Time Consumption and Productivity of Mounty 4100 PTY in Timber Processing – A Case Study in Spruce Thinning

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Abstract:
Mounty processor tower yarders (PTY) integrate the latest technologies in timber yarding and primary processing. Yarding productivities and setup-takedown consumed time were comprehensively studied in Central European conditions. Processing activities on landings were not studied to their extents, reason for which the present study refers to this aspect. Indirect chronometry and production determination studies have been realized in two spruce stands operated with thinning. There was found that a delay free work cycle consists in several time categories, having an average duration of 220 seconds in condition of an average processed trees volume of 0.77 m^3 *(2.81 trees and 10.33 cross-cuttings) per cycle.*

Keywords: PTY, timber processing, spruce stands, thinning

1 Introduction

Planning activities in forestry, especially in timber harvesting represent the premises for sustainable development in this activity sector due to multiple tools offered in design, organization and application of silvicultural interventions (Oprea and Borz 2007).

By considering every machine used in timber harvesting, as well as labor force and specific conditions as being a system, there exist specific relationships between certain components. An important component in timber harvesting is represented by productivity of different machine types. Thus, in order to establish suitable harvesting structures and optimize harvesting activities, an important requirement refers to productivity assessment for a specific machine or an overall applied system (Oprea and Borz 2007).

In Romania, productivity assessment for timber harvesting machines has been neglected in the last two decades. The last normative refers to Romanian concept machines, which currently are not produced anymore, or they are produced by considering new integrated technologies.

Also, in the last decade, the specialized timber logging companies reoriented their machine acquisition strategies to the external market, due to improved liability-cost rapports for these machines. In this way, on the Romanian market, have been introduced last generation harvesters, forwarders, skidders and cable yarders. By integrating top technologies and presenting quite different operation patterns, the last ones represent a challenge for planning activities.

By corroborating the national trend in Romania which takes in consideration the endowment of forest areas with transportation infrastructure represented by forest roads (Olteanu 2003, Bereziuc et al. 2011) with increased productivities and facile setup-takedown technologies of PTY (Oprea 2008), there can be easily observed that the future in timber harvesting in mountainous forests belongs to the last ones. In this context, knowledge accumulation in this direction represents an important requirement in order to offer adequate planning tools for production activities.

In Europe, cable yarder technology presents different traditions. The longest one belongs to countries which first developed and applied these technologies (Austria and Switzerland). Several functions had been identified for cable yarders (Heinimann et al 2001), representing sometimes steps in technology integration; the current state of technology integration refers to Processor Tower Yarders (PTY).

Nowadays, skidding function of Processor Tower Yarders has been improved by using radio-controlled chokers (Stampfer et al. 2010).

A study regarding landing site processing productivity using Mounty 4000 PTY was realized by considering spruce and oak stands (Messingerová et al 2009). The study refers to time distribution per work cycle, including processing operations realized on landing site. However, processing productivity as well as stand data (volume of processed timber) characteristics was not specified.

Productivity and time consumed per work cycle depends in a great measure by stand characteristics, as well as landing organization and the obtained assortments.

By considering the above presented context, the present paper aims to describe and quantify time consumption categories using Mounty 4100 PTY technology in spruce stands for thinning conditions.

2 Material and methods

Time chronometry and processed timber volumes determinations had been realized in two spruce stands where thinning operations were applied during August 2011. The mentioned stands are located near Leaota Mountain, (45°18'31''N, 25°17'20''E), in the proximity of Argeş and Dâmboviţa counties border, Romania. The main characteristics of the two studied compartments are presented in table 1. Both compartments were harvested using uphill yarding system. There were quantified several elements during field data acquiring.

Timber processing consumed time represents one of the most important elements in productivity assessment (Oprea 2008). Timber primary processing is described by multiple operations and phases including delimbing, sorting, crosscutting, pilling etc. Most of the operations contain several stages (phases) which could or could not occur during timber processing. Time classification concepts used in the paper were those described by specialty literature (Hidoş and Isac 1971, IUFRO 2000, Oprea 2008). Due the fact that time consumed in certain phases is very short, a classical approach using stopwatches has been considered as being not feasible. As a consequence, for time chronometry there was used a video camera and each processing work cycle has been recorded in order to be replayed at the office. The resulted files were downloaded into a computer, replayed using video splitting software, and specific work phases times were centralized in a database. Data analysis was realized using Microsoft Excel.

A total number of 48 work cycles was recorded and the following time categories were identified during data collection and analysis activities:

⇒ Complementary Work Time 1 (*CWT1*), comprising the time consumed for boom movements from the rest location to the trees to be processed, as well from the last realized action to the rest location.

