^3 (including the bark) per labour hour.

Fig. 1: Time measurements with handheld computer

Time Requirements for Processing

In general, productivity during log processing grows with an increasing degree of mechanization from ~ 0.5 solid cubic metres per labour hour (small vertical splitter) to 6 solid cubic metres per labour hour (large, combined sawing-splitting machine). For a short time, manual splitting (axe, splitting hammer) allows a degree of productivity to be achieved which is almost comparable with that of the small vertical splitter. Here, however, tiredness sets in earlier. For the subsequent piling of the split 33-cm logs (without bundling aids), assumed technical work productivity for both kinds of wood (beech and spruce) is 3.0 stacked cubic metres of piled wood per labour hour. This corresponds to ~ 1.9 solid cubic metres per labour hour. The use of smaller combined sawing-splitting machines, however, results in larger differences between the individual kinds of wood, which range from 1.36 to 3.90 solid cubic metres per labour hour

(beech and spruce). When regarding these comparisons of efficiency, however, one must take into account that the wood must still be cut before or after splitting (except when sawing-splitting machines are used) and that this process requires approximately the same time as splitting itself [1].

Process Cost Comparison

Therefore, a direct comparison of the time measurements for the individual processing methods is only possible if all individual steps are aggregated into a complete process chain. For this purpose, four model process chains ("paths") were defined which cover the range of work processes from the free-time wood producer ("path 1"), the wood farmer with a low ("path 2") or higher ("path 3") degree of mechanization to professional log suppliers ("path 4"). In these process chains, which also include transport and handling, the measured or specific work times were added up. The transport times were calculated based on the travel speeds, which depend on the distances, and the individual loading volumes. In these calculations, a forest-farm distance of 2 km and a delivery distance of 5, 10, and 15 km (paths 2, 3, and 4) were assumed. The data for crane loader- as well as harvester- and forwarder work were taken from the literature [2]. The process elements of the individual model process chains are listed in *Table 1*. This table also shows the average measured specific work time requirements. Other details of the calculations can be found in reference [1].

When the work times of individual phases listed in *Table 1* are considered and evaluated, it becomes clear that the percentage of the time required for processing, i.e. logging, splitting, and feeding tends to decrease when techniques featuring a higher degree of mechanization are employed. Only for the free-time wood producer does processing account for the largest share (52%), whereas the percentage assumed for processing in the other process chains ranges between 30 and 37 %. The share of transport work, however, increases from path 1 to path 4 from 0.3% and 1% to 8% and up to 11%. For the free-time wood producer, the wood harvest (including removal) accounts for 31% of the time requirements and increases to up to 56 % of total work time in path 3.

Conclusions

The results show the enormous range of work time required for the supply of one solid or stacked cubic metre of firewood. Depending on mechanization and work organization, this range can fluctuate by more than the tenfold amount. This shows larger rationalization reserves, whose exploitation could provide a larger supply of firewood in the future in order to avoid firewood scarcity, which occurs regularly in some regions.

Note

These studies were promoted by the Bavarian State Ministry of Food and Forestry. The entire research report is available in the series "Reports from the TFZ" (issue 11) and as a free download (*www.tfz.bayern.de*).

Table 1: Mean specific labour requirements per solid cubic metre of firewood (here: 33 cm logs) in the individual model process chains

Process chain	Path 1 Free-time wood producer (labour hours/solid cubic metre)	Path 2 Wood farmer 1, low mech. (labour hours/solid cubic metre)	Path 3 Wood farmer 2, higher mech. (labour hours/solid cubic metre)	Path 4 Professional log suppliers (labour hours/solid cubic metre)
Wood harvest + removal (free-time wood producer, 1 m)	1,79	1,79	-	-
Wood harvest + removal Tractor/cable winch (2-5 m)	-	-	0,70	-
Wood harvest (Harvester)	-	-	-	0,10
Wood harvest (Forwarder)	-	-	-	0,10
Loading (1 m unsplit, manual)	0,30	0,30	-	-
Loading (33 cm manual, poured, loose)	-	0,15	-	-
Loading (with a crane)	-	-	0,02	0,02
Loading (33 cm by machine, poured, loose)	-	-	0,01	0,01
Transport (car + trailer)	0,02	-	-	-
Transport 1 (tractor + trailer)	-	0,02	0,02	-
Transport 2 to the customer (tractor + trailer)	-	0,04	0,08	-
Transport 1 to the processing site (truck)	-	-	-	0,01
Transport 2 to the customer (truck)	-	-	-	0,05
Unloading 1 (dumping, processing site)	0,01	0,01	0,01	0,01
Unloading 2 (dumping, at the customer´s)	-	0,01	-	-
Unloading (crane)	-	-	0,01	0,01
Logging with a circular saw (33 cm)	0,63	0,63	-	-
Splitter small	2,33	-	-	-
Splitter large	-	0,67	-	-
Feeding by machine (crane)	-	-	0,02	0,02
Small comb. sawing-splitting machine	-	-	0,40	-
Large comb. sawing-splitting machine	-	-	-	0,17
Piling, (33 cm, split)	0,63	0,63	-	-
Added work time requirements:	**5,70**	**4,24**	**1,27**	**0,49**
For comparison[a]: Work time requirements in labour hours/stacked cubic metre (33 cm logs, stacked)	3,59	2,67	0,80	0,31

[a] The factors for conversion were determined separately: 1 stacked cubic metre = 0.63 solid cubic metres as stacked, 33 cm long logs (mean value for spruce and beech) [1])

Literature

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