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RESEARCH REGARDING STRUCTURE OF WORKING TIME IN SPRUCE FELLING WITH MECHANICAL CHAINSAW HUSQVARNA 365

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Abstract: *Structure of working time in spruce felling with mechanical chainsaw Husqvarna 365 was analyzed taking into account: the actual time of cutting, engine operating time, mechanical and manual working time. For a relevant analysis of work patterns there were analyzed and calculated some values, respectively: time working to felling 1 m^3 and corresponding percentages of the total time for mechanical and manual working time. It was found that between the diameter of breast height of the tree and analyzed times, correlations can be established, expressed by linear, logarithmic and polynomial regression equations, whose coefficients of determination (R^2 > 0.77) confirm the significant and very significant relationship between analyzed parameters.*

Key words: *trees, felling, time structure, chainsaw Husqvarna.*

1. Introduction

A great variety of mechanical chainsaw machinery currently in operation for wood cutting is strongly necessary to establish, for tree felling operation, specific norms for each type of chainsaw, in accordance with working conditions.

This need is justified, first by requiring agents to respect the maximal period of exploitation of cut area, to determine the number of workers and equipment needed to comply with this term. Basic parameter in determining the time needed for raw wood assortment made with mechanical saws is time norm, i.e. time taken for the specific operations: felling, debranching and crosscutting [1], [2]. Normative time is also the parameter by which there is calculated the amount of labor operations performed the amounts with that workers will be paid for performed work. This time norm must include specific components of effective work time from felling operating activities and specific components of unproductive work time, differentiated according to the working conditions characteristics.

In this paper the authors sought to determine the structure of working time, in spruce felling operation with mechanical chainsaw Husqvarna 365.

2. Study Sites

The research was conducted during the growing season, in tree cutting area, in the mountainous area, in which thinning and clear cutting were applied, in pure stands

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of spruce. Cutting area was located on the Vâlsan valley at altitudes between 1,150 and 1,600 m, on slopes with an average declination of 300. Trees stand age ranged from 40 to 120 years. Trees felled had the following dimensions: diameter at breast height between 20 and 68 cm, height 18 to 33 m and volumes between 0.243 and 4.858 m^3. The average distance between mark trees was 9.62 m.

3. Methodology

Time measurement was done separately for each of the 500 trees felled. The structure of working time adopted was one proposed by Rouă et al. (1976), namely: base time, time for maintenance of auxiliary equipment, time for preparation and end of work. In each of the components of working time there were included phases of felling operation as follows:

- for basic time: selection of direction of felling, notch cutting, back cut, tree felling and removal workers, returning workers, levelling stump, ridge trunk cutting, stump peeling;
- auxiliary time: displace to the marked tree, workplace preparation;
- auxiliary time for preparation of mechanical chainsaw: chain preparation (sharp, stretch), gasoline supply;
- time for preparation of work start and end of work: daily maintenance of equipment, fuel mixture preparation.

In the research conducted was adopted the following classification of time work was adopted: effective cutting time, mechanical time activity (cutting time and engine running time), time for manual activity, total working time for felling a tree, total work time during a shift.

For each tree were measured dendrometric characteristics: diameter at breast height and height.

For research we used mechanical chain saws Husqvarna 365, with: 65.1 cm^3 cylinder capacity, power output of 3.4 kW and blade length of 42 cm.

The working team for trees felling consisted of two workers: a mechanical chainsaw operator and a manual worker.

4. Results

Time consumption for tree felling depends on the area of cutting, respectively stump diameter.

The structure of the actual work time in felling is given in Table 1 and the total working time in Table 2. For established work time structure the features effective measured for each marked tree were diameter at breast height and stump diameter. First, was analyzed the correlation between these two dendrometric features. The result was a correlation expressed by a linear regression, highly significant (R^2 = 0.92), expressed by the formula (1):

$$d_c = 1.2139 \cdot d, \qquad (1)$$

where: d_c - stump diameter; d - diameter at breast height.

Based on this correlation structure analysis of patterns of work will be further taking into account the diameter at breast height of trees felled.

Based on results from research performed for each of the felled trees there were established: the effective time of cutting, time of running the engine; manual working time, total time of felling, unitary time for felling.

Correlations between the values of these types of time and diameter at breast height of felled trees are shown in the graphs in Figures 1, 2, 3 and 4.

