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ORDER STATISTICS OF EFFECTIVE ACTIVE TIME OF LIMBING AND CONVERSION AT USE CHAINSAW

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Abstract. The time within which, accordingly to its application, machine works, and an object of work and working groups are under load, is the effective active time. The purpose of the research was the order statistics of effective active time of limbing and conversion at chainsaw use. The removed trees were moderately diversified from the point of view of effective active time of limbing and conversion. The negative skewness coefficient qualified the distribution of effective active time of limbing and conversion as weak left-side asymmetry in variant 1 (the limbing included cutting of trees' crowns and all branches). The positive skewness coefficient qualified the distribution of effective active time of limbing and conversion as weak right-side asymmetry in variant 2 (limbing included cutting of tree crowns and only thicker branches).

Key words: limbing, conversion, effective active time, pine stands

INTRODUCTION

The effective active time of limbing and conversion at chainsaw, use is the time, within which accordingly to its application chainsaw works (cuts off the tree from stump, branches and tree crowns, divides trunk, etc.) and working groups are under load [Glazar and Bocianowski 2012, Glazar and Wojtkowiak 2009, Laurow 1999].

Wood cutting at chainsaw use is usually realised at carburetor throttle maximum opening, and the grave rotational speed of engine is achieved thanks to relevant feed force induction [Więsik and Wójcik 2007].

Such work is observed, among others. During tree branches and crowns cutting, at the time of limbing procedure, and wood assortment cutting, within the process of conversion.

The work of chainsaw on running light, within which chain is immobilized and engine speed constant, is the work without load [Wojtkowiak et al. 2007 a, b]. During limbing and conversion operations, walking of the operator from one tree to another, with the chainsaw engine on, is described as chainsaw work without load and according to BN-76/9195-01 standard is subsidiary time.

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The effective active time of realised technology or its part (operation) is the category time, within which the machine and operator are actively involved in either technology or operation. A detailed analysis of the effective active time can be helpful at planning of technology realisation [Glazar and Bocianowski 2012].

The purpose of the research was the order statistics of effective active time of limbing and conversion at chainsaw use.

MATERIAL AND METHODS

The research was carried out in a 41-year old pine stand, in which first thinning was executed. The experimental sites were situated in the Kliniska Forest Division. The basic features of the test areas are presented in Table 1.

Table 1. Basic features of research areas
Tabela 1. Podstawowe cechy taksacyjne powierzchni wybranych do badań

Number of area Numer powierzchni	1	2
Regional State Forest Directorates RDLP	Szczecin	Szczecin
Forest Division Nadleśnictwo	Kliniska	Kliniska
Forest District Leśnictwo	Załom	Załom
Compartment Oddział	450c	449c
Dimension of area, ha Wielkość powierzchni, ha	0.45	0.47
Forest site Siedlisko	Bśw	Bśw
Share of species Udział gatunków	So	So
Age Wiek	41	41
Stand quality class Bonitacja	II	II
Average d.b.h., cm Przeciętna pierśnica, cm	10	10
Average height, m Przeciętna wysokość, m	12	12
Stand density index Zadrzewienie	0.9	0.9
Stand quality Jakość	22	23

The limbing and conversion operations were carried out with chainsaw Husqvarna 346XP. On surface 1, limbing consisted of tree crowns and all branches cutting (limbing was led on a level with the wood surface or leaving 3 cm long knags). On surface 2, the limbing included tree crowns and only thicker branches cutting off. The limbing was carried out applying pendulous metho, on both surfaces. Two technological variants were used in the conversion operation. The first variant included rods conversion (length of about 4.50 m) meant for chipping (M_1, S_{3a}). The second variant included rolls (length 2.40 m – S_{2a} assortment) and rods conversion (M_1) also meant for chipping, and was used for thick trees. The first variant was applied in both surfaces, the second only on surface 1.

The effective active time of limbing and conversion, i.e. the time of the chainsaw guide bar contact with the tree branch to be cut first, to dismissing the bar after completion of limbing and conversion (most frequently it was the tree crown that was cut off), was analysed. The limbing and conversion effective active time measurement was led with the aid of stop watch, and the accuracy was 0.01 second.

The structure analysis of the researched statistical population of cut trees, from the point of view of statistic feature – effective active time of limbing and conversion, was performed on the basis of order statistics.

Distribution was characterised by location, spread and shape.

