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ESTIMATING CHAINSAW OPERATING COSTS BASED ON FUEL, LUBRICANTS AND SPARE PARTS

Răzvan POPOVICI [1]

Abstract: *Evaluating the energy and material consumptions for chainsaws in felling operations is of great importance for practice because chainsaws are used on a large scale in timber harvesting. This study was carried out for a 5 month period in order to determine the consumptions, production and operating costs for a Husqvarna H55 chainsaw which was used in thinning operations. The measurements revealed the following consumption rates: 0.428 l/m^3 for gasoline, 0.177 l/m^3 for lubricating oil, 0.015 l/m^3 for mixture oil, 0.01 pieces/m^3 for chains and 0.02 pieces/m^3 for auxiliary tools – files. The results also indicated an operating cost (excluding investment return and labour cost) of 5.71 RON/m^3. The results may be used for the supply and cash flow organization under similar work conditions.*

Key words: *chainsaw, consumption, fuel, lubricants, spare parts, cost, thinning.*

1. Introduction

Timber harvesting, as a production process, is performed in order to extract the necessary wood for industries or for direct consumption [17], [19]. If compared with the alternative felling equipments, chainsaws represent ones of the most used means [8], [17] for felling operations, due to some advantages referring, mainly, to reduced operating costs [19]. The advantages reside, mainly, in reduced requirements of fuel and spare parts [18] as well as in a reasonable initial investment and a fair serviceability life. On the other hand, the chainsaws are less safe for operators because they produce noxae and vibrations [22], [24], [26] and trees which are felled may affect the operator's safety [17]. In order to minimize the risks in operating them, special protection devices and facilities are to be used, and forest workers have to be aware of their usage importance [24]. Still, the chainsaws represent the only technical means for tree felling in some specific conditions such as increased slope terrains [2] and they will continue to represent an important component of the modern forest management [14] despite the fact that they are competed by mechanized equipment [11]. This may be one of the many reasons for which their use was quite extensively studied, especially in what concerns the time consumption, productivity and costs [1-2], [6-7], [8-10], [11-16], [20], [23], [25], [27].

[1] Department of Forest Engineering, Forest Management and Terrestrial Measurements, *Transilvania* University of Braşov.

In Romania, by considering the currently used technologies for logging operations [21], there results that the chainsaws are still the most used means for tree felling. This is generally true even in the context in which, in Romania there are used these days, to some extent, new timber harvesting technologies [4].

However, studies for determining the fuel consumption, lubricants consumption, and the serviceability of different parts may be welcomed since the overall involved costs depend in a great extent on the mentioned aspects [7], [18]. Also, other conditions such as process structure, used chainsaw and the output dimensions may affect significantly the mentioned consumptions [18]. Knowing these aspects may serve for future optimization of the processes [5] or even for the software development [3] or updating.

By considering the above mentioned needs for improvement, the present study was performed in order to determine the fuel and lubricants consumption as well as the serviceability of different parts used either as subassemblies of the chainsaw or as auxiliary tools.

2. Material and Methods

Two felling areas were considered for this study purpose. Their main characteristics are presented in table 1.

During harvesting operations, the chainsaws were used for tree felling and processing. Final assortments were obtained at landing by crosscutting which was realized using the same chainsaw. Both felling areas were the subject of thinning operations. All the consumptions determinations refer to a Husqvarna H55 chainsaw.

For the mentioned chainsaw, there were recorded, on a daily basis, the fuel consumption, lubricants consumption and different needed spare parts for replacement, including the auxiliary tools and devices. However, the production was not recorded for each day, but for the entire time spent in harvesting operations.

Table 1

Felling areas characteristics

Specifications	**58%-1**	**58%-2**
Area [ha]	10.0	7.4
Average slope [%]	57	57
Dominant species	Birch	Birch
Average volume per extracted tree [m^3]	0.110	0.070
Extraction intensity [%]	21	14
Average naturally pruned height [m]	3.0	2.9
Average distance between extracted trees [m]	6.0	5.0
Average breast diameter of the extracted tree [cm]	18.0	15.0
Average height of the extracted tree [m]	9.9	10.7
No. of men in felling and landing processing crew	2	2

Data regarding the fuel, lubricants and spare parts consumption was centralized, for each chainsaw in MS Excel sheets. The resulted databases represented the raw data inputs for further processing which was realized using the same software tool.

In order to extract consumptions rates for fuel, lubricants and other parts, the raw data provided by the primary MS sheets was statistically analyzed.

Rates for the above mentioned consumption categories, were calculated by considering the final output (commercial volumes of wood) and the recorded consumptions, by dividing the latter by the former.

The recordings regarding the fuel, lubricants and sub-assemblies, as well as those referring to the achieved volumes of commercial assortments, were realized by

considering the entire period needed for harvesting operations in the two studied felling areas. This way, the field studies were performed between 12th October 2012 and 16th March 2013.

3. Results and Discussion

3.1. Wood Essences and Commercial Assortments

Wood essence may affect the involved consumption in case of the chainsaws use. For this purpose, and by using the raw data, there was obtained the distribution of the commercial volume on wood essence categories. Beech and hornbeam quantities were grouped together whereas birch was considered separately. Figure 1 shows the participation in terms of quantities and percents for the two mentioned categories.