⇒ Complementary Work Time 2 (*CWT2*), comprising the time consumed for boom movements with or without load in order to clear the workplace (branches and short timber pieces resulted from tree edge crosscutting), as well as arranging-rearranging the timber piles during or after processing and trees manipulating before processing.

⇒ Complementary Work Time 3 (*CWT3*), comprising the time consumed for solving of some arising situations like: relocation of processing head on the tree in order to avoid big branches, utilization of chainsaw for big branches removing, time consumed for forking and curvatures solving, time consumed for repeated crosscutting at the base of the tree in order to obtain a planar section.

⇒ Main Work Time 1 (*MWT1*), comprising the time consumed for trees securing in the processor's head.

⇒ Main Work Time 2 (*MWT2*), comprising the time consumed in trees' delimbing. Delimbing can be continuous or combined with crosscutting. The second procedure was the most utilized.

⇒ Main Work Time 3 (*MWT3*), comprising the time consumed for processor head positioning to different locations on the tree where the cuttings are to be realized, as well as crosscutting. Physically, crosscutting took no longer than 1-2 seconds for the main chainsaw, but supplementary time was consumed by operator in decision making.

⇒ Main Work Time 4 (*MWT4*), comprising the time consumed for loaded boom movement between piles, movements to branches pile (in order to detach the top of the tree, as well as to release the last piece from the processor head). Most of the trees topping was done by the secondary chainsaw attached to the processor's head, reason for which, this crosscutting phase averaged more than 2 seconds.

⇒ Disturbance Time (*DT*), comprising time consumed by occurrence of breaking the work discipline such as stopping the work before the realization of entire work cycle.

Also, other time categories are provided by specialty literature, but, in reality, a work cycle in timber processing using PTY technology takes only a short time, and in field determinations, supplementary time categories were not identified. Their presence can be highlighted only by analyzing the entire applied system, from stump to processed timber.

In order to quantify the productivity for landing processing operations, there was necessary to determine the processed timber volumes. The used materials for volume determination comprised a forest specialized caliper (centimeter gradation), a measurement tape (centimeter gradation) a hypsometer and a set of color sprays.

Table 1: Main characteristics of the investigated stands

Compartment	Area [ha]	Composition	Density	Age [years]	Mean Breast Diameter [cm]	Mean Height [m]	Mean tree volume [m^3]	Silvicultural system
87B	15.4	Spruce	0.8	50	21	20	0.224	thinning
88B	13.5	Spruce	0.7	50	15	17	0.128	thinning

For each yarded tree were measured in the stand (after numbering by spraying on four directions), breast diameter and height (Leahu 1994). Yarded pieces representing only tree fragments were measured by considering two diameters at the edges and their length. In the last case the measurements were made on the landing. Volumes determination included two approaches: in case of pieces representing tree fragments the volumes were analytically determined whereas in case of trees the volumes were determined by extraction from production tables realized for spruce in Romanian conditions (Giurgiu and Draghiciu 2004).

3 Results and discussion

Descriptive statistics regarding number of trees per processing work cycle, processed volume per work cycle, volume per tree and number of cross-cuttings per cycle are presented in table 2. The total processed volume (according to the 48 investigated work cycles) was of 36.91 m^3, in conditions of a number of 135 processed trees. A total number of 496 cross-cuttings were realized in order to process the mentioned volume. The assortments lengths were of 1.5, 2, 3 and 4 meters. Only 17 investigated work cycles presented delays and all the delays occurred due to unjustified stopping of the processor during work cycle. The average delay time per work cycle was about 7 seconds. Several pieces (trees) had to be partially processed using chainsaws due to their forking, curvature or big branches and, consequently, about 4% from work cycle time was spent for these problems solving. Time distribution on categories, as well as time distribution on main categories is presented in figures 1 and 2 respectively. Average delay-free work cycle duration was of 3 minutes and 40 seconds, results which are approximately similar to those obtained in other related research (Messingerová et al. 2009). Differences may be the result of time spent for branches moving, piling and landing clearing (which in the present study took about 57 seconds per cycle).