The following descriptive parameters were used to statistical analysis:

– median (Me), mode interval, quartiles (Q_1, Q_3)
– quartile deviation (Q), coefficient of variation (V_Q)
– skewness coefficient (A_s).

RESULTS OF INVESTIGATIONS

The basis quantities characterszing the researched statistical population of cut trees, from the point of view of statistic feature – effective active time of limbing and conversion are presented in Table 2.

From the investigation surfaces (1-2) 572 and 669 trees were removed, respectively. In total, 14 m^3 wood for chipping (M_1, S_{3a}) and 3 m^3 assortment S_{2a}, from surface 1, and 15 m^3 wood for chipping, from surface 2, were harvested.

The removed tree in first thinning was a statistical unit. The effective active time of limbing and conversion of one tree was most frequently from 10.5 s to 20.49 s on surface 1, and from 0.5 s to 10.49 s on surface 2. In variant 1 (limbing included cutting of tree crowns and all branches), half the population had values of limbing and conversion time lower than 5.57 s (in variant 2 in which the limbing included tree crowns and only thicker branches cutting, less than 21.76 s). According to the statistical analysis of quartiles, 25% of the data was lower (or equal) than 16.04 s and 75% of the data was lower (or equal) than 27.12 s, on surface 1 (3.18 s and 8.75 s on surface 2, respectively).

The average deviation from the middle half of the distribution was 5.54 s, on surface 1, and 2.785 s, on surface 2. It gives bases to ascertain, that the cut trees were moderately statistically diversified from the point of view of effective active time of limbing and conversion, on both surfaces.

Table 2. Basic quantities characterising researched statistical populations – cut trees, from the point of view of statistic feature – effective active time of limbing and conversion
Tabela 2. Podstawowe wielkości charakteryzujące badane zbiorowości statystyczne ze względu na wybraną cechę – efektywny czas okrzesywania i przerzynki

Number of area Numer powierzchni	1	2
Number of removed trees, pcs Liczba usuniętych drzew, szt.	572	669
Total effective active time of limbing and conversion for all trees, s Suma efektywnego czasu okrzesywania i przerzynki wszystkich drzew, s	12 859.53	4 520.04
Minimal effective active time of limbing and conversion, s Minimalny efektywny czas okrzesywania i przerzynki, s	6.87	0.64
Average effective active time of limbing and conversion, s Średni efektywny czas okrzesywania i przerzynki, s	22.448	6.756
Maximal effective active time of limbing and conversion, s Maksymalny efektywny czas okrzesywania i przerzynki, s	125.16	38.47
Mode interval, s Przedział dominanty, s	10.5-20.49	0.5-10.49
Median, s Mediana, s	21.76	5.57
Quartile Q_1, s Kwartyl Q_1, s	16.04	3.18
Quartile Q_3, s Kwartyl Q_3, s	27.12	8.75
Quartile deviation Q, s Odchylenie ćwiartkowe Q, s	5.540	2.785
Coefficient of variation V_Q, % Współczynnik zmienności V_Q, %	25.46	50.00
Skewnees coefficient A_s Współczynnik asymetrii A_s	–0.01	0.10

The negative skewness coefficient qualifies the distribution of effective active time of limbing and conversion as weak left-side asymmetry in variant 1 (limbing included tree crowns and all branches cutting; Fig. 1). The positive skewness coefficient qualifies the distribution of effective active time of limbing and conversion as weak right-side asymmetry in variant 2 (limbing included tree crowns and only thicker branches cutting; Fig. 2).

Distribution of effective active time of limbing and conversion in both technological variants is presented in Figure 3.