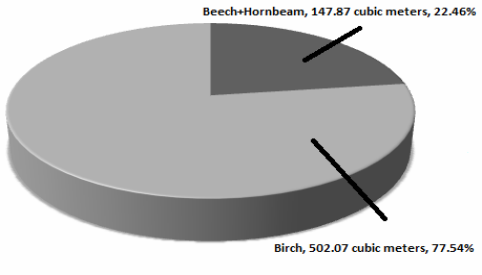

Fig. 1. *Wood essences categories in terms of quantities and percentages*

Preliminary data regarding the extracted quantity of timber on felling areas was provided by the documentation performed for each felling area apart, regarding the amount of timber to be harvested. As in the studied felling areas there were applied thinning operations, the obtained commercial assortments were fuel-wood and round-wood for boards manufacturing. The obtained assortments involved different processing elements. For example, for fuel-wood the deliverable assortments involved their crosscutting at lengths of about 1 meter (differences up to ± 20 cm were observed in the field) whereas in the case of round-wood the assortments were delivered at 2-3 meters in length. The distribution of the delivered assortments in terms of quantities and percentages is provided in figure 2.

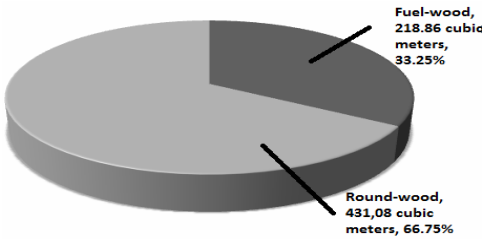

Fig. 2. *Wood assortments in terms of quantities and percentages*

3.2. Gasoline Consumption

During harvesting operations a total of 282.0 l of gasoline were used. The mentioned quantity was used for all the operations which involved the use of chainsaw. Field recorded data yielded a quantity of 658.31 m^3 of commercial wood. By dividing the quantity of used gasoline to the obtained volume of commercial wood, there resulted a specific consumption of 0.428 l/m^3. There must be mentioned the fact that the obtained wood assortments involved an increased amount of motor-manual labour during the wood processing operations in order to obtain assortments having lengths between 1 and 3 meters. Correspondingly, the gasoline cost for the production of one cubic meter was of 2.57 RON/m^3 (in conditions in which the average price for gasoline was of 6 RON/l during the harvesting operations).

3.3. Consumption of Mixture Oil

For the production of the fuel mixture there was used, during the field operations, a ratio of 1 l of oil to 33 l of gasoline, as specified by the chainsaw producer. The

used quantity of mixture oil was of 9.85 l, resulting a specific consumption of 0.015 l/m^3 and a cost of approximately 0.45 RON/m^3 (an average price of 30 RON/l during the harvesting operations).

3.4. Consumption of Lubricating Oil

The total amount of lubricating oils was quantified during field operations. There resulted a total consumption of 116.5 l. By dividing this quantity by the obtained volume of commercial wood, a specific consumption of 0.177 l/m^3 was obtained. In terms of costs, this meant an amount of 0.89 RON/m^3 (an average of 5 RON/l during harvesting operations).

3.5. Replacement of chains

During harvesting operations, a number of 6 chains were replaced. At an average price of 53.75 RON/piece there was obtained a cost of 0.49 RON/m^3. Also, office calculus yielded a consumption ratio of 0.01 chain pieces/m^3.

3.6. Other Required and Used Spare Parts

In addition to the above presented, other pieces and/or parts failed during service and needed to be replaced during harvesting and landing operations: one support for the exhaust muffler, one plug, one hose, one lever, one pinion, one saw blade, one oil pump etc. All these accounted for a total cost of 762 RON, resulting this way an additional cost of 1.19 RON/m^3.

3.7. Consumption of Auxiliary Tools and Materials

As auxiliary tools and materials there were used during harvesting operations only chainsaw files (15 pieces) resulting a consumption of approximately 0.02 pieces/m^3 of final assortments. If transposed in costs, and by considering an average price of 5.27 RON/piece, there resulted an additional cost of 0.12 RON/m^3.

3.8. Data Overview

Table 2 presents a centralizer regarding the consumptions and costs for the specific conditions from the studied felling areas.

Table 1

Centralizer for Consumptions and Costs

Specifications	**Cons.**	**Cost [RON/m^3]**
Gasoline [l/m^3]	0.428	2.570
Lubricating oil [l/m^3]	0.177	0.890
Mixture oil [l/m^3]	0.015	0.450
Chains [pcs/m^3]	0.010	0.490
Other parts [pcs/m^3]	-	1.190
Auxiliary materials (files) [pcs/m^3]	0.020	0.120
TOTAL	**-**	**5.71**

As it results from table 2, the operating cost was of 5.71 RON/m^3. However, this cost excludes the eventual financial costs regarding the initial investment of the chainsaw which was covered before the realization of the study.

4. Conclusions

Chainsaws are ones of the most utilized means for felling and landing processing operations, a fact which, if corroborated with technological progress, should be considered in order to update the existent knowledge dealing with work measurement.

According to the results presented in this study, the following consumption rates may be mentioned: 0.428 l/m^3 for gasoline, 0.177 l/m^3 for lubricating oil, 0.015 l/m^3 for mixture oil, 0.01 pieces/m^3 for chains, and 0.02 pieces/m^3 for files.

If the average prices are taken into consideration, for each cost-calculation element, and by excluding the investment return of chainsaws (real study case) and the operator's wages, there resulted, in the given conditions, an operating cost of 5.71 RON/m^3 for a Husqvarna H55 chainsaw.

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