As shown by the data presented in these figures there are significant correlations between the analyzed parameters, such as: between effective cutting time and diameter at breast height correlation is expressed by

Structure of effective cutting time for felling operation Table 1

Time consumption for felling sub-operation:									
depl*	**plm***	**add***	**et***	**etpot***	**rmc***	**nc***	**tct***	**cc***	**Total**
20.424 [s]	6.972 [s]	7.715 [s]	35.597 [s]	20.387 [s]	4.441 [s]	5.274 [s]	15.460 [s]	67.700 [s]	183.971 [s]
12 [%]	4 [%]	4 [%]	19 [%]	11 [%]	2 [%]	3 [%]	8 [%]	37 [%]	100 [%]

* *depl - displace to the marked tree; plm - workplace preparation; add - selection of direction of felling; et - notch cutting; et pot - back cut; rmc - tree falling and removal workers; nc - leveling stump; tct - ridge trunk cutting; cc - stump peeling*

Structure of total time of work for felling operation Table 2

Effective cutting time	**Engine running time**	**Non working time of engine**	**Manual working time**	**Total time for felling a tree**	**Total activity time in a working shift**
76.718 [s]	95.846 [s]	19.128 [s]	88.124 [s]	183.971 [s]	333.900 [s]
42 [%]	52 [%]	10 [%]	48 [%]	100 [%]	55 [%]

a linear regression (R^2 = 0.88), between the engine running time and diameter at breast height correlation is expressed by a linear regression (R^2 = 0.87), between manual working time and diameter at breast height correlation is expressed by a second degree polynomial regression (R^2 = 0.89), between total time of felling and diameter at breast height correlation is expressed by a second degree polynomial regression (R^2 = 0.89).

Time of felling a single tree was expressed by unitary time, i.e. the necessary time for felling a tree with 1 m^3 volume. For this there was established a correlation between

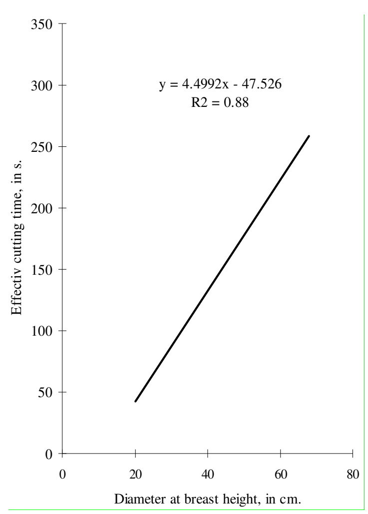

Fig. 1. *Correlation between effective cutting time and the diameter at breast height*

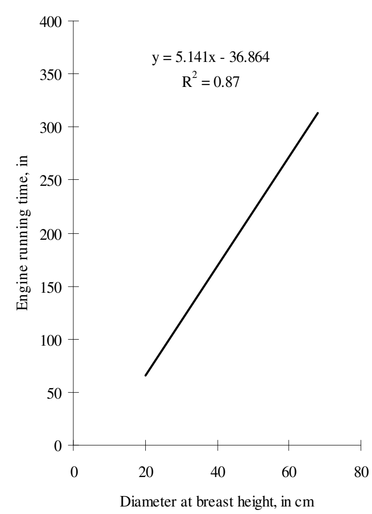

Fig. 2. *Correlation between engine running time and the diameter at breast height*

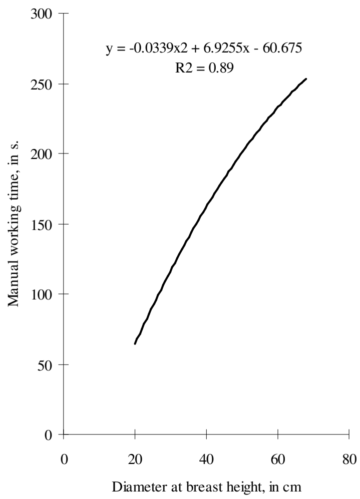

Fig. 3. *Correlation between manual working time and the diameter at breast height*

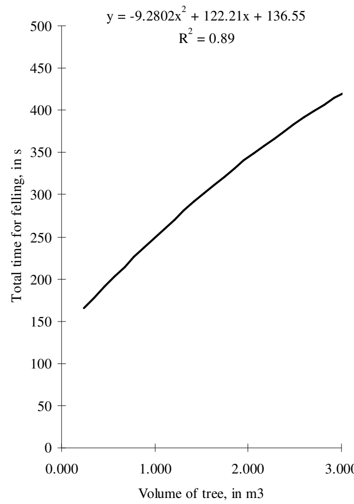

Fig. 4. *Correlation between total time for felling and the diameter at breast height*

volume and time for felling 1 m^3 and the diameter at breast height for each category of diameters (Figure 5).