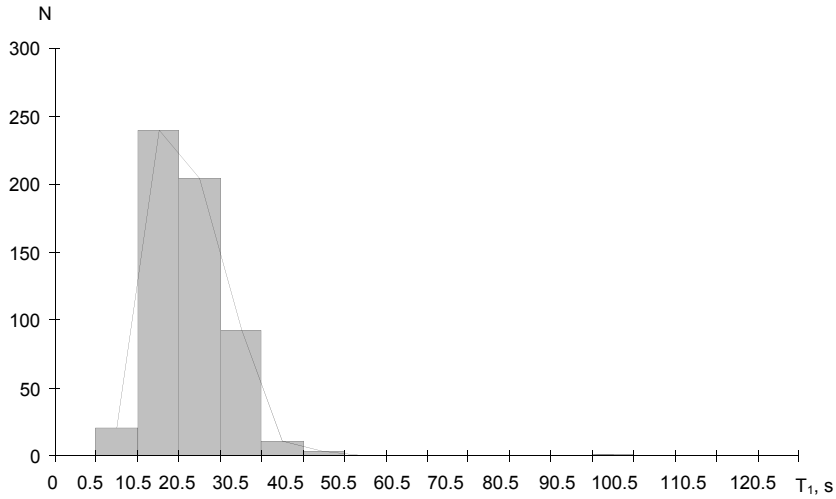

Fig. 1. Distribution of effective active time of trees limbing and conversion on surface 1: T_1 – effective active time of limbing and conversion, N – number of trees

Rys. 1. Rozkład efektywnego czasu okrzesywania i przerzynki w wariancie z okrzesywaniem w stopniu co najmniej dobrym (pow. nr 1): T_1 – efektywny czas okrzesywania i przerzynki, N – liczba drzew

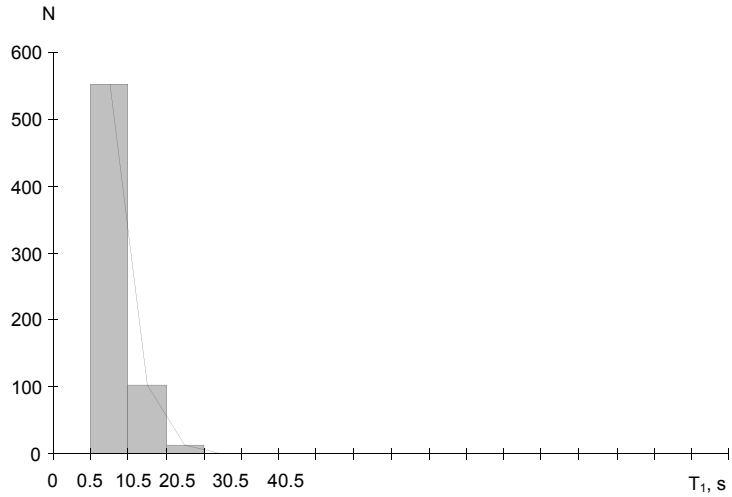

Fig. 2. Distribution of effective active time of trees limbing and conversion on surface 2: T_1 – effective active time of limbing and conversion, N – number of trees

Rys. 2. Rozkład efektywnego czasu okrzesywania i przerzynki w wariancie z okrzesywaniem zgrubnym (pow. nr 2): T_1 – efektywny czas okrzesywania i przerzynki, N – liczba drzew

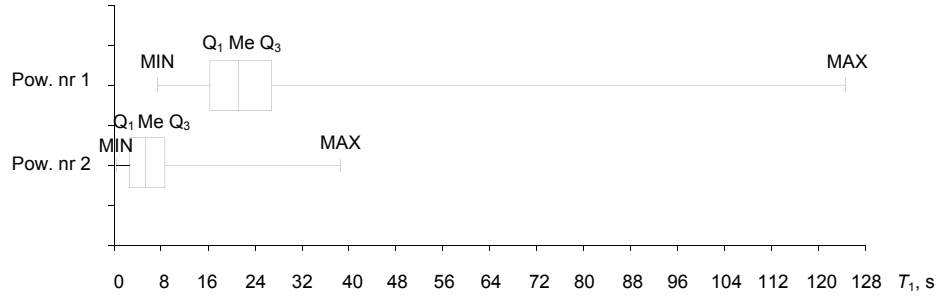

Fig. 3. Distribution of effective active time of limbing and conversion in both technological variants: Q_1, Q_3 – quartiles, Me – median, MIN – minimal effective active time of limbing and conversion, MAX – maximal effective active time of limbing and conversion

Rys. 3. Rozkład efektywnego czasu okrzesywania i przerzynki dla obu wariantów: Q_1, Q_3 – kwartyle, Me – mediana, MIN – minimalny efektywny czas okrzesywania i przerzynki, MAX – maksymalny efektywny czas okrzesywania i przerzynki

DISCUSSION

In first thinnings of pine stands mainly slash wood, in the form of pole lumber, and medium size wood, in the form of stake wood, most frequently 2.40 m long, as well as perches wood (S3) is harvested.

The round timber for trade undergoes obligatory limbing. There are four classes of limbing: very good, good, sufficient and rough, for wood meant for chipping [Pilarki... 2002].