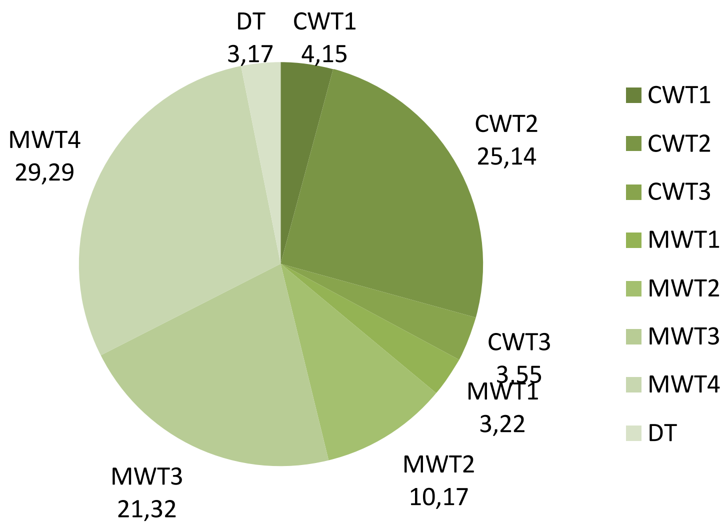

Figure 1: Distribution of consumed times on time categories

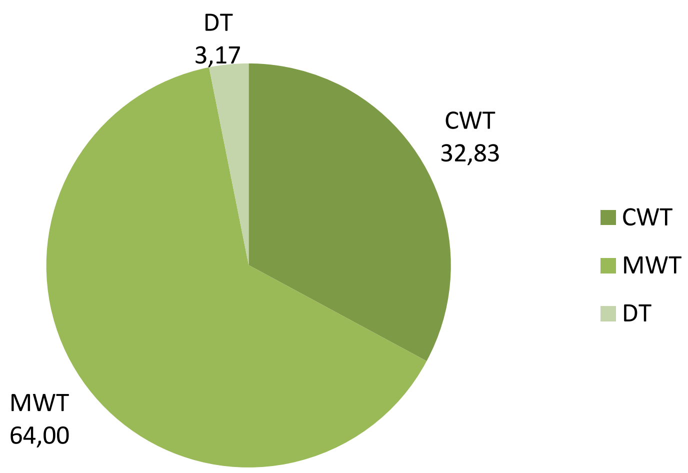

Figure 2: Distribution of consumed times on time categories – shorted

As shown in figure 1, an important part from landing time was consumed during piling and branches movement. The time consumed during branches removing from the landing is the consequence of landing organization in rapport with transportation infrastructure. Due the fact that the forest roads from the investigated area served also for other purposes (during harvesting activities), a part from the roadway had to be regularly cleared in order to assure traffic necessities.

By reporting the delay-free consumed time to the main influence factors (number of trees per processing work cycle, total volume of processed trees per work cycle and number of cross-cuttings per work cycles) there was found that the best explaining variable for the consumed time was the number of cross-cuttings.

However, a great variability was observed in time distribution, due the fact that the succession of work phases is not identical between the work cycles. This may be explained by the increased number of realized assortments.

The average productivity (excluding delays), deduced from the averages for work cycle time and processed timber, for specific studied conditions is presented in table 2.

The presented results were obtained in conditions of processing operations having the descriptive statistics of influence factors presented in table 3.

Table 2: Average productivity in processing operations using Woody 60Processor (spruce thinning) by considering delay-free work cycles

Productivity [m^3/hour]	Average delay-free time of processing cycle [seconds]	Average processed volume per work cycle [m^3]	Average number of pieces per work cycle	Average number of cross-cuttings per work cycle
12.56	220	0.769	2.81	10.33

Table 3: Descriptive statistics of processing influence factors

Description	Total tree volume per work cycle [m^3]	Volumes per processed tree [m^3]	Number of trees per work cycle	Number of cross-cuttings per work cycle
Average	0.769	0.328	2.813	10.333
Standard deviation	0.333	0.214	1.347	3.916
Minimum	0.196	0.083	1.000	4.000
Maximum	1.815	1.206	8.000	25.000

4 Conclusions

Several conclusions can be extracted from the above presented study. One of them could refer to PTY location on the forest road, which can affect the time spent in realizing a work cycle, due the fact that supplementary actions may be required in order to realize the timber processing. This fact is reflected by the time consumed for branches removing from the roadway which (along with pilling) took about 25% from the investigated time.

The realization of multiple assortments (more than 2-3) led to increment of the time spent for processing due to supplementary time consumed in sorting and decision making. About 21% from the investigated time was spent in the mentioned actions.

Delays in processing activities occurred due to the work discipline breaking, but they presented a small influence on overall system. Only about 3% from the time represented delays in the current study.

By comparison with current used technologies in timber primary processing on the landing (Romanian case), PTY technologies present important advantages by offering full mechanization of the work by comparison with alternative processing means.

The main limitation in using PTY technologies is represented by insufficient developed transportation infrastructure fact which leads to long yarding distances.

5 References

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