The volume for each tree was computed by Equation (2) proposed by Giurgiu, Decei and Drăghiciu (2004), respectively:

$$\log v = -4.18161 + 2.08131 \cdot \log d - 0.11819 \cdot \log^2 d + 0.70119 \cdot \log h + 0.148181 \cdot \log^2 h \ , \tag{2}$$

where: v - tree volume, m^3; d - diameter at breast height, cm; h - tree height, m.

The correlation between unitary time for felling and tree diameter at breast height is shown in Figure 5, which shows that the correlation is expressed by a second degree polynomial regression with a coefficient of determination R^2 = 0.77. For a suggestive expression pattern of the work time structure there were analyzed correlations between the percentage of mechanical working time and diameter at breast height and the percentage of manual working time and diameter at breast height. From this analysis it appears that in the first case, the correlation between the two parameters is expressed as a highly significant logarithmic regression with a coefficient of determination R^2 = 0.97. In the second case the value

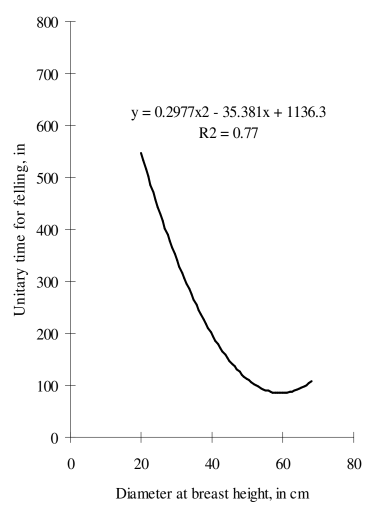

Fig. 5. *Correlation between unitary time for felling and the diameter at breast height*

of the coefficient of determination ($R^2 = 0.18$) corresponded to the situation in which the correlation was expressed by a linear regression (Figure 6). From the analysis of manual working time result that this is not correlated with the diameter at breast height.

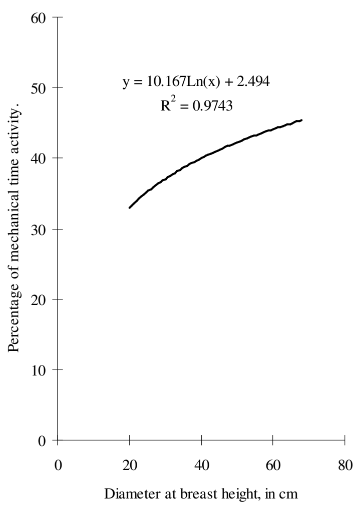

Fig. 6. *Correlation between percentage of mechanical time activity for felling and the diameter at breast height*

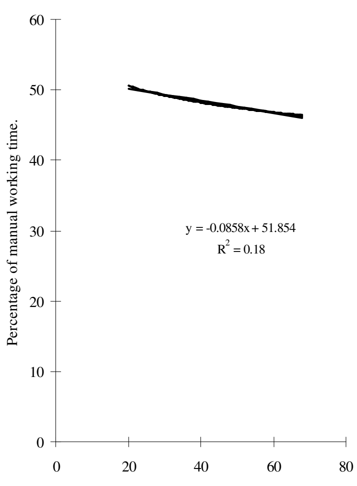

Fig. 7. *Correlation between percentage of manual working time and the diameter at breast height*

Analyzing the correlation between manual working time, without the travel time to marked tree, and diameter at breast height resulted (Figure 7) that between these two parameters there is a highly significant correlation ($R^2 = 0.94$), expressed by a linear regression.

5. Conclusions

Analysis of structure of work time at felling of spruce with mechanical chainsaw Husqvarna 365 shows that between its components (the effective time of cutting, engine operating time, manual working time, total felling time) and diameter at breast height there is a very significant correlation ($R^2 > 0.87$). Also the significant correlation ($R^2 = 0.77$) was established between unitary volume and diameter at breast height. Analyzing the percentage time including in the time structure of work, results in significant correlations between the percentage of working time, manual working time and diameter at breast height ($R^2 > 0.94$).

Research has revealed that between components of working time for felling trees and diameter at breast height there are significant correlations enabling recommendation to establish a norm of time for the felling, separated by species and for each type of mechanical chainsaw. In this way there will be ensured better conditions for planning activities in the process of wood exploitation, thereby contributing, in fact, to the increase in the quality of activity and its beneficial effects. Also by establishing structures of work time on types of mechanical chainsaw and for each forestry species may be a good way to increase the favorable effect of wood exploitation activity, and for a more correct payment of forestry workers.

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