A chainsaw is the basic device used in first thinnings, in activities such as tree limbing and conversion [Chmielewski and Porter 2012, Glazar and Bocianowski 2012, Maciak 2010].

The limbing and conversion can be led in two technological variants. In variant 1, all operations (felling, limbing and conversion) are executed on each tree by turns. In variant 2, only one operation (felling, limbing or conversion) is executed on each tree. In Polish reality variant 1 is executed most often [Wójcik 2007]. The first variant was executed on the research surfaces, too.

The time of limbing and conversion depends also on technical parameters of the harvested trees, on volume, number of removed branches and number of wood pieces cutting, within the conversion [Wójcik 2007].

From 41-year old pine stand with 0.92 ha dimension of area, 1241 trees were removed. That corresponds to the cutting intensity of Jodłowski's [2000] investigation surfaces in pine stands – number of removed trees – 1120 pcs/ha, average volume of one removed tree was about 0.03 m^3, age – 29-35 years old.

The effective active time of limbing and conversion, within which chainsaw working groups were under load, was analysed. Neither the time of the operator walking from tree to tree with a working chainsaw engine, nor the time of the operator's adjusting position before starting of limbing and conversion, were analysed.

The time of limbing and conversion by Wójcik [2007] was analysed. According to Wójcik [2007] the effective active time of limbing of one tree, about 5.9-61.0 cm diameter at breast height, was from 33 s to 437 s, and the effective active time of conversion from 7 s to 240 s. The number of removed branches influences the limbing time and the number of wood assortment cutting the conversion time Wójcik [2007].

The effective active time of limbing and conversion by Więsik [2001] was analysed, too. In a 60-year old pine stand, within the executed thinning, the effective active time of limbing and conversion of trees of about 15.8 cm average diameter at breast height and 0.18 m^3 average volume, was over 90 s and over 180 s, respectively.

The knowledge of time of wood harvesting particular operations enables to show the most dangerous operations from the point of view of different stressors (vibration, noise, exhaust gas, physical and mental load) [Wójcik 2007].

On surface 2 (rough limbing), the average effective active time of limbing and conversion was 70% lower than the time on surface 2.

In total, effective active time of limbing and conversion of all removed trees was 3.57 h (about 76% of operational active time), on surface 1 and 1.25 h (about 56% of operational active time), on surface 2.

The joint time, within which the operator works with the chainsaw in shift time, has a great importance from the point of view of ergonomics [Stempski 2007]. The proper planning of technologies should always take into consideration the proper configuration of breaks in total working shift time [Sowa et al. 2007].

CONCLUSIONS

1. The removed trees were moderately diversified from the point of view of effective active time of limbing and conversion.
2. The negative skewness coefficient qualifies the distribution of effective active time of limbing and conversion as weak left-side asymmetry in variant 1 (limbing included tree crowns and all branches cutting).
3. The positive skewness coefficient qualifies the distribution of effective active time of limbing and conversion as weak right-sides asymmetry in variant 2 (limbing included tree crowns and only thicker branches cutting).

REFERENCES

BN-76/9195-01. Maszyny rolnicze. Podział czasu pracy. Symbole i określenia [Agricultural machines. Active time distribution. Symbols and determinations]. [in Polish].

Chmielewski S., Porter B., 2012. Waloryzacja wybranych metod pozyskiwania i zrywki drewna w sosnowych drzewostanach przedrębnych [Valorization of the selected methods of harvesting and skidding of the pine stands in pre-final cut]. Techn. Roln. Ogrodn. Leśn. 3 [in Polish].

Glazar K., Bocianowski J., 2012. Classical and order statistics of effective active time of felling at use chainsaw. Acta Sci. Pol., Silv. Colendar. Rat. Ind. Lignar 11 (2), 5-13.

Glazar K., Wojtkowiak R., 2009. Koszty pracy maszyn leśnych [Costs of forest machines work]. Przem. Inst. Masz. Roln. Poznań [in Polish].
Jodłowski K., 2000. Technologia i technika pozyskiwania drewna we wczesnych trzebieżach w drzewostanach sosnowych [Technology and technicques of wood harvesting in early cutting in pine stands]. In: Stan i perspektywy badań z zakresu użytkowania lasu. IBL Warszawa, 97-108 [in Polish].
Laurow Z., 1999. Pozyskiwanie drewna [Wood harvesting]. Wyd. SGGW Warszawa [in Polish].
Maciak A., 2010. Pomiar zmienności siły posuwu podczas przerzynki drewna sosnowego [The measurement of variability of feed force during cross cutting of pine wood]. Techn. Roln. Ogrod. Leśn. 5 [in Polish].
Pilarki przenośne – budowa i eksploatacja [Alienable chain saw – structure and exploitation]. 2002. Ed. J. Więsik. Fund. Rozwój SGGW Warszawa [in Polish].
Sowa J.M., Kulak D., Leszczyński K., Szewczyk G., 2007. Związki struktury dnia roboczego z fizjologiczną gotowością do pracy na stanowisku operatora pilarki spalinowej [Relationships between the workday structure and the physiological readiness for work of the power chain saw operator]. Wyd. PTPN Poznań, 205-215 [in Polish].
Stempski W., 2007. Efektywność pozyskiwania drewna kłodowanego w użytkowaniu rębnym drzewostanów sosnowych [Effectiveness of the cut-to-length wood harvesting system in final fellings in pine stands]. Wyd. PTPN Poznań, 223-231 [in Polish].
Więsik J., 2001. O użytkowaniu pilarek spalinowych [About use power chain saws]. In: Mechanizacja prac leśnych w warunkach leśnictwa wielofunkcyjnego w Polsce. Międzynarodowe Targi Bydgoskie SAWO. Bydgoszcz, 57-66 [in Polish].
Więsik J., Wójcik K., 2007. Zużycie paliwa przez pilarkę spalinową przy pozyskiwaniu drewna [Fuel consumption of a power chain saw during timber harvesting]. In: Użytkowanie maszyn rolniczych i leśnych. Pr. Kom. Nauk Roln. Leśn. Weter. PAU 9, 265-274 [in Polish].
Wojtkowiak R., Piszcz B., Rzecznik Z., Kowszyński T., Glazar K., 2007 a. Drgania mechaniczne emitowane przez pilarkę łańcuchową z rezonansowym układem wydechowym [Vibrations of chain saw with the resonance exhaust system]. Wyd. PTPN Poznań, 249-256 [in Polish].
Wojtkowiak R., Piszcz B., Rzecznik Z., Kowszyński T., Glazar K., 2007 b. Hałas emitowany przez pilarkę łańcuchową z rezonansowym układem wydechowym [Noise emited by a chain saw with the resonanse exhaust system]. Wyd. PTPN Poznań, 257-264 [in Polish].
Wójcik K., 2007. Wpływ parametrów drzewa na czas wykonywania operacji obróbczych przy pozyskiwaniu drewna pilarką spalinową [The effect of timber parameters on work time of timber harvesting operations using a power chain saw]. In: Użytkowanie maszyn rolniczych i leśnych. Pr. Kom. Nauk Roln. Leśn. Weter. PAU 9, 275-283 [in Polish].

ANALIZA EFEKTYWNEGO CZASU OKRZESYWANIA I PRZERZYNKI DRZEW Z UŻYCIEM PILARKI SPALINOWEJ NA PODSTAWIE WYBRANYCH POZYCYJNYCH PARAMETRÓW OPISOWYCH

Streszczenie. Czas efektywny to czas, podczas którego urządzenie obrabia bądź przetwarza zgodnie z przeznaczeniem przedmiot pracy, a zespoły robocze urządzenia znajdują się pod obciążeniem. Celem badań była analiza efektywnego czasu okrzesywania i przerzynki drzew z użyciem pilarki spalinowej, dwóch wariantów technologicznych, na podstawie wybranych pozycyjnych parametrów opisowych. Drzewa usuwane w prowadzonym zabiegu trzebieży wczesnej były umiarkowanie zróżnicowane ze względu na efektywny czas okrzesywania i przerzynki. W wariancie z okrzesywaniem prowadzonym w stopniu

co najmniej dobrym, uzyskany ujemny współczynnik asymetrii kwalifikuje rozkład efektywnego czasu okrzesywania i przerzynki jako rozkład o słabej asymetrii lewostronnej. Z kolei w wariancie z okrzesywaniem zgrubnym, dodatni współczynnik asymetrii kwalifikuje rozkład efektywnego czasu okrzesywania i przerzynki jako rozkład o słabej asymetrii prawostronnej.

Słowa kluczowe: okrzesywanie, przerzynka, czas efektywny, drzewostany sosnowe

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